Environmental Impact Assessment Report

for the Facility for Treatment and Conditioning of Radioactive Waste with a High Volume Reduction Factor at Kozloduy Nuclear Power Plant

CHAPTER 4

DESCRIPTION, ANALYSIS AND ASSESSMENT OF THE POTENTIAL EFFECTS ON THE POPULATION AND THE ENVIRONMENT RESULTING FROM THE IMPLEMENTATION OF THE INVESTMENT PROPOSAL

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4. DESCRIPTION, ANALYSIS AND ASSESSMENT OF THE POTENTIAL SIGNIFICANT EFFECTS ON THE POPULATION AND THE ENVIRONMENT RESULTING FROM THE IMPLEMENTATION OF THE INVESTMENT PROPOSAL

4.1 Implementation of the investment proposal

This part of the EIAR contains description, analysis and assessment of the foreseen potential impacts on the population and environment caused by:

- The construction and commissioning of the installation;
- Operation and decommissioning;
- Emergency conditions.

4.1.1 Possible impacts during the PMF construction, analysis and assessment of the expected potential impacts

The Facility for Treatment and Conditioning of Radioactive Waste with High Volume Reduction Factor, called further on the Plasma Melting Facility (PMF), will be built in room BK301 of building AB-2, constructed for servicing of KNPP Units 3 and 4. Overall dimensions of the room are 71.3/36.4 m and 8.45 m height. The following main activities are foreseen for construction of the PMF:

- Lifting of the medium part of the roof structure of room BK301 in order to adjust it to the height of some of the PMF modules;
- Installation of a new single-rail crane (5 tons);
- Reconstruction of the air ducts, the existing ventilation system, and a number of other auxiliary technical tools.
- Installation of PMF modules.

No excavation works are foreseen. Construction activities will be performed mainly in the room, so the site will not be a source of harmful physical and/or chemical factors.

4.1.1.1 On the population (e.g. roads for vehicles supplying materials, equipment etc. for the site as well as in social aspect)

A). Health aspects

Non-radiation impacts

The health impact on the population by non-radiation factors could be caused by:

Noise. The Construction site is not an organized source of noise. Transportation traffic will be slightly increased - not more than 3-4 trucks, which will not run every day. There is no route indicated in the investment proposal. The increase of noise during the supply of the PMF modules at KNPP will be negligible and it will not cause an increase of the existing noise level in the populated areas, through which the modules will be transported. In this regard, unfavorable effects or increase of the discomfort are not expected.

Dust. Negligible increase of the transportation traffic will not cause an increase of the non-organized dust emissions generated by the vehicles passing through the populated areas.

Toxic substances. Source of toxic substances are the flue gases generated by the motor vehicles. During the combustion the diesel fuel emits: Irritating gases - mainly sulphur and nitrogen dioxide; toxic gases - mainly carbon oxide and dioxide; carcinogens - tar, hydrocarbons etc. Additional emissions generated by the transportation related to the construction will be negligible as well.

Radiation impacts

During the construction of the PMF no RAW will be delivered from or treated by the NPP, thus excluding the negative impact on the health of the radiation factors.

Conclusion

Construction activities related to the building of PMF will not have any unfavorable impact on the population health. The effect will be limited only to the negligible increase of the sense of discomfort caused by the transportation traffic.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Observation of rules and norms for best practice during the execution of the construction and installation works will ensure the good operation of the installation during the operation stage.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*Considerably low*
Territorial scope of impact (geographic region; affected population):	*Territory of the site of Kozloduy NPP*
Reversibility of the impact (reversible, irreversible):	*Yes, mostly reversible*
Duration of the impact - (short term, medium term and long term):	*Only during the construction*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy):	*Direct*
Transboundary type of the impact:	*None*
Cumulative impact	*Not expected*

B). Social aspect

The present practice related to the implementation of the Updated strategy for decommissioning of Units 1-4 of Kozloduy NPP, accepted in 2006, has proved the necessity of construction and commissioning of the Plasma Melting Facility (PMF). The purpose of the implementation of this project (Alternative 2) is to achieve considerable reduction of the volume of low and medium level radioactive waste generated until now during the operation of KNPP Units 1-6, as well as of the radioactive waste, which will be generated from the production activity of Kozloduy NPP during the next years of operation of the power plant.

With the commissioning of the PMF, based on the best available techniques and worldwide experience in this field, the current practical activities of Kozloduy NPP for treatment and conditioning of radioactive waste (RAW) generated during the operation of the power plant will be extended. Furthermore, the reduction of RAW volume by the PMF commissioning will facilitate the provision of sufficient capacity of the RAW storage facilities, which are already available on the site of Kozloduy NPP.

Commissioning of the PMF is important not only for the decommissioning activities related to the shutdown Units 1-4, but also for the operation of Kozloduy NPP as a whole.

Important condition for the assessment of the investment proposal is its location, the objectives for its implementation, commissioning, operation, decommissioning, possible emergency situations, as well as the possible consequences, which may be caused by it, including social and economic impact on the environment and the population.

Non-radiation impacts

The intention for the implementation of PMF in room BK301, located in the building of the existing Auxiliary Building 2 (AB-2) within the KNPP site, has a lot of advantages both from the social and economic point of view, which make it an effective choice. The possible impacts related to this could be as follows:

- Elimination of the need of expropriation, utilization and use of new areas for construction and installation of the PMF;
- There will not be any new construction, which leads to violation of the state of the natural complex components, as well as no need to change of the land use category. By partial reconstruction and less construction activities the existing AB-2 building will be accommodated for the PMF needs, which will have both economic and social effect;
- During the construction new jobs will be created and high employment rates can be reached for workers and experts in construction works needed for the reconstruction of the existing building. The number of employed people, as per preliminary information, will be around 400;
- New jobs will be created and qualified staff will be employed for execution of the PMF installation activities;
- In practice, the construction and installation works will result in cumulative effect in the socio-economic sphere, expressed in a number of aspects – economic, social, personal, financial security, self-confidence, etc.;
- Room BK301, selected for location of the PMF in the building of AB-2, allows connection to the already available infrastructure of Kozloduy NPP, which makes it compatible with the rest of the elements and equipment on the power plant site;
- The PMF construction activities will be done within the Controlled Area

(CA), which means that no negative non-radiation impacts on the population should be expected during the construction of the PMF.

- Construction activities, which will be executed in connection with the adjustment of existing room BK301 for the needs of the PMF, meaning partial reconstruction, will not have a negative impact on the demographic, social and economic condition and behavior of the population living in the Bulgarian part of the adjacent investigated territory of Kozloduy NPP;
- Partial construction activities, which will be carried out on the site of Kozloduy NPP related to the reconstruction of AB-2 for the needs of the PMF, could not have neither positive, nor negative social or economic impact on the population in the 30-km area of Kozloduy NPP, living on the territory of Romania.

