

MINISTRY OF ENERGY AND COAL INDUSTRY OF UKRAINE

State Enterprise National Nuclear Energy Generating Company «Energoatom»
SE «Zaporizhzhya NPP»

APPROVED

**DEVELOPMENT OF THE MATERIALS FOR ASSESSMENT OF
ENVIRONMENTAL IMPACT
IN THE COURSE OF ZAPORIZHZHYA NPP OPERATION
NON-TECHNICAL SUMMARY**

2015

CONTENTS

Page

GENERAL PROVISIONS	4
1 BASIS FOR NON-TECHNICAL SUMMARY DEVELOPMENT	5
1.1 Objective of Non-technical Summary development	5
1.2 Sources of information used during development of scientific and engineering works	6
1.3 Main ecologic content materials with regard to ZNPP power units operation	7
2 GENERAL CHARACTERISTICS OF SE ZNPP	10
2.1 General information	10
2.2 Technological characteristics	12
2.3 Data on the manufactured products. Data on raw materials, ground, water, electric power and other used resources	14
2.4 Brief characteristics of the sources and types of SE ZNPP activity impact to environment	18
2.4.1 Radiation impact	18
2.4.2 Chemical impact	20
2.4.3 Physical impact	21
2.5 List of ecological, sanitary and epidemiological, town construction and fire protection activity limitations	21
2.5.1 Ecological, sanitary and epidemiological limitations	21
2.6 Spent fuel management procedure	24
2.7. Waste management procedure	25
3 POTENTIAL ACCIDENTS DURING OPERATION OF ZNPP POWER UNITS	30
3.1 List of potential accidents during operation of ZNPP power units	30
3.2 SE ZNPP Emergency Plan	31
3.3 SE ZNPP emergency preparedness and response system	32
3.4 Mitigation of the accident consequences	33
4 CHARACTERISTIC OF THE ENVIRONMENT AND ENVIRONMENTAL IMPACT ASSESSMENT OF SE ZNPP PRODUCTION ACTIVITY	34
5 ASSESSMENT OF ENVIRONMENTAL IMPACT IN TRANSBOUNDARY CONTEXT	44
6 COMPREHENSIVE MEASURES ENSURING NORMATIVE STATE OF ENVIRONMENT AND ITS SAFETY	46
6.1 Resource-saving measures	46
6.2 Protective measures	47
6.3 Restorative and compensatory measures	48
6.4 Security measures	49
7 LIST AND CHARACTERISTICS OF RESIDUAL IMPACT	52
CONCLUSIONS	53

LIST OF ACRONYMS

ALARA	- As Low As Reasonably Achievable
CCSUP	- Complex (consolidated) Safety Update Program
DSFS	- Dry Spent Fuel Storage
EC	- European Commission
EPRS	- Emergency Preparedness and Response System
EPS	- Environmental Protection Service
ERS	- Emergency Response System
GWL	- Groundwater Level
IAEA	- International Atomic Energy Agency
MAC	- Maximum Allowable Concentration
MCP	- Main Coolant Pump
MCR	- Main Control Room
MMT	- Means of Measurement Technique
NPP	- Nuclear Power Plant
RC	- Reactor Compartment
RMS	- Radiation Monitoring System
SE NNEGC	- State Enterprise National Nuclear Energy Generating
«Energoatom»	Company «Energoatom»
SE ZNPP	- Separated Entity «Zaporizhzhya NPP»
SG	- Steam Generator
SNRIU	- State Nuclear and Radiation Inspectorate of Ukraine
TPP	- Thermal Power Plant
WVER	- Water-to-Water Energy Reactor
ZTPP	- Zaporizhzhya Thermal Power Plant

GENERAL PROVISIONS

Non-technical summary is an overview document developed based on the report «Development of the materials for assessment of environmental impact in the course of Zaporizhzhya NPP operation».

The objective of the development of the Environmental Impact Assessment materials is the assessment of the environmental impact in the course of ZNPP units operation by the results of implementation of nature protection activities, the results of long-term monitoring of the environmental compartments and comparison of the environmental conditions around NPP before and in the course of power units operation.

The result of the environmental impact assessment is the ecological justification of the acceptability of the economic activity of ZNPP facilities in operation and determination of the safety environmental conditions in the course of ZNPP further activity.

1 BASIS FOR NON-TECHNICAL SUMMARY DEVELOPMENT

1.1 Objective of Non-technical Summary development

Zaporizhzhya NPP is the largest power facility of Ukraine, the economic stability; safety and independence of country rely on its operation.

The operation of the power units of Ukrainian NPPs is determined by the «Energy strategy for Ukraine for the period until the year 2030».

Development of the non-technical summary is being performed for the involvement of the citizens and their associations for participation in the review of the issues of ZNPP environmental impacts, protection of the projects associated with placement, construction, extension of operation period and decommissioning of the nuclear facilities, and formation of the regional population's objective attitude to the operation of ZNPP and overall nuclear power industry.

The registration of the public interests shall be accomplished in accordance with the requirements of the Ukrainian Law «About territory planning» and other legislation documents.

The right to a free access to the information on the environmental conditions, participation of citizens and their association in public hearing, participation of the community in the process of ecologic expertise shall be guaranteed by the Constitution of Ukraine (Articles: 34, 36, 39, 40 and 50) and a number of Ukrainian Laws:

- «About information»;
- «About printed mass media matters»;
- «About the procedure of decision-taking concerning the placement, designing, construction of nuclear installations and facilities provided for management of the radioactive wastes that are of national importance»;
- «About radioactive waste management»;
- «About environmental protection»;
- «About municipal self-management»;
- «About unions of citizens»;
- «About property»;
- «About entrepreneurship»;
- «About address of citizens»;
- «About state secret» and the Law of Ukraine «About ratification of the Convention about access to information, participation of the community in the process of decision-taking and access to the justice for environmental issues» dated 06/07/1999 No. 832-14.

In accordance with the «Procedure for informing NPP staff, local authorities, mass media and public about the violations in the operation of ZNPP facilities», the public information shall be accomplished by the staff of the Information Center which is a Department of Public and Mass Media Relations Administration. The information Center is located at: Energodar, Str. Kurchatova, 38a, Tel.: 5-63-49, Tel./Fax: 6-21-81, 6-21-27.

The following structural units are in the composition of Public and Mass Media Relations Administration: Information Center, TV and Video Information Laboratory, Broadcasting Editorial Office, «Energy» Newspaper Editorial Office, general plant staff.

In accordance with the «Statement about Administration of work with public and mass media», the mission of Public and Mass Media Relations Administration is the implementation of the declared information policy of the management of ZNPP, SE NNEGC «Energoatom», formation of public opinion concerning the nuclear power safety and the need of its development in Ukraine, formation of a positive image of ZNPP, SE NNEGC «Energoatom» and the overall industry, support and enhancement of the corporate culture by mass media, establishment of two-way communication with public and mass media for revealing common interests and achievement of mutual understanding based on truth, knowledge and total awareness.

Main points to be provided to public refer to the fact that currently and during subsequent work the operation of power units is not related to new construction, conversion, changes to the lines and processes, replacement of main equipment, etc. It is envisaged to replace certain additional mechanisms and their details with exhausted life time and/or those that are obsolete by new ones (their analogues or more updated), that provide increase of operational reliability and safety levels of these mechanisms as well as the overall plant. Therefore, any of the factors of environmental impact is not changed, all parameters of environmental impact shall be at the same level, and with the improvement of a number of engineering elements of production and due to the implementation of planned additional environmental protection activities their decrease shall be probably expected.

Distribution of the subjects of the structural elements of Public and Mass Media Relations Administration Public and Mass Media Relations Administration (radio, TV, newspaper, Information Center) by the direction in 2014 is provided in Figure 1.1.



Figure 1.1 – Subjects of the publications of Mass Media Relations Administration Public in 2014

1.2 Sources of information used during development of scientific and engineering works

This Report has been developed based on the materials of Assessment of Zaporizhzhya NPP environmental impact prepared by State Enterprise «Ukrainian Scientific and Research and Design Institute of Industrial Technology» (Ukraine, Dnepropetrovsk region, Zhovti Vody, Str. Petrovskogo, 37) to the request of SE NNEGC «Energoatom» in person of Separated Entity «Zaporizhzhya NPP» (Ukraine, Zaporizhzhya region, Energodar, Str. Promyslova, 133, 71504).

The environmental impact assessment has considered:

- general characteristics of the existing state of the territory of ZNPP location area;
- review and evaluation of the impacts of economic activity of the facilities in operation on the natural, social and man-made environment and determination of the areas of this activity impact;
- determination of the scopes and levels of economic activity environmental impact in normal and emergency conditions;
- prediction of the changes to environmental conditions in accordance with the list of impacts during further activities of the facilities in normal conditions and emergency cases;

- determination of the complex of measures for prevention or limitation of the performed activity environmental impacts, those measures that are required for meeting environmental protection requirements/ other legislative and normative documents for environmental safety;
- determination of the level of ecologic risk and performed activity hazard;
- determination of the acceptability of expected residual impacts on the environment which can occur in the process of further economic activity upon implementation of all provided measures.

In the course of development of Environmental Impact Assessment the information received from the Customer has been used.

Main input data has been as follows:

- Plant Radiation Safety Reports (the data of ZNPP radiation safety and radiation protection conditions);
- Reports of Non-Radiation Factors Impact Assessment (the results of ZNPP environmental non-radiation impact monitoring);
- Periodical Safety Reassessment Reports. Complex Safety Analysis;
- Periodical Safety Reassessment Reports. Factor No.14. Environmental impact of NPP operation ;
- Complex (consolidated) Safety Update Program for the power units of Ukrainian NPPs: Ecological assessment;
- National Report of Ukraine «Stress-Tests Results»;
- Report on ZNPP Units Ecologic Audit;
- Ecological Assessment Report. SE NNEGC «Energoatom» Main Report, etc.;
- ZNPP Emergency Plan OO.4C.PN.01-13;
- SE NNEGC «Energoatom» Complex Radwaste Management Program for 2012-2016. PN-D.0.18.174-12;
- Inventory and justifying materials for the releases with substances for 14 ZNPP sites;
- Report by the results of additional investigations of seismic and seismotectonic conditions of Zaporizhzhya NPP sites;
- Reports of the Integrated Control System operation with regard to ecologic control by ZNPP management for 2013-2014;
- Licenses, resolutions and certificates for ZNPP activity types;
- Methods regulations, process and instruction maps developed at ZNPP;
- Plans of environmental protection measures and ecologic programs;
- Schedules and system of monitoring reviews of environmental conditions and monitoring results;
- Environmental protection reports.

1.3. Main ecologic content materials with regard to ZNPP power units operation

In 2010 the Complex (consolidated) Safety Update Program for the power units of Ukrainian NPPs was developed. This Program considers all the recommendation provided in the Final Common Report of EC, IAEA and Ukraine (IAEA Report of 02/2010).

The Complex (consolidated) Safety Update Program contains more than 800 safety update measures of 9 groups of measures (general measures, reactor core and fuel management, component integrity, development of technological systems, development of plant process computer system, electric power supply, containment and building units, internal safety, accident analysis and management).

The Complex (consolidated) Safety Update Program is approved by Donetsk Scientific Center (Scientific Ecological and Expert Assessment No.1-26.12.2011 of 26/12/2011). The consultations with public were conducted from 10 to 18 of May 2011 by means of organization and conduction of meetings with population in Kyiv and satellite towns of Energodar, Kuznetsovsk, Neteshin, and Yuzhnoukrainsk with coordination by regional state and local administrations of satellite towns.

According to the requirements of normative documents of Ukraine and IAEA the «ZNPP Program of Radiation Safety Level Update and Radiation Protection Ensuring» OO.RB.OO.pm.24.A" was developed at ZNPP. The program was agreed by the First Deputy Head of the State Nuclear Regulation Inspection of Ukraine – Main State Inspector for Nuclear and Radiation Safety of Ukraine dated 19/04/2012 No.15/42/2479 and the Ministry of Health of Ukraine dated 20/01/2012 No.7.03-58/5227.

The Program objective is solving problems of radiation safety ensuring for the staff, population and environment, namely:

- observance of dose limits and rules of safe power unit operation;
- increase of radiation protection efficiency according to optimization principle, with consideration of international and native up-to-date practice of radiation protection activity and ALARA principle implementation;
- decrease of radiation impact on the staff, population and environment due to optimization of personnel radiation protection optimization, reduction of the amount of releases and discharges to environment, safety culture update;
- activity implementation according to the requirements of normative documents, standards, etc.

The program provides for implementation of the complex of ZNPP radiation safety level update measures by different activity directions:

- upgrading of measurement methods and measures;
- measures (including compensatory measures) for elimination of violations of the radiation safety normative documents valid in Ukraine;
- the level of staff training in radiation protection and radiation safety.

In accordance with the laws and norms of Ukraine as well as respective IAEA documents, IAEA shall periodically (no less than one in 10 years) reassess safety for each power unit.

The reassessment objective is to determine:

- the correspondence of power unit safety level to valid norms and rules of nuclear and radiation safety as well as design and operational documents; safety analysis reports and other documents specified in the license for operation;
- adequacy of existing conditions that provide support for adequate safety level of a power unit until next periodic reassessment or until operation termination;
- the list and dates for implementing the measures for power unit safety update required for elimination or decrease of the deficiencies revealed in the course of safety investigation.

Based on the complex analysis of safety factors the generalizing conclusion about the possibility of power unit service life extension for the declared period. The safety reassessment report shall be agreed by the State Nuclear Regulatory Inspectorate of Ukraine.

After «Fukushima-1» accident (Japan), on the 24 of March the EC Committee declared the need for safety reassessment of European NPPs based on the comprehensive risk assessment. The European Nuclear Safety Regulators Group (ENSREG) and European Commission agreed the technical requirements for implementation of respective stress-tests. Their task was the detailed analysis of extreme natural phenomena and their combinations that could make an impact on the NPP safety functions and cause severe accidents.

The State Nuclear Regulatory Inspectorate of Ukraine in cooperation with the State Emergency Inspectorate developed the Plan of the activities for extraordinary safety state assessment and further safety update of the power units of Ukrainian NPPs with consideration of «Fukushima NPP» events. In accordance with the Plan the target extraordinary assessment of the safety state of all operating power units of Ukraine was performed.

The results of stress-tests performance are reflected in the National Report of Ukraine developed by the State Nuclear Regulatory Inspectorate. The sections that refer to ZNPP are included to Part 1 «Operating NPPs of Ukraine» of this report.

The last document «Report on periodic safety reassessment of ZNPP Units 1, 2» was developed in 2015» (Energorisk Ltd.).

The conclusions of the reassessment performed contain the results of prediction of the technical state of Units 1, 2 critical elements as well as the proposition to establish a new period for ZNPP Units 1, 2 operation, 30 years since the date of design period termination (No.1 – by 23/12/2045, No.2 – by 19/02/2046) under the conditions of implementation of safety update measures in accordance with the Schedule of the Complex (consolidated) Safety Update Program, timely extension of the reactor vessel service life, Containment System of isolating safety system, ASD-5600 of backup diesel electrical plant, primary circuit equipment.

One of the measures for observance of the legislative and normative requirements to environmental protection in the process of economic activity is the ecological audit of this activity. Main legislative and organizational techniques for ecologic audit are determined by the Law of Ukraine «About ecologic audit».

In 2015 the ZNPP ecologic audit was performed with participation of the experts and auditors of the SE «State Scientific and Research Center for Control and Emergency Response Systems», Scientific and Research Enterprise «Sotsium», National Research Authority «Ukrainian Scientific and Research Institute of Ecological Problems», State Authority «Hydrobiology Institute of National Science Academy of Ukraine».

The «Report on Zaporizhzhya NPP ecological audit» was approved by the Director of State Scientific and Research Center for Control and Emergency Response Systems.

The ecological audit covered:

- analysis of ZNPP real conditions;
- determination of main characteristics of ZNPP activity impact on the environment;
- determination of requirements and additional limitations of environmental protection legislation to ZNPP activities;
- determination of the correspondence of ZNPP activity to the requirements of legislation of environmental protection;
- evaluation of efficiency, completeness and validity of the measures implemented at ZNPP for environmental protection;
- evaluation of efficiency and adequacy of environmental activities;
- evaluation of efficiency of the environmental management;
- analysis of the data on the system of ecologic fees and payments;
- evaluation of statistic reports of environmental protection for its correspondence to real ecologic indicators;
- evaluation of the completeness of ZNPP ecologic characteristics reflection in existing documents.

By the results of ZNPP ecologic audit the following factors have been specified:

- during 30-years operational period any negative impact on the environmental conditions of the region has been revealed;

- the measures taken for environmental protection on the facility can be recognized as sufficiently complete and justified;
- the system of the environmental protection control implemented at ZNPP is in efficient operation and meets ISO 14001:2004 standard;
- ZNPP activity meets in full the requirements of valid environmental protection legislation of Ukraine.

2 GENERAL CHARACTERISTICS OF SE ZNPP

2.1 General information

SE ZNPP is a separated entity (structural unit) of the State Enterprise National Nuclear Energy Generating Company «Energoatom» (SE NNEGC Energoatom). SE NNEGC Energoatom implements its activities in compliance with its statute and is subordinated to the Ministry of Energy and Coal Industry of Ukraine which forms the state policy in the industry. In compliance with the Law of Ukraine «About nuclear power use and radiation safety», SE NNEGC «Energoatom» was assigned functions of the Operating Company responsible for safety of all Ukrainian nuclear power plants by the Order of Cabinet of Ministers of Ukraine No. 1268 dated 17/10/1996.

Territorially SE Zaporizhzhya NPP is located in Zaporizhzhya region, 400 km to the south-east of Kyiv. The district center, Kamyanka-Dniprovska, is at the distance of 12 km to the south-east from NPP; the regional center – Zaporizhzhya city – is at 55 km to the north-east from NPP, the plant satellite town Energodar is at 5 km to the east.

The diagram of SE ZNPP site location and 30 km radiation control area are shown in the Figure 2.1.

