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REPORT

DEVELOPMENT OF THE MATERIALS FOR ASSESSMENT OF ENVIRONMENTAL IMPACT IN THE COURSE OF SOUTH-UKRAINE NPP OPERATION

2015

CONTENT

10 TRANSBOUNDARY IMPACTS OF SUNPP IN STANDARD OPERATION AND IN EMERGENCY SITUATIONS WITHIN THE REQUIREMENTS OF THE ESPOO CONVENTION

10.1 Procedural Aspects

Brief contents of Espoo Convention stipulations regarding nuclear facilities

The Espoo Convention sets out the obligations of the countries, which have ratified this Convention or have joint it, to assess the environmental impact of the planned activities, if such activities can impact the environment of another country. Nuclear power production is considered to be a kind of activities, which can lead to significant harmful transboundary impact as a consequence of radiation factor effect.

Actually the Convention sets out the obligations to make a final decision with regard to the beginning of the planned potentially dangerous, in the transboundary sense, activities only after promulgation and public discussion of all consequences of such activities at the international level. In other words, the Espoo Convention is a tool of public control, to which the citizens of another countries are involved. In this sense it is important to underline that ascertainment of the ecological acceptability of the planned activities inside the country of origin of these activities in accordance with the internationally adopted levels of environmental safety unconditionally means the absence of impacts on the other countries (absence of transboundary impacts), which can be considered to be unacceptable.

The Espoo convention describes the procedure, which includes:

- Preparation for assessment of the environmental impact;
- Notification of the parties;
- Consultations of the parties.

As nuclear power production is subject to increased attention of the public ecological movements and, in a number of countries, of the general public, especially after the accidents at ChNPP and Fukushima NPP, the issue of extension of the nuclear power plants operation in Ukraine attracts meticulous attention of the certain circles inside and outside the country. However, coverage of the activities, which provide no provision for either new construction, or change of technology, by the Convention procedures, Energoatom have made a decision to ensure transparency of assessment of impacts in the transboundary aspects in full.

Legal Basis for Environmental Impact Assessment (EIA) of Nuclear Power Units Operation

At present application of stipulations of the Convention in the transboundary context for the activities related to operation extension of the power units in operation at the NPPs of Ukraine within the beyond-design period is subject to discussions between Energoatom and a number of public organizations.

The draft updated Energy Strategy of Ukraine until 2030 stipulates extension of operation of all NPP power units in operation within the beyond-design period. Energoatom have already received a legal approval of operation extension of Rovno NPP Units 1 and 2 and South-Ukrainian NPP Unit 1.

Activities of Energoatom in this area are governed with the individual legislative and legal acts. Thus, in accordance with the Law of Ukraine No. 2861-IV dated 08.09.2005 'Order of making decisions about location, design, construction of nuclear installations and facilities designed for radwaste handling possessing national importance', a decision about extension of the power units operation is made by State Nuclear and Radiation Safety Regulation Authority based on the positive conclusion of the State Expertise of the deliverables by revising the nuclear installation operation license.

A corresponding decision is made based on the results of the periodical safety re-assessment reflected in the Periodical Safety Re-Assessment Report (PSRAR) and on the positive conclusion of the State Nuclear and Radiation Safety Expertise. The structure and contents of the PSRAR are stated in the General Requirements for extension of NPP units operation within beyond-design period based on the results of periodical safety re-assessment, NP 306.2.099-2004 (approved with the SNRIU Order No. 181 dated 26.11.2004). The justification of the environmental safety is included into the separate PSRAR section ('environmental impact' safety factor).

However, based on the results of extension of Rovno NPP Units 1 and 2 operation, upon complaint of «Ecoclub» Union (Rovno City) in 2011 to the Espoo Convention Observance Committee, during its 27th session it was decided to launch an initiative of the Committee and to clarify, if the extension of the NPP units operation within the beyond-design period is subject to the definition of the Espoo Convention, and if it is necessary to apply relevant procedures with the involved parties.

In the period of 2012-2014 Energoatom, from their side, insisted on their position in view of nonproliferation of the Espoo Convention stipulations to the activities related to the operation extension of the NPP units in operation within the beyond-design period, emphasizing that they implemented and are implementing their activities in this direction exclusively in compliance with the requirements of the national legislation. The mentioned approach for the procedure of extension of the power units operation within the beyond-design period is compliant with the international experience and considers recommendations of the international organizations (IAEA, WANO, etc.) and approaches of the other operators, i.e. EDF (Operator of the NPPs in France and Great Britain), which is confirmed with the results of numerous international missions in the course of implementation of the projects in Ukraine together with IAEA and EC, as well as compliance of the national regulatory policy with the requirements of the international standards.

