Ministry of Power engineering and coil industry of Ukraine
State Enterprise "National Nuclear Energy Generating Company "Energoatom"
SE "Zaporizhzhya NPP"

Agreed
Chief Engineer (First Deputy General Manager)
ZNPP

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NON-TECHNICAL SUMMARY

Safety Case materials for lifetime extension of SE ZNPP power units №1,2 for post-design period

2015

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LIST OF ACRONYMS

NPP	Nuclear Power Plant
ASAM	Anionic surface-active material
LOCA	Loss of coolant RPV accident
DF	Power unit demineralizer facility
RMT	Radiation monitoring tank
WWER	Water – water power reactor
GRD	Geotechnical research department
VCC	Ventilated Concrete Cask
CP	Cooling pond
LPD	Labor protection department
SE ZNPP	Separated Entity "Zaporizhzhya Nuclear Power Plant
SF	Spent fuel
LC	Limiting concentration
HPP	Hydroelectric power plant
CMWRG	Group of chemical monitoring of water resources
HED	Hydraulic engineering department
MCC	Main Circulation Circuit
SNRIU	State Nuclear Regulation Inspectorate of Ukraine
SE SSEC	State Enterprise "State Scientific Engineering Center of monitoring and emergency response systems"
SE NNEGC "Energoatom"	State Enterprise National Nuclear Energy Generating Company "Energoatom"
EE	Ecological Evaluation
ECL	Ecology-chemical laboratory
ZTPP	Zaporizhzhya thermo electrical power plant
PSRR	Periodic Safety Review Report
MA	Monitoring area
IMS	Information and measurement system
IRG	Inert radioactive gases
MI	Measuring instrumentation
CSUP	Complex Safety Upgrade Program for Ukrainian power nuclear units
ERML	External Radiation Monitoring Laboratory
MP	Measurement procedure
MDA	Minimum detectable activity
MDBE	Maximum design-basis accident
MCE	Maximum credible earthquake
NTS	Non-technical summary
EIE	Environmental impact evaluation
SSS	Shared sewage system
STP	Sewage treatment plant
OSTP	Oiled sewage treatment plant
MSRRSAU	Main Sanitary Rules for radiation safety assurance of Ukraine
EDR	Exposure dose rate
DBE	Design basis earthquake
SWS	Storm water sewage
LE	Lifetime extension
SO	Scheduled outage
RW	Radwaste
RNPP	Rivne Nuclear Power Plant

RC	Reactor compartment
EDGP	Emergency diesel generator plant
RPS	Radiation protection structure
RM	Radiation monitoring
LRW	Liquid radwaste
RM	Radiation conditions
SWT	Special water treatment
BSOS	Building and structure operation service
SES	Sanitary-epidemiologic service
SPA	Sanitary protection area
CPS	Control and protection system
EPS	Environmental protection service
RPS RSD	Radiation protection service of the radiation safety department
SFDS	Spent Fuel Dry Storage
CWSSRC	Circulating water supply system for responsible consumers
LRS	Liquid radwaste storage
SRS	Solid radwaste storage
FE	Fuel element
TPP	Thermoelectric power plant
SR	Solid radwaste
CM	Construction Management
CCM	Capital construction management
UkrNDEP	Ukrainian Scientific and Research Institute of Ecological Issues
PRMMM	Public relations and mass media management
SWT	Special water treatment facility
RSD	Radiation Safety Department
SUNPP	South-Ukrainian Nuclear Power Plant

1 BASIS FOR DEVELOPMENT OF NON-TECHNICAL SUMMARY OF MATRIALS IN PART OF SAFETY CASE FOR LIFETIME EXTENSION OF ZNPP POWER UNITS №1, 2 ЗАЕС AND THEIR DISCUSSION

1.1 Introduction

Non-technical summary (NTS) is an overview document that does not contain any specific evaluations or independent conclusions and is completely based on the information specified by the provided links.

Lifetime extension of power units in operation for post-design operation period is specified by "Energy strategy of Ukraine for the period till 2030" and is one of the required condition of implementation of the strategy's objectives and tasks. 30-year periods of NPP operation established in their designs were based on exceedingly conservative approaches that in their turn were based on knowledge available for the moment of the power units design, at the absence of significant experience of their operation. Practical operating experience has shown that actual lifetime of the NPP main components is longer than it was assumed earlier, and replacement of other components can be done at acceptable costs.

The tendency to extend lifetimes of power units for post-design operation period is accepted in many countries operating nuclear power plants. Lifetime extension of Ukrainian nuclear power plants to post-design operation period shall allow ensuring both support of power production on the achieved level till new facilities are commissioned, and accumulation of required finances for decommissioning of power units without essential increase in the load on the consumer.

Economical expediency of power unit lifetime extension is demonstrated by the following figures: if approximate expenses for new unit construction in accordance with international practices are equal around ~ 60-80 billion UAH (~ 5-7 billion €); expenses for lifetime extension of SUNPP power unit№1 according to plant specialists will equal ~ 3500 UAH per 1 kWt of installed capacity or 3,5 billion UAH in general, which comprises ~ 5% of new unit construction cost.

Activities related to lifetime extension of the NPP units in operation are regulated by international agreements signed by Ukraine:

1. Law of Ukraine «About ratification of Nuclear Safety Convention», №736/ 97-ВР dated 17.12.1997.
2. Law of Ukraine «About ratification of Convention about access to information, public participation in the decision making process, access to justice administration in part of issues concerning environment», № 832-XIV dated 06.07.1999.
3. Law of Ukraine «About ratification of Unified convention about safety of spent fuel treatment and safety of radwaste treatment», № 1688-III dated 20.04.2000,

By Laws of Ukraine:

1. Law of Ukraine «About environmental protection» № 1264-XII dated 25.07.1991.
2. Law of Ukraine «About use of nuclear power and radiation safety» №39/ 95-ВР dated 08.02.1995.
3. Law of Ukraine «About the procedure of decision making in part of location, design, construction of nuclear facilities and objects intended for radwaste treatment, of the State significance» № 2861-IV dated 08.09.2005 р.
4. Law of Ukraine «About radwaste treatment» №255/ 95-ВР dated 30.07.1995.
5. Law of Ukraine «About licensed activities in the area of nuclear power use» № 1370-XIV dated 11.01.2000.
6. Law of Ukraine «About protection of people from ionizing radiation» №15/ 98-ВР dated 14.01.1998.
7. Law of Ukraine «About ecological expertise» №45/ 95-ВР dated 09.02.1995.
8. Law of Ukraine «About regulation of issues related to nuclear safety assurance» № 1868-IV dated 24.06.2004.

And other legal standards.

1.2 Procedure of taking decisions in part of NPP units lifetime extension

The procedure of making the decisions about NPP power units lifetime extension is specified by the Law of Ukraine «About the procedure of decision making in part of location, design, construction of nuclear facilities and objects intended for radwaste treatment, of the State significance». In compliance with this law, the decision about power unit lifetime extension shall be taken by the State nuclear and radiation regulation body by means of making changes in the license based on periodic safety review materials.

Important moments of lifetime extension activities of SE ZNPP power units №1, 2 are the following:

- The activity doesn't foresee new construction or changes in the existing design;
- Power unit capacity remains the same and power production amounts are not changed;
- Environmental impact does not change, and even decreases due to implementation of new planned activities.

Ukrainian legislation and ratified international agreements in part of issues related to potential impact of planned activities on environment foresee participation of public in the process of taking decisions: timely information about planned activities and their discussions, with possibility of submitting of any questions, notes or opinions during public sessions, both orally or in written form, related to corresponding activities, with proper account of public participation in consequent decisions.

In order to involve public and their associations in consideration of issues related to nuclear power use, local state bodies and self-government bodies can organize public hearing. Public hearing procedure is established by the Cabinet of Ministers of Ukraine.

In compliance with the Order of the Cabinet of Ministers of Ukraine "About public hearing procedure in part of issues of nuclear power use and radiation safety» № 1122 dated 18.07.1998, the matter of public hearing is, among others, review of materials of safety justification of power unit lifetime extension, and of issues related to the impact of the specified facilities on environment and public health.

1.3 List of information sources used for development of the Summary

One of important aspects of SE ZNPP activities is maintaining on a high level and constant increase in nuclear, radiation and ecological safety, and environmental protection. Constant monitoring of releases and discharges of radioactive material to the environment, measurement of radionuclide concentrations in water, bottom sediments, ground, vegetation, atmospheric air and precipitation are done in the frames of this activity.

This monitoring during the entire period of ZNPP operation is reflected in annual reports. Besides, data about radiation safety state and radiation protection at ZNPP can also be found in the annual reports called "State of radiation safety and radiation protection at ZNPP". Results of monitoring of ZNPP impact on the environment can also be found in "Reports on evaluation of non-radiation factors impact".

Besides, significant amounts of output data and information related to evaluation of ZNPP environmental impact and lifetime extension of its power units are reflected in general reports:

- Periodic Safety Review report. Factor №14. NPP operation impact on the environment;
- Complex Safety Upgrade Program of Ukrainian NPPs: ecological evaluation;
- National Ukrainian report "Stress-tests results";
- Report about ZNPP ecological audit.

The main document that serves as the basis for approval of the decision to extend ZNPP license validity period for operation of power units during post-design operation period is "Periodic Safety Review Report" further (PSRR)

Analysis of 14 safety factors grouped into Chapters and represented by independent reports is performed within PSRR scope.

SF-14 Chapter contains the report "NPP operation impact on the environment. Its objectives are as follows:

- description of the existing system of radiation monitoring of SE ZNPP impact on the environment, activities in part of modernization of the system, representation of information about actual NPP impact on the environment based on the monitoring results;

- conduction of comparative analysis of the actual ZNPP impact on the environment with the specified limits;

- representation of information about activities aimed at decrease in ZNPP impact on the environment, and about absence of preconditions for exceeding of the specified limit during extended post-design operation.

«Complex Safety Upgrade Program for Ukrainian nuclear power plants" (CSUP) is developed on the basis of the Order of President of Ukraine №585/2011 dated 12.05.2011 "About putting into force of the National Safety and Ukrainian Defense Council decision, dated 8 April 2011, and named "About safety improvement of Ukrainian nuclear power plants operation".

The objectives of the program are as follows:

- Improvement of the safety level of nuclear power units and of reliability of their operation;
- Risk decrease in accident occurrence at nuclear power plants during natural disasters or other extreme situations;
- Improvement of effectiveness of design-basis and beyond-design basis accident management at nuclear power plants and minimization of their consequences.

To ensure compliance with environmental protection requirements and ecological safety, Ecological Evaluation of CSUP implementation was made.

After the severe accident on Fukusima-1 (Japan) that occurred on 11 March 2011, European Community Council made a statement on 24 March 2011 about the necessity to re-evaluate safety of European nuclear power plants based on comprehensive risk analysis. ENSREG and European Commission approved technical requirements to conduction of corresponding "stress-tests", the objective of which was detailed analysis of extreme natural events and their combinations that could possibly impact NPP safety functions and lead to severe accidents.

State Nuclear Regulatory Inspectorate of Ukraine together with State Man-caused Safety Body and SE NNEGC "Energoatom" developed an Action Plan for targeted special safety evaluation and further safety improvement of Ukrainian nuclear power units, taking into account the events on Fukusima-1. Targeted special evaluation of safety conditions of all Ukrainian nuclear power units in operation was performed in compliance with the plan.

Results of stress-tests are reflected in Ukrainian report developed by State Nuclear Regulatory Inspectorate of Ukraine.

Beside evaluations and stress-tests mentioned above, similar ecological audit of ZNPP power units was performed in 2014 – 2015. Its objective was recognition by an independent expert company of ecological justification and effectiveness of SE ZNPP power units operation during extended post-design period, determination of compliance of lifetime extension activities with requirements of Ukrainian legislation in the area of environmental protection.

2 GENERAL CHARACTERISTICS OF SE ZNPP

2.1 General information

SE "Zaporizhzhya NPP" is a separated entity (structural unit) of the State Enterprise National Nuclear Energy Generating Company "Energoatom". SE NNEGC Energoatom implements its activities in compliance with its statute and is subordinate to the Ministry of Energy and Coil Industry of Ukraine that forms 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.

SE ZNPP site is located in Zaporizhzhya region, in Kamyanka-Dniprovska district, on the left bank of the central part of the Kakhovka water reservoir, 70 km downstream Zaporizhzhya and 160 km upstream from Kakhovka hydroelectric plant dam.

The plant satellite town is Energodar. In the 30 km monitoring area beside Energodar, several other towns are located: Kamyanka-Dniprovska, Marganets, Nikopol. There are also villages, making in total 59 settlements located in the 30 km monitoring area: 27 - in Zaporizhzhya region, 30 - in Dniepropetrivsk region and 2 - in Kherson region.

SE ZNPP site location and boundaries of its monitoring area are shown in the Figure 2.1.