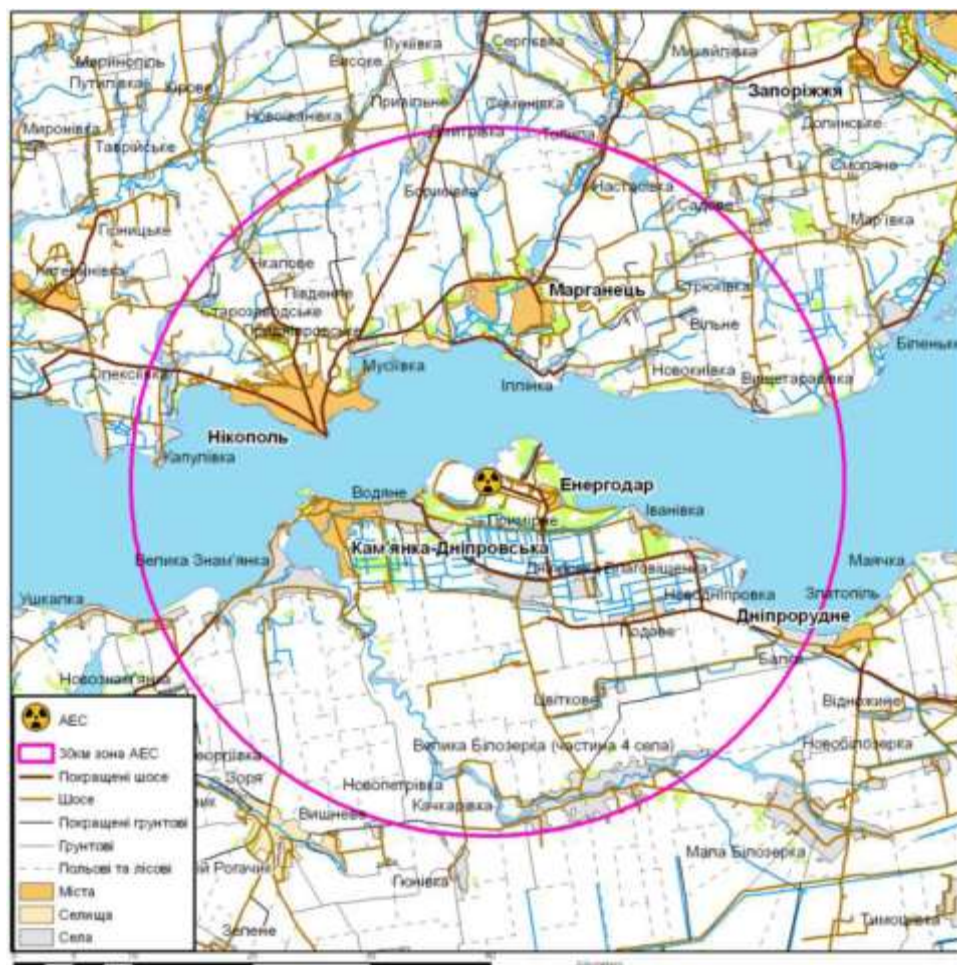


Figure 2.1 – The diagram of SE ZNPP site location and 30 km radiation control area

In accordance with physical and geographical demarcation of Ukraine, ZNPP site is located in the steppe zone of the north-steppe Left-bank-Dnipro-Azov province. The natural landscapes are presented by sand complexes, sand dunes with single vegetation, shallow aqua complexes. Directly within the area of industrial site the natural landscapes have not been saved. Aqua landscapes are presented by the bank part of the Kakhovka water reservoir.

The industrial site of SE ZNPP is located at the Azov plain in Kamyanka-Dniprovsk area of Zaporizhzhya region on the left bank of the Kakhovka water reservoir. The industrial site is located within the industrial zone of Energodar, at the distance of 2.5 km from Zaporizhzhya Thermal Plant in operation. The distance from the bank line of the water reservoir (from the water area of cargo berth) to the nearest main building of ZNPP (Unit 6) is 0.23 km, the distance to Unit 1 is 0.92 km.

The technical and economic justification of SE ZNPP construction was made by Kharkiv Division of «Atomenergoprojekt» Institute, it was agreed by State Plan Body of USSR and State Build Body of USSR (the letter of August 16, 1977 No.BI 1570 (22-953) and approved by the Ministry of Energy of USSR, Order of 02/09/1977 No.36-IIIC.

NPP construction was conducted on the basis of Technical Project of Series 1 (400 MWt) and Series 2 (2000 MWt) approved by Orders of USSR Council of Ministers No. 200r dated 04.02.1980 and No. IIII-21084 dated 01.10.1988. The General Designer was Open-Stock Joint Company «Kharkiv Scientific-Research and Design-Constructional Institute «Energoprojekt».

The construction was conducted by the General Contractor – SE ZNPP Construction Management – «Soyuzatomenergostroy» subordinate to the Ministry of Energy of USSR.

In the period of 1984 – 1987, first four units were commissioned into operation. Unit 5 was commissioned in 1989, and Unit 6 - in 1995.

SE ZNPP of SE NNEGC «Energoatom» consists of 14 industrial sites, namely:

- industrial site No.1 - SE ZNPP;
- industrial site No.2 – SE ZNPP Transport Division;
- industrial site No.3 – Plant of Reinforced Concrete Products and Construction Materials;
- industrial site No.4 – Warehouses of Fuel and Oil-Firing Materials of SE ZNPP;
- industrial site No.5 - SE ZNPP Section of Construction Materials;
- industrial site No.6 - SE ZNPP Section of Mechanized Operations;
- industrial site No.7 - SE ZNPP Printing Section of Computer Service);
- industrial site No.8 - SE ZNPP Diesel-Generator of Plant Process Computer Means Section;
- industrial site No.9 – SE ZNPP Charging Plant of Maintenance Department;
- industrial site No.10 - SE ZNPP Maintenance Staff Training Center, Training Center;
- industrial site No.11 - SE ZNPP Section of Maintenance and service for main Heat Supply Systems, Heat and Industrial Pipelines Department;
- industrial site No.12 - SE ZNPP Electric Department, substation Rainbow;
- industrial site No.13 - SE ZNPP Chemical Shop, sludge collector No.2 (first series);
- industrial site No.14 – pump station for water supply to SE ZNPP cooling towers.

The facility that are at the stage of construction finalization and commissioning:

- industrial site No.1 (Radwaste Reprocessing Complex (commissioning -2017));
- industrial site No.1 (Gas Building (commissioning - 2016));
- additional water pumping facility (commissioning - 2020);
- open switchyard (750 kV) (commissioning – 2015 - 2016).

2.2 Technological characteristics

Zaporizhzhya NPP is the largest power facility in Ukraine, the economic stability, safety and independence of country depend on its operation.

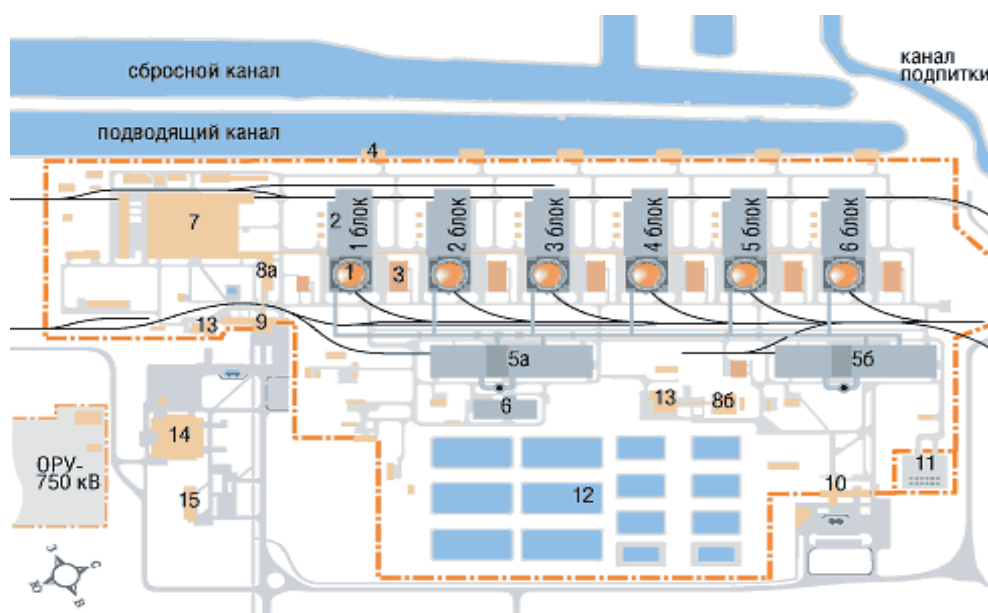
Annually the plant generates 40-42 milliard kW·year of electric power, that is the fifth part of the overall annual production of electricity in country and the half of its generation by the Ukrainian NPPs. ZNPP is also a source of the heat for industrial site, the town of Energodar and other consumers. Total heat power is 1200 Gkal/hour (200 Gkal/hour per each power unit).

Currently six power units of 6000 MW total electric power are in operation at ZNPP.

Each of the six SE ZNPP power units includes the following equipment:

- WWER-1000 (B-320) reactor;
- K-1000-60/1500 – 2 type turbine;
- TBB-1000-4 Y3 electrical generator.

General diagram (layout) of ZNPP main industrial site is given in Figure 2.2.



- | | |
|--|--|
| 1. reactor vessel | 9. administration buildings and Check Gate 1 |
| 2. turbine building | 10. Check Gate 2 |
| 3. diesel generator | 11. dry spent fuel storage facility |
| 4. unit pumping plant | 12. spray ponds |
| 5. radwaste treatment buildings a and b | 13. canteen |
| 6. solid radwaste storage | 14. Full Scope Simulator |
| 7. additional buildings | 15. Training Center |
| 8. laboratory and service structures a and b | |

Figure 2.2 – Layout of Zaporizhzhya NPP main industrial site

WWER-1000 water-to-water nuclear reactor on thermal neutrons serves for production of thermal power (rated heat capacity is 3000 MW). The reactor operation is based on controlled chain nuclear fission reaction of ^{235}U , which is contained in nuclear fuel. Reactor core comprises fuel assemblies located in the hexagonal grid nodes and manufactured from reduced enrichment uranium dioxide, located inside zirconium cladding.

WWER-1000 power unit operates based on two-circuit diagram: primary circuit (radioactive) is a water circuit which takes directly heat from the reactor; secondary circuit (non-radioactive) is a steam circuit that receives heat from the primary circuit and utilizes it in the turbine generator.

Primary (main) circulation circuit consists of:

reactor;

four circulation loops, each of them contains:

- steam generator (SG);
- main coolant pump (MCP);
- reactor coolant pipes (RCP), connecting the equipment of loops with reactor.

Energy from nuclear fuel fission in the reactor core is removed by the coolant that is pumped through it by main coolant pumps. From the reactor, via reactor coolant pipes, «hot» coolant is fed to the SG, where heat is conveyed to the secondary circuit water; and the coolant is returned to the reactor by main circulation pump. Dry saturated steam is produced on the secondary side of the steam generators, is fed to the turbines of the turbine generator equipped with 1000 MW capacity electrical generator.

As moderator and coolant, WWER-100 reactor utilizes boron water under a pressure of 160 kgf/cm². Total flow rate of the coolant through the reactor is 84800m³/year. Water temperature at the reactor inlet during operation on nominal power equals 290°C, at the output it equals 320°C.

Same as with any steam-turbine power plant, thermal and dynamic limitations allow for transformation of only one part of the heat power in the form of steam to electrical power. Drop of low-potential energy of steam that left the turbines is done via the water cooling system, that is performed via the water cooling system operating by reversal procedure. The cooling system consists of cooling pond and sprinkler ponds. The reverse cooling operates in the mode of blowdown (replacement) of water masses causing the reverse water discharge to Kakhovka water reservoir.

Main structures of the power units at Zaporizhzhya NPP are oriented to the cooling pond. There are pumping plants and service water supply pipelines between the cooling pond and main buildings of power units.

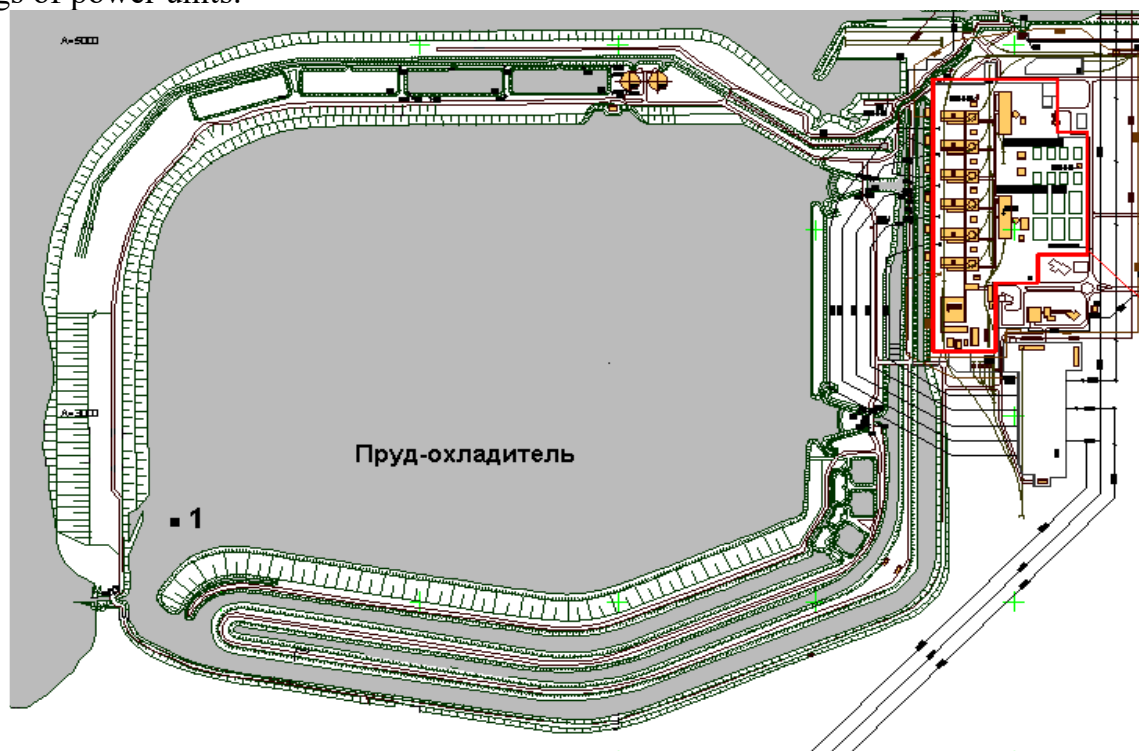


Figure 2.3 – Layout of SE ZNPP cooling pond

Zaporizhzhya NPP is connected to the unified power grid of Ukraine by means of three 750 kV transmission lines and one 330 kV transmission line.

Main industrial operation is provided by ZNPP auxiliary departments^ Maintenance Department, Instrumentation and Control department, Electrical department, Oil and Gas Facility, Heat and Industrial Pipelines Department, Transport Department, Building Administration, etc.

The emergency electrical mode for SE ZNPP facilities is provided by 7 diesel electrical plants (emergency diesel electrical plants).

SE ZNPP development for the nearest future is reflected by local projects which have obtained the positive expert conclusions:

- «Design of SE ZNPP construction facility. Reconstruction of the 750 kV open switchyard for connection of the 750 kV «Zaporizhzhya – Kakhovka», 2013 – a positive expert conclusion of SE «Ukrainian State Building Expertise» dated 31/10/2013 No.00–0052–13/IZ;
- «SE Zaporizhzhya NPP. Establishment of the Radwaste reprocessing Complex. Reconstruction.», 2012. – a positive expert conclusion of SE «Ukrainian State Building Expertise» dated 21/05/2013 No.00–11725–12/PB;
- «SE Zaporizhzhya NPP. Technical and economic justification of the investments in building industry. Additional water pumping plant», 2012 – a positive expert conclusion of SE «Ukrainian State Building Expertise» dated 30/12/2013 No.00–0053–13/IZ;
- «SE Zaporizhzhya NPP. Gas building. Hydrogen-oxygen plant-2. Construction finalization and commissioning of the overall Zaporizhzhya NPP». Industrial construction, 2012;
- «SE Zaporizhzhya NPP. Gas building. Nitrogen-oxygen plant-2. Construction finalization and commissioning of the overall Zaporizhzhya NPP». Industrial construction, 2012.

2.3 Data on the manufactured products. Data on raw materials, ground, water, electric power and other used resources

Annually SE ZNPP generates more than 20 % of total electric power generated in Ukraine and with the amount produced meets the requirements to electric power and normal conditions for vital activity of more than 9 million of individuals.

SE ZNPP is also a heat source at the industrial site and the town of Energodar. Total installed heat power is 1200 Gkal/year (200 Gkal/year per each power unit).

Land resources

NPP territory (including the cooling pond) comprises approximately 1670.2 hectares:

- plant site – 104 hectares;
- sewage disposal plant for plant sewage water treatment – 23 hectares;
- hydraulic structures, together with the cooling pond – 1520 hectares.

Water resources

There are four water supply systems (potable, service, reverse and reusable).

The sources of abstraction of water of potable quality are the artesian wells of the communal enterprise «Communal Property Enterprise» of Energodar Municipal Council. Water flows to the pumping plant of the 3rd elevation of NPP where is distributed by two collectors for the needs of NPP and communal zone facilities.

The water supply designated for multiple water use in the plant process cycles refers to the systems of reverse water supply.

Three systems of reverse water supply are provided per each power unit, as follows:

- cooling system for main equipment (turbogenerators and secondary circuit auxiliary systems);
- cooling system for non-essential consumers (B group);
- cooling system for essential consumers (A group).

Circulation water use via the cooling pond is approximately 300 mln. m³ per year.

Reusable water is the water on the outlet of water treatment plants of the industrial chemical structures located in «contaminated» area of series 1 and series 2, water treatment plants of oil and fuel oil sewage disposal plants, neutralizer tanks, tanks of radiation monitoring, blowdown of spray ponds of A group essential consumers.

Service water supply is provided by discharge and entrance channels of Zaporizhzhya Thermal Plant.

The discharge channel of Zaporizhzhya Thermal Plant provides service water to:

- SE ZNPP service water pumping plant for continuous service water supply to the consumers of industrial site, SE ZNPP industrial and community zone;
- supply water to SE ZNPP cooling pond for making good the loss due to natural evaporation from the water surface of the pond, evaporation and drop removal from spray ponds and cooling towers, partial filtration and for cooling pond blowdown.

Water evaporation for cooling purpose is approximately 70 mln. m³ per year.

Summary data on SE ZNPP water use for 2014 are given in Table 2.1.

Table 2.1 – Summary data on SE ZNPP water use for 2014

№	Denomination of water type and source	Limit per year thousand m³	Removed, thousand m³	Really used, thousand m³	Removed, thousand m³	Real non-reversed water losses in ZNPP water circulation system, thousand m³
1.	<i>Potable water, in total:</i>	1722.3	943.5	880.8	426.0	454.8
	«Communal Property Enterprise» of Energodar Municipal Council	1719.1	940.6	877.9	425.0	452.9
	Communal Enterprise «Zhilkomservice», Sanitary and Recreational Institution «Youth»	3.2	2.9	2.9	1.0	1.9
2.	<i>Service water, in total:</i>	380 272.9	346 348.9	346 303.2	245 998.4	100 304.8
	Discharge channel of Zaporizhzhya Thermal Plant	380 047.2	346 306.7	346 261.0	245 990.3	100 270.7
	«Communal Property Enterprise» of Energodar Municipal Council	38.2	4.7	4.7	-	4.7
	Discharge channel of Zaporizhzhya Thermal Plant	26.8	9.6	9.6	8.1	1.5
	Removal from Dnipro river (Water and Sports Base)	47.3	7.5	7.5	-	7.5
	Removal from internal pond (Water and Sports Base)	18.6	2.8	2.8	-	2.8

№	Denomination of water type and source	Limit per year thousand m ³	Removed, thousand m ³	Really used, thousand m ³	Removed, thousand m ³	Real non-reversed water losses in ZNPP water circulation system, thousand m ³
	Removal from internal pond (Water and Sports Base)	59.9	9.1	9.1	-	9.1
	Removal from internal pond (After-work sanatorium)	34.9	8.5	8.5	-	8.5
3.	Artesian water, in total:	36.9	6.1	6.1	-	6.1
	Sanitary and Recreational Institution «Youth» (shaft well)	3.29	2.1	2.1	-	2.1
	Artesian well No.89 (Hydro Department)	9.1	0.0	0.0	-	0.0
	Artesian well No.1-T (Water and Sports Base)	9.3	1.4	1.4	-	1.4
	Artesian well No.6-T (Water and Sports Base)	10.0	2.5	2.5	-	2.5
	Artesian well No.3-T (Hydro Department)	8.5	0.1	0.1	-	0.1

Dynamic of SE ZNPP real water consumption for the period of 2009-2014 is given in Figure 2.4 and Figure 2.5.