Also, it was noted that, as no essential changes are made to the design basis of a power unit in the course of extension of the power unit operation and making a correspondent decision by SNRIU, the mentioned activity of Energoatom cannot be treated as «planned activity» in understanding of the Espoo Convention. Along with this the decision of SNRIU cannot be considered as a final one, which is required to be made in case of the «planned activities». On the other hand, a final decision in understanding of the Espoo Convention can be considered a decision about impossibility of the further extension of the power unit operation (with the further termination of the «Operation» life cycle of the nuclear installation) and about the necessity to obtain a license for implementation of activities at a separate stage, «Decommissioning».

Also, the activities related to extension of the power units operation within the beyond-design period are implemented in the frames of a separate life cycle «Operation of nuclear facility», for which a corresponding license is issued by the authorized body (SNRIU). The license validity is limited with the issuance of a new license for implementation of activities at the next separate stage of the life cycle «Decommissioning of nuclear installation». In case of Rovno NPP, a license was issued with new identification by revising of the previous license.

The mentioned position of Energoatom was supported by Ministry of Ecology and Natural Resources of Ukraine, being a specially authorized body in Ukraine for control of the Espoo Convention observance. The Committee was informed by the Ministry with the letters No. 8679/13/10-13 dated 30.05.2013, No. 14925/13/10-13 dated 15.10.2013 and No. 5/1-13/2147-14 dated 13.02.2014.

At the 6th meeting of the Espoo Convention parties in June 2014 the decision ECE/MP.EIA/20/Add.1−ECE/MP.EIA/SEA/4/Add.1 was adopted, stating the following:

- sec. 68 of the decision VI/2: «endorses the conclusions of the Implementation Committee that NPP life-time extension, being a subject for consideration, after expiration of the original license should be considered as a proposed activity in accordance with the paragraph v) of Article 1 of the Convention and therefore it is covered by the provisions of the Convention»;
- sec. 71 of the decision VI/2: «proposes the Implementation Committee in the process of further activities related to analysis of this case to consider, when assessing compliance with the Convention by Ukraine, the particular circumstances of this case and the fact that Ukraine has acted in good faith in relation to the design, based on the information to be submitted by Ukraine, which will be analysed by the Implementation Committee».

10.2 Technical aspects

Potential transboundary radiological impact of SUNPP

Preliminary analysis based on the results of the long-term integrated environmental monitoring, reflected in the numerous technical reports and several scientific studies, shows that the impact of all non-radiation factors almost does not extend beyond the SPZ and under no conditions (even with potentially possible accidents) does not extend outside the surveillance area. The parameters of these impacts do not exceed acceptable national and international levels, in fact, such cases were not recorded for the observation period. Thus non-radiative effects are excluded from consideration in a transboundary context

The background radiation and concentrations of radionuclides ^{90}Sr, ^{137}Cs, ^{134}C, ^{60}Co, ^{54}Mn in air and atmospheric fallouts, according to observation data, are on the level of the values, which were measured before commissioning of SUNPP. Thus, the SUNPP impact on atmospheric environment during the period of its operation was not significant even for the surveillance area. As in a distance from the release source the radionuclides contamination density of the territory decreases rapidly, under normal operating conditions and even for neighbouring countries – the Republic of Moldova (the distance from SUNPP to the border ~ 130 km) and Romania (~ 250 km), so the significant transboundary impact associated with the SUNPP is not expected.

Transboundary impact under normal operation

Below there are the results of the radionuclides activity calculations on the surface air layer depending on distance and density of fallouts on the ground. To simulate spread of the radioactive substances in the atmosphere and formation of doses from releases of radionuclides from the South-Ukraine NPP under normal operation the software complex PC CREAM was used, that was developed by the National Radiological Protection Board (England).