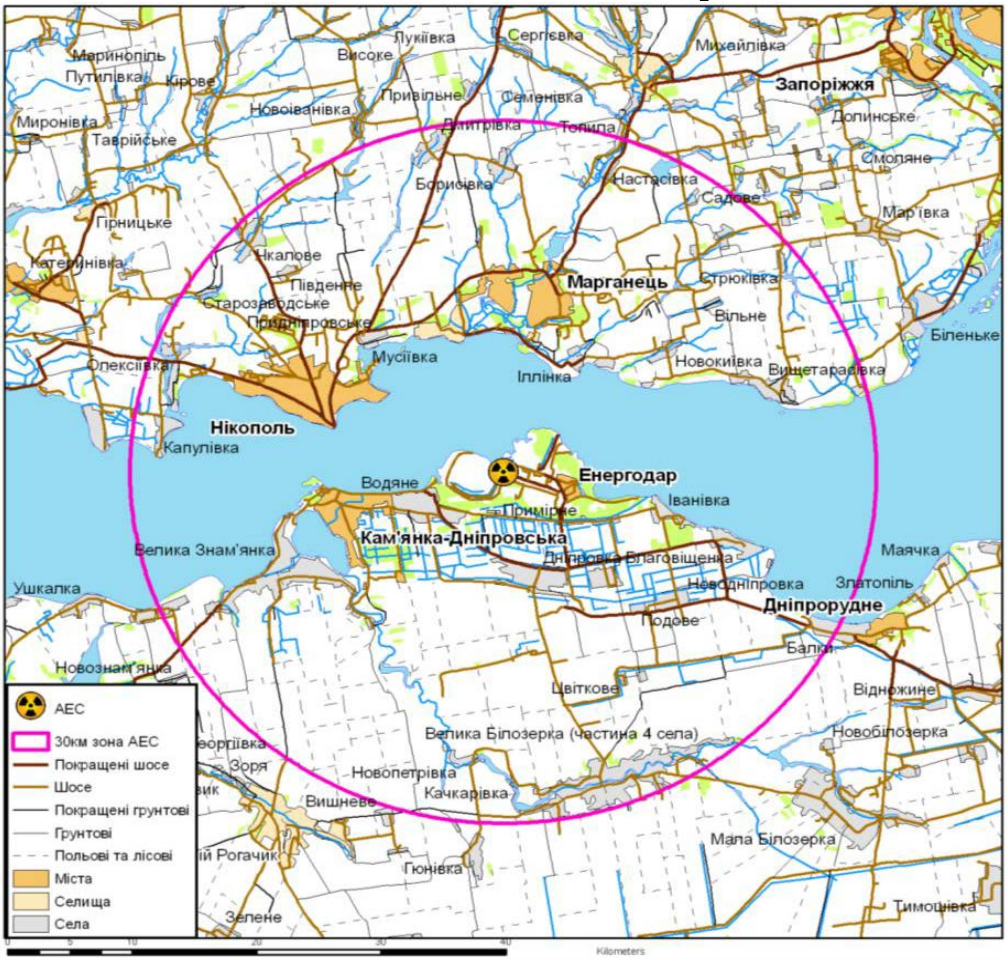

Figure 2.1 – SE ZNPP location area

Technical and economical justification of SE ZNPP construction was made by Kharkiv division of "Atomenergoproject" Institute, it was approved by StatePlan Body of USSR and SateBuild Body of USSR (letter № VI-1570(22-953) dated 02.09.1977.

NPP construction was conducted on the basis of Technical Project of Series 1 (400 MWt) and Series 2 (2000 MWt) approved by the Orders of USSR Council of Ministers No. 200r dated 04.02.1980 and No. PP-21084 dated 01.10.1988.

The General Designer was Open-Stock Joint Company "Kharkiv Scientific-Research and Design-Constructional Institute "Energoproekt". The construction was conducted by the General Contractor – SE ZNPP Construction Management – "Soyuzatomenergostroy" subordinate to 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.

Total installed capacity of the nuclear power plant is 6000 MWt.

2.2 Lifetime periods of SE "Zaporizhzhya NPP power units

Taking into account analysis of the applicable legislation, nuclear and radiation safety norms and rules, state construction norms, scope of the completed works during SE ZNPP Unit 1 commissioning, Act of commissioning into operation of the constructed unit by the State

Acceptance Commission and other documents, the decision was to consider **23.12.1985 –** the date of taking of SE ZNPP Unit 1 to full power operation as the date of beginning of the "operation" stage of its life cycle.

Based on the said above, the design 30-year lifetime of SE ZNPP Unit 1 will expire on 23 December 2015; of SE ZNPP Unit 2 – 19 February 2016.

Table 2.1 – Information about SE ZNPP power units

Unit №	Reactor facility type	Reactor facility series	Date of unit connection to the grid	Date of commissioning to commercial operation	Design lifetime expiration
ZNPP-1	WWER-1000	B-320	10.12.1984	23.12.1985	23.12.2015
ZNPP-2	WWER -1000	B-320	22.07.1985	19.02.1986	19.02.2016
ZNPP -3	WWER -1000	B-320	10.12.1986	05.03.1987	05.03.2017
ZNPP -4	WWER -1000	B-320	18.12.1987	04.04.1988	04.04.2018
ZNPP -5	WWER -1000	B-320	14.08.1989	27.05.1990	27.05.2020
ZNPP -6	WWER -1000	B-320	19.10.1995	21.10.1996	21.10.2026

2.3 Brief characteristics of SE ZNPP production

Each year, SE ZNPP generates more than 20 % of the total power generated in Ukraine; by the production amounts, it satisfies power needs and provides normal living conditions for more than 9 mission people.

SE ZNPP also provides heat source for the plant site and Energodar. Total installed capacity is 1200 Gkal/year (200 Gkal/year per each unit).

2.4 Data about raw, land, water, power and other types of used resources

The following resources are used for SE ZNPP production needs:

- NPP territory (including the cooling pond) comprises approximately16 km^2:
- plant site - 104 hectares;
- sewage disposal plant for plant sewage water treatment - 23 hectares;
- area under structures and constructions - 97 hectares;
- hydraulic structures, together with the cooling pond - 1520 hectares;
- use of circulating water via the cooling pond is more than 300 mln m^3 per year;
- water evaporation with cooling aim: around 100 mln m^3 per year;
- house load power: 6% from total production amount.
- diesel fuel (for emergency power supply etc): 3 000 m^3 resource;
- oil (for turbines etc): 4 800 m^3 resource;

2.5 Brief description of the power units and technological processes

SE ZNPP general diagram (layout) is given in the figure 2.5.1

1.Reactor building
2.Turbine building
3.Diesel generator
4.Unit pumping plant
5ª, 5б.special buildings № 1, 2 (including radwaste treatment building

6.Solid radwaste storage
7.Plant shared building
8ª, 8б.Laboratory and office buildings № 1, 2
9 Administration buildings and Check Gate 1
10.Check Gate 2

11. SFDS site
12. Sprinkler pond
13. Canteen
14. Full Scope Simulator
15. Training Center

Figure 2.5.1 – SE ZNPP diagram

The principle of module setting-up lies in the basis of SE ZNPP design. Beside normal operation systems, each of the power units foresees all the systems that ensure unit's radiation and nuclear safety, safety shutdown, cooldown, residual heat removal – irrespective of modes of operation of other power units.

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

- WWER-1000 (В-320) reactor;
- K-1000-60/1500 – 2 type turbine;
- ТВВ-1000-4 УЗ electrical generator.

Water-water nuclear reactor VVER-1000 on thermal neutrons serves for production of thermal power (rated heat capacity is 3000 MWt.). The reactor operation is based on controlled chain nuclear fission reaction of ^{235}U that 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.

Power unit with WWER-1000 operates based on two-circuit diagram: primary circuit (radioactive) – is water directly taking heat from the reactor; secondary circuit (non-radioactive) is steam that receives heat from the primary circuit and utilizes in the turbine generator. Operation diagram for NPP with WWER-1000 reactor type is given in the figure 2.5.2.

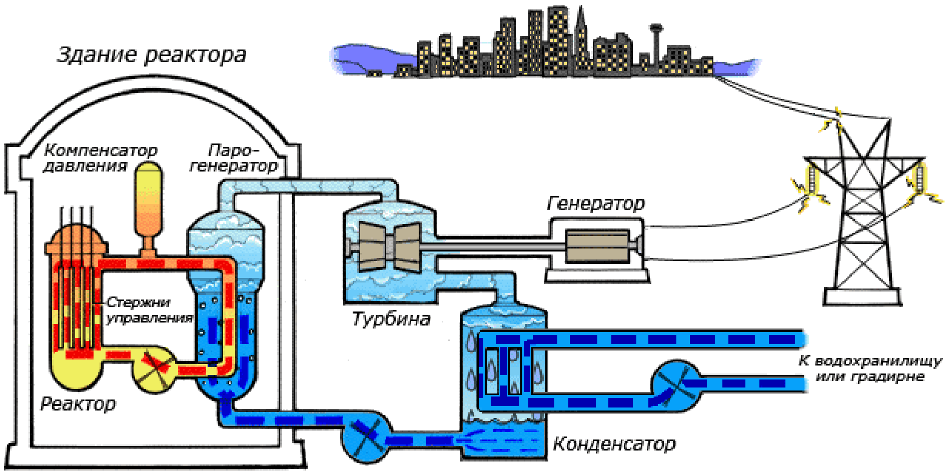

Figure 2.5.2 Operation diagram for NPP with WWER-1000 reactor type

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

As moderator and coolant, WWER-100 reactor utilizes pressurized water, pressure of 160 kgf/cm^2. Total flow rate of the coolant through the reactor is 84800 m^3/g. Water temperature at the reactor inlets during operation on power equals 290ºC, at the output it equals 320ºC.

Same as with any steam-turbine power plant, thermal 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 at ZNPP is based on open cooling pond, sprinkler ponds and cooling towers that are connected in parallel (figure 2.5.3).

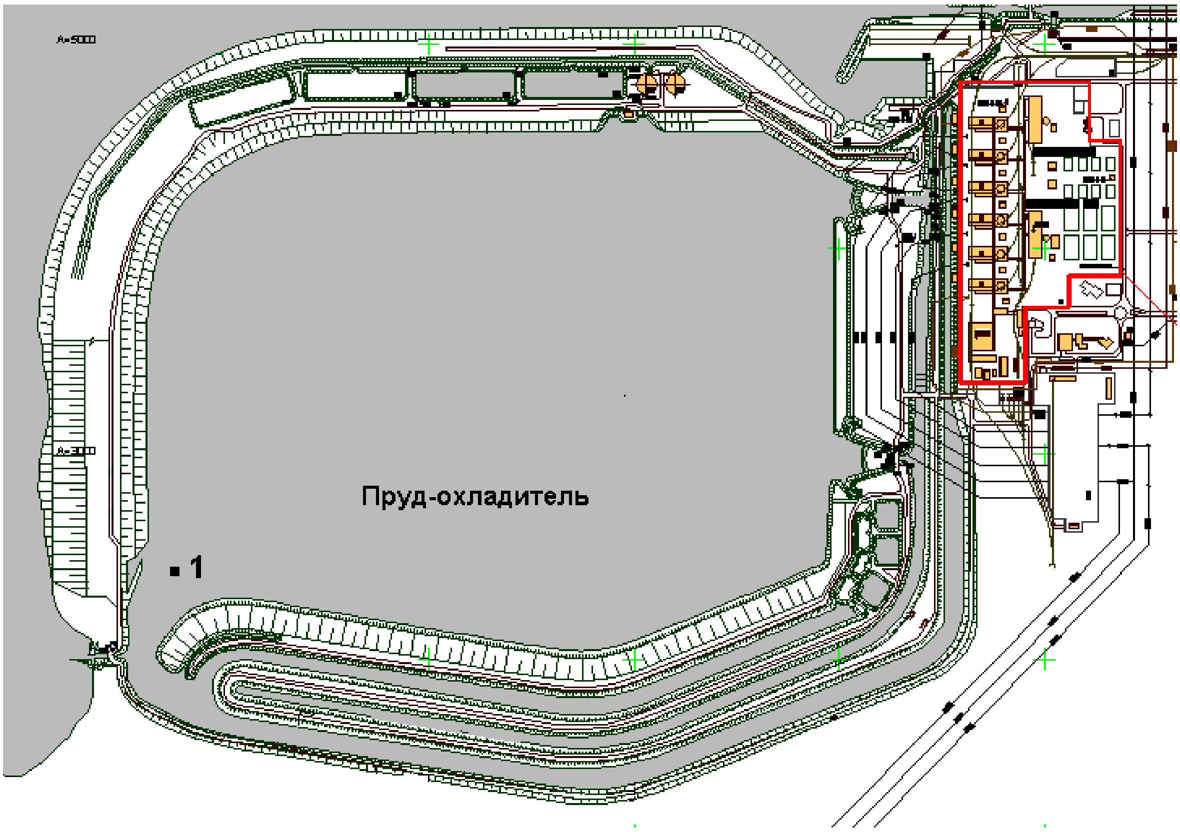

Figure 2.5.3 ZNPP cooling pond diagram

2.6 Main radiation safety sources

Main radiation sources at SE ZNPP are the following:

- 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 systems;
- 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)

During NPP operation in the normal operation mode, localization of the main amount of radioactive material is ensured in the reactor facility and in specialized water and gas treatment systems

2.7 Spent nuclear fuel treatment system. Spent nuclear fuel amounts

Spent nuclear fuel generated during power generation in reactors is one of the most important components of NPP operating cycle.

After operation in the reactor core (reaching design burn-out value), spent nuclear fuel is loaded to the spent fuel ponds in the reactor hall where it is stored within 4-5 years, to decrease radioactivity and residual heat generation. After cooling down in the spent fuel ponds, spent nuclear fuel is loaded to special casks that ensure safety of its transporting.

Modern conditions of nuclear power industry in the world at the contemporary state of science and engineering development does not allow for taking an unambiguous decision in relation to future spent fuel treatment. World practices have several approaches to this issue:

- Suspended decision foresees long-time spent fuel storage, which face allows for taking a final decision in part of SF treatment in future, taking into account future technologies and economical factors. The way of such suspended decision was chosen by such countries as Argentina, Denmark, Spain, Canada, Lithuania, Germany, Norway, South Korea, Slovakia, Hungary, Czech Republic and Croatia;
- Spent fuel processing allows for obtaining components and materials use of which is economically expedient (in particular, uranium and plutonium that are further used for manufacture of MOX fuel for thermal reactor or fuel for reactors on fast neutrons) and significant reduction in total amount of waste for disposal. Processing is possible both local (Great Britain, India, Russian, France, Japan) and processing in other countries with return of high radioactivity level waste to the spent fuel manufacturing country (Austria, Bulgaria, Greece, Netherlands, Switzerland);
- Spent nuclear fuel disposal: spent fuel after technological conditioning is sent for final disposal to underground (geological) repository designed thus as to retain radioactive fission materials and actynoides during time periods sufficient for prevention of any hazardous impacts on the environment (USA, Finland and Sweden).