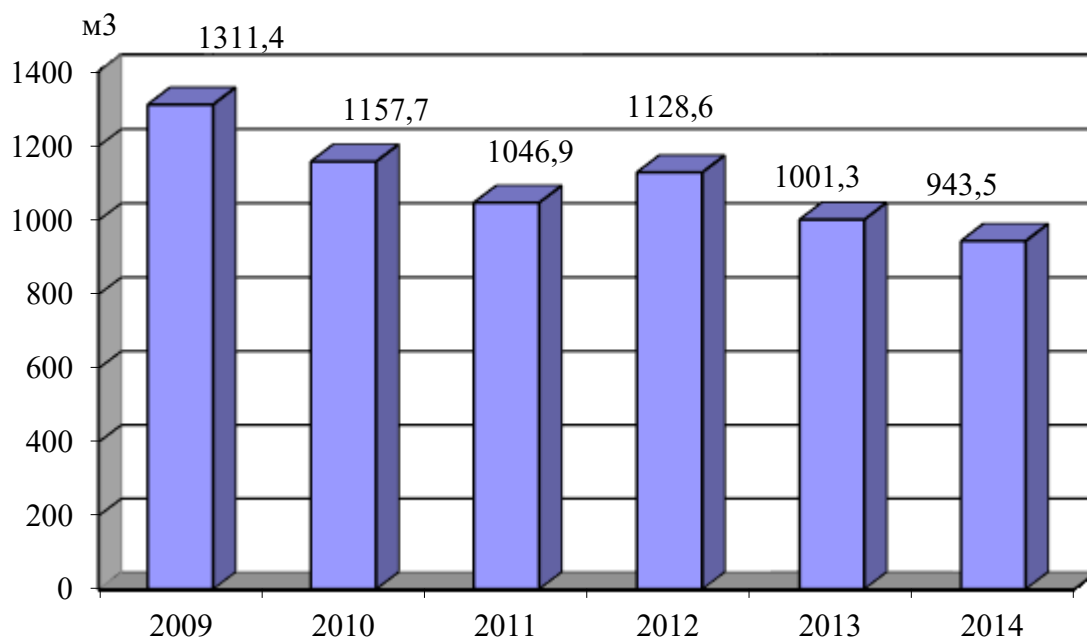


Figure 2.4 – Dynamic of SE ZNPP real potable water consumption for the period of 2009-2014

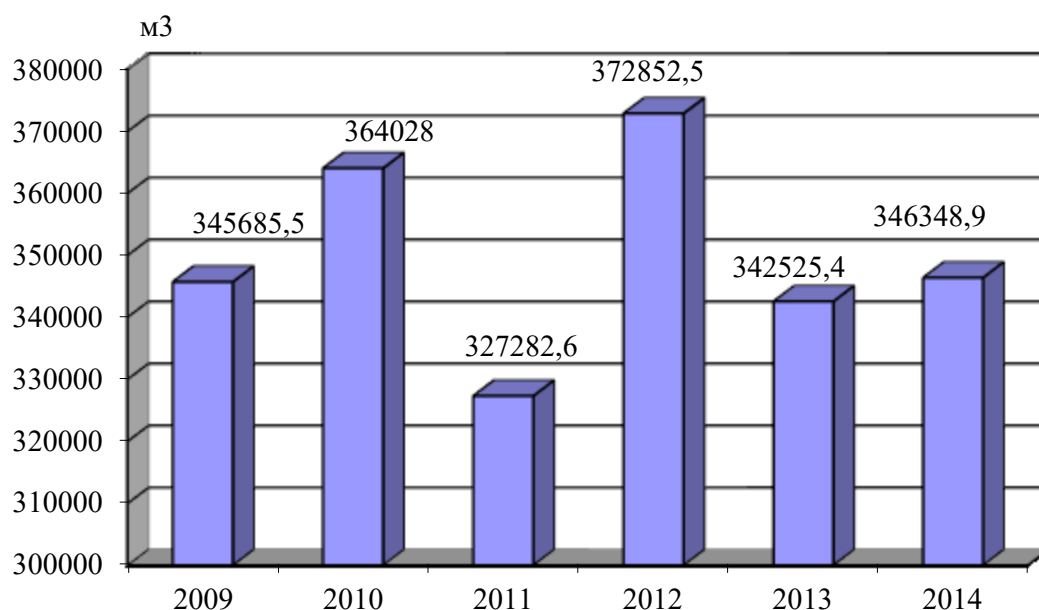


Figure 2.5 – Dynamic of SE ZNPP real service water consumption for the period of 2009-2014

Energy resources

The use of electric power for NPP house loads is 6 % from total production amount.

For emergency power supply and other needs 3000 m³ of diesel fuel are used annually. For ensuring turbogenerator turbine operation and for other needs 4800 m³ of oil are used. Besides, for implementation of economic activities in accordance with bookkeeping, the raw materials, semi-finished products and materials given in Table 2.2 are used.

Table 2.2 – Raw materials, semi-finished products and materials used at the plant

No.	Types of raw and other materials	Annual consumption, (t, m³, pcs.)
1	Water	346485.5 thousand m³
2	Construction lime	335 t
3	Abrasive circles	7 t
5	Filter material – crushed coal	40 t
6	Mixture (sand, lime, broken stones, bricks)	924 t
7	Heat insulating mats	900 m³
8	Abrasive (in bulk)	60 t
9	Activated carbon	14,8 t
10	Porcelain insulators	30 t
11	Construction lime	335 t
	Ferrous sulfate	74 t
	Flocculants	0.3 t
12	Solution (sodium nitrite, ammonia, trilon B, ammonium acetate)	1500 t
13	Ion-exchange resins (anions, cations)	60 t
14	Paraffin, nature paraffin	0.03 t
15	Sealed insulating glass units, chemical glassware	2 t
16	Paper, packing cardboard	115 t
17	Overall	5.328 t
18	Safety shoes	2.344 t
19	Gas masks	0.4697 t
20	Filtering material «Sipron»	0.1 t

No.	Types of raw and other materials	Annual consumption, (t, m ² , pcs.)
21	Silicon organic liquid	0.8 t
22	Film for printer	0.005 t
23	Car tires	16.236 t
24	Steel wire	70 t
25	Gun oil PVK (GOST 19537-83)	70 t
26	Potassium iodide tablets	0.013
27	Rag	4 t
28	Sawdust	0.01 t
29	Hardener AGFA	0.4681
30	Developer AGFA, LSP19	0.444 t
31	Photographic film AGFA	0.1864
32	Rubber gaskets	1 t
33	Car oil filters	0.274 t
34	Sand	0.4 t
35	Oil	80 t
36	Diisopropylamin in metal packs	0.04 t
37	Paints, enamels, lacquers, ink, adhesive substances	32.25 t
38	Silica gel	0.2 t
39	Transformer paper	0.2 t
40	Morpholine and hydrazine-hidrate in metal and plastic packs	33.89 t
41	Accumulator batteries	7 t
42	Chemical reagents	0.4625 t
43	Fluorescent lamps	43400 pc.
44	Thermometers	0.00291 t
45	Normal elements	0.005 t

The resolution documents regulating ZNPP activities for environmental protection shall be timely executed in accordance with the requirements of national normative documents. ZNPP production activities shall be implemented without any environmental protection limitations and penal sanctions.

2.4. Brief characteristics of the sources and types of SE ZNPP activity impact to environment

Based on technological processes of main and auxiliary industries of SE ZNPP, the main types of environmental impact are radiation, chemical and physical impacts. In normal operation conditions of power units the significant impacts (decrease of significance) are physical (thermal), chemical and radiation impacts. The radiation impact becomes dominant in the cases of low probability but principally probable of maximum design or beyond-design accident.

2.4.1 Radiation impact

SE ZNPP radiation impact is possible due to release of radioactive substances formed during the plant production cycle to the environment.

Main sources of radiation impact on SE ZNPP environment are:

- reactor, including reactor internals and active coolant;
- spent fuel and reloading pond;
- spent nuclear fuel;
- primary circuit equipment (circulation pumps, steam generators, pressurizers, valves etc);
- special water treatment systems and their equipment;

- radioactively contaminated pipelines, ventilation system equipment and gas purification system;
- details and mechanisms of the control and protection system (RCPS); measuring instrumentation and radiation monitoring detectors directly connected to measurement of the primary circuit parameters;
- radwaste;
- radioactive sources supplied for technical needs (for flaw detection, calibration and graduation of the devices etc.).

Main types of potential radiation impact are conditioned by:

- gaseous radioactive releases to atmosphere;
- solid radwaste;
- liquid radwaste;
- liquid releases containing radioactive substances.

Gaseous radioactive releases can be generated in the cases of:

- ventilation of primary coolant volatile precipitates occurring as a result of small leaks, controlled and non-controlled leaks;
- evaporation from spent fuel pond, instrument inspection shaft and inspection shaft of protection tubes unit during annual reactor outage as well as equipment maintenance and repair activities;
- release of radioactive substances to atmosphere in course of technological processes of special water treatment plant and liquid and solid radwaste management;
- drop removal and evaporation from spray pond;
- activation in air, in immediate proximity from reactor vessel (insufficient amount of gaseous radioactive particles).

In the course of normal operation the main radiation releases to atmosphere are ventilation tubes of reactor compartment and special building as well as spray ponds.

Radioactive gaseous substances of the releases are distributed into three groups:

- radioactive noble gases;
- aerosols;
- iodine isotopes.

Solid radioactive releases are formed in the process of NPP normal operation, during repair works and emergency situations.

Solid radwaste consist of:

- metal waste formed as a result of reconstruction and repair activities;
- rubber and technical products, plasticates and cable products inappropriate for use;
- waste filters of reactor compartment and special building ventilation systems;
- heat insulation inappropriate for reuse;
- material for wiping, clothes inappropriate for use, waste individual protection equipment, paper;
- construction waste (concrete, plaster, etc.), formed as a result of reconstruction and repair activities;
- primary circuit equipment and the equipment technologically associated with the failed one;
- all assemblies and details removed from reactor core;
- bulky waste (dismantled steam generators).

By the level of specific activity, the solid waste is distributed into three categories:

I – low level activity;

II – medium level activity;

III – high level activity.

Solid radwaste shall be collected at the locations of their generation, sorted based on the activity categories and technological characteristics.

Low active solid radwaste capable to be reprocessed are subject to reprocessing at the pressing and ignition plants. The products of waste reprocessing shall be transported in casks to the reprocessing unit storage for their keeping.

Low active solid radwaste non capable to be reprocessed as well as medium and high active solid waste shall be transported to the storages for temporal storage without reprocessing (solid radwaste system of the radwaste reprocessing building, storages of Special Building-1 and Special Building-2).

Liquid radwaste and liquid discharges containing radioactive substances are formed as a result of the contact of water with fuel elements and operation of special water treatment plants and contamination of reactor compartment oil systems.

Liquid radwaste are mostly composed of:

- non-controlled leaks of primary coolant;
- radiation contaminated oil;
- spent ion-exchange resins of special water treatment plant;
- water formed after decontamination;
- sewage water of decontamination stations and special laundry;
- water from the hydrodischarges of filters;
- evaporator sludge;
- spent filter materials of special water treatment plant;
- sludge of special water treatment plant.

Liquid radwaste are subject to evaporation or treatment on filter materials. The reprocessing products of special water treatment plant (ion-exchange resins in the mixture with different sorbents and dispersed deposition and salt fusion cakes and evaporator sludge) shall be transported to respective storages for their keeping.

Contaminated oil is subject to regeneration or it shall be ignite on the ignition plant.

Radioactive substances are contained in the liquid discharges to surface waters formed in the process of cooling pond lowdown.

In NPP normal operation the localization of basic amount of radioactive products in reactor plant and special water and gas treatment systems.

2.4.2 Chemical impact

SE ZNPP chemical impact on environment can be made by chemical substances contained in industrial releases, discharges and waste.

Releases to atmosphere which contain chemical contaminants are provided by 20 emergency diesel generators, plant transport and auxiliary departments.

Main chemical contaminants are carbonic oxide, nitrogen dioxide, hydrocarbons, sulfuric anhydride, substances in form of suspended solid particles. Besides, the vent releases can contain nonmethane volatile organic compounds, gasoline, acids, hydrazine, etc.

SE ZNPP sewage water include:

- industrial drains: service cooling water from the equipment of special buildings, oil coolers of unit transformers, conditioners of Trainer Center and Administrative Building, nitrogen and oxygen plant, automatic fire extinguishing systems; blowdown waters of chemical water treatment clarifiers; rinsing waters of mechanic filters; regeneration and washing water of ion exchanger filters of chemical water treatment plant, automatic demineralizer, unit demineralizer;
- oily sewage water;
- storm discharges;
- service-utility discharges.

NPP industrial, storm and utility discharges directly to water facilities of common use are not accomplished. Discharges after their treatment on respective plants shall be removed to the cooling pond that is a water facility for SE NPP specific use.

Water exchange in the cooling pond is accomplished due to its blowdown. Continuous blowdown of the cooling pond provides a stable chemical content of NPP return water and on the inlet to Kakhovka water reservoir meets the requirements established for the fishery ponds.

Discharges of the cooling pond return water to Kakhovka water reservoir are accomplished in accordance with the «Resolution for special water use» given by the Department of Ecology and Natural Resources of Zaporizhzhya Regional Administration, under observance of limit allowable discharge of contaminants and Blowdown Regulation.

In the course of SE ZNPP operation the non-radioactive solid waste are formed, and they are capable to cause chemical contamination of the environment. In the process of SE ZNPP industrial activities 59 types of non-radioactive waste of I-IV hazard class are formed.

SE ZNPP waste management is provided in accordance with the requirements of Laws and Sanitary and Hygienic Norms of Ukraine and in accordance with the license AE No.460721 for the operations in the field of hazardous waste management (collection, transportation, disposal, and removal) dated 20/02/2015 No. 46, validity period: until 26/07/2016.

2.4.3 Physical impact

SE ZNPP environmental impact is characterized by:

- thermal impact related to the operation of the cooling systems of NPP process equipment (spray ponds and cooling pond, cooling towers);
- humidity increase due to water evaporation to air from spray ponds, cooling pond and cooling towers;
- impact of electric field of 330/750 kV transmission line;
- noise of equipment in operation.

2.5 List of ecological, sanitary and epidemiological, town construction and fire protection activity limitations

2.5.1 Ecological, sanitary and epidemiological limitations

SE ZNPP operation is regulated by ecological, sanitary and epidemiological limitations conditioned by the normative documents for environmental safety.

The limit values for following main criteria are established at the plant:

- dimensions of sanitary protection area;
- internal and external irradiation of the staff and population;
- maximum limit values of the releases and discharges of radioactive and non-radioactive substances to environment;

- impact level of open sources of ionizing irradiation;
- disposal modes and storage places for liquid and solid waste shall meet normative requirements and permit documents.

Radiation control area is the territory in which the ZNPP discharges and releases can occur and radiation monitoring is performed, the latter consists of measurement of radionuclide content on the facilities of environment, food staff, etc.

In accordance with the Plant Norms 306.2.141-2008 (OPB-2008. «General safety statements for Nuclear Power Plants») the sanitary protection area is the territory around ZNPP where the people irradiation level can be higher than the dose limit quota for B category.

The population living is prohibited in the sanitary protection area, the limitations for industrial activities not related to NPP are established and radiation monitoring is performed here.

SE ZNPP sanitary protection area has radius of 2.5 km. Radiation control area is a circle 30 km radius. In accordance with DGN 6.6.1-6.5.001-98 (NRBU-97) the categories of the people exposed to irradiation are specified:

- A category (staff) – the individuals involved constantly or temporary in the activities with ionizing irradiation sources;
- B category (staff) – the individuals not involved directly in the activities with ionizing irradiation sources, but due to the location of their working places in the compartments and industrial sites of the facilities with radiation and nuclear technologies can be additionally exposed to irradiation;
- B category – all population.

The values of dose limits of external irradiation for a calendar year depending on a group of organs or tissues, as well as total external and internal irradiation are provided in DGN 6.6.1-6.5.001-98 (NRBU-97).

List of radionuclides and values of acceptable release to atmosphere and values of the limits of annual radioactive substances discharges is specified by the documents valid at SE ZNPP: «Zaporizhzhya NPP acceptable gas and aerosol release (radiation and hygienic regulation of the first group) OO.RB.XQ.Pr.04-12» and «Zaporizhzhya NPP acceptable water discharge» (radiation and hygienic regulation of the first group) 00.RB.XQ.Pr.05-15». Acceptable release and acceptable discharge in accordance with the Radiation Safety Norms (DGN 6.6.1-6.5.001-98 (NRBU-97) are specified on the basis of dose limit quota and initial data specific for NPP.

In accordance with the requirements of DGN 6.6.1-6.5.001-98, the control levels are established for determination of the achieved level of radiation safety on a radiation and nuclear facility, in a settlement and in the environment based on the information about facility radiation conditions for its specific compartments, sanitary protection area, radiation control area and other facilities for planning the measures of protection and operative monitoring of radiation conditions. The control levels are established by the Administration of the radiation and nuclear facility and obligatory agreed by State Regulatory Authorities.

In addition to the control levels valid at NPP for gas and aerosol releases and water discharges to environment, in order to reveal the causes of non-controlled increase of the values of NPP releases and discharges, the administrative and technological levels (A-TL) are established. In effect, these are the investigation levels. Excess of A-TL does not refer to the category of violation of norms and rules valid at NPP, and they do not require reporting to the State Regulatory Authorities. Observance of A-TL facilitates optimization of technological processes, development of organizational and technical measures oriented to the decrease of the level of NPP gas and aerosol releases and water discharges to environment and prevention of plant achievement of the control levels of releases and discharges established by the plant.

The amount of chemical (non-radioactive) releases of contaminants to atmosphere from SE ZNPP sources is regulated by «Resolutions for the contamination releases to atmospheric air by stationary sources».

Water intake and water discharges are performed in accordance with the «Resolution for special water use» No.0078/Zap, validity period: 01/01/2014-31/12/2016.

Management of hazardous and general industrial (non-radioactive) waste is regulated by the «License AE No.460721 for operations in the field of hazardous waste management» dated 20/02/2015 No. 46 (issue (reissue) date), validity period: 26/07/2011-26/07/2016.

Rules and procedure of collection, sorting, transportation, registration and temporal storage of radwaste are regulated by ND.306.607-95 «Radwaste management. Requirements to radwaste management before their disposal. General statements» «Radwaste Management Complex Program of SE NNEGC «Energoatom» for the period of 2012-2016» PM-D.O.18.174-12, «Procedures for solid radwaste management at SE Zaporizhzhya NPP» OO.VN.OO.IN.10-13, «Procedures for Zaporizhzhya NPP Radiation Safety» OO.VN.OO.IN.10-13 and regulations and procedures for radwaste reprocessing plant operation.