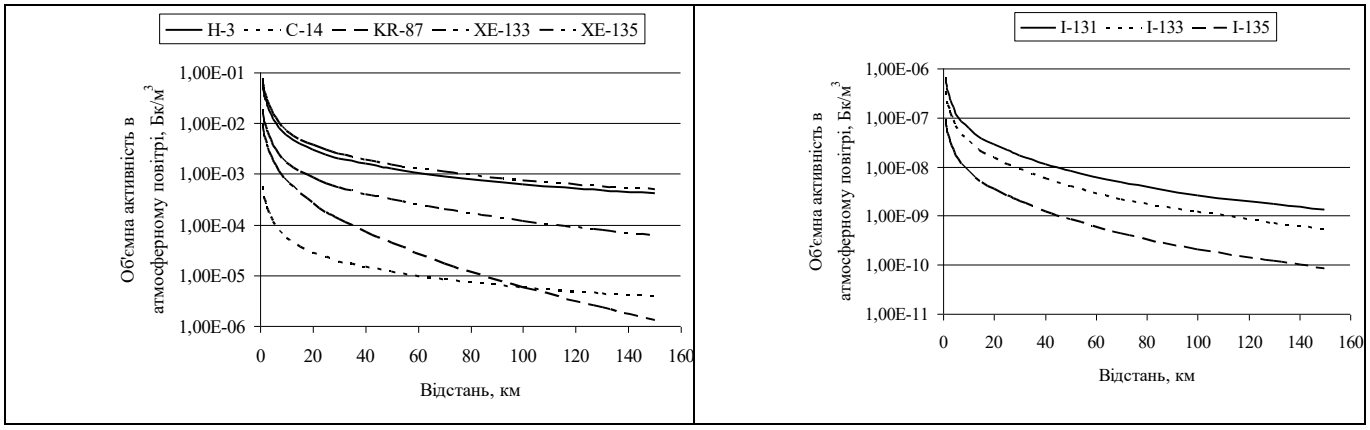
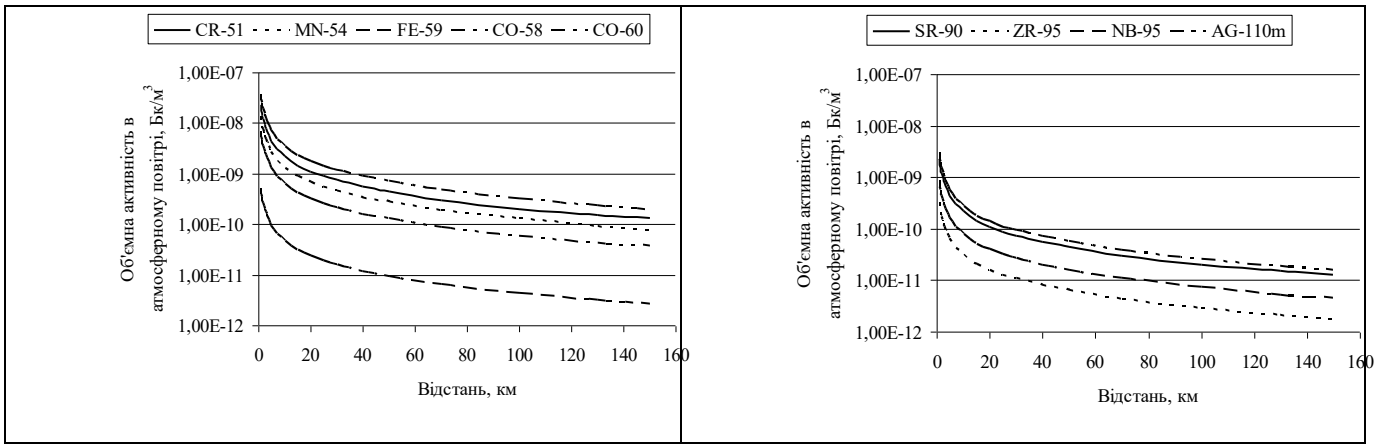


Fig. 6.1. − Expected volumetric activities IRG, tritium, carbon and iodine isotopes in the surface air layer vs. distance