At present spent fuel from SE Rivne NPP, SE Khmelnitsky NPP and SE South-Ukrainian NPP is sent to Russian Federation: fuel from WWER-1000 type reactors goes for storage (for further processing) and fuel from WWER-440 (RNPP 1 and 2) – goes directly for processing.

Taking into account significant concentration of capacities at SE Zaporizhzhya NPP – 6 power units with WWER-1000/B-320 reactors - in 1998 a decision was made to construct spent fuel storage on the NPP site.

For SE ZNPP, Design of “Duke Engineering & Services” (DE&S) jointly with “Sierra Nuclear Corporation” (SNC), was selected. It is based on the technology of interim fuel storage in ventilated concrete casks installed on concrete site (VSC-WWER system).

The storage is designed for 380 casks capable of housing 9000 spent fuel assemblies. This system is capable to store SE ZNPP spent fuel for all its operational lifetime period. Spent fuel can be safely stored in the SFDS during 50 years – till final decision of the issue of its further storage, processing or disposal.

To ensure monitoring of safe cask operation, constant radiation monitoring is established onsite. Radiation environment monitoring on SFDS site is comprehensive and constant. Safe plant operation, including SFDS operation as an independent nuclear facility is considered by SE ZNPP administration as a highest priority task.

In compliance with the design, a radiation protection wall is constructed allowing for exclusion of any impact of radiation factors on SE ZNPP, public and environment.

As of 01.08.2015, ZNPP SFDS site has 129 casks installed, they contain 3090 fuel assemblies with spent fuel.

2.8 Design decisions on radwaste treatment

2.8.1 Solid radwaste

Solid radwaste is split into 3 categories in compliance with their radioactivity level:

- Category I includes: cleaning and insulation materials, special overalls, footwear, individual protection means, flexible plastic, construction waste, devices and tools.

- Category II includes: pipes, valves, components of pumps and drives of control and protection system, ventilation filters, metal scrap, thermal insulation materials, replaceable indicators.

- Category III includes: interim hoses, emergency/compensation controls nodes, ionization chambers with connection cables, heat and energy emission detectors with connecting cables.

Radwaste of categories I, II is stored in concrete casks in the storage the capacity of which is designed based on the following criteria:

- storage period: till the unit decommissioning;
- possibility of future relocation and disposal;
- storage of fire hazardous and fireproof waste in plastic bags;
- storage of specialized ventilation filters without preliminary processing.

Radwaste of category III is stored in corresponding storages on the power units. Their capacity is determined so that it is sufficient for the entire NPP operation period.

Quarterly and annual solid radwaste generation amounts for 2012 and 2014 at SE ZNPP are given in the table 2.8.1.

Table 2.8.1 – Solid radwaste amounts generated during 2012-2014 at SE ZNPP

	2012					**2013**					**2014**				
	I quarter	**II quart**	**III quart**	**IV quart**	**Total year**	**I quart**	**II quart**	**III quart**	**IV quart**	**Total year**	**I quart**	**II quart**	**III quart**	**IV quart**	**Total year**
Solid radwaste generat.	121,	19	21	17	69	192	186	221	183	784	152	171	162	143	629

amount, m³	447	3,033	0,777	3,475	8,732	,5563	,5716	,9519	,3404	,4202	,7526	,4898	,1007	,4406	,7837
1-a cat	120,98	173,45	190,1	168,75	653,28	188,4	181,05	198,25	174,91	742,61	141,42	162,41	153,23	140,195	597,256
2-a cat.	0,2	19,5	20,1	4,05	43,87	3,75	5,0	22,125	8,425	39,300	11,02	8,25	8,7	2,75	30,720
3-я cat.	0,267	0,05	0,577	0,675	1,577	0,40	0,5216	1,5769	0,0054	2,5102	0,3126	0,8297	0,1697	0,4956	1,8076

2.8.2 Liquid radwaste treatment during ZNPP operation

Liquid radwaste are treated in two stages. Initial vaporizing is done in two special buildings. The concentrated solution resulting from vaporizing is transported to the interim storage. From the storage, the residue is sent to deep evaporation facilities.

Quarterly and annual amounts of liquid radwaste generation at ZNPP during the period of 2008-2014 are given in the table 2.8.2.

Table 2.8.2 – Liquid radwaste amounts generated at SE ZNPP during the period of 2008-2014

Quarters	**Liquid radwaste generation, m³**						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
1	210	194,2	212	152,1	177	198,1	164
2	275	284	224,1	243	234	188,1	204
3	300,8	227,4	311,1	328,3	248	203,8	210,6
4	230,3	147,88	165,6	191,6	155	218	185,4
Per year	**1016,1**	**853,48**	**912,8**	**915**	**814**	**808**	**764**

For the values given in the table for 2014 (764 m^3), 758 $м^3$ was of vat residue, 6 m^3 of filtering material

2.9 Design data about non-radioactive waste generation

As a result of its activities, SE NPP generates the following waste types:

- First hazard class: spent luminescent lamps, normal elements, spent thermometers containing mercury etc.

- Second hazard class: waste from engineering production processes and distribution of electrical, gas, steam and hot water energy, not indicated in any other way (tare form hazardous chemicals); batteries and accumulators – spent or defected; nickel-cadmium spent or defected batteries (including lamps); waste from auxiliary materials used in power production (expired chemical reagents)

- Third hazard class: spent oil products (slug and paste-like) oiled sand, spent oiled automobile filters, paints, varnish, lacquers, ink, spent glues, their remains that cannot be used for their purpose (expired paints); waste from engineering production processes and from distribution of electrical, steam and hot water energy not indicated in any other way (tare from diisopropylamine) other materials and substances used in power generation industry, polluted or not identified, their remains that cannot be used for their purpose (oiled paper, oiled silica gel).

- Fourth hazard class: spent oiled rugs, tare from paints (drums and cans), tare from oils (drums and cans), spent tires with metallic cord (solid), ferrous metal scrap, non-ferrous metal scrap, paper waste, pharmaceutical materials (including veterinary ones), , pharmaceutical materials and substances (including veterinary ones), medical materials (including aerosols), their spoilt remains, expired or non-identified (expired potassium iodide pills); chemical or bacterial protection means, spoiled or expired (including anti-gas masks), protection overalls, spoil, expired or polluted (spent hydraulic protection overalls), broken glass, housekeeping waste (solid) spent ion exchange resins (solid) lime slaking waste (solid) etc.; sludge of oil and water separators (mud after auto transport wash), waste from healthcare services, other (spent hydrogen sulfide mud, spent paraffin, ozokerite), oil or grease spoilt or spent (grease remaining from the canteens sewage system cleaning); fixation solution ill-conditioned (fixing agents); photography film and paper containing silver or silver compositions, ill-conditioned (spent radiography film); worn or spent footwear (safety shoes), waste from auxiliary materials and substances used during water extraction, treatment and distribution (spent filtering material “Sipron”), waste of auxiliary materials and substances used in power generation industry (spent silica materials), remains of other films (printer film); other substances and materials used in power production industry, spoilt, polluted or not identified, their remains that cannot be used for their purpose (spent steel wire with oils), other waste from healthcare services (spent medical waste, needles, syringes, ampoules), office devices and ill-conditioned PCs (spent cartridges, keyboards, monitors, computer mice, monitors, UPS units, servers, printers, scanners); remains resulting from decomposition of equipment, tools, other rejected technical means (plastic scrap), development solutions and development catalysts made on water basis; ill-conditioned; rubber materials and items, spoilt or spent; ill-conditioned sawed or shaved wood, waste generated during operation of transport, during transporting, not identified by any other means or composite (oiled sawdust); composite construction or deconstruction waste; construction insulation materials including spoiled or polluted mats (spent thermal insulation material); sediments from tank cleaning in the process of electrical power production sand-like abrasive material); composite waste from preparation of service water (spent filtering material of mechanical water cleaning), activated charcoal (spent coal sorbent), spoilt materials used in power production such as broken porcelain insulators), dust from polishing circles, abrasive-metallic; abrasive ill-conditioned items (spent abrasive circles), spent washing solutions, sludge resulting from water clarification.

12 types of 4 hazard class waste are located in specially designed places: sites and sludge collectors. All the other waste (hazard classes 1 – 4) is transported to specialized companies in compliance with signed agreements.

SE ZNPP conducts monthly monitoring of the environmental conditions in the site location area. Monitoring grid and monitoring points correspond to the design.

Sludge collector № 1 is located in the industrial area of Energodar, on the left bank of Kakhovka water reservoir.

Sludge collector № 1 serves for location of sludge from water treatment clarifiers, with sludge waters, via two head pipelines lying on the open viaduct.

Characteristics of sludge collector №1

Sludge collector № 1 size	260м x260m
Filling mark	27,5m
Bottom mark	25,0m
Plane area	6,76 hectares
Volume (design)	206,6 thousand m^2
Volume (design)	285,108 thousand m
Amount of located waste as of 01.01.2015 (actual)	122,18982 thousand m
Number of mode-monitoring boreholes	12

SE ZNPP conducts annual monitoring of environmental conditions in the area of sludge collector № 1 location. Monitoring grid and monitoring points correspond to the design.

Sludge collector № 2 is located in the industrial area of Energodar, on the left bank of Kakhovka water reservoir.

Sludge collector № 2 serves for location of spent washing solutions after chemical washing of steam generators of the power units 1-6 via head pipelines lying on the open viaduct.

Characteristics of sludge collector № 2

Sludge collector № 2 size	100м x115m
Filling mark	32,0m
Bottom mark	5,5m
Plane area	9,77 thousand m^2
Volume (design)	33,73 thousand m^2
Volume (design)	34,74 thousand m
Amount of located waste as of 01.01.2015 (actual)	6,3 thousand m
Number of mode-monitoring boreholes	4

SE ZNPP conducts annual monitoring of environmental conditions in the area of sludge collector № 2 location. Monitoring grid and monitoring points correspond to the design.

Dynamics of overall waste treatment for 5 years is given in the table 2.9.1.

Table 2.9.1 – Dynamics of overall waste treatment for 5 years (tons)

Indicator	*2010*	*2011*	*2012*	*2013*	*2014*
Waste generated	12595,40	16587,65	11950,81	10852,16	7143,26
Waste stored	9334,84	15462,08	10666,84	9768,29	5952,40
Waste removed	3260,56	958,53	1316,02	1087,17	1151,50

2.10 ZNPP sanitary protection area and monitoring area

SE ZNPP sanitary protection area has radius of 2.5 km. Monitoring area is a circle 30 km radius, with ZNPP location in its centre.

Radiation monitoring system for the sanitary protection and monitoring areas is aimed at performance of the following functions:

- supervision over protection barriers conditions;
- monitoring of radiation processes: their conditions and contents of radionuclides in technological media;
- radiation dose measurement;
- individual monitoring;
- monitoring of radio-ecological conditions;
- monitoring of non-spreading of radioactive contamination.

All monitoring data are processed by the data processing system which is a component part of overall automated radiation monitoring system at ZNPP and was developed for the following:

- in-service monitoring of radiation conditions of the environment by means of constant measurements of gamma dose rate along the plant perimeter (North, South, West and East parts), in the sanitary protection area and 30 km monitoring area; of radionuclide activity in water in specified points;
- evaluation of radiological conditions along ZNPP perimeter, in the sanitary protection area and monitoring area and of meteorological investigation data.

The system is in constant operation. The system comprises 18 monitoring facilities. Figure 2.10 shows a map with marked monitoring points

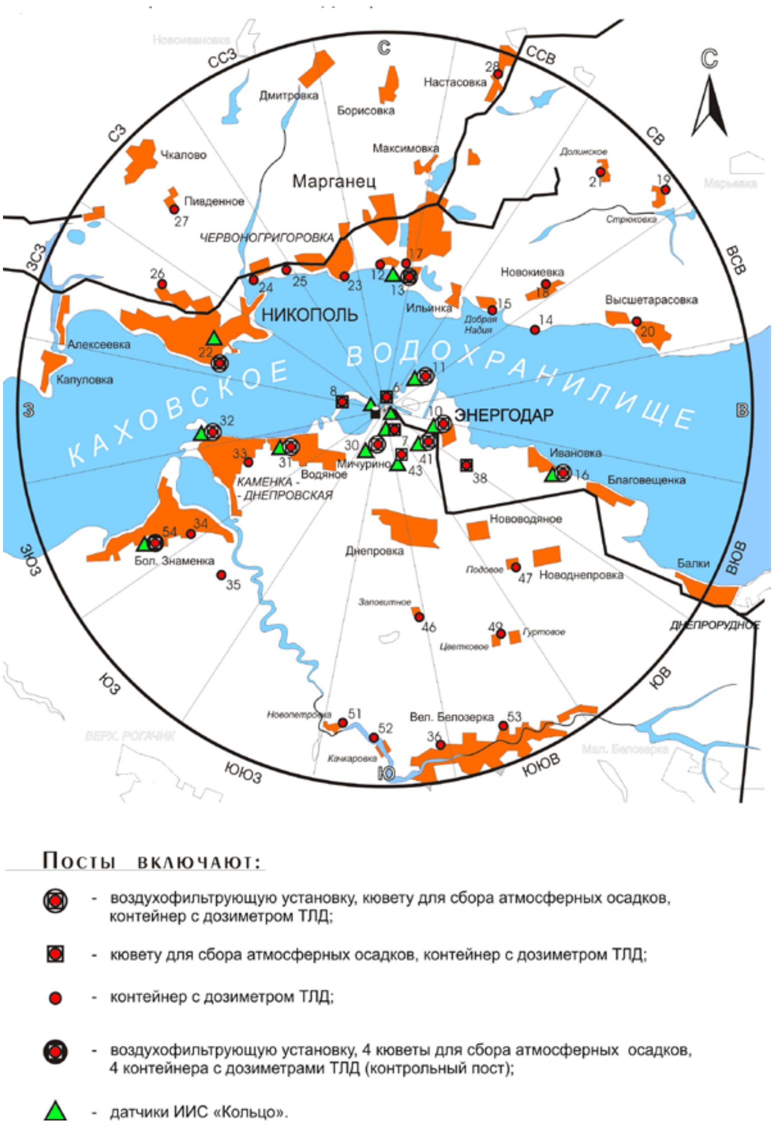

Figure 2.10 Diagram of location of radiation monitoring posts in ZNPP 30-km monitoring area

2.11 Brief description of analyzed design-basis and beyond-design basis accidents

Criterion of acceptance of radiation accident consequences is determined in NRBU-97/D-2000.