Radiation impacts

The nature of the PMF construction activities does not require any use of radioactive materials, which means that there should not be any conditions and possibilities for radiation impact on the population and economy. Foreseen construction activities are not related to radioactive contamination or dose irradiation of the population due to the lack of radioactive sources and materials. The construction will be executed in the Controlled Area of Kozloduy NPP. Besides, the strict observance of the technical requirements and the normative documents (Laws, Ordinances, Rules, Norms, etc.) valid for the site of Kozloduy NPP during the construction works ensures that there will be no radiation impact on the population living in the 30-km area of Kozloduy NPP on the Bulgarian side.

This conclusion can also be made for the population in the 30-km area of Kozloduy NPP on the Romanian side, i.e. there is no practical opportunity for radiation impact on the population in this part of the Republic of Romania.

Due to the fact that there will not be any negative impacts, as well as social and economic negative effect during the construction activities of the PMF, no application of any special measures is required in this regard.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Local; no negative impacts on the population are expected*
Reversibility of the impact (reversible, irreversible):	*Reversible for the population; irreversible for the industrial site*
Duration of the impact - (short term, medium term and long term):	*Short term for the employees; long term for the industrial site*
Frequency of impact occurrence (permanent/temporary):	*Temporary for the employees; permanent for the industrial site*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*For the population - positive for the employment; direct; with high probability of occurrence.* *For the site - positive; direct; with high*

	probability to occur
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Positive, because of the expected employment growth*

4.1.1.2 On the PMF staff and the staff on the site of Kozloduy NPP

Non-radiation impacts

The health effect on the construction workers from **non-radiation factors** can be caused by:

Unfavorable micro climate: Construction activities will be executed most probably during one year. Since work will be performed mainly in the already constructed building, the overheated and/or overcooling micro climate will have impact on the health of the workers.

Welding aerosols: During the installation most probably the electrical welding will be applied and use of automatic equipment is possible. Welding aerosols are condensed vapors of electrode coatings metals, and from the melted metal of the welded parts. Alloying substances such as ferromanganese, ferrochrome ferrotitanium, etc. are mostly used for the electrode coatings. As slag generating substances in the electrodes the fluorine and carbonate substances are used. The chemical composition and the toxic effect mostly depend on the type of the used electrodes.

In the welding aerosol 98 % of the particles are below 1 μm, and they are not retained in the upper airways and penetrate in the lungs alveoli. They contain compounds of manganese, nickel, vanadium, molybdenum, chrome, etc. Besides metal aerosols, the welding aerosols contain nitrogen oxides, carbon oxides and dioxides as well. For the outdoor activities measured concentrations of welding aerosols range from 2 to 12°mg/m^3, in closed areas from 100 to 150°mg/m^3.

Unfavorable health effects from the welding aerosols could be severe or chronic. Severe impacts cause the development of so called "metal fever", when the body temperature increases within several hours after the exposition, accompanied with coughing, red eyes, tightness in the chest and shortness of breath. These symptoms disappear after several days. After outdoor expositions these cases are rare.

Chronic unfavorable health effects are the development of chronic bronchitis, emphysema and the development of asthma

Radiant energy: During the welding activities there is a combined effect of chemical exposition and radiant energy - ultraviolet and infrared, as well as rays of the visible spectrum.

Intensity of the infrared radiation varies from 100 to 2450 W/m^2 depending on the technical characteristics and the weight of the heated metal.

For the ultraviolet radiation the specified overall spectral density at 1-m distance from the heating zone is 0.4 – 162 W/m^2

Infrared and ultraviolet radiations damage the visual analyzer and, if no personal protective equipment is used during the work (glasses or helmets), they could cause cataract and injury of the retina.

Noise: During the installation activities some perforating and cutting tools and devices are used, which depending on their type, could generate noise levels above the norm. Norms for noise in work environment are based on daily exposition and, when reaching the limit values of (Lex.8 h – 87 dB(À)) and the upper exposition limits for undertaking of activities (Lex.8 h – 85 dB(À)), it is necessary to systematically apply the prophylactic measures, which are already proven in practice. Noise levels above the norm could cause permanent damage of the auditory nerve, as well as development of occupational disease. Noise impacts the nerve system and could lead to sleep disorders and development of neurotic-like conditions. It is also a risk factor for development of Arterial Hypertonia.

Vibrations: The use of machines generating general vibrations is not expected during the construction activities. Usually, the local vibrations of perforating and cutting hand instruments are within the limits of the permissible norms.

Occupational accidents: The coefficient of occupational accidents in the construction exceeds the average one for the country. This requires strict observance of the occupational safety rules during the construction and installation of the facilities. The organization of the construction activities should exclude the possibility of increased risk of occupational accidents concerning other KNPP workers as well.

Radiation impacts

The health risk for the construction workers by radiological factors could be caused by:

- During the reconstruction of the air ducts of the existing common exchange ventilation system in room BK301, there is a probability that the civil workers could be exposed to radiation dust particles and that some radionuclide could penetrate the organism.
- RAW generated during the reconstruction of the air ducts may increase the external and internal exposure of other KNPP staff as well.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Application of the well-known and proven in practice conventional measures for the reduction of the risk of unfavorable effect of the physical factors of the work environment, such as use of personal protective equipment, work and rest regime, as well as some other technical and medical-prophylactic activities.

- Assessment of the dose rates from internal and external exposure of the construction workers before starting of the reconstruction of room BK301.

- Systematical measurement of the dose rate from external and internal exposure of the construction workers should be carried out during the construction works.

Measurement of the radionuclides penetrating the body and determination of the dose rate of the internal exposure should also be performed.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Considerably low*
Territorial scope of impact (geographic region; affected population):	*Construction workers building PMF*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative*
Transboundary type of the impact:	*None*
Cumulative impact	*Not expected*

4.1.1.3 On the material assets - consumption of fuel, raw materials and supplies

Non-radiation impacts

The Plasma Melting Facility (PMF) will be constructed in room BK301 of building AB-2. Overall dimensions of the room are 71.3/36.4 m and 8.45 m in height. In this regard, the following activities related to the reconstruction of the building will be executed:

- Lifting of the medium part of the roof structure of room BK301 in order to fit to the height of some of the PMF modules;
- Installation of new single-rail crane (5 tons).
- Reconstruction of the air ducts, of the existing ventilation system as well as of some other auxiliary technical tools.
- Installation of the PMF modules;

During the construction stage it is expected that the following natural materials will be used as construction materials: sand, wood and water, in quantities specified by the detailed design. The materials will be purchased from commercial companies. During the construction works some materials for hydro insulation, polymer glue, paints and varnish will be used. It is very important not to allow use of asbestos materials for insulation, and other appropriate materials should be used instead.
Cables supplying electricity for the annual consumption of 3500 MWh for the plasma torch have to be laid. Based on the total installed capacity of the PMF, the annual power consumption, except the Plasma Torch, is 2292 MWh.
In table 4.1.1.3-1 some hazardous substances and mixtures are listed, which may present a risk for the health of the PMF construction workers.