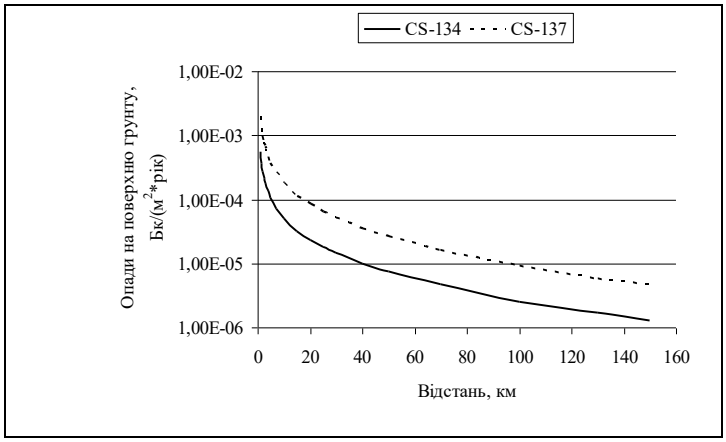


Fig. 6.4. − Expected LLA fallouts on ground surface vs. distance

As can be seen from the figures, the maximum values of volumetric activity in atmospheric air on the sanitary protection zone (SPZ) boundary (2 500m) are expected to be – 0,03 Bq/m^3 and tritium - 0.024 Bq/m^3. On the border with the nearest country – Moldova, distance 130km, the values of volumetric activity of radionuclides, released by SUNPP in atmospheric air, will not exceed 0,00057 Bq/m^3.

The maximum value of fallouts on the ground at the border of SPZ (2 500m) is expected to be for tritium – 781 kBq/(m^2*year) and carbon - 7.2 kBq/(m^2*year). On the border with Moldova the values of radionuclide releases, made by SUNPP on the ground, will not exceed 15 kBq/(m^2*year).

In Fig. 6.5. there are results of calculations of maximum committed doses for population dependant on a distance. The results are given for three age groups: children under 1 year old, children under 10 years old and adults.

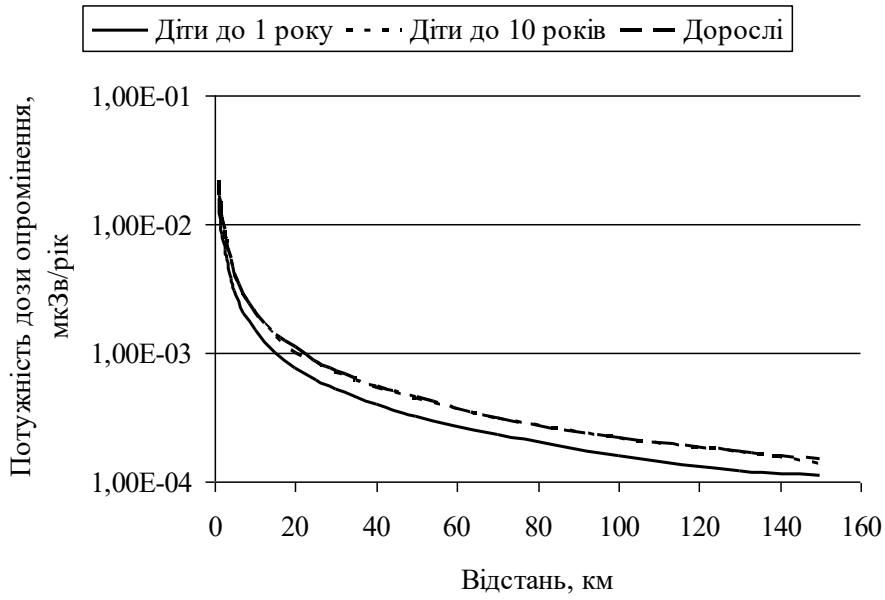


Fig. 6.5. – Population committed doses vs. distance

As we can see from the figure, the dose limit quota 40 μsv/year according to NRBU-97 for releases from NPPs, is not exceeded (independently on location of the critical group of the population). The maximum dose on the border of the sanitary protection zone will not exceed 8,6 nZv/year. On the border with the nearest country – the Republic of Moldova, the distance is 140 km, the radiation dose from radioactive substances, which were released from SUNPP, will not exceed 0.17 nZv/year

Transboundary impact in the event of an accident

Below there are results of calculation on radioactive releases to the environment of different types of accidents. The software complex PC COSYMA was used for the calculations, it was developed by the National Radiological Protection Board (national Committee on radiation protection, England) for emergency situations. All calculations were performed for conservative conditions of spreading contamination and formation of exposure doses (maximum doses).