The following design-basis accidents were studied for analysis of radiation consequences of accidents at SE ZNPP:

- maximum design-basis accident – an accident caused by double sided break of cooling system (nuclear power reactor accident with coolant loss (LOCA) during operation on power;

- coolant leak from the primary to the secondary circuit – an accident caused by tear of SG collector lead (primary to secondary leak event (PRISE) during operation on power;

- accidents caused by leaks in the spent fuel pond (accidents during transportation or technological operations with fuel);

- accidents caused by drop of fuel assembly to spent fuel pond (accidents during transportation or technological operations with fuel);

- accidents caused by waterlock drop into the spent fuel pond (accidents during transportation or technological operations with fuel).

Analysis of design-basis accidents for SE ZNPP was done within the scope of work on Periodic Safety Review and during development of severe accident management guidelines.

During development of severe accident management guidelines, analysis of radiation impact was performed for consequences of the following severe accidents:

- Primary to secondary leak in conditions of total blackout;
- Total blackout with non-isolated containment;

- Primary to secondary leak, passage diameter 2x13 mm in conditions of total blackout, with restoration of one re-heater and decompression of the primary circuit;
- Primary leak, passage diameter 12 mm in conditions of total blackout with restoration of sprinkler system operation after core melt beginning and non-isolated containment;
- Total unit blackout with power restoration from TK system;
- Total blackout with containment pressure release in place.

Besides, identification of ZNPP monitoring area was made in compliance with "Requirements for establishment of NPP monitoring area sizes and boundaries", NP 306.2.173-2011. It included analysis of impact on public in case of most representative beyond-design basis accidents: those that lead to maximum releases of radioactive material, namely the following:

- Middle primary leak with failure of Safety Factor "Maintaining coolant reserve within high pressure range";
- Small non-compensated primary leaks with failure of Safety Factor "Primary circuit pressure control";
- Middle primary to secondary leaks with failure of Safety Factor "Heat removal via the secondary circuit";
- PRV break with failure of Safety Factor "Steam generator isolation and primary circuit pressure control";
- Power loss of all normal power supply sections, with failure of Safety Factor "Heat removal via the secondary circuit";
- Vacuum loss in SG condenser, with failure of Safety Factor "Heat removal via the secondary circuit";
- Loss of Low Pressure ECCS in the mode of residual heat removal, with failure of Safety Function "Heat removal via the primary circuit".

The obtained results confirm the design size monitoring area that equals 30 km.

2.12 Brief description of design decisions that decrease risks or mitigate accident consequences

SE ZNPP design is based on the following safety principles and criteria:

- NPP safety is ensured by consistent implementation of physical barriers on the way of ionizing radiation and radioactive material release to the environment; of technical and organizational activities system in part of barrier protection and maintaining their effectiveness with the aim of personnel, public and environment protection.

- during NPP operation, integrity of barriers is monitored on the entire way of radioactive material spreading. During normal operation, all barriers and their protection means are operable. If any malfunction of any of barriers or means of its protection foreseen by the design is detected, NPP operation on power is forbidden by the requirements of safe plant operation.

System of technical and organizational means used in NPP design has 5 levels:

Level 1: Creation of conditions preventing deviations of normal operation;
Level 2: Prevention of design-basis accidents by normal operation systems;
Level 3: Prevention of accidents using safety systems;
Level 4: Beyond-design basis accident management;
Level 5: Planning of activities on personnel and public protection

The following basic safety principles are implemented in the design:

- creation of physical barriers on the way of radioactive material spreading (fuel matrix, fuel cladding, coolant boundary, tight RF containment, biological protection);

- presence of special safety systems based on the principle of independent parallel trains performing the same function;

- ensuring principles of independency, redundancy, physical isolation and account of each accident during creation of safety systems;

- high technological characteristics of the isolation system for prevention of radioactive material release to the environment;

- high level of control and automation of engineering processes includes ensuring of accident control during the most responsible (first) accident stage, without personnel participation;

- safety assurance in conditions of external impact specific for the considered sites, including natural and man-caused impacts;

- safety assurance during wide specter of initiating events, taking into account postulated conditions, possible personnel errors and additional impacts;

- implementation of conservative approach to choice of technical decisions impacting safety;

- Implementation of activities and technical decisions aimed at the following:

  - o protection of isolation systems during design-basis accidents;
  - o prevention of initiating event to transform to design-basis accident;
  - o mitigation of consequences of accidents that could not be prevented;

- assurance of possibility of inspections and tests of safety-important equipment and systems in order to maintain them in operable conditions;

- organization of the sanitary protection area and monitoring area;

- safety assurance in compliance with requirements of applicable standards.

In compliance with the requirements of NP 306.2.141-2008 “NPP Safety fundamentals”, “SE ZNPP emergency plan” was developed at the plant. The plan is approved by SE ZNPP General Manager on the 03.10.2013 and put into force starting from 20.08.2014 by the Order № ЮК-835 dated 28.07.2014. Emergency plan specifies ZNPP emergency organization structure, responsibility and duty distribution in part of emergency response; storage of emergency response means, storage of external companies taking part in emergency response; it also establishes the composition and the order of emergency protection activities at ZNPP site and in the sanitary protection area.

Emergency plan provisions are mandatory for all employees of ZNPP departments and external companies that participate in emergency response at ZNPP site and in the sanitary protection area.

Emergency response activities implemented by SE NPP excluding activities on public and environment protection are limited by the NPP site and sanitary protection area. Activities in part of public and environment protection implemented by the NPP are limited by the monitoring area.

SE ZNPP has in place and implements “Program of radiation safety level improvement at SE ZNPP”, the objective of which is resolving of main issues of radiation protection of the personnel, public and environment. The program covers all NPP departments and all companies that perform activities at SE ZNPP, and it is mandatory for implementation.

Based on the results of targeted periodic safety review (stress-tests) conducted by SE NNEGC “Energoatom”, in compliance with “Action plan for non-scheduled evaluation and further safety improvement of Ukrainian nuclear power plants, taking into account events at Fukusima-1”, that were conducted by request of SNRIU and European Regulators’ Group (ENSREG), the following was determined:

- The designs of all nuclear power plants in operation take into account all possible extreme hazards. ZNPP safety design values were justified in the materials of Safety Analysis Report. Results of additionally performed reviews and walk downs did not detect and additional sources impacting operability of the equipment ensuring NPP safety;
- NPP operated in Ukraine have safety reserve in relation to external hazards, characteristics of which exceed design values; this fact is confirmed by the results of the equipment qualification;

- To ensure constant heat removal in conditions of external hazards, NPP sites have additional capabilities to ensure power supply during total blackout, and activities implemented for constant emergency heat removal.

2.13 Environmental impact

Main types of possible impact on the environment during NPP operation based on the engineering processes are radiation, chemical and physical impacts. In normal operation conditions, the most significant (in descending) impacts are thermal, chemical and radiation. In unlikely but possible cases of maximum design basis or beyond design basis accidents radiation impact becomes dominating.

2.13.1 List of potential sources of impact on the environment

2.13.1.1 Thermal impact

Nuclear power plants are sources of heat release to the environment. Approximately two thirds of the thermal power produced in the reactors are not used for power production in steam turbines, but are released to the environment via cooling systems.

For water cooling, SE ZNPP uses a complex system including cooling pond, sprinkler ponds, cooling towers. In the cooling process significant amount of heat and moisture is released to the adjacent atmosphere layer. This leads to changes in particular climate characteristics, to large degree localized within the sanitary protection area.

Thermal impact on the environment is possible from ventilation releases to the atmosphere and thermal discharge during operation of hydro-engineering structures: sprinkler ponds of the circulating water supply system to the responsible consumers and from heat exchanging equipment of turbine condensers and non-responsible consumers.

System of circulating water supply to responsible consumers is circulating and closed. Design heat generation in the power unit reactor compartment removed by the system of responsible consumer cooling is as shown below during normal operation:

- minimum – 2,9x10^6 Wt,
- maximum – 23,4x10^6 Wt,
- working average – 17,4x10^6 Wt.

Water evaporation in circulated cooling systems leads to accumulation salts in them that are received with makeup water. Technological limitations for salt contents in cooling water require blowdown of cooling systems for maintaining of salt mode on acceptable levels.

Starting from 2005, in compliance with “Specifications for continuous blowdown of SE ZNPP cooling pond to Kakhovka water reservoir”, the blowdown in conducted continuously.

Planned blowdown amount is 315 360,000 thousand m^3 at flow rate of 10 m^3/sec.

Blowdown of the circulating water system is implemented to the NPP cooling pond only during normal operation of the units. Water temperature in the responsible consumers’ system is lower that in the cooling pond (up to 33°C), that is why blowdown water from the sprinkler ponds does not have any negative thermal impact on the cooling pond.

Temperature mode of hyromechanical structures (cooling pond, sprinkler ponds and cooling towers) beside natural factors are specified by the number and capacity of the power units in operation. With one unit in operation, thermal flow to the atmosphere equals (1,9÷2,0)x10^9 Wt; in total from 6 power units it equals (9,5÷10,0)x10^9 Wt.

Temperature monitoring at the discharge of return water of the cooling pond to Kakhovka water reservoir, on feeding and discharge channels of the ZNPP cooling pond, cooling pond makeup water, Kakhovka reservoir water area is performed by the ecology-chemical laboratory of the environmental protection service. Monitoring of thermal characteristics of discharge is done in compliance to the qualification established in the area (EHL SONS, qualification certificate № g-4/14-59-5 dated 26.11.2012) for the right to perform measurement in the area subordinate to state metrological supervision. Measurements are performed in compliance with the procedure MVV081/12-0311-06 “Surface, underground and return waters. Temperature measurement methodology”. Measurement instrumentation used are glass liquid working thermometers TL-4 calibrated within specified time periods. Temperature monitoring periodicity (twice a month) at the specified objects is established in the «Time schedule for water sampling for determination of quality indicators during blowdown of ZNPP cooling pond», approved by the State Ecological Inspection in Zaporizhzhya region, Energodar Sanitary-Epidemic Station.

Impact of ZNPP cooling pond blowdown on hydro-thermal mode of Kakhovka water reservoir many times was investigated by design and scientific and research organizations (Energoproject, LvivORGRES, KDU, UGMI etc). The investigations and regular (twice a month) water surface temperature measurements in specified monitoring points show that water temperature increase in the closest area of Kakhovka water reservoir for 3°C is observed at the distances up to 0,7 km; for 1,0°C – up to 1,0 km.

During blowdown from the cooling pond, 500 m down the water flow in Kakhovka water reservoir water temperatures are increased for the following values in comparison to the natural temperatures: in winter - for 0,2…3,0°C, in summer -0,4…2,1°C. At this, water temperature in 2010-2014 reached 6,2°C and 25,7°C accordingly in the 500-m area. Water temperature in Kakhovka water reservoir does not exceed the rated values for water bodies that are used for fish-farming objective (not more 28°C in summer and 8°C – in winter).

Warmed water coming from discharge channel, are completely isolated in the cooling pond. Temperature snapshots of the cooling pond and adjacent water plane of Kakhovka water reservoir allow for making the conclusion about absence of any impact on the ecological system of Kakhovka water reservoir of the warmed water from the cooling pond.

Evaluating impact of warmed cooling pond water on hydro-thermal mode of Kakhovka water reservoir for the period of 2010-2014, it can be said that blowdown water brings insignificant (not more than 3°C) thermal load to Kakhovka reservoir water in the monitoring range. This increase is allowable in compliance with the “Rules of protection of surface water from polluting by sewage waters”.

2.13.1.2 Chemical impact

Impact on surface waters

SE ZNPP impact on surface waters can be identified in the locations of direct contacts of NPP technological components and constructions with water objects of public use. Such contact points are NPP water intake and water discharge structures.

There is no discharge of industrial, rain and household sewage waters of Energodar town directly to water body of public use. Sewage after treatment and radiation monitoring is discharged to the cooling pond that is a water body of independent ZNPP use.

Zaporizhzhya NPP has the following:

Four water supply systems (drinking, service, return and recycled-circulating);

Three drainage systems (household, industrial sewage and sumps);

Four sewage treatment structures (sewage treatment for oiled sewage; for sewage after transport washing; for the “contaminated area” lines 1 and 2).

Water supply serving for non-expendable water use in the technological cycles of the company belongs to the return water systems.

Each unit foresees three return water supply systems:

- Main equipment cooling system (turbine generators and auxiliary systems of the secondary circuit);
- Non-responsible consumer cooling system (B group);
- Responsible consumer cooling system (A group).

Reuse water is water after the special water treatment facilities of “restricted access area” lines 1 and 2, sewage treatment systems of oiled sewage; neutralizer tanks, radiation monitoring tanks, blowdown of sprinkler ponds of group A responsible consumers.

Circulating water supply is implemented from the draining and supply water channels of Zaporizhzhya thermal power plant.

Circulating water from the discharge channel of Zaporizhzhya thermal power plant is supplied to the following:

- ZNPP circulating water pumping plant for uninterrupted supply of circulating water to the plant site consumers, to the industrial and household zones of SE ZNPP;
- Water makeup in the ZNPP cooling pond for make up of consumption due to natural evaporation from the water body surface; evaporation and mist spray carried out from the sprinkler ponds and cooling towers, partial filtration, and for blowdown of the cooling pond.

Water consumption by circulating water system coolers of the turbine equipment is reflected in the hydroeconomic balance document. For instance, the table 2.13.1 shows hydroeconomic balance of the system for 2014.

Water cycle in the cooling pond is ensured due to the existing blowdown structure located on the cooling pond dam in the area of maximum cooling of the circulation water. The design capacity of the blowdown structure is 20 m^3/sec.