Table 4.1.1.3-1 Characteristics of the main substances used as raw materials and supplies, as well as the unfavorable effects, which could be caused by them

Chemical substance or preparation CAS N	Sign for danger	Impact on the people	Impact on the environment
Cement	Irritant	Irritant of skin, eyes and respiratory tracts. Allergen. Contains pollutants (Cr-VI, Cd, Co, Ni) and is controlled by Decree of the Council of Ministers No 156/2004). Inflammation and allergic damages of skin and mucous membrane.	If it is used properly, it will not cause any risk for the environment. Usually, it is not used in dry condition, but in a consistency with water.
Paints, varnishes, glues, floor coatings, polymers	Xi Irritants Xn Harmful	They damage the nervous system, liver, endocrine system, respiratory tract, skin and mucous membrane. They provoke allergic diseases.	Considering the size of the packaging, in which they are offered, no impact on the environment caused by emergency leakages is expected. Empty packages in some cases could be hazardous waste and should be treated as such.
Diesel fuel 94114-59-7	Xn Harmful	Danger of cumulative effects. Allergen. Damage of the nervous system, skin, blood organs, liver, kidneys. Mutagen.	In case of emergency overflows and leakages there is a possibility to pollute the soil, underground and surface waters. Contains pollutants: sulphur and heavy metals. Inflammable liquids. Dangerous for the environment - especially for the aquatic organisms.

These substances could cause chronic diseases in case of failure to observe the safety occupational requirements and when the personal protective equipment is not used, when this is mandatory and recommended on their label, in compliance with the Ordinance for classification, labeling and packaging of dangerous chemical substances, adopted with CMD 182/20.08.2010, last amended SG 68/31.08.2010.

The other construction materials (wood material for formwork, reinforcing steel in preform, bricks, insulation materials, metal structures, ceramic products) are not risky for the human health and environment. Their quantities will be specified in the Bills of Quantity of the Detailed Design and will be purchased from trade companies, which have the right to produce them or to distribute them.

The diesel fuel, which will be used for the construction equipment during its operation, though in small quantities, will emit pollutants as specified in table 4.1.1.3-

2. Emissions of the diesel fuel contain fine dust particles of 10 μm and smaller (PM10, FDP5, FDP2.5). Their impact will be short term and local.

Table 4.1.1.3-2 Characteristics of the dangerous substances in the emissions of the construction equipment

Chemical substance, CAS	Sign for danger	Impact on the people	Impact on the environment
Carbon oxide 630-08-0	F^+,T	Highly inflammable, toxic in case of inhaling. It creates carboxihemoglobin. It injures the nervous system, cardiovascular system, blood organs. It is toxic for the reproduction.	It is dangerous for the environment. Main cause for global warming.
Carbon dioxide 124-38-9		Asphyxiant - displaces the oxygen in the air. Injures the nervous system.	
Nitrogen oxides 10102-44-0	T^+, Xn	Toxic, injure the lungs alveoli. Irritate respiratory airways, eyes and skin, chronic bronchitis, more frequent pneumonias.	Dangerous for the environment.
Sulphur dioxide 9/5/7446	T, C	Toxic in case of inhaling - injures the respiratory system, nervous system and the heart. It irritates the respiratory airways, eyes and skin. It has a strong and unpleasant smell.	Harmful for the flora and fauna. Dangerous for the environment.
Polycyclic aromatic hydrocarbon (PAH)	Xn N	Harmful. Danger of cumulative effects. Allergens. Injure the nervous system, skin, blood organs, liver, and kidneys. Mutagens.	Stable organic pollutant. Dangerous for the environment - especially for the aquatic organisms.

The PMF construction activities are related to additional short-term impact by certain dangerous substances. This is a result of the use of construction equipment, mostly of diesel fuel, increased pollution with spent lubricating oils, construction dust, cement, and generation of construction waste containing materials for hydro-insulation, hydro-insulation materials, polymer glues, paints and varnishes.

All chemical substances, preparations and products available on the market and used in the construction and household, should have safety information lists, safety packaging and labeling, depending on their danger classification, and based on the physical and chemical, toxicological and eco-toxicological tests. The labels of the hazardous substances are required to identify the risk phrases (R-phrases) and safety advices (S-phrases), which have to be taken into consideration during the work with these substances for reduction of the health risk for the construction workers.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Purchase of construction materials from active trade companies.

Requiring information safety list for the chemical substances and mixtures used in the construction.

Organizing the construction and installation activities in such a way that spilling of any substances and materials is prevented.

Elaboration of a procedure for determination of radioactivity of the construction waste from the reconstruction of the building where the PMF will be located.

Collection of the conventional (non-radiation) construction waste and their timely storage in KNPP Repository for conventional municipal and industrial waste (RCMIW).

Separate collection of the radioactive construction waste and treatment according to the RAW procedures available in Kozloduy NPP.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists during the construction stage*
Territorial scope of impact (geographic region; affected population):	*Locally, only on the construction site*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short term during the construction stage*
Frequency of impact occurrence (permanent/temporary):	*Daily during the construction stage*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Insignificant, direct, negative*
Transboundary type of the impact:	*None*
Cumulative impact	*Not expected*

4.1.1.4 On the atmospheric air and the atmosphere

Non-radiation impacts

The Plasma Melting Facility (PMF) will be installed on the site of Kozloduy NPP, and the proposed location is within the Auxiliary Building 2 (AB-2), room BK301, which is currently unused. The room area is serviced by three cranes with 6.3 t, 4.0 t and 2.0 t lifting capacity.

The place of PMF installation is the central part of the room. In order to provide the necessary space for placement of the facility equipment, the roof of the building is planned to be lifted.

Room BK301 has ventilation air ducts connected to the ventilation installation of the AB-2. Also, there are connections for supply of electricity, steam, pressurized air, demineralized water, and cooling water. In the south-eastern part of room BK301, covered by the 6.3 t crane, an area for temporary storage of incoming RAW, secondary waste and final drums with vitrified waste is planned.

Due to the fact that the Plasma Melting Facility will be installed in the existing building, the construction will be mainly related to changing of the height of the building roof, reconstruction of the room and installation activities. During the construction period excavation and embankment works, transportation and disposal of earth, and other activities emitting large amounts of dust in the atmospheric air, are not foreseen. Construction activities are related to the reconstruction of the building, as a result of which no generation of dust emissions is expected.

Air pollution during the construction will be a result only of the exhaust gases emitted in the atmosphere by the internal combustion engines (ICE) of the machines executing construction and transportation activities. The main pollutants, which will be emitted, are: CO_2, CO, NOx, SO_2, CnHm and dust.

Pursuant to the emissions inventory methodology (Uniform methodology for inventory of emissions of harmful substances in the air, MEW, EEA, 2007, http://eea.government.bg/bg/legislation/air/mpg-07/Metodika_2007.html), the harmful substances released into the atmosphere in combustion of 1 ton diesel fuel are specified in table 4.1.1.4-1.

Table 4.1.1.4-1 Emissions from the construction and transport equipment

Substance/Emission (kg/t)		Substance/Emission (kg/t)	
NMVOC	7.3	Cd	0.01
NO_x	30.2	Cu	1.7
CO	12.6	Zn	1.0
CO_2	3188	Ni	0.7
N_2O	0.12	Cr	0.05
CH_4	0.3	Se	0.01
NH_3	0.01	PAH	0.23
PM	2.4	DIOX	0.042

The amount of the emitted pollutants during the construction activities will be specified after determination of the type and number of used heavy loading and construction equipment.