Table 6.1. − Release of radioactive substances at maximum design accident

Radionuclide	**Environmental release,** Bq
Kr-88	2,00E+13
Sr-90	3,10E+11
Ru-103	4,50E+12
Ru-106	6,60E+11
I-131	4,98E+12
I-132	2,70E+12
I-133	4,00E+12
I-135	2,30E+12
Cs-134	7,80E+11
Cs-137	5,00E+11
La-140	8,40E+12
Ce-141	1,40E+13
Ce-144	8,60E+12
Total activity	7,17E+13

Table 6.2. − Release of radioactive substances in the accident, «Steam generator header break– emergency spike»

Radionuclide	**Environmental release,** Bq
Kr-87	6,50E+13
Kr-88	2,00E+14
I-131	2,53E+13
I-132	9,20E+13
I-133	8,44E+13
I-134	1,00E+14
I-135	7,90E+13
Cs-134	2,10E+11
Cs-137	5,30E+11
La-140	2,60E+12
Xe-133	2,00E+15
Xe-135	1,70E+15
Total activity	4,35E+15

Table 6.3. − Release of radioactive substances in the accident «Steam generator header break – pre-accident spike»

Radionuclide	**Environmental release,** Bq
Kr-88	2,00E+13
I-131	4,50E+12
I-132	1,60E+13
I-133	1,54E+13

Radionuclide	**Environmental release,** Bq
I-134	1,70E+13
I-135	1,30E+13
Cs-134	2,10E+11
Cs-137	5,30E+11
La-140	2,60E+12
Xe-135	1,70E+14
Total activity	2,59E+14

Table 6.4. − Release of radioactive substances in the accident «Drop of hydrolock in cooling pool»

Radionuclide	**Environmental release,** Bq
Sr-90	4,70E+11
Ru-103	3,60E+12
Ru-106	4,10E+11
I-131	1,65E+13
I-133	1,50E+12
Cs-134	9,30E+11
Cs-137	5,80E+11
La-140	1,90E+12
Ce-141	6,60E+12
Ce-144	1,40E+12
Xe-133	5,00E+14
Total activity	5,34E+14

Table 6.5. − Release of radioactive substances in the accident «Drop of spent fuel assembly in reactor core and at top nozzles of fuel assemblies in cooling pool»

Radionuclide	**Environmental release,** Bq
Kr-87	1,10E+13
Kr-88	1,70E+13
Sr-90	3,90E+10
Ru-103	4,50E+11
Ru-106	6,90E+10
I-131	3,80E+11
I-133	2,60E+11
Cs-134	8,30E+10
Cs-137	6,50E+10
La-140	8,40E+11
Ce-144	9,70E+11
Xe-133	7,40E+13
Total activity	1,05E+14

Table 6.6. – Release of radioactive substances in the accident, «Drop of container with spent fuel from height of over 9 meters»

Radionuclide	**Environmental release,** Bq
Sr-90	4,40E+11
Ru-106	1,00E+11
Cs-134	3,50E+11
Cs-137	7,30E+11
Ce-144	8,30E+11
Total activity	2,45E+12

Table 6.7. – Release of radioactive substances in the accident «Drop of fuel assembly into reactor core»

Radionuclide	**Environmental release,** Bq
Sr-90	1,20E+12
Ru-103	2,30E+12
Ru-106	4,30E+11
I-131	4,63E+12
Cs-134	1,60E+12
Cs-137	8,20E+11
Ce-144	4,10E+10
Xe-133	1,10E+14
Total activity	1,21E+14

Table 6.8. − Release of radioactive substances in the accident «Rupture of pulse tube outside containment»

Radionuclide	**Environmental release,** Bq
Kr-88	7,10E+11
I-131	6,70E+12
I-132	1,70E+13
I-133	1,30E+13
I-134	9,60E+12
I-135	1,10E+13
Cs-137	7,40E+09
Xe-133	6,40E+13
Xe-135	9,80E+12
Total activity	1,32E+14

Table 6.9. − Release of radioactive substances in the accident «Rupture of planned cooldown line»

Radionuclide	**Environmental release,** Bq
I-131	6,42E+07

Radionuclide	**Environmental release,** Bq
Cs-134	2,50E+07
Cs-137	3,70E+07
Xe-133	6,80E+12
Total activity	6,80E+12

Table 6.10. – Release of radioactive substances in the accident «Rupture of the inlet pipe of technological blowing-in for cleaning in the system of technological blowing-in of reactor island»