Accepted water amounts supplied for cooling pond makeup are given in the reporting materials of ecology-chemical laboratory of environmental protection service and hydrolic engineering department of SE ZNPP for 2014. Water consumption for additional evaporation and mist spray is determined by actual load on the consumers.

Monitoring of chemical conditions of all sewage waters supplied to the cooling pond, and water of the cooling pond and Kakhovka water reservoir above and below blowdown structures is performed by SE ZNPP ecology-chemical laboratory. Sampling is done systematically in compliance with approved schedules.

Table 2.13.1 – Water balance of the cooling pond in 2014

	Water consumption and makeup	**mln m^3**
Consumed part	Blowdown to Kakhovka water body	245,990
	Evaporation, wind carrying and supply for auxiliary needs	105,863
	Water loss for dam filtration	3,295
	TOTAL	**355,148**
Make up part	Makeup from ZTP discharge channel	337,496
	Atmospheric precipitation	4,319
	Industrial and rain sewage*, including:	11,093
	Unit pumping plant	0,140
	Radiation monitoring tank of special water treatment system	0,048
	Treated effluent after shared sewage system	5,073
	Treated effluent after the oiled sewage treatment system	0,396
	Blowdown water of the circulating water supply system for responsible consumers	2,424
	TOTAL	**352,908**

* Amount of industrial sewage is given without consideration of cooling water from oil coolers of Units №№1-6 transformers

Impact on atmospheric air

The main sources of pollutants release to the atmosphere at SE ZNPP site are the following:

- 20 reserve diesel power plants for 6 NPP units with WWER-1000 reactors. The main pollutants are carbon oxide, sulfurous anhydride;
- A series of auxiliary productions located on ZNPP site: energy-maintenance company, I&C department, chemistry department, electrical department, oil-diesel system, thermal and underground communication department etc.;
- Auto transport department is located on a separate site. Main pollutants are gasoline, carbon oxide, nitrogen dioxide, lead and its carbohydrate compounds, not differentiated to separate compositions.

Main pollutants are sulfurous anhydride, carbon oxide, non-organic dust (SiO_2 20-70%), nitrogen dioxide.

Table 2.13.2 shows a list and actual amounts of main pollutants released to the atmosphere by stationary sources of SE ZNPP and ZNPP construction management.

Table 2.13.2 – List of main pollutants released to the atmosphere from SE ZNPP site

Code	Pollutants	Released for 2013, tons	Released for 2014, tons
00000	Total for the enterprise (without consideration of carbon dioxide)	10,244	11,941
01000	Metals and their compositions	0,024	0,018
03000	Substances as suspended solid particles (micro particles and fibers)	5,996	3,683
04000	Nitrogen compounds	1,730	3,150
05000	Dioxide and other sulphuric compounds	0,116	0,206
06000	Carbon oxide	0,696	1,539
11000	Non-methanoic light organic compounds	1,620	3,341
12000	Methane	0	0
15000	Chlorine and its compositions (recalculated for chlorine)	0,060	0,002
16000	Fluorine and its compositions (recalculated for fluorine)	0,002	0,002
18000	Freons	-	-

2.13.1.3 Radioactive impact

In the process of NPP operation, generation of gaseous, solid and liquid material containing radionuclides (radioactive chemical isotopes) is indispensable. Radiation impact of the power units is related to their release to the environment.

During normal operation conditions, any release of radionuclides – fission products – from fuel cladding leads to radioactive contamination of the primary coolant.

Significant amounts of radionuclides get to the primary coolant as a result of neutron activation of the structural materials and consequent processes o erosion and corrosion of these materials.

One more source of the primary circuit radioactivity is tritium.

Tritium release from the primary coolant is possible during the following:

- Organized leaks;
- Draining of the primary coolant to the primary coolant tanks.

Tritium ^3H is radioactive isotope with half-decay period equal 12,34 years. In WWER reactors tritium is generated:

- Directly during the fuel nuclei fission as triple fission result;
- As a result of interaction of neurons with deuterium nuclei contained in the primary coolant as D_2O;
- As a result of different reactions of fast neutrons with structural materials of the reactor core;
- As a result of boric acid activation in the primary coolant.

Besides, process of air activation in close proximity to the RPV lead to generation of insignificant amounts of gaseous radioactive particles including evaporation of tritium water and inert gases.

Radioactive fission products and activation products are released from the coolant due to ion exchange processes, resulting to contaminated ion exchanging resins of special water treatment facilities. As a result of periodic replacement, both liquid and solid radwaste is generated.

Radioactive media treatment process at the special water treatment facilities located in the special buildings lead to generation of solid, liquid and gaseous radwaste.

Primary to secondary leaks acceptable in the steam generators lead to generation of radioactively contaminated water of the secondary circuit.

Gases accumulated in the primary circuit during operation are removed from it. This leads to generation of gaseous releases flow. Releases to the atmosphere can also be generated due to ventilation of flying emissions from the primary coolant generated due to small leaks, both organized and non-organized. Such releases usually contain tritium water steam, inert gases, aerosols and other gaseous particles.

During annual reactor shutdown pressure in the cooling systems is decreased, the reactor lid is removed and one third of the fuel assemblies is removed and placed in the spent fuel pond for storage. Other two thirds are relocated for maintaining of optimum integrity of neutron flux, and fresh fuel is loaded to the core. Fuel reloading procedures can lead to increase of liquid radwaste generation and releases to the atmosphere from the spent fuel pond, reactor inspection pit and protection tube bank inspection pit. These radwaste in its nature are similar to the waste released from the primary coolant.

Besides, procedures of maintenance and repair conducted during the RPV shutdown are also sources of different radwaste generated in the process of opening and maintenance of the equipment. Independent components of the primary circuit contaminated in the process of neutron irradiation, as well as reactor compartment equipment and special building components subjected to radioactive contamination can be replaced, which fact causes additional generation of solid radwaste.

Liquid and solid radwaste treatment, their storage is implemented in compliance with the requirements of “Sanitary rules of NPP design and operation”. Release of these kinds of radwaste to the environment during normal operation conditions, design-basis accidents and most credible beyond-design basis accident is practically excluded.

2.14 Radioactive conditions of SE ZNPP location area during pre-commissioning period

During pre-commissioning period (1982-1983) average gamma background level in the ZNPP area was equal (0,72±0,09) mSv/year. This is natural level characteristic of the area.

Specific activity of radionuclides in the atmospheric air corresponded to global radionuclide levels of the and was equal the following:
Total beta activity – (309,69±140,60) mkBq/m^3;
Sr-90 - (11,10±5,92) mkBq/m^3;
Cs-137 - (2,22±0,74) mkBq/m^3.

Specific activity of radionuclides in the atmospheric precipitation was equal:
Total beta activity: from (7,03±4,07) Bq/m^2·month to (9,25±3,33) Bq/m^2·month;
Sr-90 - (1,11÷1,48) Bq/m^2·quart;
Cs-137 – (0,74÷1,11) Bq/m^2·quart.

Specific activity of radionuclides in the surface ground layer was equal:
Sr-90 - (24±11) mCu/km^2 ((0,89±0,41) kBq/m^2);
Cs-137 - (32±14) mCu/km^2 ((1,18±0,52) kBq/m^2).

Volumetric activity of radionuclides in the Karhovka water reservoir was equal:
Sr-90 - (6,57±0,33) $\cdot 10^{-13}$ Cu/l ((24,30±1,22) Bq/m^3);
Cs-137 - (7,05±2,16) $\cdot 10^{-14}$ Cu/l ((2,61±0,80) Bq/m^3).

Specific activity of radionuclides in agricultural products of local manufacture was equal:

Sr-90 – from (0,06±0,02) to (0,40±0,03) Bq/kg
Cs-137 – (0,06±0,01) to (0,49±0,16) Bq/kg.

In general, during pre-commissioning period in the area of ZNPP location, gamma background and radionuclide levels in the atmospheric air, precipitation and food products corresponded to the global levels and did not exceed average values characteristic for the area.

3 IMPACT OF OPERATION ON THE ENVIRONMENT

3.1 Impact on the surface and underground waters

3.1.1. Non-radioactive impact and underground water

SE ZNPP impact on surface waters can be detected in the locations of direct contacts of the NPP technological components and structures with water bodies of public use. Such contact paces are water intake and water discharge structures of the NPP.

Discharge of industrial, rain and household sewage of the NPP and Energodar household sewage directly to water bodies of public use is absent. Sewage after treatment and radiation monitoring are discharged to the plant cooling pond that is independent water body of the NPP usage.

NPP cooling system is reverse. Cooling of turbine condensers and other heat exchanging equipment is based on the operation of the cooling pond, sprinkler ponds and cooling towers operating in parallel.

In order to improve quality of the circulating water, SE ZNPP implements blowdown of the cooling pond. Starting from 2005, in compliance with "Specifications for continuous blowdown of ZNPP cooling pond to the Kakhovka water reservoir", blowdown is conducted in continuous mode.

Scheduled blowdown scope is 315 360,000 thousand m^3 at the flow rate of 10 m^3/sec.

Analytical monitoring of the conditions of surface, underground, technological and sewage water is performed by the Group of chemical monitoring of water resources of the ecological-chemical laboratory of the Environmental Protection Service in compliance with the Schedule of monitoring by ecological-chemical laboratory of the Environmental Protection Service. 00.ОС.ГР.01-14", and "Specifications for continuous blowdown of ZNPP cooling pond to the Kakhovka water reservoir". Based on the results of reports, actual discharge of pollutants does not exceed the established limits.

Continuous blowdown of the cooling pond ensures stable chemical composition of the reused water ensures stable chemical composition of the NPP reused water and requires the requirements established for fishing water reservoirs at the discharge to Kakhovka water reservoir.

Complex ecologicalinvestigations are conducted at ZNPP water bodies on 32 indicators: mineralization, sulphates, chlorides, calcium, magnesium, natrium, potassium, ammonium nitrogen, nitrites, nitrates, phosphates, manganese, copper, zink, dissolved oxygen, suspended materials, oil products, anione surface acive substances; pH, temperature, total hardness, carbonate hardness, total alkalinity, cobalt, nickel, cadmium, lead, fluorides, morpholine.

Results of the measurements conducted by ZNPP ecological-chemical laboratory and inspection companies confirm that since the start of continuous monitoring of the cooling pond to Kakhovka reservoir, ZNPP production activity have not led to any significant impact on change in its chemical composition and water quality of the nearest area of Kakhovka reservoir.

Characterizing quality of water in Kakhovka reservoir and dynamics of changes for 5 years in compliance with chemical indicators, it is necessary to underline that based on the results of the examined samples from Kakhovka reservoir, its stable chemical composition is maintained.

Increased contents of iron, manganese, and zinc in the cooling pond (higher than the values established for fish farming water bodies) is explained by their high contents in the Kakhovka water reservoir. At discharge of reused water to Kakhovka water reservoir, water quality in compliance with the specified indicators does not deteriorate

Water discharge from the cooling pond and water filtration through the dam body leads to insignificant thermal pollution of Kakhovka reservoir. Temperature increase area is limited by 500-meter around the water discharge point. Water temperature at this does not exceed the norms established for fish farming water bodies.

Based on the results of regulated monitoring in 2009-2014, negative impact of SE ZNPP activities on hydro-geological and hydro-thermal modes is absent.

Results of many years of water body monitoring in the SE NPP location area confirm the following:

- Significant chemical and thermal impact of SE ZNPP on surface and underground waters is absent;
- Thermal impact of SE ZNPP on surface waters is limited by the areas adjacent to the discharge channel (up to 1 km)

In the normal operation mode, significant long-time impact of SE ZNPP on Kakhovka reservoir water conditions is not expected.

3.1.2. Radiation impact on surface and underground waters

For monitoring of the radiation condition, samples of waer, weeds, botom sediments and fish were made by the External Radiation Monitoring of the Radiation Safety Department of SE ZNPP in the cooling pond and adjacent water of Kakhovka reserfoire upstream (Recreation center of the Thermal Plant), 500 m and downstream the blowdown facility (first water consumpliton point in Vodyane village), on the other bank of Kakhovka water reservoire, in the area of water consumption of Nikopol and Marganets.

Water sampling from the intake and discharge channels of SE ZNPP was performed two times a week, with the scope of 8 dm^3, for the total beta activity and direct gamma-spectrometry in Marinelly vessel with the volume of 2,5 dm^3, with following accumulator of samples during the month and radionuclide concentration on ferrocyanides from the volume of 40 dm^3. In addition, radio cezium was identified by radiochemical technique. Water samples from the adjacent territory of Kakhovka reservoir were taken each month for total beta activity, and each qarter – for radiochamical analysis. Measurements of the tritium volumetric activity in water samples were made each month on ultra-low background liquid-scintillation spectrometer-radiomenter Quantulus 1220.

Long-lived radionuclides Sr-90 and Cs-137 contents in all components of water medium of Kakhovka reservoir during the period of 1985 – 2014, remained on the same level both up and downstream SE ZNPP (Recreation centre of the Thermal Plant, t. 19 and first consumption point downstream (Vodyane), and on the other bank of Kakhovka water reservoir in the area of Nikopol and Marganets.

Concentrations of radionuclides ^{90}Sr and ^{137}Cs in water bodies during ZNPP operation do not exceed the rated values in compliance with the Ukrainian norms and rules in NRBU-97, and they remain within the range of background values from 7 to $5{,}03 \cdot 10^1$ Bq/m^3 for ^{90}Sr and from 4 to $2 \cdot 10^1$ Bq/m^3 for ^{137}Cs. Values of radionuclide concentrations measured prior to ZNPP commissioning and at present are practically at the same level.

Tritium concentrations in Kakhovka water reservoir during NPP operation have not exceeded the rated values in compliance with the Ukrainian norms and rules in NRBU-97 and stay in the range of $6{,}2 \cdot 10^3$ - $4{,}0 \cdot 10^4$ Bq/m^3.