The planned activity is operation of SE ZNPP power units.

Due to the fact that the development of SE ZNPP industrial complex is provided do be performed by means of reconstructions and modernization of existing production departments that are functionally implemented in available infrastructure of NPP within its territory, the limits of town construction are not considered.

Fire safety is provided by implementation of legislative requirements of acts and norms:

- NAPB A.01.001-2004 Rules of fire safety in Ukraine;
- VBN B.1.1-034.03.307-2003 Fire safety norms of designing the nuclear power plants with water-to-water energy reactors;
- NAPB 06.015-2006 List of compartments and building structures of power plants of the Ukrainian Ministry of Energy with specification of category and classification of zones of fire and explosion hazard zones;
- NAPB B.03.002-2007 Norms of specification of compartment categories, buildings and external facilities by fire and explosion safety;
- NAPB 05.028-2004 Fire protection for power plants, specific facilities and power component units. Procedure for operation design;
- NAPB B.01.034-2005/111 Fire safety rules for companies, enterprises and organizations of power industry of Ukraine;
- Law of Ukraine «About fire safety» dated 17/12/1993 No. 3745-XII.

For the period of operation and reconstruction of SE ZNPP industrial complex the normative mismatching, distances between buildings and structures, fire extinguishing systems, road arrangements, etc. are envisaged.

The fire protection measures accepted at SE ZNPP reflect all the aspects of fire safety:

- objective and functions of fire safety system;
- fire safety solutions from the General Plan;
- fire safety classification of buildings and structures;
- space and planning solutions, fire barriers, flame retardance of building structures and main statements concerning selection of flame retardant materials;
- evacuation routes and emergency exits, access routes and provision of safety for engineering departments;
- fire protection measures for technological processes;
- fire protection measures for electric plants;
- fire protection measures for ventilation systems;

- fire protection systems: fire safety water supply, fire alarm, fire suppression system, smoke protection system, fire alert and people evacuation management, lighting protection and grounding;
- primary fire suppression means.

2.6 Spent fuel management procedure

The spent fuel formed in the course of power generation in nuclear reactors is one of the most important components of NPP production cycle.

The current conditions of nuclear power industry in the world at present level of development of science and engineering do not allow taking final solutions regarding further spent fuel management. The world practice has several approaches concerning such a solution:

A postponed solution provides for a long-term storage of nuclear fuel; this gives a possibility to take a final solution about further spent fuel management, with consideration of future technologies and economic factors.

Spent fuel reprocessing provides a possibility of obtaining its components and substances with economically beneficial use and a significant reduction of total amount of waste for disposal. The reprocessing can be performed locally as well as in other countries with return of high active waste to the country of origin.

Spent fuel disposal provides for residual location of spent fuel after technological exposure and conditioning to underground (geological) storage designed for retention of the radioactive decay products and actinide elements within the time period required for prevention of any impact dangerous for environment.

Zaporizhzhya NPP was the first NPP in Ukraine which implemented in commercial operation the Dry Spent Fuel Storage established on the basis of tested technology of American Company «Duke Engineering & Services» and meets all requirements of Norms, Rules and Standards of Nuclear and Radiation Safety.

In accordance with procedure of spent fuel management at SE ZNPP, the nuclear fuel, after its operation in reactor core, shall be reloaded into the reactor spent fuel pond where it is stored during 4-5 years for the reduction of residual power release.

After cooling in the spent fuel pond, the spent fuel shall be loaded into the special casks that ensure safety during its transportation and transported to the Dry Spent Fuel Storage.

The storage is designed for 380 casks, where 9000 assemblies with spent fuel can be placed. The Dry Spent Fuel Storage capacity is sufficient for the SE ZNPP spent fuel for the its overall period of operation. The spent fuel can be stored in safe condition there for 50 years – until the decision on its further storage, reprocessing or disposal is taken.

In order to ensure control for safe operation of the casks, continuous radiation monitoring is provided within the storage site. The radiation environment control within the Dry Spent Fuel Storage is comprehensive and continuous. Safety operation of the plant, including Dry Spent Fuel Storage as an individual nuclear facility is under consideration of SE ZNPP Administration as a priority task.

Around the Dry Spent Fuel Storage site there is a radiation protection wall erected, it allows do exclude any impact of radiation factors on SE ZNPP staff, population and environment.

An average amount of the spent fuel reloaded for storage from one WWER-1000 reactor is 42 fuel assemblies. Annual amount of the assemblies that are used annually at Zaporizhzhya NPP is about 252. For 30/09/2015 131 casks were installed on the storage site.

The experience of storing spent fuel in «dry» casks got by Ukrainian specialists at Zaporizhzhya NPP, facilitated contract conclusion between the operating company SE NNEGC «Energoatom» and American Company «Holtec International» for construction of Centralized Spent Fuel Storage of «dry» type for Rovno, Khmelnytskyi and South-Ukrainian NPP by the results of international tender.

Technical and Economic Justification of the investments to the construction of Centralized Spent Fuel Storage was developed by General Designer Production Joint-Stock Company Kyiv Scientific, Research and Design Institute «Energoprojekt». Law No.4384-VI approved by Supreme Council of Ukraine on 09/02/2012 defines that the Centralized Spent Fuel Storage is a part of a unified complex of spent fuel management, reported to the State Specialized Enterprise Chornobyl NPP and it is situated in Kyiv region, in the exclusion area of the territory contaminated in consequence of the Chornobyl accident. Total capacity of the centralized storage is 16529 spent fuel assemblies of the reactors of WEER-440 and WWER-1000 types.

2.7. Waste management procedure

The production activity of SE ZNPP is accompanied by generation of solid, liquid radioactive and non-radioactive waste and gaseous releases.

Radioactive waste

Solid radiation wastes are generated in the process of NPP normal operation, during repair works and in emergency cases.

By the level of specific activity the solid radwaste are distributed into three categories:

I – low active;

II – middle active;

III – high active.

For solid radwaste the technological classification given below is used at ZNPP, it is for different potential procedures of their reprocessing:

- sorted solid radwaste, including:
 - solid radwaste for pressing;
 - solid radwaste for ignition;
 - metal solid radwaste;
 - spent filters;
 - non-reprocessed solid radwaste.
- non-sorted solid radwaste.

Solid radwaste shall be collected at the places of their generation, sorted by activity categories and technological properties.

Low active solid radwaste capable to be reprocessed are subject to reprocessing pressing and ignition plants. The products of waste reprocessing shall be transported to the storage of reprocessing unit for their keeping.

Low active solid radwaste not capable to be reprocessed, as well as middle and high active solid radwaste shall be transported to the storages for their temporal keeping without reprocessing (solid radwaste storage of the Radwaste reprocessing Building, storages of Special Building-1 and Special Building-2).

Annual volumes of solid radwaste generated at ZNPP are specified in Figure 2.6.

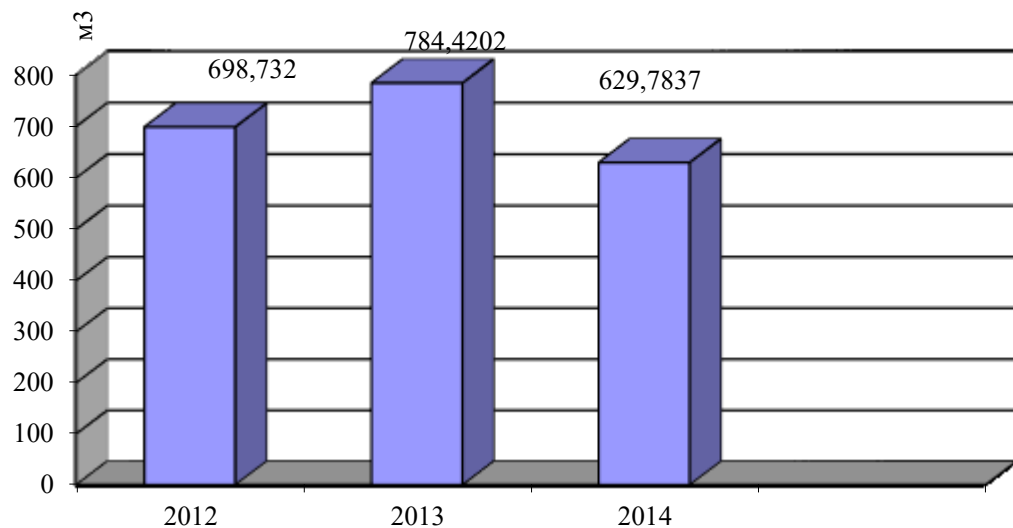


Figure 2.6 – Annual volumes of solid radwaste for 2012-2014

In 2013 on the ignition plant 294.9 m³ of solid radwaste were reprocessed and 8.2 m³ of the product (ash) were generated. On the pressing plant 713.2 m³ of solid radwaste were reprocessed and 141.6 m³ of solid radwaste were generated.

Total volume of solid radwaste taken for storage was 199.3 m³ in 2013.

For 31/12/2013 the total volume of solid radwaste in the storages of SE ZNPP was 9813 m³.

The storages listed below are in operation at SE ZNPP for solid radwaste intake and keeping:

- solid radwaste storage of Special Building-1, purposed for intake and storage of the radwaste volume up to 5910 m³;
- solid radwaste storage of Special Building-2, purposed for intake and storage of the radwaste volume up to 1906.7 m³;
- solid radwaste storage located in the reprocessing building (storage unit), purposed for intake and storage of the radwaste after the radwaste reprocessing plants, volume up to 11174 m³.

Liquid radiation wastes are generated as a result of water contact with fuel elements, operation of water treatment plants and contamination of reactor compartment oil systems.

Liquid radwaste are subject to evaporation or treatment on filter materials. The products of water treatment plant reprocessing (ion-exchange resins mixed with different sorbents and dispersed depositions, salt fusion cakes and evaporator sluge) are transported to respective storages for their keeping.

Contaminated oil is subject to regeneration or it shall be ignited on the ignition plant.

Volumes of liquid radwaste generated at SE ZNPP for 2008-2014 are specified in Figure 2.7.

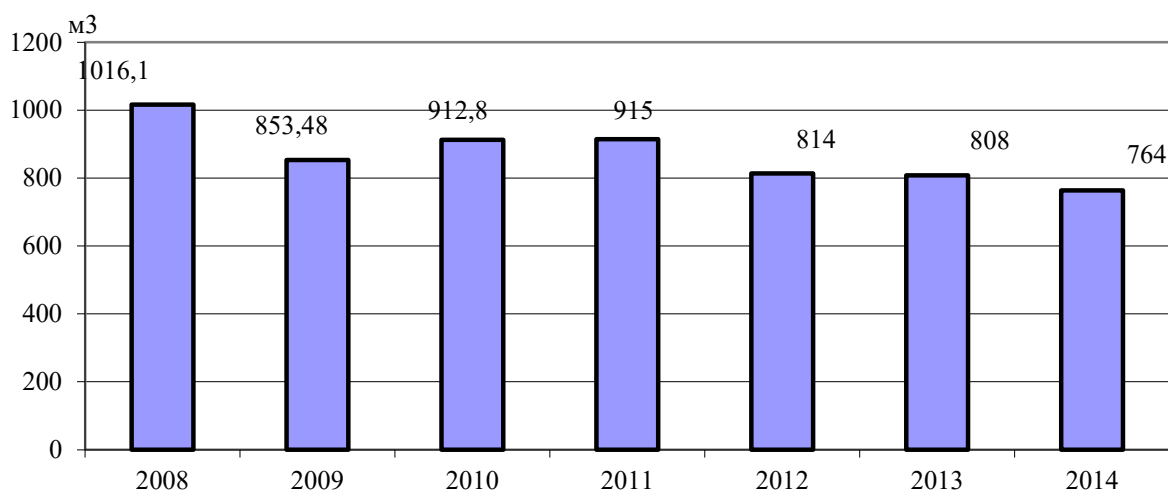


Figure 2.7 – Volumes of liquid radwaste generated for 2008-2014

For the value of 764 m³ specified in the given table for the last year, 2014, the generation of liquid radwaste was as follows: evaporator sludge – 758 m³, filter material – 6 m³.

Radwaste management is accomplished in accordance with:

- Law of Ukraine «About radwaste management»;
- Updated Energy Strategy of Ukraine for the period up to 2030;
- Strategies of radwaste management in Ukraine approved by Order of Cabinet of Ministers of Ukraine dated 19/08/2009 No.990-p;
- Common State Target Ecological Program for Radwaste Management (Law of Ukraine dated 17/09/2008 No.516-VI «About Common State Target Ecological Program for Radwaste Management»);
- «SE NNEGC «Energoatom» Complex Program for Radwaste Management for the period of 2012-2016» PM-D.0.18.174-12 (hereinafter referred as Complex Program), put in force by Order of 01/10/2012 No.838-p.

Nonradioactive wastes

In the course of SE ZNPP operation 59 types of radioactive waste, I-IV hazard class, are generated.

Waste management dynamic for 5 years in general volumes is specified in Figure 2.8.

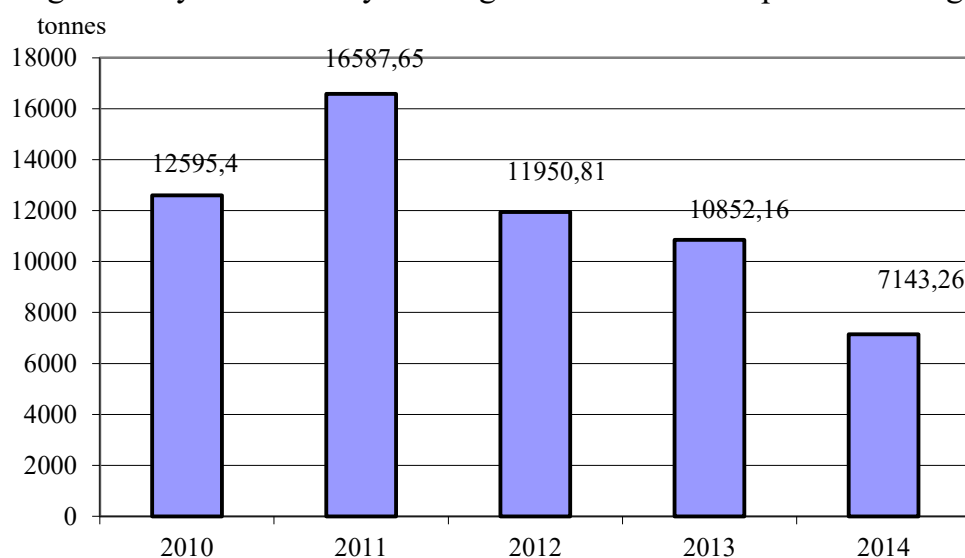


Figure 2.8 – Waste management dynamic

For 2014 the volumes listed below were generated by hazard class:

- 1 hazard class: 9.717749 t;
- 2 hazard class: 9.62741t;
- 3 hazard class: 211.74764 t;
- 4 hazard class: 6912.169606 t.

Nonradioactive waste management at the operating company SE NNEGC «Energoatom» is performed in accordance with the requirements of Law of Ukraine «About environmental protection» and Law of Ukraine» «About waste».

AT SE ZNPP the works for establishment of the system of industrial (nonradioactive) waste management have been performed; the functioning of this program is accomplished in accordance with main requirements of International Standards DSTU ISO 14001 and DSTU ISO 14004, associated with the environment management system. The system of industrial waste management provides the requirements to the ecological management system were the policy and enterprise objectives are specified for waste management and methods of their achievement.

The system of industrial (nonradioactive) waste management includes:

- orders for organization of the activities of waste management and assignment of responsible individuals;
- regulation about Environmental Protection Service;
- job procedures of the plant staff, with specification of their obligations and responsibilities in the field of waste management.

Operations in the field of dangerous waste management for collection, storage, transportation shall be accomplished in accordance with License AE No.460721 dated 20/02/2015 No.46. License validity period: 26/07/2011-26/07/2016.

In the Departments there are places for temporal waste storage in accordance with hazard class, the procedures for waste management have been developed. The primary accounting by the Form No1-BT is accomplished. The report on waste management by the Form 1 – Waste is developed and submitted to the statistics organs annually.

12 waste types of the fourth hazard class shall be placed within specially allocated areas: polygons and sludge storage sites. All other types of waste (1 – 4 hazard classes) shall be delivered to specialized organizations in accordance with the signed contracts.

SE ZNPP shall place the waste on:

- SE ZNPP polygon of the disposal site fore nondisposed industrial waste;
- SE ZNPP sludge storage site No.1;
- SE ZNPP sludge storage site No.2;
- Energodar polygon for solid household waste (in accordance with the signed contracts).

Dynamic of waste management for 5 years is specified in Figure 2.9.

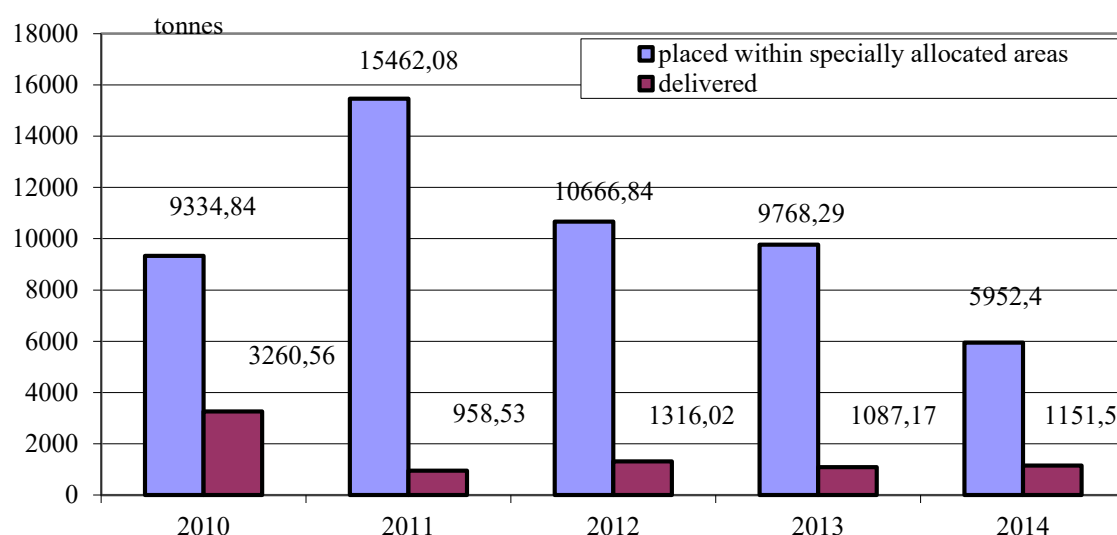


Figure 2.9 – Dynamic of waste management

Sewage water

SE ZNPP water includes:

- industrial discharges: service cooling water from the equipment of special buildings, oil coolers of unit transformers, conditioners of Trainer Center and Administrative Building, nitrogen and oxygen plant, automatic fire extinguishing systems; blowdown waters of chemical water treatment clarifiers; rinsing waters of mechanic filters; regeneration and washing water of ion exchanger filters of chemical water treatment plant, automatic demineralizer, unit demineralizer;
- oily sewage water;
- storm discharges;
- service-utility discharges.