In general, these emissions are typical for each construction, and their duration, amount and area are limited.

Emissions, as expected during the construction, will affect mostly the construction site, and they will not impact the air quality in the closest areas. Depending on the transportation schemes for delivery of the equipment and materials, the traffic on some motor roads in the region will be increased. Taking into consideration that the intensity of the traffic in the region is not high, the increase of the traffic will not impact considerably the air quality. In case of poor maintenance of the road covering of the streets in the settlements, there is a significant probability for increase of air pollution with dust and PM. If such situation arises, measures for pollution reduction should be implemented.

The assessment of pollution dispersion based on the PLUME methodology during operation shows negligible concentrations of air pollutants.

The results from the assessment are presented in attachment 10 of chapter 11.

Radiation impacts

During the reconstruction of the air ducts of the existing common exchange ventilation system in room BK301, there is a probability of emitting radioactive dust particles in the air. This will affect the air in the work areas and will produce local impact on the atmosphere air around the building. RAW generated during the air duct reconstruction could increase the external and internal exposure.

The analysis of the planned PMF construction activities shows that impact caused by radiation factors is not expected outside of the construction area.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Use of well-maintained construction and transportation machinery.

Maintenance of the road covering of the motor roads on which the transportation will take place.

Selection of suitable transportation schemes, ensuring that the populated areas are affected as little as possible.

Delivery of construction materials in suitable packaging preventing their spill out.

Dose control of the external exposure of construction workers during the construction phase and measurement of radionuclide penetration in the body.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Minimal*
Territorial scope of impact (geographic region; affected population):	*Depending on the transportation schemes.* *local as a whole*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative/direct* *cumulative in view of the transport emissions*
Transboundary type of the impact:	*None*
Cumulative impact	*Expected concerning the transport emissions*

The nature of the construction activities does not imply impact on the meteorological conditions and the climate.

4.1.1.5 On the waters

Non-radiation impacts

The possible impacts on the surface and ground waters during the construction of the PMF could be summarized as follows:

Increase of water consumption

The construction phase will require potable and sanitary water for the workers taking part in these activities, as well as water for cleaning and for the works executed on the site (wet processes, etc.). This means that there will be some increase in the water consumption. The quantities will be limited and they will not be a considerable violation of the water use in KNPP. This impact will have local character. Although negligible, the impact will be negative and direct, with limited territorial scope and low degree within the area of influence around the water intake facilities. It will be temporary (only for the term of construction) and short-term.

Generation of limited waste water quantities

Limited waste water quantities will be generated mostly during cleaning. They will be polluted mainly with suspended substances. Waste waters will not be a problem neither for the NPP sewage system, nor for treatment facilities of the power plant. The characteristics of the impact are similar to the above. There will be some impact, but it will be limited within the site of Kozloduy NPP. The impact will be negligible, but negative and non-direct. There will not be any secondary or cumulative impacts. Impact will be temporary (only for the term of construction) and short-term. Sewage waters generated during the construction will not impact the quality of the surface waters in the adjacent basins. They will not impact the ground waters, since all sewage water flows will be collected and deviated for cleaning to the needed extent, and after that they will be discharged in the Danube River. An impact to the chemical state of the underground water body *BG1G00000N2034* (Neogene pore waters) is not expected, because the possible infiltration of polluted waters will be retained in the relatively strong aeration zone, not able to reach the ground water level beneath it.

According to the provided information the water will be the only natural resource which will be used during the project implementation. Pursuant to permit No 1375000/20.04.2007 for discharge of sewage waters in the main drainage channel, the sewage water quantities generated in 2010 are 24.34 % of the permitted quantity. This information allows us to make a conclusion that the drainage facilities have the capacity to accept the sewage waters generated during the construction of the PMF, which are expected to be of negligible quantity. Their treatment will follow the practices established in Kozloduy NPP for the generated sewage water flows, as well as for observance of the emission restrictions. Within the in-house monitoring shall be monitored the respect of the conditions in the issued permits for water use and water discharge, the prohibitions for direct discharge of water containing harmful and hazardous substances within the underground water protection areas and the respect of the regulations for environmental protection during construction and technologies with probability for worsening of the potable water rate and/or quality.

Radiation impacts

The analysis of the planned PMF construction activities shows that no impact caused by radiation factors is expected on the surface and groundwater. At this stage the installation will not be commissioned, due to which the generated sewage waters will be only residential waters and sewage waters generated during the construction process with expected pollution by suspended particles.

During the construction stage significant adverse impact on water is not expected provided that the best practices for activity performance are me. Specialized measures for avoidance, reduction or off-set of these impacts include prohibition of the use of materials, containing priority substances during construction of engineering facilities or auxiliaries, where contact with underground water is a fact or is anticipated – measure with a code BG1MS0117; prohibition for disposal of priority substances as other activities on surface and ground water bodies, which are anticipated to lead to direct evacuation of priority substances in underground water bodies

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Minimal*
Territorial scope of impact (geographic region; affected population):	*Local as a whole*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short- term*
Frequency of impact occurrence (permanent/temporary):	*Temporary for the construction term*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative, direct in view of the quantities Negative, indirect in view of the water qualities, without accumulation.*
Transboundary type of the impact:	*Non expected*
Cumulative impact	*Not expected*

4.1.1.6 On the soils and earth bowls

A). On the soils

Non-radiation impacts

The PMF construction and installation period is not related to considerable construction activities. The new facility will be installed in an existing building.

In this period no excavation and embankment works will be made, which are the common source of impact on the soils during the construction stage. The Plasma Melting Facility will be serviced by currently existing road network and infrastructure, and no construction of new similar facilities is required.

During the construction non-radiation impacts on the soils are not expected, because the planned activities will be carried out in rooms in the controlled area.

Non-radiation impact on the soils of neighboring Romanian territories is not possible.

Radiation impacts

The PMF construction stage represents assembling of modules in a closed room and it is not a source of radiation pollution of the soils.

It is assumed that an emergency radiation impact is possible to occur on the staff during the connection of the PMF to the existing systems in AB-2 (e.g. ventilation and drainage system), and it will be comparable with the impacts during KNPP operation. In case of such an impact, it will occur indoors and will not be dangerous for the soils. The PMF commissioning is not related to radiation pollution of the soils from the site of the power plant and in adjacent territories; cumulative impact is not expected.

Radiation impact on the soils of the neighboring country of Romania is not expected.

No measures are needed for avoidance, mitigation or compensation of considerable negative impacts on the soils, since such impacts are not expected during the construction period.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

B). On the earth bowels

The geological environment on the site of Kozloduy NPP is destroyed by the executed excavations, embankments and compacting works for foundation within the range of the large-scale current construction of the number of buildings and facilities, underground and overhead communications etc.

Such impact regarding the earth bowels and the geological foundation could not be expected during the construction of the PMF, because the proposed PMF location is within the Auxiliary Building 2 in room BK301 at elevation +6.30 m and room BK039/3 at elevation +0.00 m.