Accumulation of radionuclides in bottom sediments significantly differ in part of dispencer distribution of sediments and organic contents in them. Increase of concentrations in bottom sediments is explained by cumulative characteristics of the silts. At the same time it should be noted that value of radionuclide activity in bottom sediments of the cooling pond and Kakhovka water reservoir correlate with their “background” levels.

Radiation monitoring of ground water contidions at the NPP site is performed quarlerly with the help of the grid of monitoring boreholes. Monitoring of ground waters was performed by means of borehole water sampling and consequent laboratory analysis.

Values of total beta activity and tritium activity in water boreholes have not exceeded the rated values in compliance with the Ukrainian norms and rules in NRBU-97 for drinking water.

3.2 Impact on air environment

3.2.1 Non-radioactive impact on air environment

Total amount of non-radioactive pollutants released to the atmosphere from SE ZNPP is 25,8 tons/year. The main release sources of pollutants at SE ZNPP are emergency diesel generators and technological transport. Released pollutants are carbon oxide, nitrogen dioxide and sulfuric anhydride. More than 50% of carbon oxide and 40% of hydrocarbon gets to the air from transport means.

3.2.2 Radiation impact on air environment

3.2.2.1 Radionuclide content in ground layer of atmospheric air

Radioactivity of ground air of SE ZNPP is mostly spevified by ^{137}Cs isotope on the background of natural and cosmogenic radionuclides (^{40}K, ^{7}Be).

Monitoring of radionuclide contents in atmospheric air is done in twenve staionary monitoring points located with consideration of wind rose in the main directions, in relatioin to the chimneys of ZNPP power units № 1, 2.

Volumetric activity of radionuclides Sr-90 and Cs-137 in the atmospheric air for 26 monitoring years has not exceeded the rated values in compliance with the Ukrainian norms and rules in NRBU-97, even in 1986, during the accident at Chernobyl NPP.

For radionuclides ^{90}Sr and ^{137}Cs, values of their concentrations measured prior SE ZNPP commissioning and during operation remain at the levels of values measured during first years of NPP opeation

3.2.2.2 Radionuclide contents in atmospheric precipitation

Gas and aerosol radioactive releases to the atmosphere through the chimney are dispersed in the atmosphere creating a so-called release cloud. Aerosol particles fall out of the cloud and migrate in components of the ecological systems adjacent to the NPP.

For sampling of atmospheric precipitation, radiation monitoring laboratory uses stainless steel pans with bottom area of0,25m^2. The pan bottom is covered by filtering paper, in compliance with the standard DST 12026-76.

The pans are located in 18 monitoring points in compliance with the binding design, based on many years of pre-commissioning meteorological at the NPP construction site (according to wind rose), mostly in the settlements area of the monitoring zone. Sampling intervals for atmospheric precipitaiton in compliance with the “Radiation Monitoring Specification during SE ZNPP objects implementation: - twice a month.

Results of many years of monitoring show that total beta activity of precipitation and contents of Cs-137 and Sr-90 in them during the monitoring period of 1985 – 2014 correspond to the global precipitation levels and do not depend on the distance to the monitoring point from the NPP.

Volumetric activity of Sr-90 and Cs-137 raionuclides in the atmospheric air for 26 years of monitoring has not exceeded the rated values in compliance with the Ukrainian norms and rules in NRBU-97; even after the Chernobyl accident of 1986

3.3 Impact of operation on the soil

3.3.1 Non-radioactive impact on soils

Natural landscapes in the SE NPP monitoring area are practically absent. All of them were transformed by people and are used for production of industrial and agricultural products. The territory belonging to the sanitary-protection area comprises turf grounds, light-humus sands and sands of natural and artificial origin.

Results of ecological monitoring give a possibility of objective evaluation of the impact level of ZNPP production activity on the conditions of soils in the area of the NPP location. Analysis of many years of monitoring of the ground chemical composition and properties has shown that, in part of most ecologically important movable forms of chemicals (because they are responsible for the speed of migration in food chains), exceeding of the established level are absent.

3.3.2 Radiation impact on soils and vegetation

Soil samples in the constant monitoring points were taken simultaneously with sampling of green vegetation. Radionuclide content in the soil and vegetation was specified mainly by radionuclides of global origin: Sr-90 and Cs-137.

Specific activity of Sr-90 in the surface ground layer (0-5 cm) was within the limits of 1,2E-02 kBq/m^2 on the sand grounds to 1,5E-01 kBq/m^2 on sprayed areas; Cs-137 : from 1,0E-01 kBq/m^2 on the sand grounds to 6,4E-01 kBq/m^2 on black earth. These values correspond to the “zero background”

Low level of releases (below minimum detectable activities) does not allow for detection of radionuclide of the nuclear plant origin.

Sr-90 contents is even in all the areas on different distance from the NPP, and this confirms very low level of Sr-90 release to the environment by ZNPP objects. The impact on soil and vegetation contamination related to the NPP object operation is much lower than the established one.

3.3.3 Monitoring results for radionuclide contents in agricultural products

In samples of milk, grains, vegetables and fruit of the ZNPP monitoring area specific activity of radionuclides was measured. Specific activity of Sr-90 and Cs-137 in agricultural products is at the “zero background” level, with the exclusion of the data obtained in 1986 that have direct connection to Chernobyl NPP event.

3.4 Impact of spent fuel dry storage on the environment

Annual monitoring shows that during the entire peiod of SFDS operation radionuclide contents in the atmospheric air and precipitaion correspond to the levels characteristic of the area.

Due to dispersion of characteristics of the spent fuel loaded in the casks, total dose rate of gamma and neutron radiation in the center of the ventilation outlets of different casks comprises 10,72 - 203,60 mkSv/hour, which does not exceed the design criteria. Absence of radioactive contamination, inert radioactive gases and aerosols confirm tightness of the casks.

Gamma dose rate in the monitoring points at the distance of 50 m from the site on the height of 1 m equals 0,11 - 0,13 mkSv/year, which corresponds to the “zero background” value.

Radiation conditions in the VCC and SFDS area is stable and safe.

3.5 Impact on plant, animal life and objects of the natural reserve fund

Natural vegetation of the territory located in SE ZNPP proximity is typical for sub-area of motley and feather grass steppe, but it has been preserved only partially until now because most part of the adjacent territory is cultivated and used as agricultural lands. Feather grass is characteristic of the steppe. Beside feather grass other gramineae are also widespread. Most typical are Apera, Couch-grass, Koeleria, Agropropyron. Also, ravine forests and shrubs are spread.

Sand terraces are taken for pine plantations. Natural vegetation is preserved in significantly changed form on terrace slopes (motley grass-fescue and stipa capillata communities).

Different ambrosia types are also widespread. With the aim of fighting its spreading, activities on lowering quarantine plant spreading are in place and implemented in compliance with ZNPP site housekeeping procedure.

Emergency response plan foresees prevention and elimination of fires related to inflammation of dry vegetation on the plant site and within the limits of ZNPP sanitary protection area. With this aim, notification and response means are specified and fire fighting brigades and equipment were assigned in the company.

In order to monitor pollutants accumulation in vegetation, comparative measurements of the soil composition are performed after snow melt and in autumn, after plants wilting. Based on the measurement results, exceeding of heavy metal contents in the samples, with the account of the vegetation, is absent.

Changes in the ZNPP 30-km monitoring area growth are mainly caused by agriculture development. They had occurred long before the construction start, that is why NPP itself and its cooling pond didn't cause any significant changes in the type composition and vegetation groups in the area. Growth damage caused by the construction was decreased by means of implementation of activities on planting greenery at the NPP site and around it.

Within 30-km monitoring area of ZNPP no endemic animals are detected but there is a series of types that are either extinct in the region, or with decreasing numbers. First of all it applies to the types of steppe that is practically completely destroyed in the region.

Dnipro river and Kakhovka water reservoir in full provide food to birds that feed on water (maggots, moth and mosquitoes, small fish).

SE ZNPP monitoring area is characterized by the following trends in its flora and fauna:

- Decrease in the number of birds (related to decrease in the migrant bird kinds);
- Spreading of urban territories, consequently, reduction in natural areas;
- Possible implementation of new agricualtural crops;
- Reduction in the forest areas due to errosion processes;
- Increase in the natural reserve areas (parks, reserves) due to the State policy.

None of the listed deviations is related to SE ZNPP operation.

Thus, in the normal opeation conditions, ZNPP does not have any negative radiation or chemical impact on the flora, fauna or natural reserve objects.

4 IMPACT ON THE NATURAL AND SOCIAL ENVIRONMENT

4.1 Brief characteristics of the social environment conditions in SE ZNPP monitoring area

SE ZNPP site belongs to Kamyanka-Dniprovska district of Zaporozhye region. The district center Kamyanka-Dniprovska is situated at the distance of 12 km to the South entrance to the plant site. Marganets and Nikopol cities of Dniepropetrivsk region are situated to the North and North-West from the NPP site, at the distance of 13 km. Vodyane village is situated to the South-West from the plant site, at the distance of 4,5 km. Energodar is situated at the distance of 5 km from the NPP site to the East. Zaporizhzya thermoelectric plant site is situation at the distance of 2,5 km from ZNPP site. 30-km monitoring area covers Nikopol and Tomakivka districts of Dnipropetrivsk region, Kamyanka-Dniprovska, Vasylivka and Velyka Bilozirka districts of Zaporizhzhya region.

59 settlements are situated in the monitoring area territory: 27 – in Zaporizhzhya region, 30 – in Dnipropetrivsk region and 2 – in Kherson region. Population density around NPP within the radius of 3 – 10 km is very high and equals about 316 persons/m2, due to urban population, and density of country population as a whole in this radius equals 70 persons/m2. In general, in 30-km monitoring area around ZNPP – ZTEP complex, the population density is 134 persons/m2.

At present, SE ZNPP area is densely populated and has rather high industry and agriculture development level with industrial and transport companies. Mining industry is represented by manganese ore mining and Bilozirka iron ore body. 30-km monitoring area in part of agriculture is an area of high farming with developed cattle-breeding, dairy and vegetable production.

At present, about 340 people live within the 30-km area of ZNPP, comprising the following: 54 509 in Energodar, 116 968 people in Nikopol, 49 144 in Marganets, 40 702 people in Kamyanka-Dniprovska district.

According to the data of the Main Statistical Management in Zaporizhzhya region, natural reduction in the population in 2014 was identified in all the cities and villages of the region beside Energodar, where natural increase is observed: 2,7 persons for 1000 of the population.

Natural population reduction level in Berdyansk district was the highest (12,1 %). In cities, natural population reduction is lower than in the country (4,2% again 6,3 %).

Based on the data of the Statistics Management, natural population reduction in Dnipropetrivsk region takes place mainly due to the fact that the number of dead people exceeds the number of newborn for approximately 1,5 times. There is a steady tendency to population increase in the region. At present, each fifth (21,9 %) region inhabitant is older than 60.

Analysis of death reasons shows that almost two thirds (64%) of the persons died from heart diseases. Each seventh died from oncology diseases. Each fifteenth died from external reasons (murder, suicide, poisoning (including alcohol poisoning, fires, traffic accidents, on water etc). Practically one fourth of the people who died (24,7%) are people of 16 – 59 years old.

4.2 Impact of the activities on the public health in the monitoring area

During normal NPP operation, radiation monitoring and exposure doses of the area public are specified by the existing natural factors. In general, level of ZNPP radiation impact on the public and environment does not exceed 0,05 % from the dose created by natural radiation sources and it does not change natural radiation level in the region of the ZNPP location.

Results of many years of radiation monitoring point to the absence of significant radiation impact of ZNPP on the environment, and consequent impact on the public health in the monitoring area.

The greatest contribution to the doses for the public at the 30-km monitoring area during plant operation in normal conditions is made by natural radionuclides K-40, U-238 and Th-232, and their decay products. Artificial radionuclides from global precipitation, radionuclides of Chernobyl origin, and radionuclides from ZNPP releases show significantly smaller impact on the public dose rate. A dose rate obtained during one hour exposure to natural radionuclides is higher than the dose from SE ZNPP releases for a year.

Dose rates of the personnel servicing ZNPP equipment stay much below the allowable dose rates; ingress of radionuclides to the personnel's bodies is minimum and is not a significant dose-forming factor. Cases of exceeding the established administrative-technological, monitoring and allowable levels of personnel exposure for the last 5 years are absent.

Thus, the conclusion can be made that SE ZNPP operation in normal operation conditions does not have and will not have in future any negative impact on public health.

The evaluated maximum doses for public at the sanitary-protection zone boundary, caused by design-basis accidents are given in the table 4.2.

Table 4.2 – Maximum postulated exposure doses from design-basis accidents at the ZNPP sanitary protection area boundary

Design-basis accident	Effective dose for the body mass, mSv	Dose for thyroid gland, mGy	Dose for the skin, mGy
Accident caused by two-sided break of main circulated circuit	6,51	1,43	$3{,}29 \cdot 10^{-2}$
Radiation accident caused by SFP leaks	0,26	0,74	0,01
Radiation accident caused by drop of fuel assembly to SFP	3,44	9,25	66,3
Radiation accident caused by drop of water gate to SFP	6,87	18,5	133

As seen from the table, postulated dose rates during all design-basis accidents, including maximum credible accident, are lower than the lowest reasonable for such countermeasure as stay of children outside, even for the sanitary-protection area boundary.

5 IMPACT ON THE ANTHROPOGENIC ENVIRONMENT

5.1 Brief description of the actual conditions in the monitoring area

Anthropogenic objects of Energodar

Energodar is a regional significance town in Zaporizhzhya region. The town is situated on the left bank of Kakhovka water reservoir, at the territory of Kamyanka-Dniprovska district; the town area is 63,5 km^2.

At present, woods occupy 1146 hectares (33 % of the town territory). The town division into districts is given in the Figure 5.1.