NPP industrial, storm and utility discharges directly to water facilities of common use are not accomplished. Discharges after their treatment on respective plants shall be removed to the cooling pond that is a water facility for SE NPP specific use.

Water exchange in the cooling pond is accomplished due to its blowdown. Continuous blowdown of the cooling pond provides a stable chemical content of NPP return water and on the inlet to Kakhovka water reservoir meets the requirements established for the fishery ponds.

Discharges of the cooling pond return water to Kakhovka water reservoir are accomplished in accordance with the «Resolution for special water use» given by the Department of Ecology and Natural Resources of Zaporizhzhya Regional Administration, under observance of limit allowable discharge of contaminants and Blowdown Regulation.

Gaseous releases

SE ZNPP radioactive gaseous releases consist of radioactive noble gases, aerosols and iodine isotopes.

The indicators of radioactive substances releases in normal operation are given in Table 2.3.

Table 2.3 – ZNPP of radioactive substances releases

Radionuclide	SE ZNPP releases, Bq/year
^{137}Cs	$5.30 \cdot 10^6$
Cs-134	$2.64 \cdot 10^6$
^{60}Co	$6.02 \cdot 10^6$
^{58}Co	$2.31 \cdot 10^6$
^{54}Mn	$1.97 \cdot 10^6$

^{51}Cr	$1.88 \cdot 10^7$
^{90}Sr	$7.32 \cdot 10^5$
^{95}Zr	$6.80 \cdot 10^5$
$^{95}\text{Nb-}$	$4.30 \cdot 10^5$
$^3\text{H}^*$	$4.44 \cdot 10^{13}$
$^{14}\text{C}^*$	$4.14 \cdot 10^{11}$
$^{87}\text{Kr}^*$	$3.19 \cdot 10^{12}$
$^{133}\text{Xe}^*$	$2.30 \cdot 10^{13}$
$^{135}\text{Xe}^*$	$5.74 \cdot 10^{12}$
$^{131}\text{I}^*$	$5.83 \cdot 10^7$
$^{133}\text{I}^*$	$3.12 \cdot 10^7$
$^{135}\text{I}^*$	$8.08 \cdot 10^6$

Notes: * – the values calculated based on reference sources and real releases.

In the course of SE ZNPP operation 63 contaminants are released to ambient air from stationary release sources located at SE ZNPP industrial sites.

Main chemical contaminants are the substances in form of suspended solid particles, nitrogen dioxide, hydrocarbon oxide, ammonia, saturated hydrocarbon, gasoline evaporations, mineral oils, etc.

Potential releases of contaminants to ambient air from 514 stationary releases are ~ 25.78181 t/year (dust releases – 8.07402 t/year, gas-aerosol mixtures – 17.70779 t/year), from non-controlled sources (from road transport and river transport) the release is ~ 0.6769 t/year.

Besides, ~ 28.0012 t/year of green hose gases are released to ambient air.

3. POTENTIAL ACCIDENTS DURING OPERATION OF ZNPP POWER UNITS

3.1 List of potential accidents during operation of ZNPP power units

The criterion of acceptance of environmental consequences of accidents is defined by NSCU- 97 (National Security Council of Ukraine).

For the analysis of radiation consequences of accidents at Zaporizhzhya NPP were studied the following design basis accidents:

- Maximum design accident.
- Break of collector cover of steam generator - emergency spike.
- Break of collector cover of steam generator - pre-emergency spike.
- The fall of the hydraulic locking to the spent fuel pool.
- The fall of a cassette of spent fuel to the reactor core and to the heads of the cassettes in the spent fuel pool.
- The fall of the container with the spent nuclear fuel from height more than 9 meters.
- The fall of assembly to the reactor core.
- The break of impulse piping outside the containment.
- The line break of planned cooldown.
- Rupture of the supply pipeline of technology blowing in to the purification in a system of operating blowing in the reactor building.

In addition, the influence of beyond design basis accidents is considered.

The main factors of impact on the environment are accidental releases to the atmosphere.

From design basis accidents the most dangerous to human in the period of 2 days and 2 weeks is the design basis accident, «Break of collector's cover of steam generator – emergency spike», a dose of up to 0.19 mSv and 0.32 mSv, respectively, at the boundary of sanitary protection area. For the period of 1 year, the most dangerous to human is the design basis accident «The fall of assembly to the reactor core», the maximum design accident and design accident «The fall of the hydraulic locking to the spent fuel pool» – 1.44 mSv, 1.28 mSv and 1.17 mSv.

Total emissions of radioactive substances to these accidents can be:

- «Break of collector cover of steam generator - emergency spike» – $4.35 \cdot 10^{15}$ Bq;
- «The fall of assembly to the reactor core» – $1.21 \cdot 10^{14}$ Bq;
- Maximum design accident – $7.17 \cdot 10^{15}$ Bq;
- «The fall of the hydraulic locking to the spent fuel pool» – $5.34 \cdot 10^{14}$ Bq

The maximum total volumetric activity in surface layer of atmospheric air will amount to $1.35 \cdot 10^6$ Bq/m³ and the maximum density of precipitation onto the surface of the soil will be $3.57 \cdot 10^7$ Bq/m² for the accident «Break of collector cover of steam generator – emergency spike».

During design basis accidents the levels of justified emergency intervention in acute irradiation are not exceeded, levels of abstract dose do not exceed the levels of absolute justification; there is no need for planning of basic emergency countermeasures; at this level of doses, the use of subsidiary countermeasures is impractical; under the most adverse conditions at the border of sanitary protection area and outside its borders the individual equivalent doses for 1 year on thyroid gland due to the inhalation body and external irradiation do not exceed the threshold values 0.3Sv/year and 0.1Sv/year according to DNAOP 0.03-1.73-79. Sanitary rules for design and operation of nuclear power plants (SR ASS-88).

In the case of beyond design basis accident, maximum activity of radio nuclides in near-surface layer of atmospheric air and the density of precipitation onto the surface of the soil is expected within the sanitary protection area. Maximum values of volumetric activity in the atmospheric air are expected to ⁹⁵Zr – on the border of the sanitary protection area to 10.3 MBq/m³. The maximum value of precipitation on the surface of the soil at the sanitary protection area boundary is expected also for ⁹⁵Zr – up to 9.58 GBq/m². The effective doses of the population exposure for 2 days, 2 weeks and 1 year will amount to 0.43 Sv, 1.79 Sv and 9.46 Sv. The levels of unconditional justification for the use of countermeasures are exceeded and there will be the need to use all kinds of countermeasures, including evacuation.

3.2 SE ZNPP Emergency Plan

According to the requirements of the document «General regulations of NPP safety. NP 306.2.141– 2008, p.10.13, at Zaporizhzhya NPP was developed « SE ZNPP Emergency Plan». The plan is approved by SE ZNPP General Manager on 03/10/2013 and put into effect by Order dated 28/07/2014, No.IOK-835 from 20/08/.2014.

The emergency plan defines the emergency organizational structure of SE ZNPP, distribution of responsibilities and duties regarding emergency response, structure of emergency response means, the composition of external organizations involved in emergency response, the composition and procedure of activities of the emergency response at the NPP site and in the sanitary protection area.

The regulations of the emergency plan are mandatory for officials, NPP structural subdivisions and external organizations involved in emergency response at the NPP site and in the sanitary protection area.

Emergency plan is interdependent and coordinated with the emergency response plans of SE NNEGC «Energoatom».

3.3 SE ZNPP emergency preparedness and response system

SE ZNPP emergency preparedness and response system (EPRS) is defined by the document as an integral part of the preparedness and response systems of SE NNEGC «Energoatom» for accidents and emergencies at Ukrainian NPPs. It is an interdependent complex of technical means and resources, organizational, technical and radiation-hygienic measures, which are implemented by the operating organization for preventing or reducing radiation impact on personnel, population and environment in the case of nuclear or radiation accident at the NPP.

EPRS has two interrelated levels:

- the level of SE NNEGC «Energoatom» (EPRS of SE NNEGC «Energoatom» level);
- the level of the NPP (NPP EPRS).

The basic tasks for ZNPP EPRS :

- maintaining of the required level of ZNPP emergency preparedness;
- responding to accidents and emergencies at SE ZNPP, including the implementation of measures aimed at the protection of personnel, population and environment.

The main activities to maintain the required level of emergency preparedness for ZNPP EPRS are:

- development and timely review of the emergency plan;
- equipping and maintenance of technical support, Internal and External Crisis Centers;
- interaction with the Crisis Center of SE NNEGC «Energoatom», center of organization of interaction and assistance to the NPP, Information and Crisis Center of SNRIU, regional and local governments of the territorial and functional subsystems of the unified system of civil protection;
- maintaining in working condition and improvement of the system of collecting, processing, documenting, storage, display and data transmission of SE ZNPP crisis centers, communication and alarm system;
- timely forming and maintaining in the state of preparedness of the emergency set: control measuring devices, personal protective equipment, means of decontamination and sanitary treatment, tools, equipment, and other emergency equipment;
- training of emergency personnel, developing of schedules and training programs, performing of emergency response training, including common-state emergency drills;
- support up to date regulatory, organizational and operational documentation, regarding emergency preparedness and response;
- ensuring of emergency preparedness in the case of the introduction of new radiation-hazardous objects at SE ZNPP.

The main EPRS measures for responding to incidents and emergencies are:

- identification and classification of accidents and other dangerous events at SE ZNPP;
- warning of ZNPP management, personnel, population outside NPP, responsible persons of the operating organization, SNRIU (State Nuclear Regulatory Inspectorate of Ukraine), central and local executive authorities, local governments, other organs, institutions and organizations that participate in emergency response, their informing about an accident and the initiation of countermeasures;
- introduction of the emergency plan, cancellation of the actions according to this plan;
- support of the MCR staff, ZNPP operational staff on management of beyond design basis accidents;
- evaluation and prediction of the accident and its consequences, assessment of releases and discharges of radioactive substances, monitoring and forecasting changes in radiation situation and exposure doses of the personnel;

- execution of works on liquidation of accident consequences, including emergency rehabilitation, repair and other works;
- logistical support for emergency activities;
- implementation of activities to protect SE ZNPP and zones of radioactive contamination;
- interaction with SNRIU;
- interaction with authorities and forces of functional subsystem of the Ministry of Energy and Coal Industry of Ukraine, with territorial and other functional subsystems of the unified system of civil protection that participate in an emergency response;
- documentation of emergency conditions and actions for emergency response;

The main activities of ERS for personnel protection are:

- activity for radiation protection of personnel;
- delivery of health care .

The main activities of ERS for population and environment protection are:

- enhanced radiation monitoring of indicators of environmental objects and population exposure in the radiation control area;
- prediction of doses to the population in the radiation control area;
- informing of central and local executive authority and local governments about results of the monitoring and dose prediction;
- providing recommendations for the protection of the population of central and local organs of executive authority and local governments.

Measures of emergency response, executed with the NPP, are limited to within the NPP site and sanitary protection zone, except for actions to protect population and environment. Measures of population and environment protection, executed with the NPP, are limited to the observation area.

3.4 Mitigation of the accident consequences

Emergency safety of ZNPP is based on the following principles and criteria of safety:

- NPP safety is ensured with successive use of:
 - physical barriers on the way of spreading of ionizing radiation and radioactive substances to environment;
 - the system of technical and organizational measures to protect barriers and maintain their efficiency for the protection of personnel, population and the environment;
- In the course of NPP operation, the integrity of the barriers on the way of spreading of radioactive substances is controlled. During normal operation, all barriers and their protection are in working condition. According to the safe operation conditions, the operation of the NPP for power is forbidden if there is any failed barrier or failed means of its protection, provided for in the plant design.

Installation of the physical barriers on the way of spreading of radioactive emission (fuel matrix, fuel rod cladding, the boundaries of the coolant circuit, the hermetic casing of the reactor, biological protection):

- availability of special safety systems, which are based on the principle of installation of parallel channels and perform the same function;
- ensuring the principles of independence, redundancy, physical distribution and accounting of every incident while creating a security system;
- high technical characteristics of the localization system to prevent the release of reactive substances to environment;

- high level of monitoring and process automation, it provides overcoming of emergency situations during the most important (first) stage of the accident without personnel participation;
- security subject to external influences, specific for sites that are considered, including natural and anthropogenic impact;
- security in a wide range of initial events with regard to postulated failures, possible personnel errors and additional influences;
- taking a conservative approach to the choice of technical solutions that affect the safety;
- the use of measures and technical solutions aimed at:
 - the protection of localization systems during design basis accidents,
 - prevention of an initial event transfers to the design basis accident,
 - mitigating of the accident consequences that could not be avoided,
- ensuring of inspection and testing of equipment and systems that important to safety, with the aim of supporting them in working condition;
- organization of the sanitary protective zone and the surveillance zone;
- quality assurance with regard to the requirements of the relevant regulations.

The system of technical and organizational measures has 5 levels:

Level 1: Instalation of conditions that prevent violation of normal operation;

Level 2: Preventing design basis accidents by normal operation systems;

Level 3: Prevention of accidents with safety systems;

Level 4: Management of beyond design basis accidents;

Level 5: Planning of measures for the personnel and population protection.

4. CHARACTERISTIC OF THE ENVIRONMENT AND ENVIRONMENTAL IMPACT ASSESSMENT OF SE ZNPP PRODUCTION ACTIVITY

On the basis of SE ZNPP technological processes of main and auxiliary industry, the main impacts on environment are radiation, chemical, and physical impacts.

The negative impact extends to the following components of environment: air environment, water and geological environment, flora and fauna, social and technological environment.

Climate and microclimate

SE ZNPP is situated in Zaporizhzhya region in the South-Eastern part of Ukraine.

The climate of the region is temperate-continental, which is characterized by the indicators that are typical for a dry hot southern Ukrainian steppe, in conditions of high evaporation from the water surface when there is insufficient moisture.

In accordance with the map of climatic zoning for building (DSTU-N B V.1.1-27-2010) the area belongs to II architectural South-East area.

The impact of SE ZNPP on the microclimate of area can be caused with emissions of heat and greenhouse gases, evaporation of water in cooling systems that may affect the changes of temperature in air and water objects, the intensification of fog, precipitation. Analysis of changes in the microclimatic conditions is analyzed with comparing of long-term data of air temperature and water temperature in the Kakhovka water reservoir.

Dynamic of changes in average, maximum and minimum air temperature for each year of observation is shown in Figure 4.1

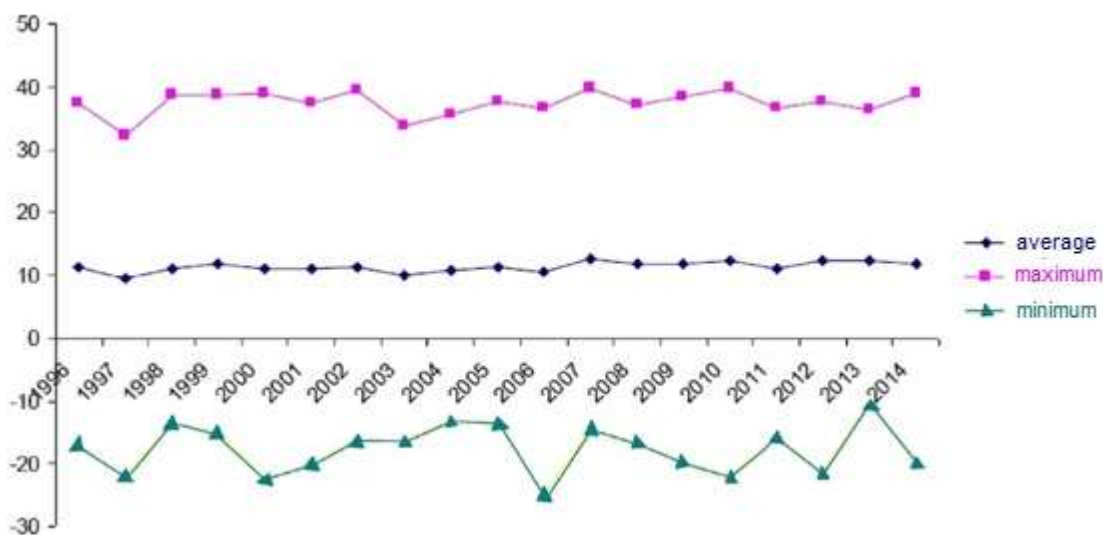


Figure 4.1 – Dynamic of air temperature changes

Heat emissions to atmosphere occur through the vent pipes and the discharge of warmed water (cooling towers, spray pools and cooling pond).

Average heat dissipation in recent years in reactor building for each unit (for spray pools similarly) in nominal operation mode was changed from $4.7 \cdot 10^6$ W (in cold period) to $16.3 \cdot 10^6$ W (in warm period).

The temperature regime of hydraulic structures (cooling pond, spray devices and cooling towers), except for natural factors, is determined with the number and capacity of operating units. During the operation of one unit, heat flux to atmosphere is $(1.9 \div 2.0) \times 10^9$ W, overall, from 6 units are $(9.5 \div 10.0) \times 10^9$ W.

Water evaporation in circulating cooling systems results in accumulation of salts that come with makeup water. Technological limitations of salt content in cooling water require the blowdown of cooling systems to maintain the salt mode in them at an acceptable level.

Since 2005, according to the «Regulations of continuous blowdown of SE ZNPP cooling pond to the Kakhovka water reservoir, blowdown has been carried out in continuous mode.

The planned volume of the blowdown is 315 360.000 m³ at a flow rate of 10m³/h. The increase of water temperature in adjacent waters of the Kakhovka water reservoir by 3°C is observed at a distance of 0.7 km, by 1.0°C – up to 1.0 km.

During the blowdown of the cooling pond, in the Kakhovka water reservoir, 500 meters downstream, water temperature increases compared with natural background: in winter by 0.2...3.0°C, in summer by 0.4... 2.1°C.. The water temperature during 2010-2014 reached in 500-meter zone accordingly 6.2°C and 25, 7°C.

The water temperature in the Kakhovka water reservoir never exceeds the standard for water objects that used for fishery purposes (no more than 28°C in summer and 8°C in winter), and additional heat load is acceptable, in accordance with the «Rules of surface water protection from pollution with sewage».

Heated water, coming from the discharge channel, are fully localized in the cooling pond.

The results of studies of the Kakhovka water reservoir hydrothermal regime (with organizations XI "Energoprojekt", LvivORGRES, KSU, UGM, etc.) and regular (twice a month) temperature measurements of water surface at the control points are presented in Figure 4.2.