Radionuclide	**Environmental release,** Bq
Ar-41	4,00E+11
Kr-85m	7,20E+11
Kr-88	2,20E+11
Xe-133	2,90E+13
Xe-135	4,00E+12
Xe-138	7,90E+10
Total activity	3,44E+13

The analysis of the given results shows that amount of potential accidental releases does not exceed the levels which meet the maximum permissible values of radiation criteria for equivalent and absorbed doses on the border and outside the sanitary protection zone, specified in the documents SP AS-88 and NRBU-97. Thus, the maximum dose rates of all types of design and beyond design-basis accidents will be lower the levels of unconditional justification. The transboundary spread of radiation releases in case of accidents, considering the distance of SUNPP from the borders with the other countries, will be slightly different from the indicators for normal operation of the power units.

The analysis results for the beyond design-basis accidents confirm the surveillance area (30 km), specified by the plant design, which defines area of unconditional justification for urgent countermeasures.

Probable environmental contamination due to transboundary atmospheric transfer of releases from SUNPP power units.

Spread of releases depends on scope and intensity of the atmospheric transfer – velocity and direction of wind. Below there are probable consequences of SUNPP impacts to the adjacent territory, based on the average wind-rose in the Yuzhnoukrainsk town in 2014 for tritium radionuclides which releases are most significant, and exposure dose limit.

Fig. 6.6. – Probable activity of radionuclides of tritium in the surface layer of air due to atmospheric transfer of releases from SUNPP

The area of contamination, Bq/m^3:
1 - ≥ 0,01; **2** - ≤ 0,01, ≥ 0,005; **3** - ≤ 0,005, ≥ 0,001; **4** - ≤ 0,001, ≥ 0,0005; **5** - ≤ 0,0005, ≥ 0,0001

The global indicators of tritium activity in atmospheric air amount to 0,12 Bq/m^3.

As wee can see from Fig. 6.6., content of tritium in air of the neighbouring countries due to releases from SUNPP in 2014 caused the probable increase in activity which does not exceed 0.4% of the average global value.

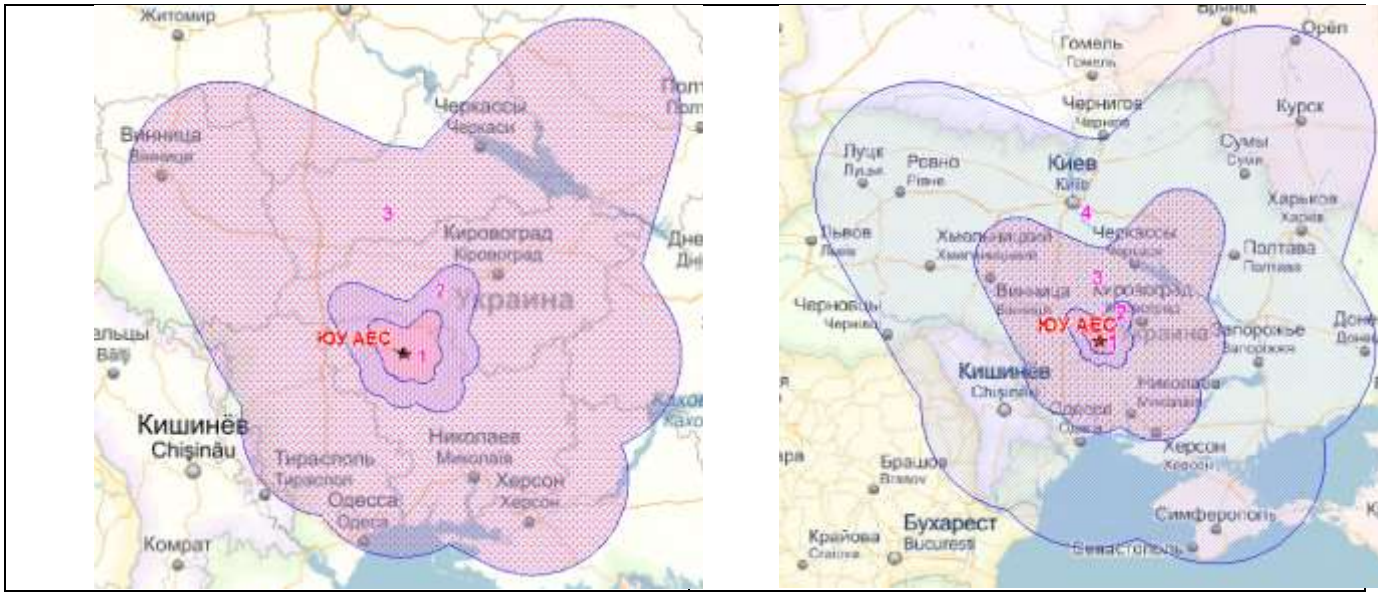


Fig. 6.7. – Probable activity of tritium radionuclides in fallouts on the ground surface due to atmospheric transfer of releases at SUNPP