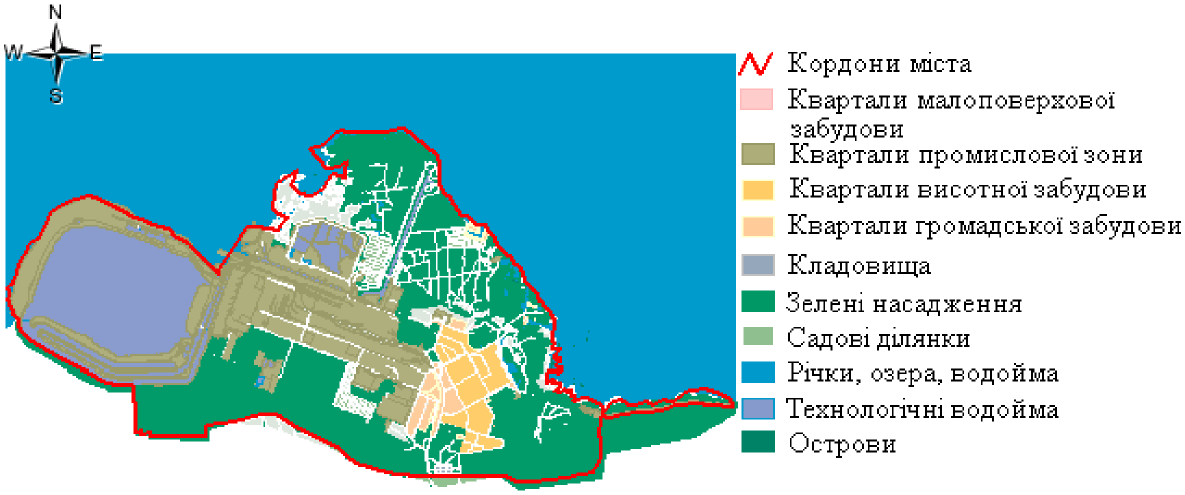

Figure 5.1 – Energodar boundaries

6 enterprises operate in the industrial area and Energodar itself: SE “Zaporizhzhya NPP” of SE NNEGC “Energoatom”, SE “Zaporizhzhya TEP” of SJC DTEK “Dniproenergo” (these two companies are the main budget payers of the town and the components of the local power generating complex); SE “Atomenergomash” of SE NNEGC “Energoatom”, PC “Enhol”, Production Complex “Thermal Water Channel”. Zaporizhzhya Thermoelectric Plant that is one of the largest air pollutants in Zaporizhzhya region is located to the East from SE ZNPP for, in 2.5 km impact area.

Anthropogenic objects of Nikopol

Nikopol is situated on the right bank of Kakhovka water reservoir, in the South-East part of Dnipropetrivsk region. The city extension in the North-South direction is 13 km; in the East-West direction it equals 17 km. As of 1 January 2012, the city population was 123 838 people.

There are three industrial areas in the city. In the territorial administration of the city 38 main companies are located. They are potential environmental polluters. A complex of ore mining companies operates on the basis of Nikopol manganese ore basin. More than 300 mln tons of ore mining and other hazardous waste is located within the radius of 20-30 km around Nikopol.

Nikopol ferroalloy plant, the largest in Europe and the second largest in the world one (according to some data it is the largest in the world), a manganese alloy manufacturing plant, is situated 3 km to the North from Nikopol.

Several pipe manufacture companies are situated in the west part of Nikopol: former “South Pipe Plant” which is one of the largest manufacturers of pipe products in Eastern Europe.

One of the largest manganese ore bodies is located at the territory of Nikopol district.

Anthropogenic objects of Marganets

Marganets is a regional significance town in Dnipropetrivsk region, It is the 8th town in the region in part of the population number and a center of mining and processing of manganese ore. The population is 48 345 people (2014). The town territory is 37 km^2.

One of the leading industries in the town is metalworks comprising two main companies: PSC "Marganets ore mining and processing plant" and PSC "Marganets ore-maintenance plant"

Beside the companies mentioned above, 12 other companies belonging to metallurgical industry are situated at the town territory: OSC "Metalurgmodule", Building company-11, OSC Kryvbasrudoremont"; other enterprises: OSC "Marganets city printing house", OSC "Margenets claydite gravel plant", OSC "Marganets bakery", OSC "Kvazar-excavation" etc.

Anthropogenic objects of Kamyanka-Dniprovska

Kamyanka-Dniprovska is situatied on the left bank of Kakhovka water reservoir, 125 km away from Zaporizhzhya. The population is 15,3 thousand people. Kamyanka-Dniprovska is a district center, its territory equals 1,7 thousand m2; population is 66,7 thousand people (including country population of 50,5 thousand people and urban population of 16,2 thousand people) The district has 4 settlements and is subordinate to one city and nine village councils; it has 9 collective farms, 11 state harms and one mink farm; cropland is 94,4 thousand hectares (including 14,8 thousand hectares of irrigated lands), fruit and berry land territory equals 6,1 thousand hectares; also – 11 companies and construction organizations.

In total, Kamyanka-Dniprovska is an agricultural region.

Industrial area on production of metal and reinforced metal structures, of non-standard equipment and special structure is located in Kamyanka-Dniprovska region, in Dniprorudne town situated 3 km away from SE ZNPP.

5.2 Impact on anthropogenic objects

In conditions of normal SE ZNPP operation, anthropogenic environment is characterized by the following factors:

- Activities and infrastructure that can possibly develop on territories adjacent to SE NPP are limited based on safety considerations. Such limitations in particular concern development of potentially hazardous activities, recreation activities, flying objects, transportation of hazardous materials;
- Location of SE ZNPP in the area promotes development of the local economics, of small and average businesses that provide direct or indirect services related to SE ZNPP activities;
- Satellite town Energodar benefits from some investments into the infrastructure made by SE ZNPP.

Hazardous atmospheric releases and discharges to the water environment as well as heat releases and water consumption of SE ZNPP do not significantly impact the anthropogenic environment.

During design-basis accidents at SE ZNPP, including the maximum credible accident, their negative impact on anthropogenic environment does not exceed the acceptable limits and will not require any additional measures.

Thus, during normal operation, SE ZNPP does not have any negative impact on the anthropogenic environment.

5.3 Impact of anthropogenic objects on SE ZNPP operation

Potential negative impacts of anthropogenic objects located in the 30-km monitoring area that could possibly cause deviations in SE ZNPP operation mentioned below are absent:

- Fires on any of the monitoring area objects will not impact Power Unit 1 safety. Fire safety is ensured by the normative safe disconnections and fire prevention activities;
- All potential explosion hazard sources are located at a safe distance from SE ZNPP, as a result of which overpressure during explosions it its value will be less than 10 kPa. Explosive transportation is foreseen as bypass of the 5-km NPP area;

• From all enterprises within the 30-km monitoring area that can possibly impact SE ZNPP operation, release impact on the NPP safety is absent. Allowable limiting concentrations correspond to the norm. Emergencies on these structures will not have any impact on the NPP safety;

• During all possible accidents at hydraulic nodes of Dnipro Hydroelectric Plant Cascade situated upstream from SE ZNPP, water level in Kakhovka water reservoir will be equal 19,36 m; this is 2,64 lower than the design site level of the ZNPP Unit 1. Accidents on hydraulic nodes of Dnipro Hydroelectric Plant Cascade situated upstream will not impact NPP safety;

• As for possible fall of aircraft, it should be noted that there are not air corridors within 20 km area around the NPP. The closes commercial airport is situated in Zaporizhzhya at the distance of 7 km from the NPP.

Thus, activities on lifetime extension of SE ZNPP units and their further operation will not lead to any negative impact of anthropogenic character on objects in the monitoring area, and impact of these objects on ZNPP object operation.

6 EVALUATION OF ENVIRONMENTAL IMPACT IN TRANSBOUNDARY CONTEXT

6.1 Transboundary context in normal operation conditions

From all types of hazardous transboundary impact of SE ZNPP more, only radiation impact can be considered as having any significance.

Data obtained for almost 30 years of monitoring in stationary radiation monitoring points prove that concentrations of radionuclides ^{90}Sr, ^{137}Cs, ^{134}C, ^{60}Co, ^{54}Mn in air and precipitation samples in the monitoring area are at the levels measured prior to SE ZNPP commissioning. Thus, SE ZNPP impact on atmosphere during the period of its operation will be insignificant even for the monitoring area.

For almost 30 years of SE ZNPP operation, negative chemical and radiation impact on flora, fauna and natural reserve objects of the monitoring area has not been detected. No impact was observed even in relation to the closest country – Russian Federation.

During lifetime extension of the ZNPP power units No. 1, 2 such impact is not expected either.

6.2 Transboundary impact in case of an accident

Evaluated maximum doses during all design-basis accidents including maximum credible accident, are lower than the reasonably expected for such activities as stay for children outside (see p. 4.2) already at the sanitary protection area boundary (2.5 km from the release source). Results of analysis of the considered beyond-design basis accidents (see p. 2.11) confirm the monitoring area territory (30 km around ZNPP) established by the design, as territory for unconditional for urgent measures.

ZNPP remoteness from boundaries with other countries (about 280 km – to Russian Federation boundary, 360 km – to Moldova boundary and 520 km – to Byelorus boundary) allows for making the conclusion about absence of significant hazardous transboundary impact on these countries related to lifetime extension of the NPP power units 1,2, in case of design basis accidents, taking into account possibility and scales of the considered beyond design basis accidents.

7 COMPLEX ACTIVITIES IN PART OF ASSURANCE OF NORMATIVE CONDITIONS OF THE ENVIRONMENT AND ITS SAFETY

7.1 Resource saving activities

7.1.1 Land resources

In compliance with the State Act for the right of permanent use of land plot, series ЯЯ №119249 dated 28.09.2006, the land plot with the area of 1670,2371 hectares is assigned for constant use of SE NNEGC "Energoatom", based on the decision 31of Energodar City Council, 4 convocation, dated 23.03.2005.

Saving and rational use of land is ensured by maximum use of the allocated territory.

The territory is well-planned, the site with the power unit is with good housekeeping and green.

7.1.2 Water resources

Saving and rational use of water resources is ensured by the design decisions in part of technical and drinking water supply system. With the aim of water saving, the design foresees reused circulating water system with use of Kakhovka water reservoir.

7.1.3 Fuel and energy resources

SE ZNPP consumes 6 % of the produced electrical power for house load. To decrease the consumption, SE ZNPP implements a series of activities: installation of power-saving lamps, consideration of possibilities of replacement of the existing equipment for more power saving one (pumps).

With the aim of further decrease in the power consumption, ZNPP also has implemented measures for decrease of fuel consumption by transport.

7.2 Protection activities

One of the main important measures foreseen for the design is assurance of tightness of buildings and structures intended for radioactive material treatment or saving. The design foresees tight reactor containment around the primary equipment for activity isolation during leaks and breaks, and for protection of the primary circuit from external hazards.

Main hygienic principle lies in the basis of planning of the production facilities: their separation into areas depending on the character of the engineering processes. All production compartments are divided into two areas:

- Restricted access area where impact on radiation hazardous factors on personnel is possible;
- Free access area where impact of radiation hazardous factors on the personnel is absent during normal operation conditions.

Division of the plant site into conditionally "contaminated" and "clean" areas is also aimed at prevention of non-controlled spreading of radioactive contamination both on the plant site territory and beyond its boundary. Decision on the site improvement and planting of greenery is also implemented taking into account the site territory.

7.3 Compensation activities

7.3.1 Compensation of environmental damage

Ukrainian legislation foresees economic measures for encouragement of activity aimed at decrease of environmental impact, namely y the following:

- Establishment of limits of natural resource usage and release of pollutants;
- Establishment of tariffs for use of natural resources and release of pollutants;
- Compensation of damage caused with violation of the valid legislation in the established order.

In particular, SE ZNPP design documentation foresees a series of compensation activities that have already been timely implemented, in particular the following:

– Activities related to alienation and compensation of expenses on land occupation;

– Establishment of limits on use of natural resources, limits for release of pollutants to the environment and limits for waste disposal;

– Establishment of norm and sizes of payment for use of natural resources, for releases and discharge of pollutants and waste disposal.

Payments specified above are aimed at implementation on the regional level of compensation for damage to the environment caused by the economical activities.

7.3.2 Social-economic compensation of risks for public dwelling in the NPP monitoring area

In compliance with the valid Ukrainian legislation, the public that constantly dwells in 30-km ZNPP monitoring area has the right to social-economic compensation for risk from implementation of their activities, including in particular the following:

- Creation and maintenance in operable conditions of social infrastructure;
- Benefits from payment for consumed electrical power according to tariffs established in compliance with the Law of Ukraine “About electrical power generation”.

Financing of activities for social-economical compensation of public risks is from a special fund of the State Budget of Ukraine. The Operating Company (operator) of the nuclear facilities – SE NNEGC “Energoatom” – pays a duty for social and economical compensation of risk at the rate of 1% of the amount of sold electrical power for the corresponding period (VAT not included).

Funds from the paid duty on social-economical risk compensation are made as subvention to special funs of the regional, district and city council budgets of multifunctional satellite cities of the nuclear facilities the territories of which are covered with corresponding monitoring areas of the duty payers, and they are distributed among the budgets mentioned above in the following proportions:

– Regional budgets - 30%;

– Budgets of districts and regional significance cities belonging to the monitoring area (with the exclusion of multifunctional satellite cities) – 55%;

– Budgets of multifunctional satellite cities – 15%.

Distribution of funds among special funds of regional, district funds and funds of regional significance satellite cities is done with consideration of specific weight of the population number dwelling in the monitoring area of these administrative-territorial units, and in the order established by the Cabinet of Ministers of Ukraine. Use of funds for financing of activities on social-economical risk compensation from special funds of local budgets is exclusively for the areas and in the order established by the Cabinet of Ministers of Ukraine.

Control over targeted use of funds for financing of activities on social-economical risk compensation by local state power bodies and bodies of local self-government is in compliance with the law. Regional, district and city councils report quarterly for the public about use of funds for social-economical risk compensation from the special funds of corresponding budgets in periodic editions of the local self-government bodies.