AB-2 is a building designed to service KNPP Units 3 and 4, and Room BK301 is currently unused. The PMF design provides for partial reconstruction of room BK301. This reconstruction is required because of the overall height of some PMF modules, and due to the need to provide conditions for installation, maintenance and dismantling activities. No excavation, embankment, compacting and other construction works related to the foundation of the buildings and equipment are foreseen, because they already exist.

Only reconstruction and increasing of the height are planned by lifting of the medium part of the roof structure of room BK301 in view of the necessity to install a new single-rail crane for servicing the PMF. The planned reconstruction of the air ducts of the existing common exchange ventilation system of room BK301 and the implementation of additional fire safety engineering and technical measures are not related to damages and impact on the geological environment, because they do not affect it.

Impacts on the geological environment during the process of construction works for building of the PMF are not expected.

Due to the fact that no foundation activities are foreseen the earth bowels will not be affected by the implementation of the investment proposal.

No special measures for avoidance, reduction or compensation of considerable negative impacts are needed.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*None*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*No impact of the implementation of the PMF project is expected.*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.1.7 On the land use

Non-radiation impacts

The investment proposal does not foresee the execution of construction activities - no new buildings, roads, etc. will be constructed. PMF will be installed in the already existing building of Kozloduy NPP, which will be located within the controlled area (CA).

The facility will be provided by modules, which will be assembled on spot. For delivery of the equipment elements, an existing crane is planned to be used. These facts show that during the period of commissioning of the PMF no new areas will be used and no expropriation or change of use of land of other lands will be needed.

During the period of construction of the PMF non-radiation impact on the use of land is not expected on the territory of Kozloduy NPP and beyond it.

Radiation impacts

Commissioning of the Plasma Melting Facility is related only to the installation works in the existing building on the territory of KNPP, which are not a source of radiation contamination. No radiation impact is expected on the use of land within the 30-km area on the neighboring territory of Romania.

Radiation impact on the use of land during the construction period is not expected.

No special measures are needed for avoidance, reduction or compensation of considerable negative impacts on the soils, since such impacts are not expected during the construction period. Cumulative impact is also not expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.1.8 On the landscape

Non-radiation impacts

During the construction of the PMF negative impacts on the landscape components are not expected. During the construction period considerable construction activities are not expected, because the new equipment will be located in the existing building on the KNPP territory.

Only increase of the height of the building is foreseen in order to provide sufficient space for location of the entire PMF equipment.

Although the height of the building will be increased in the middle, it will not have any negative impact on the vertical landscape structure.

The existing building will be preserved and only one of its elements will be changed - the height. The visual perception of the "anthropogenic" landscape will be partially changed.

Commissioning of the PMF will not cause any chemical pollution of the landscape components.

During the construction the social and economic landscape functions will not be changed.

Non-radiation impacts on the structure, functioning and cycle of substances in the landscape in the construction stage are not expected, because the foreseen activities will be executed in rooms of the controlled area.

Non-radiation impacts on the landscape of the neighboring Romanian territories are not expected.

Radiation impacts

Construction of the PMF will be executed indoors on the KNPP territory and it is not related to any impact on the landscape components.

Radiation impacts on the landscape are not expected during the construction stage, because the foreseen activities will be executed in rooms of the controlled area. Subject to compliance with the technical requirements, there will be no pollution sources, and so no radiation impacts on the landscape of the neighboring Romanian territories are expected.

No measures for avoidance, reduction or compensation of considerable negative impacts are needed. No cumulative impact on the landscape components, on their horizontal and vertical structure and functioning, should be allowed**.**

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.1.9 On the mineral diversity

During the construction no impact by non-radiation and radiation factors is expected on the mineral diversity.

No measures for avoidance, reduction or compensation of considerable negative impacts are foreseen.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*No impact from the implementation of the PMF project is expected.*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.1.10 On the flora

Non-radiation impacts

During the construction upon execution of the following elements of the IP: lifting of the medium part of the roof structure of room BK301, (axis 14 to axis 19) and limitation of under crane road of the existing 2-ton crane servicing this section to axis 14; installation of new suspension single-beam crane (of 5 t lifting capacity) for servicing of the PMF, whose under-crane road covers the area under the lifted part of the roof structure of room BK301; reconstruction of the air ducts of the existing total exchange extraction system of room BK301; implementation of additional fire safety engineering and technical measures, **no impact on the flora and vegetation on the territory of KNPP and adjacent territories is expected.**

Radiation impacts

Commissioning of the Plasma Melting Facility is related only to the installation works in the existing building on the territory of KNPP, which are not a source of radiation contamination. No radiation impact is expected on the flora and vegetation in the 30-km area on the neighboring territory of Romania.

Radiation impact on the flora and vegetation during the construction period is not expected.

Regarding the flora and vegetation during the construction period no special measures are recommended for avoidance, reduction or compensation of considerable negative impacts on them, besides compliance with the best practices for implementation of these activities.

No cumulative impact related to the decommissioning activities for KNPP Units 1-4 and the construction activities for the National Disposal Facility for Low and Intermediate Level Short-Lived RAW (NDF RAW) is expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact (geographic region; affected population):	*Locally, on the IP site*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short-term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Indirect, secondary*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.1.11 On the fauna

Non-radiation impacts

During the construction upon execution of the following elements of the IP: lifting of the medium part of the roof structure of room BK301 (axis 14 to axis 19) and limitation of under crane-road of the existing crane to axis 14; installation of new suspension single-beam crane (of 5 t lifting capacity) for servicing of the PMF, which under-crane road covers the area under the lifted part of the roof structure of room BK301; reconstruction of the air ducts of the existing total exchange system of room BK301; implementation of additional fire safety engineering and technical measures, considerable impact on the fauna is not expected.

The maintenance activities for the PMF construction are precondition for noise pollution and intensive anthropogenic presence around the building AB-2. There is small probability that this could lead to chasing away of individuals and respectively damaging of the normal population structure.

Impact on the fauna on the territory of KNPP site and on the adjacent territories is not expected.

Radiation impacts

The commissioning of the Plasma Melting Facility is related only to the installation works in the existing building on the territory of KNPP, which are not a source of radiation contamination. No radiation impact is expected on the fauna within the 30-km area on the neighboring territory of Romania.

Radiation impact on the fauna during the construction period is not expected.

Regarding the fauna during the construction period no special measures are recommended for avoidance, reduction or compensation of considerable negative impacts, besides compliance with the best practices for implementation of these activities.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*None*
Territorial scope of impact (geographic region; affected population):	*Locally, on the IP site*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short-term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Indirect, secondary*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.1.12 On the cultural and historical heritage

Non-radiation impacts

During the construction stage upon lifting of the medium part of the roof structure of room BK301, limitation of under crane road of the existing 2-ton crane servicing this section; installation of new suspension single-beam crane (of 5 t lifting capacity) for servicing of the PMF, which under-crane road covers the area under the lifted part of the roof structure of room BK301; reconstruction of the air ducts of the existing common ventilation system of room BK301; implementation of additional fire safety engineering and technical measures, impact on the cultural and historical heritage on the territory of KNPP and adjacent territories is not expected.

Radiation impacts

The commissioning of the Plasma Melting Facility is related only to the installation works in the existing building on the territory of KNPP, which are not a source of radiation contamination. No radiation impact is expected on the cultural and historical heritage within the 30-km area on the neighboring territory of Romania.