The areas of contamination, kBq/(m^2/year)
1 - ≥ 100; **2** - ≤ 100, ≥ 50; **3** - ≤ 50, ≥ 10; **4** - ≤ 10, ≥ 5.

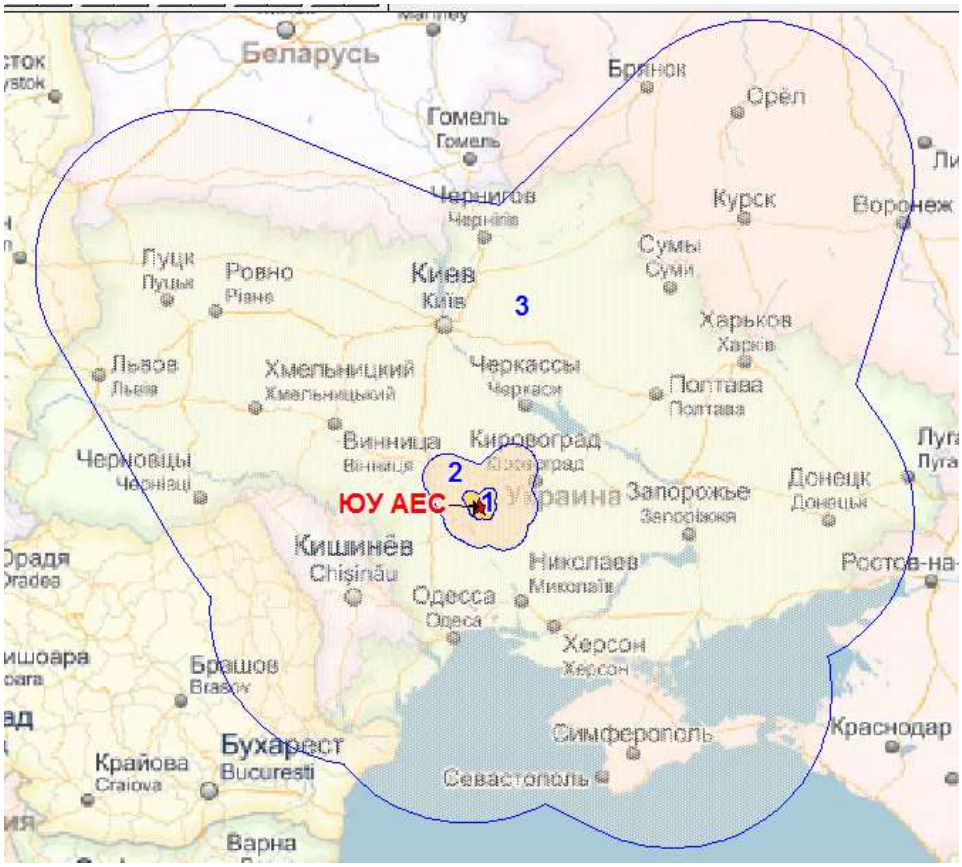


Fig. 6.8. – Probable additional exposure dose due to atmospheric transfer of releases at SUNPP

The areas of contamination, mSv/year:

1 - ≥ 0,001; **2** - ≤ 0,001, ≥ 0,0005; **3** - ≤ 0,0005, ≥ 0,0001.

The average global value for exposure dose limit is 2.4 mSv/year.

As we can see from the figure, the impact of releases from the SUNPP power units to the neighbouring countries is almost not noticeable (it is 2 E-5% of global average value).

Considering the nature of the proposed activity, it can be stated that the analysed impacts of radioactive releases from the SUNPP will remain at the current level.

The analysis allows to make a conclusion about practical absence of harmful transboundary impacts associated with life-time extension of the SUNPP power units in normal operation or in case of design or beyond design-basis accidents.