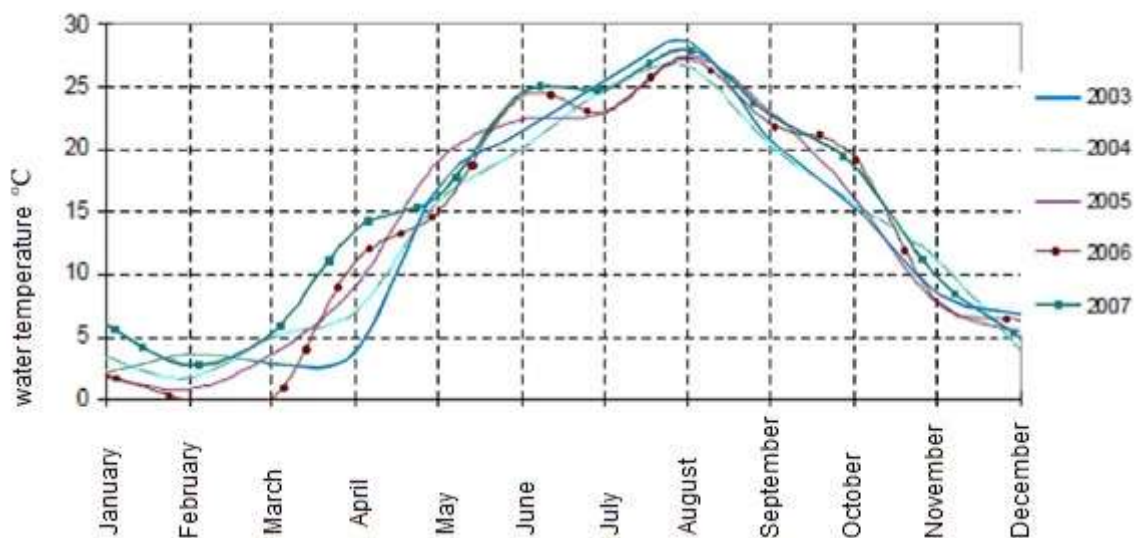


Figure 4.2 - Water temperature changes of the Kakhovka water reservoir in the monitoring section.

The data of Figure 4.2 show that temperature increase in water of the Kakhovka water reservoir during 2003-2007 is not observed.

Source of greenhouse gas emissions at SE ZNPP is industrial complex of the river port and road vehicles (mobile sources). Annual emission of greenhouse gases is ~ 28.0012 tons/year. Follow-up activity does not involve the changes in volume of greenhouse gases, emitted to atmosphere.

In general, the analyses of long-term data of air temperature (Figure 4.1) and water temperature in the Kakhovka water reservoir show that in the background of the global rise in average annual temperatures, due to global warming, temperature fluctuations within ZNPP observe zone are practically not observed.

Thus, at this stage it can be stated, that influence on the climate and microclimate is environmentally acceptable.

Air environment

Radiation impact

In the pre-starting period (1982-1983) an average level of gamma background in ZNPP area was (0.72 ± 0.086) mSv/year. This is a normal level, typical for this area.

The specific activity of radio nuclides in ambient air was consistent with global levels of radio nuclides and was:

- total beta activity (309.69 ± 140.60) $\mu\text{Bq}/\text{m}^3$;
- ^{90}Sr – (11.10 ± 5.92) $\mu\text{Bq}/\text{m}^3$;
- ^{137}Cs – (2.22 ± 0.74) $\mu\text{Bq}/\text{m}^3$.

The specific activity of radio nuclides in atmospheric precipitation is equal to:

- total beta activity – from (7.03 ± 4.07) $\text{Bq}/\text{m}^2 \cdot \text{month}$ to (9.25 ± 3.33) $\text{Bq}/\text{m}^2 \cdot \text{month}$;
- ^{90}Sr – $(1.11 \div 1.48)$ $\text{Bq}/\text{m}^2 \cdot \text{quarter}$;
- ^{137}Cs – $(0.74 \div 1.11)$ $\text{Bq}/\text{m}^2 \cdot \text{quarter}$

In general, in the pre-starting period, an average level of gamma background in ZNPP area and levels of radionuclides in ambient air, precipitation and food products were consistent with global levels and did not go beyond average values, typical for this area.

During operation, radioactive gaseous emissions consist of radioactive noble gases, aerosols and iodine isotopes.

Monitoring of radioactive content of ambient air in ZNPP monitored area is carried out in twelve points of stationary observations, situated with consideration of the wind rose in preferential directions with respect to the ventilation pipes of SE ZNPP Units No.1, 2.

The radiation situation in an observation area of operating ZNPP is not different from what was in this area before the construction of Zaporizhzhya NPP, and is determined with the radiation of natural radio nuclides ^{40}K , ^{238}U and ^{232}Th ; radio nuclides of cosmogenic origin (^7Be etc.); radio nuclides of global atmospheric pollution with the products of separation of ^{90}Sr and ^{137}Cs , resulting from nuclear weapons tests that were conducted on the Earth to the 1980s, as well as a large range of radio nuclides, contained in emissions and discharges of ZNPP.

During 26 years of observations volumetric activity of radio nuclides ^{137}Cs and ^{90}Sr was at the level of «zero background», from $3,33 \cdot 10^{-3}$ to $9,55 \cdot 10^{-5} \text{Bq/m}^3$ for ^{90}Sr , and from 0.244 to $1.17 \cdot 10^{-3} \text{Bq/m}^3$ for ^{137}Cs . Total beta-activity of radio nuclides in atmospheric air, in the reporting period at observation points, ranged from 145 to $1480 \mu\text{Bq/m}^3$. The maximum was in 1986 during an accident at Chernobyl nuclear Power Plant.

The specific activity of radio nuclides in atmospheric precipitation during 26 years of observations ranged from 0.141 to $4.07 \text{Bq/m}^2 \cdot \text{year}$ for ^{90}Sr and from 0.586 to $851 \text{Bq/m}^2 \cdot \text{year}$ for ^{137}Cs . Total beta activity – from 74.8 to $1.07 \cdot 10^4 \text{Bq/m}^2 \cdot \text{year}$. Radioactive precipitation from atmospheric air in all controllable observation points of SE ZNPP is caused with global emissions.

During 2014 emissions of radioactive substances to atmosphere did not exceed the specified control levels. The rate of radioactive gas-aerosol emissions for the last five years was at the level of 0.112 – 0.141 % from the valid values, that corresponds to the normal operation zone.

Thus, the concentration of radionuclides in the surface atmospheric layer of the region, for the period of operation of SE ZNPP, did not exceed permissible concentrations for air regulated by NSCU-97.

Chemical impact

At ZNPP the main sources of chemical polluting emissions to atmospheric air are 20 emergency diesel generators for 6 nuclear power units with WWER-1000 reactors and a number of auxiliary production facilities: maintenance division, chemical department, electric department, hydraulic department, transport department, heat and industrial communications, special warehouses, laboratories, administrative offices.

In the course of SE ZNPP operation, in accordance with «Documents that substantiate amount of emissions, to obtain permits for polluting emissions to atmospheric air from stationary sources for industrial areas of «Zaporizhzhya NPP» of SE NNEGC «Energoatom», from 514 stationary emission sources, located on ZNPP industrial sites, atmosphere gets 63 chemical pollutants, potential emission of which is ~ 25.78181 tons/year, from informal sources (road transport and river transport) emission is ~ 0.6769 tons/year.

Most emissions of ZNPP chemical pollutants are generated from sources of industrial site No.1.

According to the report «Atmospheric air protection» (No.2-TP (air) – annual), for 2014 actual amount of polluting emissions from emission sources amounted to 11.941 t. The distribution of pollutants in total emission is presented in Figure 4.3.

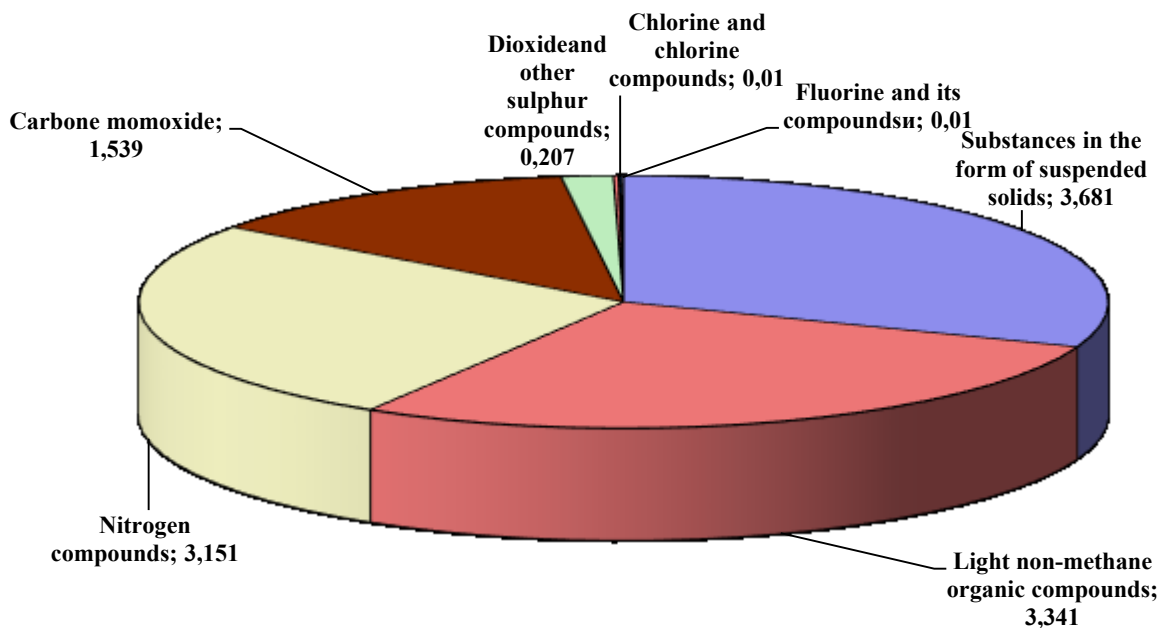


Figure 4.3 Distribution of pollutants in total emission

The maximum fractional contribution of ZNPP emissions to atmospheric pollution with chemical substances at a distance of 100 m from emission sources is observed from nitrogen dioxide and benzo-pyrene, it does not exceed 0.56% of normative values for residential areas.

Therefore, the degree of atmospheric pollution with chemical pollutants from SE ZNPP emission sources during normal operation is in the range that meets the requirements of applicable sanitary norms.

Thermal impact

Thermal impact on environment is possible due to heat ventilation emissions to atmosphere and thermal discharges of hydro-technical facilities: spray ponds of the system of technical water of responsible consumers, coolers of heat transfer equipment of the turbine condensers and non-responsible consumers. Analysis of thermal pollution is reflected in evaluation of thermal effects on the climate and microclimate.

Thermal pollution of the natural environment from ZNPP does not affect the change in environmental situation.

Acoustic impact

The sources of acoustic impact on environment are the main technological equipment and auxiliary units, ventilation units, compressors; units of building materials reloading, etc. The main sources of noise on ZNPP industrial site No.1 are power units No.1, 2, 3, 6.

The value of non-permanent broadband noise at ZNPP site is 47-56 dBA that does not exceed the maximum permissible levels in accordance with DSN 3.3.6.037-99.

On the border of ZNPP sanitary protection area the maximum level of temporary broadband noise is 51 dBs.

In Energodar, in area of the 7th district, noise level is 41 dBA, in the village Michurino is 46 dBA. It does not exceed the maximum permissible levels, according to SN No.3077-84.

The impact of ultrasound, vibration and electromagnetic radiation

The effect of ultrasound and vibration is possible only in NPP premises. There is no impact on environment.

At ZNPP power units there are no sources of electromagnetic radiation that exceed the limits, specified in the regulatory documentation.

Geological environment

The impact of ZNPP on the geological environment within its location was fully defined during the construction and commissioning of industrial complex.

Further activities of ZNPP do not detect the additional load on geological environment.

ZNPP area is geologically located in the South-Western part of the Ukrainian crystalline massif, composed of crystalline rocks of pre-Cambrian rocks, covered with a layer of sediment Paleogene and Quaternary systems.

There are no carbonate karst rocks on the territory of ZNPP industrial site. According to the National report about the state of technogenic and natural safety of Ukraine, in 2012 in Zaporizhzhya region karst processes are not registered.

According to the natural conditions, that affect the safety of the NPP (structurally and dynamically unstable, subsiding type II, water-soluble soils, the presence of active cracks, landslides, mudflows, landslides during the last 2 million years, etc.), ZNPP site has no contraindications.

The results of engineering-geological investigations allow making a conclusion that even in the case of the maximum possible seismic effect of 6.85 points, in modern engineering geological and hydrological conditions of ZNPP site, such phenomena as surface shift, water waves, caused with seismic phenomena, displacement of soil, caused with earthquakes will not appear at ZNPP site.

Analysis of engineering-geological conditions (during ZNPP operation period) showed that the density of natural soils and the boundaries of roof layers, including foundations of buildings and structures containing systems, important to safety, remained unchanged and are in the design conditions.

For the purpose of registration of local seismic events at ZNPP area, four temporary observation sites were organized in 2012. They are equipped with accelerometers of GURALP type.

Thus, the level of safety within the location of SE ZNPP is assessed as satisfactory.

Water environment

Volumetric activity of radionuclides in the water of the Kakhovka water reservoir in the pre-starting period (1982-1983) was:

- $^{90}\text{Sr} - (6.57 \pm 0.33) \cdot 10^{-13} \text{ CI/l } ((24.30 \pm 1.22) \text{ Bq/m}^3)$;
- $^{137}\text{Cs} - (7.05 \pm 2.16) \cdot 10^{-14} \text{ CI/l } ((2.61 \pm 0.80) \text{ Bq/m}^3)$.

The impact of Zaporizhzhya NPP on surface water can be designated in areas of direct contact of technological elements and NPP structures with water objects for general use. Such contact places are the water intake and outlet structures of the NPP.

The discharge of ZNPP industrial and domestic waste water, and Energodar domestic waste water directly to water objects of general use is not occurred. The effluent water after purification and radiation monitoring is discharged to the cooling pond, which is an object of ZNPP separate water use.

Influence of ZNPP on surface water is formed with discharge of water from the cooling pond to the Kakhovka water reservoir in the period of blowdown.

Water discharge is carried out in accordance with the document: «Permission for special water management» No.0078/Zap, validity period: 01/01/2014 – 31/12/2016 and «Permissible water discharge of radioactive substances of Zaporizhzhya NPP (radiation-hygienic regulations of the first group) 00.RB.XQ.PR.05-15».

The planned volume of blowdown, which is defined with the permit for special water management, is equal 315360.000 thousand m^3 at a flow rate of $10 \text{ m}^3/\text{s}$.

The volume of blowdown of the cooling pond to the Kakhovka water reservoir in 2014 amounted to 245990.304 thousand m^3 with an average consumption of $7.77 \text{ m}^3/\text{s}$. Average annual salinity in the cooling pond was $401.0 \text{ mg}/\text{dm}^3$.

Discharge of blowdown water to the Kakhovka water reservoir does not significantly affect the hydrological regime. In the course of the planned annual water discharge to the square of the reservoir, its level will rise by 0.14 7m; actual discharges increase the level by no more than 0.114 m. On the background of seasonal fluctuations of water level in the Kakhovka water reservoir, that reach 3.3 m, impact on the hydrological regime is insignificant.

According to long-term observations, water discharge from the reservoir-cooler and water filtration through the dam lead to insignificant thermal pollution of the Kakhovka water reservoir in the range from 0.3° to 2.9°C — in comparison with background values. Area of rising temperatures is limited to 500 m radius from the point of water discharge. Water temperature does not exceed the norms for fishery reservoirs.

In accordance with the results of monitoring, content of radionuclides ^{90}Sr and ^{137}Cs in the water of the Kakhovka water reservoir are at the same level, as up-stream of ZNPP (ZTPP after-work sanatorium, t.19), as at the first point of water use downstream (village Vodyanoe), and on the opposite bank of the Kakhovka water reservoir, in area of the water intakes of Nikopol town and Marganets town, indicating the global nature of the pollution of the reservoir. It is illustrated in Figure 4.4 – Dynamic of average annual concentrations of ^{90}Sr in the Kakhovka water reservoir.

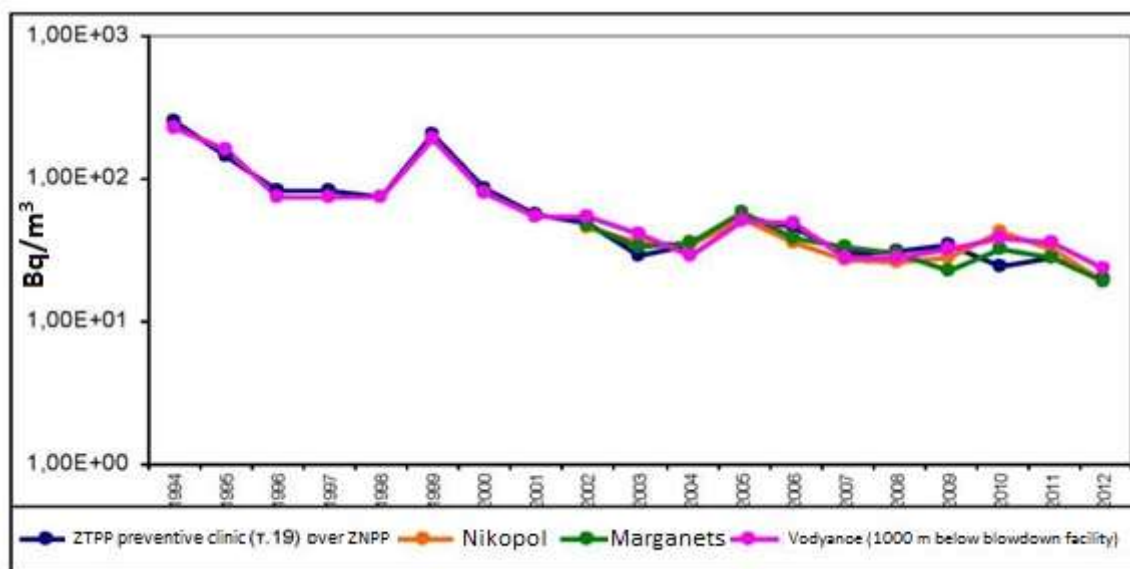


Figure .4.4 – Dynamic of average annual concentrations of ^{90}Sr in the Kakhovka water reservoir

Maximum volumetric activity of radionuclides ^{90}Sr and ^{137}Cs in water objects during the operation of ZNPP did not exceed the guideline values, established by NSCU-97 and DR-2006, and it was in the range of background values from 7 to $6.03 \cdot 10^2 \text{ Bq}/\text{m}^3$ for ^{90}Sr and from 4 to $1.89 \cdot 10^2 \text{ Bq}/\text{m}^3$ for ^{137}Cs .

The content of tritium in water in the lower part of the Kakhovka water reservoir (background values) averaged: during spring flood – $1.5 \cdot 10^4 \text{ Bq}/\text{m}^3$, during summer low water flow – $3.0 \cdot 10^4 \text{ Bq}/\text{m}^3$, during autumn-winter low water flow – $1.1 \cdot 10^4 \text{ Bq}/\text{m}^3$ (up to 30% of NSCU-97 normative values).

Thus, discharges of Zaporizhzhya NPP have no significant impact on the content of radionuclides in the Kakhovka water reservoir.

Continuous blowdown of the cooling pond provides a stable chemical composition of ZNPP recycled water and, under release of water to the Kakhovka water reservoir, it meets the requirements, established for fishery water objects.

Comprehensive ecological researches of ZNPP water bodies are carried out with 32 indicators: mineralization, sulphate, chlorides, calcium, magnesium, sodium, potassium, nitrogen amonini, nitrites, nitrates, phosphates, iron, manganese, copper, zinc, dissolved oxygen, suspended solids; petroleum products; BOD₅; COD; pH; temperature; total hardness; carbonate hardness; total alkalinity; cobalt; nickel; cadmium; plumbum; fluorides; morpholine.