Radiation impact on the cultural and historical heritage during the construction period is not expected.

Regarding the cultural and historical heritage during the construction period no special measures are recommended for avoidance, reduction or compensation of considerable negative impacts, besides compliance with the best practices for implementation of these activities.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*None*
Territorial scope of impact (geographic region; affected population):	*Local*
Reversibility of the impact (reversible,	*Not expected*

Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38,
E- mail: office@eninbg.com

irreversible):	
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*None*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*None*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.1.13 Waste

Non-radiation impacts

During the construction works waste is generated by the cleaning and reconstruction of the site for construction and installation of the PMF. This is solid waste by inert construction materials (bricks, concrete parts, wooden parts, reinforcement bars), metal scrap waste, packaging waste and municipal waste. In table 4.1.1.13-1 presents the classification of waste (*according to Ordinance No 3/2004 for classification of the waste*) and the quantities of waste generated during the construction period.

Table 4.1.1.13-1 Classification and quantities of non-harmful waste during the construction period

Description	Code under Ordinance 3/2004 for waste classification	Quantity (t)
Packaging of wooden material	15 01 03	1
Metal packaging	15 01 04	2
Mixed packaging	15 01 06	1
Mixtures of concrete, bricks, tiles, faience and ceramic products, different than the ones specified in 17 01 06	17 01 07	5
Iron and steel	17 04 05	1
Mixed municipal waste	20 03 01	0.5

If it will be detected after the radioactivity measurement that the waste is conventional, the available infrastructure will be used for its transportation. Disposal of the waste from construction will be made in the KNPP Repository for Conventional (Non-radioactive) Municipal and Industrial Waste (RCMIW).

The construction equipment maintenance will be done by external companies outside the site, so generation of hazardous waste is not expected.

Construction waste will be managed in compliance with the Ordinance on the management of construction waste and use of recycled building materials (prom. SG 89/13.11.2012).

Municipal waste should be managed in compliance with the KNPP Program for management of the activities with non-radioactive waste (2010), approved by RIEW Vratsa, Decision 130-00/03.01.2011, in force until 31.12.2013. During the stage of construction of the PMF the good practice in this regard has to continue. At the same time, the requirements of the WML for the separate collection of packaging waste, according to art. 33. Par. 4 of the WML should be introduced at the construction stage.

Ferrous and non-ferrous waste metals should be submitted for further treatment to companies holding license under art. 67 of the WML. The new WML has led to changes in the bylaws as well. In this connection, it is recommended that an update of the account books of the waste is done in accordance with Regulation 2/2013 on the procedures and forms for providing information on waste management activities and the procedures for conduct of public records (prom. SG 10/05.02.2013).

Radiation impacts

The commissioning of the Plasma Melting Facility is related only to the installation works in the existing building on the territory of KNPP, which are not a source of radiation contamination.

If during the radioactivity control measurement the waste generated during the construction stage is classified as RAW, they should be managed not as conventional waste, but as radioactive waste, under the existing procedures for its management.

RAW generated by the activity of Kozloduy NPP will be stored in the same manner as before the implementation of the IP. No radiation impact is expected within the 30-km area on the neighboring territory of Romania.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Measurement of the radioactivity of the construction waste and, if it is within the norms, its management will be as conventional waste and its disposal will be made in the KNPP Repository for conventional municipal and industrial waste (RCMIW).

If the waste is radioactive, the management will be done under the procedures available in Kozloduy NPP.

Establishment of places on the construction site for temporary storage of generated waste suitable for recycling, which is not radioactive.

Conventional waste with code 17 04 05 has to be submitted to a company with permit pursuant to Article 67 of the WML.

Provision of containers for separate collection of municipal waste in accordance with the Waste Management Act.

Conventional waste, which will be generated during the construction, has to be stored in KNPP Repository for conventional municipal and industrial waste (RCMIW).

Continuation of the existing practice for RAW treatment generated by the activity of Kozloduy NPP until construction of the PMF.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Local*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*During the construction stage*
Frequency of impact occurrence (permanent/temporary):	*Daily, during the construction stage*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Direct Negative*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected because of the insignificant quantity of waste*

4.1.1.14 From noise, vibrations, dust, gas etc.

During the construction, unfavorable impact could be caused by the following physical factors:

Noise Construction of the PMF will be made in the already constructed building and the construction site will not be an organized noise source. The noise outside AB-2 from the installation machines and tools will be much lower than the permissible norms, and the common noise level of the KNPP site will not be increased.

Vibrations No heavy excavation equipment or other facilities, which could generate common vibrations and infrasound, will be used on the construction site.

Dust During the process of reconstruction of BK301 common dust will be generated. These dust emissions will be mostly of coarse disperse dust, which will be precipitated rapidly on the floor of the building and around it.

Toxic gases Toxic gas emissions are expected to be only from:

Trucks supplying the construction materials and equipment. During the combustion the diesel fuel emits: Irritating gases - mainly sulphur and nitrogen oxides; Toxic gases - mainly carbon oxide and dioxide; Carcinogens - tar, hydrocarbons etc.

Toxic gases emitted during the execution of different types of welding. The chemical composition and mostly the toxic effect depend on the type of the used electrodes. In the welding aerosol 98 % of the particles are below 1μm, and they are not retained in the upper air ways and penetrate the lungs alveoli. They contain compounds of manganese, nickel, vanadium, molybdenum, chrome etc. Besides metal aerosols, the welding aerosols contain nitrogen oxides, carbon oxides and dioxides. During outdoor activities the measured concentrations of welding aerosols are from 2 to 12 mg/m^3, in closed areas from 100 to 150 mg/m^3.

Measures for avoidance, reduction or compensation of considerable negative impacts:

During the construction works measures should be undertaken for reduction of non-organized dust emissions - irrigation and frequent washing out of the area around AB-2, as well as the road cover inside the KNPP site.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Construction site* *KNPP site*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short-term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative*
Transboundary type of the impact:	*It is not of transboundary type*
Cumulative impact	*Not expected because the activities are performed in the existing building*

4.1.1.15 From lighting, thermal and electromagnetic radiation

During the construction activities the following types of radiant energy could be expected:

Infrared radiation/heat radiation/

During execution of welding infrared radiation is generated. Its intensity varies from 100 to 2450 W/m², depending on the technical characteristics, weight of the heated metal, duration of the execution of the welds, etc.

Ultraviolet radiation This is the second type of radiant energy emitted during the execution of the welds. For ultraviolet radiation the total spectrum density is specified at 1 m from the zone of heating of the metal within the range of 0.4 – 162 W/m².

Light beams Visible beams are radiations with wave length from 400 to 760 nm.

Electromagnetic radiation During the generation, distribution and consumption of electrical energy the main source of electromagnetic radiation is the electrical current. Around the generators, transformers, Switchyard, Switchgear, transmission network and other facilities some electrical and magnetic fields are detected from ultra-low frequent range - with industrial frequency and its harmonic ones, up to 1 kHz frequency. On the KNPP site during the PMF construction the functioning Switchyard and Switchgear will be in operation. Electrical machines and tools, which will be used during the construction, are source of electrical magnetic fields. Usually, their intensity is within the limits of the established norms.