7.4 Protection activities

7.4.1 Activities on protection from radioactive release

Prevention of mitigation of radioactive release impact is ensured by the following technical decisions:

- Treatment of air containing radioactive materials using filters;
- Absorbing and filtering of gases containing radioactive components, majority of which are isotopes of noble inert gases (xenon and krypton);
- Implementation of barriers on the way of radioactive material spreading;
- Use of closed circuits in order to prevent leaks of liquids containing radioactive components;
- Organization of special system of liquid and solid radwaste collecting and storage;
- Organization of sanitary-protection area and monitoring area;

- In-service monitoring of releases to the air and levels of radioactive contamination of soils, vegetation and water in the sanitary-protection area and monitoring area.

7.4.2 Activities on non-radioactive impact protection

At present, SE ZNPP has passed procedure of qualification of the ecological management system in compliance with the standards of ISO 14000 series

Protection and reasonable use of woods, protective green plantations and areas

SE ZNPP maintains green areas located at the plant site. Trees, bushes and grass are planted each year and kept in good order. Actions are implemented for weeding and elimination of quarantine grass at the ZNPP site.

Water body protection

SE ZNPP policy of environmental protection is concentrated on water resource (surface and underground) protection, using methods of engineering and ecological monitoring. In particular, in order to decrease copper contents in the cooling pond, in 2008 – 2009 quantitative evaluation was performed of copper sources contributing into the cooling pond, and the recommendation to minimize negative impact on the ecological system was made.

Monitoring of underground and surface waters is done within 30-km monitoring area of the NPP. Data in part of underground water are included in a report and submitted to the State Environmental Protection Management.

During the recent years also several activities were completed to prevention of chemicals spreading to underground waters via sediments of the cooling pond.

In 2008 – 2009, a building was constructed for disinfection using ultraviolet, for improvement of treatment of spent water.

Prevention of air contamination

With the aim of monitoring and maintaining high air quality, the following activities are implemented at SE ZNPP:

– Monitoring of pollutants release into the environment close to the release sources and in the monitoring points;

– Regular technical inspection of the gas treatment facility;

– Maintaining actual the register of objects and sources including materials that ruin the ozone layer;

– Replacement of technologies damaging ozone;

– Monitoring of carbon oxide in the composition of flue gases released to the environment from transport.

Processing of industrial and household waste

With the aim of appropriate management of industrial and household waste, SN ZNPP implements the following activities:

- regular collection and submittal to the regulating bodies of information about generation, location, collection and transporting of SE ZNPP waste;

- sampling and chemical inspection of soil samples;

- in order to minimize amounts of radioactive waste, a radwaste treatment complex is being constructed, including incineration facilities, compactor and fragmentation of radwaste.

7.5 Environmental radiation monitoring

Radiation monitoring of the environment at SE ZNPP includes the following:

– Monitoring of gas-aerosol releases and water discharge to the environment;

– Monitoring of activity and radionuclide composition of radioactive releases from solid, liquid radwaste storage, reactor compartment and sprinkler ponds;

– Monitoring of exposure dose rate in the sanitary protection area and monitoring area;

– Monitoring of radioactive contamination of atmospheric air, precipitation, ground, vegetation, water in open water bodies, bottom sediments, weeds, agricultural products (grains, fruit and vegetables).

Besides, meteorological parameters are measured in the area of the NPP location.

Environmental radiation monitoring is performed by the External Radiation Monitoring Laboratory qualified in the area of the State Metrological Supervision for measurements during radiation monitoring of environmental objects.

For monitoring of radiation environment resulting from gas-aerosol releases to the atmosphere, a network of specially designed network of equipped posts located in the places accessible for auto transport and servicing is created in the ZNPP monitoring area, mainly in settlements of 30-km radius area. The monitoring point in Velyka Znamyanka village (21 km) has complete scope of equipment for sampling for monitoring of the background.

Monitoring objects, numbers, intervals of sampling and specified parameters of the environment performed by the External Monitoring Laboratory of the Radiation Safety Department, are foreseen by the “Specification of radiation monitoring during operation of SE ZNPP objects”.

Monitoring of meteorological parameters in the ZNPP location is done by Hydro-meteorology Parameters Monitoring Group of the Radiation Safety Department which is qualified for the right to conduct hydro-meteorology measurements in compliance with “Specifications for meteorology monitoring by hydro-meteorology parameters monitoring group in the ZNPP location”.

Starting from February 2002, ZNPP has introduced into commercial operation an informational-measurement system “Ring”. Continuous monitoring of gamma dose rate is performed at 18 radiation monitoring posts. Location of detectors of the monitoring points is given in the figure 2.10.

In the normal operation mode, the “Ring” system serves for acquiring and processing of radiation environment data in the monitoring area required for on-line conclusions about radiation conditions compliance with requirements of standards establishing activities and procedures for ensuring ZNPP safety.

IN case of accidents, the “Ring” system serves for acquiring of reliable information about the radiation conditions in the monitoring area, for making recommendations in part of elimination of radiation accident consequences.

7.6. Analysis of deviations in compliance with INES scale

For informing of public about nuclear and radiological events in the nuclear power generating industry, an international INES (International Nuclear Event Scale) scale developed by IAEA is widely used.

In the frames of INES, nuclear and radiological accidents and incidents are classified with consideration of three impact areas:

- public and environment: exposure doses are considered for the public close to the event place, and large non-planned radioactive material release from the facility;

- radiological barriers and monitoring: covering events that do not have any direct impact on public or environment and concern only those occurring on large facilities. High radiation and spreading levels for radioactive materials within the facilities belong here;

- defense-in-depth protection: covering events that do not have any direct impact on public or environment, and represent a set of activities foreseen for prevention of accidents that have not been implemented in full as it was designed.

General description of event levels according to INES scale is given in the Table 7.6.1

Total number of deviations at SE ZNPP for the period of 2005 - 2014 is given in the Table 7.6.2.

Table 7.6.2 – Number of events at SE ZNPP for the period of 2005-2014

Period	Total number of deviations
2005	10
2006	10
2007	8
2008	5
2009	7
2010	8
2011	7
2012	5
2013	5
2014	4

Distribution of categories of the specified deviations according to INES scale I given in the Table 7.6.3

Table 7.6.3 Categories of deviations according to INES scale, that occurred at SE ZNPP during the period of 2005-2014

Period	Deviation category according to INES			Total, events
	1	Below the 0 point	Non-classified	
2005	1	5	4	10
2006	0	5	5	10
2007	0	3	5	8
2008	0	4	1	5
2009	0	4	3	7
2010	0	7	1	8
2011	0	4	3	7
2012	0	3	2	5
2013	0	5	0	5
2014	0	4	0	4

The data allow for making the conclusion that during the 10 year period, number of deviations at SE ZNPP has stayed at the lowest level; since 2006 accidents classified by level 1 or higher in the INES scale were absent

Table 7.6.1 International scale of nuclear and radiological events INES, general description of the levels

Description and INES Level	**People and the environment**	**Radiological barriers and controls at facilities**	**Defense in depth**
Major accident **Level 7**	• Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures		
Serious accident **Level 6**	• Significant release of radioactive material likely to require implementation of planned countermeasures		
Accidents with wider consequences **Level 5**	• Limited release of radioactive material likely to require implementation of some planned countermeasures • Several deaths from radiation	• Severe damage to reactor core • Release of large quantities of radioactive material within an installation with a high probability of significant public exposure. This could arise from a major criticality accident or fire	
Accident with local consequences **Level 4**	• Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls • At least one death from radiation	• Fuel melt or damage to fuel resulting in more than 0,1% release of core inventory • Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure	
Serious incident **Level 3**	• Exposure in excess of ten times the statutory annual limit for workers • non-lethal deterministic health effect (e.g. burns) from radiation	• Exposure rates of more than 1 Sv/hr in an operating area • Severe contamination in an area not expected by design, with a low probability of significant public exposure	• Near accident at a nuclear power plant with no safety provisions remaining • Lost or stolen highly radioactive sealed source • Misdelivered highly radioactive sealed source without adequate radiation procedures in place to handle it.
Incident **Level 2**	• Exposure of a member of the public in excess of 10 mSv • Exposure of a worker in excess of the statutory annual limits	• Radiation levels in an operating area of more than 50 mSv/year • Significant contamination within the facility into an area not expected by design	• Significant failures in safety provisions but with no actual consequences • Found highly radioactive sealed orphan source, device or transport package with safety provision intact • Inadequate packing of a highly radioactive sealed source
Anomaly **Level 1**			• Overexposure of a member of the public in excess of statutory limits • Minor problems with safety components with significant defense in depth remaining • Low activity lost or stolen radioactive source, device or transport package
NO SAFETY SIGNIFICANCE (below scale / level 0)			

7.7 **Public informing about impact of power unit operation on the environment**

In compliance with “Procedure of informing of the NPP personnel, local authorities, mass media and public about deviations in operation of SE NPP objects”, public informing is done by the personnel of the Informational Centre which is a ZNPP structural department on public and mass media relations. The Informational Centre is located by the following address: Kurchatova st 38a, Energodar, tel. 5-63-49, tel./fax: 6-21-81, 6-21-27.

In compliance with “Fundamentals for public and mass media relations”, the public and mass media relations department purpose is implementation of the established informational policy of SE ZNPP, SE NNEGC “Energoatom” management, forming of public opinion about nuclear power generating industry safety and the necessity of the industry development in Ukraine; creation of positive image of SE ZNPP, SE NNEGC “Energoatom” and the industry as a whole; maintaining and improvement of corporate culture using mass media, establishment of two-way communication with public and mass media with the purpose to identify common interests and achieve mutual understanding based on truth, knowledge and complete informing.

SE “Zaporizhzhya NPP” regularly provides information to the public by means of the following:

- Internet. Specially assigned web site (http://www.npp.zp.ua/) provides public with information about the NPP and its operation. In on-line mode, results of radiological monitoring in the 30-km area are displayed on the site, too;
- plant newspaper: SE ZNPP publishes weekly newspaper called “Energy”. The newspaper is distributed free in public places and provides different information in part of the NPP and 30-km monitoring area;
- other newspapers: from time to time articles are published in local and regional newspapers, usually with the aim of public informing about specific issues;
- thematic brochures: distributed in informational centers and public places;
- regular public activities;
- voice mail system (phone number 5 68 02): updated 3 times a day, information about the NPP conditions and radiation monitoring

CONCLUSIONS

About the possibility of further operation of SE Zaporizhzhya NPP power units No. 1,2

The analysis of the current design configuration of the power units shows the following:

• taking into account the completed modernizations, the power unit designs include all components required for assurance of effectiveness of the barriers on the way of radioactivity spreading;

• sufficient number of safety systems is provided to ensure safety system preparedness; principles of redundancy, independence, physical separation and diversity are implemented;

• unit design deviations from requirements of the valid normative documents are analyzed; their safety impact is evaluated; corrective activities are being implemented for the identified insignificant deviations;

• availability at ZNPP of the technical documentation set required for assurance of safe power unit operations is confirmed.

Conducted analysis of the technical conditions of the unit systems and components shows the following:

• technical conditions of the safety-important systems and components of the power units ensure reliable performing of their design functions;

• program of activities on equipment qualification and the reporting system for performing of activities are in place, with reliable data storing;

• program of aging management for safety-important structures, systems and components is in place.

As a result of power unit deterministic and probabilistic safety analysis, it was confirmed that for today, requirements in part of safety assurance of the reactor facilities foreseen by the standards are sufficiently satisfied for SE ZNPP power units No. 1, 2. Safety analysis evaluation requires constant study, monitoring and analysis of the CSUP activities and modernizations at the power units aimed at safety improvement, and of accumulation and maintaining in the actual conditions of the statistical data.

Based on the results of the completed safety analysis it can be stated that prerequisites for decrease in the safety level of the power units are absent during operation of the power units during post-design period; moreover, there is a stable tendency of increase in the power unit safety level due to implementation of organizational and technical activities of different programs for safety improvement (for the PSR moment, CSUP program is active, and it is calculated for the period of 2011-2017).

The completed analysis of different operation aspects of the power units shows the following:

• operation of ZNPP power units №1, 2 is in compliance with the design; LCO foreseen by the operation license are satisfied, all the requirements of the valid norms and rules in the nuclear and radiation safety are satisfied;

• the management and the personnel are committed to the safety culture principles;

• operating personnel have high qualification and it is constantly maintained and improved due to systematic approach to study;

• operating documentation complies with requirements of the nuclear and radiation safety, it clearly and unambiguously specified all modes of operation of the nuclear facility and complies with the safety analyses and current conditions of SE ZNPP power units;

• the operating company has corresponding emergency plans, qualified personnel and equipment for actions during emergencies and accidents; it coordinates its plans with the Unified State System of prevention and response to man-caused and natural emergencies. Coordination of this is performed by the State Emergency Service of Ukraine which also regularly reviews emergency preparedness by means of exercise and drills;

• an accounting system for operating indicators for safety and safety-important events is developed and implemented, with compensation activities, for all nuclear power units of the same type in Ukraine; foreign experience and data from latest science and engineering developments are also taken into account;

• conditions and tendencies in safety conditions of the power units No. 1, 2 were evaluated based on their operation conditions

Analysis of the radiation impact on the environment from power unit operation shows the following:

• radiation impact on the environment is sufficiently lower than the established sanitary norms and practically it stays at the natural background level measured at the site before the plant commissioning;

• system of monitoring of the NPP releases and discharges is created and operates productively. Results of analysis of NPP operation impact on the environment allow for the conclusion that in future impact will stay at the same level, i.e there are no prerequisites for degradation of radiation conditions of the environment around ZNPP.

Integrated analysis of the evaluated safety factors allows for the conclusion that power unit design, technical means and administrative arrangements in part of protection of structures, systems and components ensure safe, reliable and effective operation of the power units.

Safety of operation of the power units No. 1, 2 during post-design period is ensured by the implemented and planned technical and organizational activities aimed at prevention of deviation of normal operation, accidents and emergencies, and mitigation of their consequences.

Safety level of the power units No. 1, 2 is not lower than that established in the applicable nuclear and radiation safety norms and rules.

All prerequisites specified above allow for making a general conclusion about the possibility to extend lifetimes of the SE ZNPP power units without any essential impact on the environment