The results of measurements of SE ZNPP ecological-chemical laboratory and regulatory organizations confirm, that at the time of introduction of continuous blowdown of the cooling pond to the Kakhovka water reservoir, the production activity of ZNPP has not caused significant effect on the change of chemical composition and water quality of the surrounding water of the Kakhovka water reservoir.

During operation period of the station, the groundwater level (GWL), due to man-made causes, have increased, in comparison with the groundwater level prior to construction, from 0.8 m to 1.6 m and at the moment GWL on industrial area has an oscillatory character. The tendency towards a permanent increase is not defined.

The highest temperature of groundwater is observed at the site of the power units, where the maximum values up to 39.0°C and average annual values up to 19.2 – 23.0°C were detected. The temperature indicators of groundwater near power units are characterized as warm.

According to the results of the hydrochemical observations, the process of ZNPP operation does not affect the hydrochemical composition of water.

Chemical and radiological composition of the ground water on the territory of ZNPP, in the zone of influence, changes periodically and depends on local climatic and hydrological conditions.

The results of long-term monitoring of the water objects in area of SE ZNPP indicate the following:

- there is no significant chemical and thermal influence of Zaporizhzhya NPP on the surface water and ground water;
- thermal influence is limited with the territory, which is adjacent to the cooling pond.

Soils

In pre-starting period (1982-1983) average background of gamma level in area of ZNPP was (0.72 ± 0.086) mSv/year. This is a normal level, typical for this area.

The specific activity of radionuclides in the surface soil layer during this period consisted of:

- ^{90}Sr – (24 ± 11) MCI/km² $((0.89 \pm 0.41)$ kBq/m²);
- ^{137}Cs – (32 ± 14) MCI/km² $((1.18 \pm 0.52)$ kBq/m²).

ZNPP impact on the soil was in the course of the NPP construction; it was the destruction of the fertile layer of soil and it was limited to the territory of an industrial site.

Currently the impact on the soil is the result of deposition of radioactive and chemical contaminants from atmosphere.

According to long-term observations of the chemical composition and properties of soil cover, it was determined that among the mobile forms of chemical elements (that is the most ecologically significant, as it is responsible for the migration velocity on the food and cenosis chains), MAC of contaminants has not been exceeded.

The specific activity of ^{90}Sr in the surface soil layer (0-5 cm) is in the range from $1.2 \cdot 10^{-2}$ kBq/m² on sandy soils to $1.6 \cdot 10^{-1}$ kBq/m² in irrigated areas; ^{137}Cs – from $6.3 \cdot 10^{-2}$ kBq/m² on sandy soils to $4.5 \cdot 10^{-1}$ kBq/m² on the black earth, which corresponds to the «zero background».

The state of air in area of SE ZNPP is mostly conditioned by emissions of chemical pollutants from sources of ZTPP and other operating industrial enterprises of area.

The contribution of Zaporizhzhya NPP to total emissions of chemical pollutants is insignificant. Therefore, influence of SE ZNPP on the chemical composition of the soil is not dominant.

Expected impact of SE ZNPP on the soil, due to precipitation of radiation and chemicals from atmosphere, is insignificant and it will not cause the change of their characteristics.

Flora and fauna

In the pre-starting period (1982-1983) an average level of gamma background in area of Zaporizhzhya NPP was (0.72 ± 0.086) mSv/year. This is a normal level, typical for this area.

The specific activity of radionuclides in the local agricultural production during this period was:

- ^{90}Sr – from (0.06 ± 0.02) to (0.40 ± 0.03) Bq/kg;
- ^{137}Cs – (0.06 ± 0.01) to (0.49 ± 0.16) Bq/kg.

ZNPP impact on flora, fauna and protected objects is possible due to low-level emissions and discharges of chemical and radioactive substances to atmosphere and water objects.

According to the monitoring observations, the level of radionuclides in vegetation is significantly below that regulated one.

Mutagenic cases from activities of the NPP have not been found.

According to the measurements of chemicals, there is no excess of heavy metals in samples of vegetation.

Thermal pollution can lead to changes in the species composition of plankton and benthos in areas adjacent to the discharge. The temperature in water objects does not exceed the norms for fishery reservoirs.

According to the results of regime observations, in 2012-2014 the negative impact of ZNPP activities on hydrothermal regime is not detected. An impact on protected objects is significant.

During the further activity of ZNPP, additional degradation of flora and fauna groups in this area is not expected.

Social environment

The construction and operation of energy complex SE "NNEGC "Energoatom" have changed the demographic structure of socio-economic complex of the region and its socio-economic situation. Energodar, the satellite- town of ZNPP, was built. Today it has a high level of social conditions.

The dose exposure of the personnel, who serve equipment of SE ZNPP, is significantly below the permissible one, intake of radionuclides into the body of the personnel, is minimal and it is not a significant dose-forming factor.

Dependence of expected doses for the population on distance during operation of Zaporizhzhya NPP is shown in Figure 4.5.

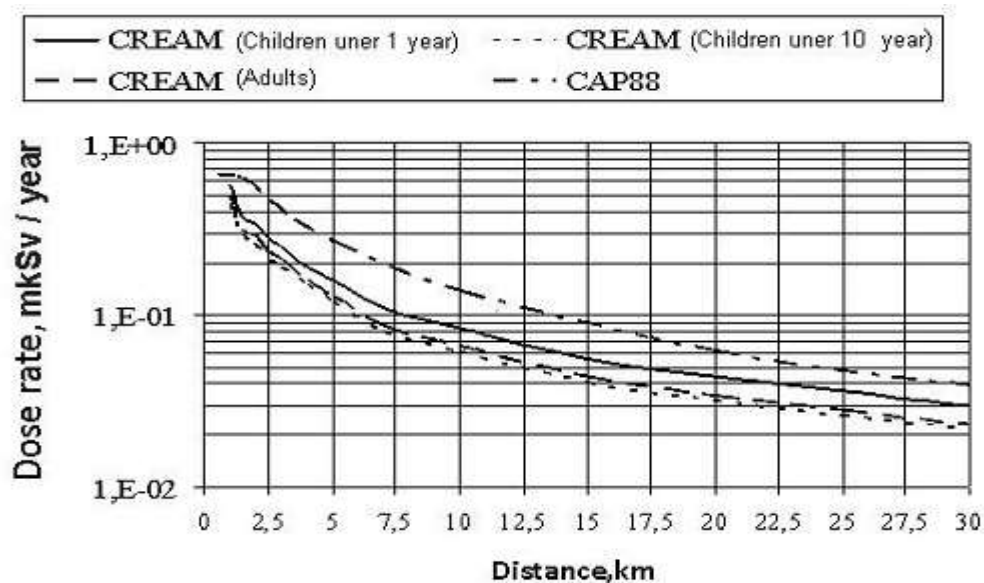


Figure 4.5 – Dependence of expected doses for the population on distance.

The maximum individual effective dose of population, due to emissions of radionuclides to atmosphere, during normal operating conditions at the SPZ boundary will not exceed 0.47mSv/year. It is 1.18 % of the quota of the dose limit for nuclear power plants due to emissions (40 mSv /year).

Values of expected individual effective doses of the critical group of population, due to discharges of radionuclides to surface water in the course of ZNPP operation, are given in Figure 4.6

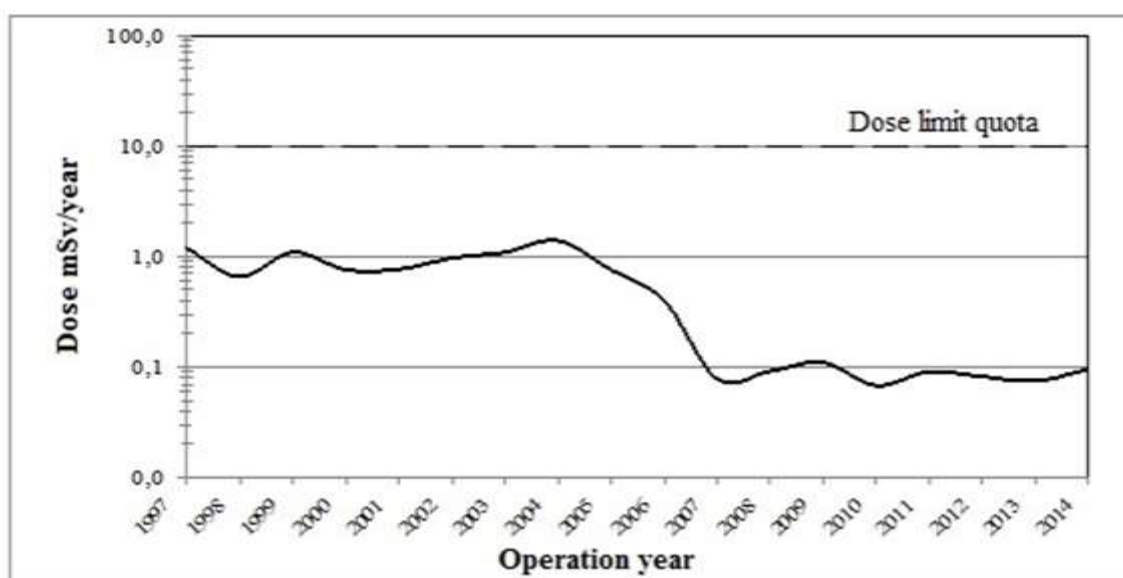


Figure 4.6 – Expected annual individual effective doses for the critical group of population due to discharges of radionuclides to surface waters.

The total expected individual effective dose for the critical group of population due to discharges of radionuclides to surface water will amount to 0.96% of the quota of the dose limit due to the critical use ($10 \mu\text{sv}/\text{year}^{-1}$), according to NSCU-97.

Radiation impact to the population due to emissions and discharges of ZNPP objects, under normal operation conditions, is significant. It does not exceed the established Ukrainian standards (at the moment as well as in the future). Doses for the critical group of population due to emissions and discharges are much smaller than the specified quota limit doses 40 and 10mSv/year (they are established by NSCU-97).

During design basis accidents the levels of unconditional justifiable emergency intervention under acute exposure are not exceeded, the levels of averted doses do not exceed the levels of unconditional justification; there is no need for planning of major emergency countermeasures, the use of auxiliary countermeasures at this level of averted doses is inappropriate; for 1 year under the most adverse conditions at the border of sanitary-protection zone and beyond, through inhalation of the whole body, and due to external irradiation, equivalent individual doses to the thyroid gland of children do not exceed the threshold of 0.3 SV/year or 0.1 SV/year.

The chemical impact of industrial objects of SE ZNPP on the population of adjacent territories is insignificant, but the location of the enterprise refers to industrialized, area of NPP refers to industrialized ones and the environment is anthropogenically polluted.

There is a developed system of effective social protection for employees and pensioners of ZNPP, effective social programs, social guarantees, compensations and different types of financial aid.

Anthropogenic environment

The region of location of SE ZNPP is populated, with a high level of industry and agriculture development. There are industrial and transport enterprises. Mining industry is represented with manganese-ore pool and Belozerka group of iron ore deposits. Agriculture is an intensive agronomy and developed cattle breeding.

Conditions of the location of ZNPP industrial sites exclude the possibility of external anthropogenic impact of other objects of economic activity (fire, explosion, emission of harmful gases, flooding, etc.), that may lead to violation of ZNPP normal operation.

Impact of SE ZNPP on anthropogenic objects of adjacent territories does not exceed the normative values. It suggests the possibility of further operation of the NPP, ensures the reliable operation of anthropogenic objects in area of its location.

The development of infrastructure and new enterprises (new anthropogenic objects) is restricted for reasons of safe operation of SE ZNPP. These limitations are related to the development of potentially hazardous activities, recreation activities, flying objects, transport of dangerous substances.

Operation of SE ZNPP is characterized with positive factors:

- the presence of ZNPP contributes to the development of the local economy, small and medium businesses that provide direct or indirect services related to activity of SE ZNPP;
- Energodar, the satellite-town, benefits from SE ZNPP investments to the infrastructure of the town.

5. ASSESSMENT OF ENVIRONMENTAL IMPACT IN TRANSBOUNDARY CONTEXT

According to the calculations and monitoring measurements, the concentration of pollutants in atmosphere at the sanitary protection area boundary does not exceed MAC for human settlements. The distance to the nearest neighboring country (Russia) is 250 km. Thus, there is no transboundary impact of NPP activities from the chemical factor.

Data, collected during a 30-year period of observations on the stationary points of the radiation monitoring, indicate that concentration of radionuclides ^{90}Sr , ^{137}Cs , ^{134}C , ^{60}Co , ^{54}Mn in air samples and atmospheric precipitation of the radiation control area are at the level of values, measured before the operation of NPP units. Thus, the impact of NPP on atmospheric environment, during its operation, was not significant even for the radiation control area.

The calculation of the total expected individual doses for the population at a distance of 200-1000 km from ZNPP, under adverse weather conditions is shown in Figure 5.1.

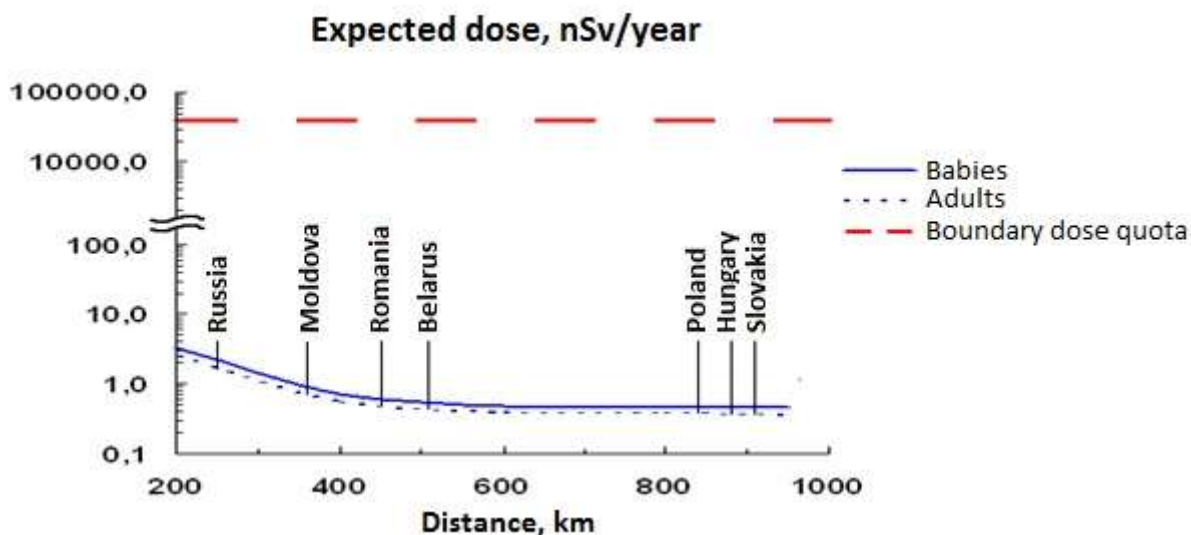


Figure 5.1 – Total expected individual doses for the population within the distance range of 200-1000 km from ZNPP

The dependence of total dose on distance is shown for two categories: children under one year and adults. Expected doses in a year are calculated after 50 years of emissions. It is seen that the critical group in this case are babies who receive larger doses. For the critical group – children aged 10 years, the calculation gave mean values between adults' doses and babies' doses.

Radiological impact of gas-aerosol emissions of ZNPP during normal operation is significantly less than the established dose limits for the population in the neighboring countries (this limitation for different countries is in the range of 0.2–0.3 mSv/year). At the border of the nearest country Russia (a distance of 250 km), annual individual effective dose doesn't exceed the value of 3.3 nSv/year.

The total effective dose over 50 years would not exceed 18 mSv, which corresponds to the basic criterion of limiting the population exposure in Europe due to the anthropogenic sources (effective dose for all routes of exposure 1 mSv/year).

The calculation of the expected effective individual doses during design basis accidents at ZNPP is done. Maximum value in the case of accidents 1 and 2 (Maximum design accident and break of collector cover of steam generator) is shown in Figure 5.2.

All distances to neighboring countries are within the range of the calculated distances.

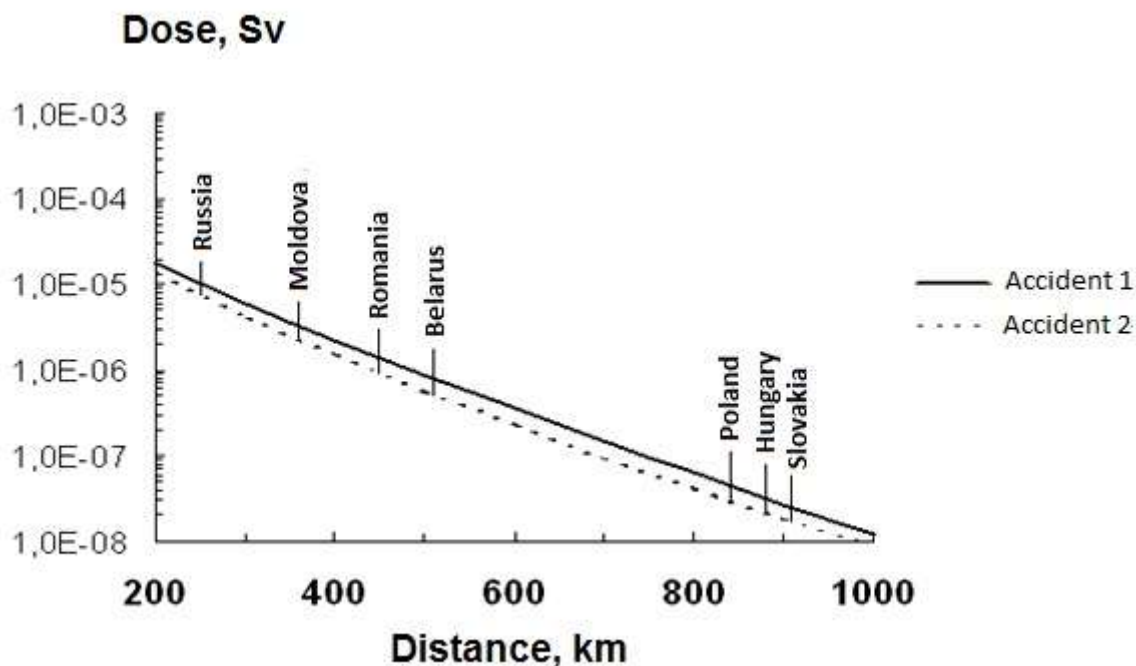


Figure 5.2 – Dependence of the expected effective dose on distance in the case of accidents 1 and 2.

Expected effective doses for the population after accident 1 are smaller, compared to natural radiation background. According to the report of the Scientific Committee of the UN General Assembly in 1993 (effects of nuclear radiation), an annual effective dose from natural sources of radiation in areas of normal radiation background is 2.4 mSv. In the case of accident 1, even at a distance of 200 km, expected effective doses in 50 years will be less than 20 mSv. That is, on the border with Russia (250 km), Moldova (360 km), Romania (450 km), Belarus (510 km), Poland (840 km), Hungary (880 km), Slovakia (910 km); expected effective doses will be even less in 50 years.