Measures for avoidance, reduction or compensation of considerable negative impacts:

According to our regulations the equipment which is a source of electrical field should be installed in such a manner that the intensity of the electric static field does not exceed 25 kV/m.

Use of personal protective equipment by the workers.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Construction site*
Reversibility of the impact (reversible, irreversible):	*Reversibility*
Duration of the impact - (short term, medium term and long term):	*Short-term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Harmful and neutral*
Transboundary type of the impact:	*None*
Cumulative impact	*Not expected*

4.1.1.16 From possible radiation impact in connection with the construction of the facility

During the reconstruction of the air ducts of the existing common exchange ventilation system in room BK301, there is a probability that the civil workers will be exposed to radiation dust particles and that radionuclide may penetrate the organism.

RAW generated during the reconstruction of the air ducts may increase the external and internal exposure of other KNPP staff as well.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Assessment of the dose rates of internal and external exposure of the construction workers before beginning of the reconstruction of room BK301.

During the construction works systematic measurement of the dose rate of external exposure of the construction workers should be made. Measurement of the radionuclide penetrating the body and determination of the dose rate of the internal exposure.

RAW generated from the reconstruction of the air ducts and other construction activities will be treated according to the rules for RAW disposal.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Construction site and NPP site*
Reversibility of the impact (reversible, irreversible):	
Duration of the impact - (short term, medium term and long term):	*Short-term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative, secondary*
Transboundary type of the impact:	*It is not of transboundary type*
Cumulative impact	*Not expected*

4.1.2 Possible impacts during PMF operation and decommissioning

4.1.2.0 Justification and assessment of direct impacts from the radionuclide emissions during normal PMF operation on the personnel at the PMF site and he KNPP site.

This part is further developed since the emissions of radionuclide are important for the assessment of some areas of environmental protection as population, atmosphere/air, soil, water and protected areas.

Emission of radionuclide from the PMF depends on many factors, the most important of which are:

- incoming activity and nuclide composition as well as quantity of waste;
- the behavior of the fed material during the plasma state in the Primary treatment chamber (PTC), and the distribution of different radionuclide in the slag and off- gases;
- the behavior of off-gases in the off-gas treatment system;
- and, the effectiveness of the off-gas treatment system, including purification through HEPA filters.

Incoming activity

According to the Technical specification of the project [3], the maximum specific activity of the incoming waste to be treated in the PMF is 5.17E+05 Bq/kg. Therefore, PMF has been designed according to that value.

This is the maximal annual average value. As described in chapter 1.2.4.2 of this report on the control of incoming RAW for treatment, individual waste packages with a specific activity less than or equal to 4.00E+06 may be accepted, but the specific activity for all the waste must be less than or equal to 4.00E +05 Bq/kg.

Nuclide composition

The nuclide composition specified in table 4.1.2.0-1 is based on the Technical specification of the project [3] and is the average result from many measurements. The main nuclides are ^{60}Co and ^{137}Cs.

Behavior of incoming RAW in the Primary treatment chamber (PTC)

Chapter 11, section 11.3.1 "International experience in plasma waste treatment" of this EIAR presents the results from a literature research on this issue.

In the publications [17] and [57] the volatility of cesium during the plasma treatment of RAW is examined by laboratory tests.

Metallic cesium as alkali earth metal is very reactive and is therefore available in the RAW only as a compound. Volatility at high temperatures during the thermal treatment is caused by the thermal dissociation of the cesium vapor, according to the following equation:

$$Cs_2O \leftrightarrow 2Cs(g) + ½\, O_2$$

The volume of the evaporation and the subsequent deposition of the Cs in the slag depend on many factors, among which:

- Temperature;
- Oxidizing or reducing conditions in the gas phase;
- Surface of the molten slag;
- Alkalinity content (CaO) of the slag;
- Duration in time.

Therefore, 100 % of the Cs evaporation without further precipitation in the slag is only possible under very adverse conditions.

The expected isotopic distribution for the slag and the flue gases, based on experimental measurements in the test facilities performed by the Contractor (IBERDROLA), is shown in the following table:

Table 4.1.2.0-1 Distribution of radioactivity in isotopes during PMF operation (source [2])

Isotope	**Isotopic distribution of incoming waste (%)** According to KNPP Technical specification KPMU/RWT/005 Rev. 6 Appendix 2	**Share in the slag (%)**	**Share in the flue gases (%)**	**Isotopic distribution in the slag (%)**	**Isotopic distribution in the flue gases (%)**
^{60}Co	57.00 %	51.30 %	5.70 %	60.50 %	37.50 %
^{110m}Ag	6.00 %	5.40 %	0.60 %	6.37 %	3.95 %
^{134}Cs	6.00 %	4.20 %	1.80 %	4.95 %	11.84 %
^{137}Cs	20.00 %	14.00 %	6.00 %	16.51 %	39.47 %
^{95}Nb	1.00 %	0.90 %	0.10 %	1.06 %	0.66 %

<table>
<tr><th>Isotope</th><th>Isotopic distribution of incoming waste (%)
According to KNPP Technical specification KPMU/RWT/005 Rev. 6 Appendix 2</th><th>Share in the slag (%)</th><th>Share in the flue gases (%)</th><th>Isotopic distribution in the slag (%)</th><th>Isotopic distribution in the flue gases (%)</th></tr>
<tr><td>^{54}Mn</td><td>6.00 %</td><td>5.40 %</td><td>0.60 %</td><td>6.37 %</td><td>3.95 %</td></tr>
<tr><td>^{59}Fe</td><td>1.00 %</td><td>0.90 %</td><td>0.10 %</td><td>1.06 %</td><td>0.66 %</td></tr>
<tr><td>^{58}Co</td><td>3.00 %</td><td>2.70 %</td><td>0.30 %</td><td>3.18 %</td><td>1.97 %</td></tr>
<tr><td rowspan="2">Total</td><td rowspan="2">100 %</td><td>84.80 %</td><td>15.20%</td><td rowspan="2">100 %</td><td rowspan="2">100 %</td></tr>
<tr><td colspan="2">100 %</td></tr>
</table>

The results show that about 70 % of the semi-volatile components such as Cs nuclides are deposited in the slag. The results from the first test period of the ZWILAG PMF (presented in [24]) show 86.7 % deposition of ^{137}Cs in the slag.

Behavior of off-gases in the off-gas treatment system

In the Secondary treatment chamber before the off-gas treatment system the predominant off-gases are under the following conditions: minimum temperature of 850°C, residence time of a few seconds and excess oxygen. Under these conditions, changes in the composition of the flue gases in terms of Cs are not expected.

At the latest after cooling in the boiler cesium vapor cannot exist.

*Die Verbrennungs- und Schmelzanlage der ZWILAG, W. Heep; KONTEC 2005 Proc. Int. Conf. Berlin, Germany 2005.

Effectiveness of the off-gas treatment system

The off-gas treatment system described in chapter 1 of this report consists of the following parts: cooling down in a boiler, preliminary filtration with coating (bag), HEPA filters, cooling unit, scrubber, heater and DeNox Unit. The filtrating systems, cooling unit and scrubber are important for the effectiveness regarding radionuclide deposition.