Thus, there is no transboundary impact of the planned activity. According to the Convention on environmental impact assessment in the transboundary context, there is no impacted party. To execute point 8 of article 3 of the Convention (ensuring public information), is sufficient to place the materials about assessment of impact of the planned activity on environment in transboundary context on public Internet resources, for example, on the websites of relevant state bodies: the Ministry of Environment and the Ministry of Energy and Coal.

6. COMPREHENSIVE MEASURES ENSURING NORMATIVE STATE OF ENVIRONMENT AND ITS SAFETY

The regulatory environment is ensured with activities that introduced at ZNPP. Environment protection measures are grouped by the following directions:

- resource-saving;
- protective;
- restorative;
- compensatory;
- security.

6.1 Resource-saving measures

The use of soil, water and fuel-energy resources belong to the resource-saving activities.

In accordance with the State act on the right of permanent use of land Series YaYa No.119249 dated 28/09/2006, land area of 1670.2371 hectares is in permanent use of State Enterprise National Nuclear Energy Generating Company «Energoatom» on the basis of the Decision 31 of Session of the 4th convocation of Energodar Municipal Council dated 23/03/2005.

Zaporizhzhya NPP is located at a sufficient distance from human settlements, objects of historical and cultural, natural-reserved fund.

The conservation and rational use of water resources is ensured with the design solutions in the field of technical and drinking water supply. For the purpose of saving water, there is a circulating water supply system with the use of the Kakhovka water reservoir.

SE ZNPP consumes 6 % of electricity of total production for house loads. To reduce these costs, certain measures are used at SE ZNPP: installation of energy-saving lamps, replacement of existing equipment with more energy efficient (pumps).

At NPP there is a storage of spent nuclear fuel in cooling ponds and dry spent nuclear fuel storage for further potential use.

6.2 Protective measures

It is very important for ZNPP to ensure the tightness of premises that contain radioactive substances. There is a containment of reactor building around the equipment of the first circuit for localization of activity in the case of leaks and ruptures and also for protection of the first circuit from extreme external influences, for the use of systems under pressure of the 1st circuit within containment and the intermediate circuits of cooling water.

Zoning of buildings and sites, according to their functional purpose, operates at ZNPP.

Depending on the purpose, the nature of technological processes and the level of radiation impact on the personnel, all production facilities and premises are divided into two zones: restricted area (controlled area) and free access area.

The division of NPP site into zones is also aimed at preventing the uncontrolled spread of radioactive contamination throughout the site and beyond.

Prevention or mitigation of the impact of NPP industrial activities are ensured with the following technical solutions:

- air purification from radioactive gaseous and chemical contaminants before release to atmosphere;
- collection of liquid and solid radioactive waste;
- organization of a special system of preserving and processing of liquid radioactive waste and solid radioactive waste;
- organization of a system of handling of general industrial non-radiation waste;
- the collection and purification of radioactive leaks are organized;
- waste water treatment in the system of special water purification;
- the conducting of processes according to instructions;
- –repairs and preventive work according to schedules;
- the use of tight, technological, gas treatment equipment and systems of gas waste;
- timely and regular treatment of gas purification plants;
- continuous monitoring of the serviceability of the ventilation system;
- installation of tanks with acids, ammonia, sodium hydroxide, lime and combustible-lubricating materials in the pallets;
- installation of barriers for radioactive substances;
- the use of closed circuits to prevent leakage of liquid substances, containing radioactive components;

General protective measures, conducive to the safe operation of NPP, obstacle and localization of emergency situations are:

- organization and arrangement of the sanitary protection zone;
- the system of accident localization of the reactor building;
- special localization systems, to prevent the spread of radioactive substances to environment;
- operation of systems of drainage and dewatering at ZNPP industrial site;
- operation of drainage system of buildings and industrial drain sewage system within industrial site;
- the use of special sewage pipes, made of stainless steel;
- regular maintenance work of water supply facilities;
- the surface slope of industrial site towards the coastline of the Kakhovka water reservoir;
- monitoring and cleaning of the roofs of turbine halls of power units from snow in winter;
- lightning protection of buildings and facilities at industrial site;
- the use of personal protective means by NPP personnel;
- improving and landscaping of ZNPP territory;
- monitoring of emissions to air, discharges to water objects, levels of radioactive and chemical pollution of soil, flora and water in the sanitary protection zone and surveillance zone.

6.3 Restorative and compensatory measures

Restoration of planting with means of reconstruction (lawns, planting of trees, shrubs, flowers) is carried out on ZNPP territory every year.

Economic measures to encourage activities aimed at reducing of impact on environment and their compensation are:

- establishing limits for the use of natural resources, emissions of polluting substances;
- establishing rates of payment for use of natural resources, emissions of polluting substances;
- reimbursement (in accordance with established procedure) of the losses caused with violation of applicable laws;
- promotion of the development of local economy, small and medium businesses that provides direct or indirect services, connected with activities of ZNPP;
- benefit from some investment to infrastructure of satellite-town Energodar, made by ZNPP.

In accordance with the current legislation of Ukraine, the population that resides in the 30-km zone of NPP supervision has the right to socio-economic compensation of risk from their activities, which includes:

- creation and maintenance of special social infrastructure;
- preferential rates for the use of electricity, established according with the law of Ukraine «About electricity».

Funding for compensation of risk of the population is carried out from special Fund of the state budget of Ukraine. Operating organization (operator) of nuclear installations - SE NNEGC «Energoatom» - pays a tax for the socio-economic compensation of risk in amount of 1 % of the total sales of electricity generated at the NPP during the relevant period (excluding VAT).

These funds are allocated as subsidies to special funds budgets of regional, district and city councils of multifunctional satellite-cities of nuclear installations, and distributed between the budgets in this ratio:

- regional budget – 30 %;
- budgets of districts and cities of regional subordination (except nonfunctional satellite-towns) – 55 %;
- budgets of multifunctional satellite-towns – 15%.

6.4 Security measures

Security measures include the monitoring of ZNPP activity impact area and the warning system of the relevant authorities and population.

Monitoring of the radiation conditions in industrial area, on industrial site of ZNPP, within sanitary protection area and radiation control area is carried out with use of radiation monitoring system (RMS). Radiation monitoring system includes:

- radiation monitoring of condition of protective barriers;
- process radiation monitoring;
- radiation monitoring;
- radiation monitoring of environment.

Radiation monitoring of environment includes:

- monitoring of gas and aerosol releases and water discharges to environment;
- the monitoring of activity and radionuclide composition of the radioactive substances, leaking from solid radwaste storage, liquid radwaste storage, reactor compartment, spray ponds;
- monitoring of annual irradiation dose in sanitary protection area and radiation control area;
- monitoring of radioactive pollution in atmospheric air, atmospheric precipitation, soils, vegetation, open water reservoirs, bottom sediments, algae, agricultural products (cereals, vegetables, fruit).

Radiation monitoring of environment in area of ZNPP is performed with using a network of fixed monitoring stations, located in the 30-km zone of ZNPP, (Figure 6.1) in the following parameters:

- exposure dose rate of gamma radiation in area with using measuring information channels «Ring»– 18 stations;
- annual dose of gamma radiation on the basis of thermoluminescent dosimeters TLD-500 K (42 stations with TLD dosimeters);
- total beta activity and radionuclide composition (density) of atmospheric deposition (18 ditches);
- concentration of radionuclides in atmospheric air (the surface layer) (12 aspiration systems);
- radionuclide composition of water and total beta activity of water systems in the area of NPP location and industrial site;
- total beta activity and radionuclide composition in the components of aquatic environment (bottom sediments, algae);
- the content of radionuclides in soil and vegetation;
- dose rate of gamma-radiation with portable MMT (means of measuring technique).

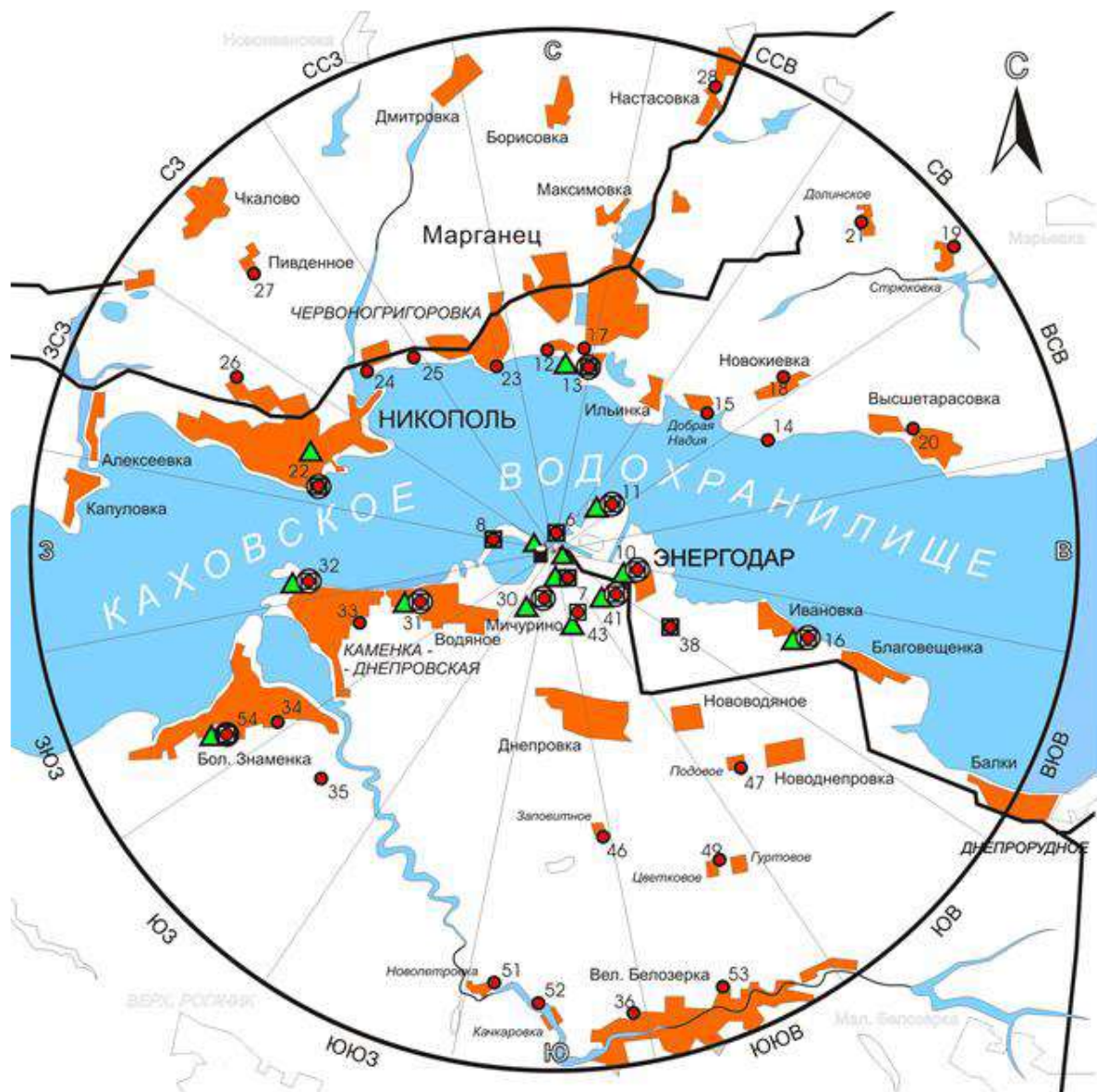


Figure 6.1 – Location of the stations for radiation monitoring in the 30 km zone of ZNPP
Stations include:

-  - Air filter installation, ditch for collection of atmospheric precipitation, container with TLD;
-  - Ditch for collection of atmospheric precipitation, container with TLD;
-  - Container with TLD;
-  Air filter installation, 4 ditches for collection of atmospheric precipitation, 4 containers with TLD (monitoring station);
-  -Detectors of IMS «Ring».

Objects and monitoring parameters, the number and frequency of sampling of the environment stipulated in the «Regulations for radiation monitoring during operation of ZNPP objects».

A full range of samples for background monitoring is provided at the checkpoint in village V. Znamenka (21 km).

Radiation monitoring of the environment (RME) under normal radiation situation and emergency radiation situation is performed with the laboratory of external radiation monitoring (ERM) of ZNPP Radiation Safety Department. It is certified in the state metrological supervision of the measurement while performing radiation monitoring of environmental objects. State of environmental quality, doses for the population, living in the surveillance zone of ZNPP, are estimated according to the results of radiation environmental monitoring information.

Environmental monitoring of non-radiation factors of ZNPP influence to the environment includes:

- inventory of all types of non-radiation sources of air pollution, surface water and groundwater pollution;
- performing accurate measurements of volume and concentrations of chemical pollutants, which are emitted and discharged with NPP to environment;
- transfer of results to the NPP and state statistical bodies;
- estimation and forecast of non-radiation pollution;
- inventory of NPP non-radioactive waste;
- evaluation of the use of natural resources;

Chemical monitoring of water resources, soils, and air pollution sources is carried out in accordance with:

- SEP Operations Chemical Laboratory schedule of chemical monitoring of external facilities water;
- SEP Operations Chemical Laboratory schedule of chemical monitoring of soil and bottom sediments;
- SEP Operations Chemical Laboratory schedule of chemical monitoring of air pollution sources;
- Schedule of stationary hydrogeological observations on the territory of ZNPP and in the area of its influence;
- Schedule of sampling for the determination of macro and micro components from piezometric wells of operating network and zone of its influence;
- Schedule IMQI measurements (ECL SEP 00.OS.GR.01-14);
- Regulations of continuous blowdown of ZNPP cooling pond to the Kakhovka water reservoir 00.OS.RG.01-12 that defines the locations and frequency of sampling;
- GOST 17.4.2.01-81 Nature protection. Soils. Sanitary condition nomenclature;
- Environmental monitoring of non-radiation influence on the environment at SE ZNPP is performed by Environmental Protection Service (SEP).

Since 1996 the monitoring group of hydro-meteorological parameters has been monitoring the meteorological environment in the area of ZNPP and informing ZNPP subdivision about dangerous and especially dangerous atmospheric phenomena.

It is recommended to perform activities on determination of seismic stability of important NPP facilities under the maximum design earthquake from Conesco fracture zone and Vrancea distant seismically active zone.

According to the results of seismic stability (vulnerability) to seismic impact, if necessary to develop measures of environment protection from the consequences of natural and technogenic disasters connected to the potential effects of earthquakes at ZNPP.

To assess the seismic risk of NPP from the seismic data, obtained with instrumental observations, it is necessary to complete the arrangement of local networks of seismological observations in regions of their location, according to the «Plan of actions for the seismic hazard assessment and verification of seismic stability of operating NPP», approved by the Ministry of Energy and Coal Industry of Ukraine, National Nuclear Energy Generating Company "Energoatom" and State Nuclear Regulatory Inspectorate of Ukraine.

Monitoring data are used with SE ZNPPP to report to the environmental supervision and state statistics bodies, to determine measures for conservation, restoration and rational use of natural resources, and to inform local authorities, public and public environmental associations.

According to the requirements of environmental and sanitary legislation of Ukraine, conducted comprehensive assessment of the NPP impact on the environment, social, nature, technogenic conditions and factors in the NPP area, implemented activities at NPP are estimated as optimal.

7 LIST AND CHARACTERISTICS OF RESIDUAL IMPACT

Excess negative residual impact of ZNPP activities on the environment is not fixed and not expected in future, under the condition that the full range of implemented activities will be carried out.

Residual negative impact includes radiation, chemical and acoustic contamination that does not exceed the normative values, as well as the impact on surface water due to discharges of return waters and during blowdown of the cooling pond.

All industrial wastes are saved and utilized in accordance with sanitary regulations in the prescribed manner.

Operation of SE ZNPP is characterized with positive factors:

- ZNPP contributes to the local economy, small and medium business, which provides direct and indirect services, connected with the activities of NPP.
- satellite-town Energodar benefits from ZNPP investments to the infrastructure of the town.

CONCLUSIONS

Non-technical Summary is a document review, which was prepared on the basis of the report «Development of materials for assessment of environmental impact in the course of ZNPP operation».

The main conclusions of this analysis are the following:

1. Operation of ZNPP power units No.1, 2 is done in accordance with the design, the limits and conditions of the security, provided with the operating license; requirements of the applicable standards and rules on nuclear and radiation safety are performed;

2. As a result of the safety analysis of power units with deterministic and probabilistic methods, it was confirmed that to date, requirements for the safety of reactor installations of units No.1 and No.2, defined with the regulatory documents, are performed in sufficient volume. Evaluation of security analysis requires continuous study, monitoring and analysis of CCSUP implemented measures (Complex (consolidated) Safety Update Program) and modernization, aimed at improving safety, accumulation and maintenance of statistical data up to date.

3. The construction of NPP power units caused some changes to local landscapes, topography, surface and groundwater, soil and vegetation cover and the like.

4. Current state of the natural environment, climate, the surrounding landscape, flora and fauna, geological environment is not fundamentally different from the situation that was prior to the construction of the NPP.

5. At the moment it is recorded that general ecological state of the components of the natural environment within the monitoring zone of NPP is defined as stable. There are not any anomalous effects of technological processes of power units operation and accompanying infrastructure.

Assessment of individual components of the natural environment showed the following:

– *Microclimate* – at the present level of research it is impossible to fix and select the changes in microclimatic conditions from the global climate trend that can be related to the effects of ZNPP. The consequences of the intensified evaporation and thermal effects are offset with atmospheric convection transfer.

– *Atmospheric air* – effects are revealed in the form of thermal, chemical, radiation pollution, admission of water vapor, etc. Levels of air pollution outside of the sanitary protection zone, according to one of controlled ingredients, do not exceed the accepted national and international sanitary, ecological, radiological restrictions.

– *Geological environment* – the NPP impact on the geological environment within its location was defined during the construction and commissioning of the industrial complex.

The influence of processes of newest tectonics, geodynamic and seismic impacts do not cause complications for ZNPP further work.

– *Water environment* – gets constant thermal, chemical and radiation exposure, their levels (none of controlled levels) do not exceed the accepted national and international sanitary, ecological, radiological restrictions. Changes in the conditions of flow and operation levels of surface and groundwater, connected with the operation of facilities, do not cause complications that may require intervention.

– *Soils* – levels of chemical and radiation pollution of soils do not exceed thresholds, established with national and international standards.

– *Flora and fauna, objects and territories of nature reserve fund* - impact on flora, fauna and protected objects, related to the work of ZNPP, hardly noticeable outside the sanitary protection area of the plant.

6. Radiation doses for the personnel and the population are much below the levels, permitted with the applicable regulations and standards.

7. There is a probability of potential consequences of design and beyond design basis accident of various types. Simulation of different situations, in terms of estimation of influence of the emergency emissions to the environment and the population, has showed that in any scenario, outside of the sanitary protection area, existing regulations will not be violated. The transboundary impact in the course of continued operation of NPP power units (that could potentially require a response) is excluded.

8. There is an effective monitoring system of ZNPP emissions and discharges.

In general, the production activity of SE ZNPP does not lead to significant negative consequences for the natural environment, it has significant positive social and economic impact at the level of the entire state, and it is environmentally acceptable.