The basis for a (very conservative) calculation of the annual emissions from the PMF: 6.03E+06 Bq [2] was only the 99.975 % effectiveness of the HEPA filters.

The actual effectiveness of the off-gas treatment system is higher, considering the following:

- The 99.975 % retention in HEPA filters class H14 is according the standard EN 1822 for the local retention, the overall retention is 99.995 %.
- The effectiveness of the preliminary filtration unit can be around 90 %;
- The cooling unit and the scrubber are additional parts for radionuclide separation.

The comparison with the existing RAW processing facilities ZWILAG [58], CILVA [47] and the incineration facility WAK [59] in terms of effectiveness is shown in table 4.1.2.0-2.

The off-gas technology of the incineration facility CILVA is the same as the one planned for the KNPP PMF project. ZWILAG, as the only existing facility for plasma treatment of RAW, and the incineration facility WAK have other technological concepts, but what they have in common is the combination of preliminary filtration or separation, scrubbers and HEPA filters. The annual mass flows are comparable (see also table 11.3.4-1 in chapter 11 of this report).

Table 4.1.2.0-2 Effectiveness of the off-gas treatment systems compared to the PMF design characteristics

Facility	Incoming RAW (Bq/a)	Releases into air (Bq/a)	Coefficient of decontamination*	Comments
ZWILAG	1E+12	5E+05	2E+06	
CILVA	2E+11**	1E+05	2.E-06	
WAK	1E+13	1E+06	1.E+07	
PMF Kozloduy	1.3E+11	6E+06	2.2E+04	Design

* Decontamination coefficient: activity of incoming RAW (Bq/a)/outgoing activity by emissions in the air (Bq/a).

**Personal information fromMr. J. Deckers, BELGATOM, 07.03.2013

4.1.2.1 On the staff on the site of the PMF and on the Kozloduy NPP site (impacts by radiation and non-radiation factors), during normal operation and decommissioning (data about the possible radiation exposure)

During operation

Processes of RAW treatment by Plasma Melting will be executed in the conditions of approximately full automation. Activities related to the current and planned maintenances of the PMF will be highly mechanized. It is foreseen that the PMF will operate in continuous operation mode in three work shifts. There will be a Deputy Shift Supervisor and three operators working per shift. During the day two more operators will work, who will be involved in the control of receipt and unloading of RAW. The activities related to maintenance, cleaning, calibration and decontamination of components will be performed by workers responsible for maintenance activities. During the operation of the PMF the workers will be subject to the following impacts.

A). Non-radiation factors

Noise. Organized noise sources will include the processes related to the acceptance, unloading and feeding of RAW to the shredder, the operation of the shredder itself, as well as the operation of the PTC and STC. In the IP no forecast data about the noise are specified. Besides, it is not clear whether there will be some permanent work places next to them, and where the monitoring and control room will be located. In this regard, at this stage we are not able to forecast to what extent the noise could have unfavorable health effects. After the commencement of the operation it is needed to measure the equivalent noise level and, if needed, to undertake the respective technical and medical prophylactic measures. It has to be taken into consideration that except the direct effect on the auditory system, the noise has a clear extra-oral effect on the nervous system, and from this point of view it is also an important factor for the reliability of the "man-operator" system.

Vibrations. General vibrations could be generated by the cranes. In the IP such option is not specified. It is clear that they will operate remotely and the possible vibrations generated by them will not have any direct impact.

Microclimate. PTC and STC will be lined outside with refractory and insulation materials, they will be serviced remotely and the operators will be remote. Nevertheless, it is needed to detect the infrared radiation emitted by the facilities. It is one of the main components of the micro climate; it could penetrate the tissues in depth and warm them up. Besides that, together with the rest of the components of the micro climate, it causes heat exhaustion and overheating, and could also cause heat stroke.

Maintenance and repair workers could also be exposed to levels of infrared radiation exceeding the norm.

Toxic gases. Non-radioactive air pollutants will be discharged under the same conditions as the radioactive ones. Declared values of dust concentrations, CO, SO2, HF, HCl and TOC are below the permissible norms, and they are not expected to have any unfavorable health effect.

Shift and night work. Shift work mode and night work could cause sleeping disorders and influence the nervous system, as well as disturbances of the daily and nightly rhythm of a number of systems in the organisms. During the night work there is an increase of the frequency of the diseases of the digestive system.

B). Radiation factors

In the IP it is declared that after a number of filters - bag filters, HEPA filters, two coarse filters and two fine filters, the efficiency of the system will be retention of 99.7 % of the particles with size up to 0.3 µm. HEPA filters have an efficiency of 99.97 %, and after the scrubber system an effectiveness of 99.995 % can be assumed, taking into account the activity captured in the solid products (slag and ash) and in the liquid products (scrubber water).

Radiation exposure of the operation staff and the maintenance staff could occur during servicing of the storage activities, during operation and maintenance of the PMF, maintenance activities, by the radiation background. Taking into account the use of the best protection techniques and consequent use of the ALARA principle, the dose rate due to inhalation and absorption is very low. The total collective Effective Dose Rate of the operational staff and the maintenance staff based on the radiation background in AB-2 is forecasted at 18.984 mSv/year. This radiation background is a result of:

- Operation of storage facilities – 8.108 mSv/annually;
- Operation and maintenance of the PMF - 10.449 mSv/annually

Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38, E- mail: office@eninbg.com

- Radiation background of AB-2 – 0.427 mSv/annually.
- Individual dose rate of the staff varies as follows:
- Two operators involved in storage facilities – 4.1 mSv/annually.
- Nine operators from the PMF operation - 0.6 mSv/annually.
- Two operators from the maintenance of the PMF - 2.4 mSv/annually.

Forecast data about the radiation dose rate of the staff are lower than the permissible levels; the effective dose limit for the personnel is 20 mSv for each year. These forecast data provide **avoidance of stochastic and non-stochastic effects** as a result of radiation damage.

Stochastic effects depend linearly on the absorbed dose rate. In that case the dependence dose/effect is considered as statistically probable occurrence of damage and increasing of their frequency among certain group, but is not related to the increase of the severity of the diseases.

For non- stochastic effects, in case of exceeding of certain dose rate all exposed persons will be injured, and the increase of the dose rate raises the severity of the injury. Non-stochastic effects are the acute and chronic radiation sickness, radiation skin burnings, injuries of the embryo, etc.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. **In view of the non-radiation factors of the work environment:**

- Establishment of the parameters of the impact of a certain factor (intensity, exposition, characteristics) and regular control.
- Application of the approved conventional measures for protection - respective personal protective equipment, technical devices for reduction of the intensities of the physical and chemical factors, medical and prophylactic measures for reduction of the impact effect (occupational and rest regimes, occupational norms and rules, prophylactic examinations and in time readjustment etc.).

2. **In view of the radiation factors**

- Classification of the work places and radiological zones in the PMF, strict control of entering and leaving of the staff.
- Execution of regular individual dosimetric control of the operation staff and staff for maintenance and repair of the PMF in compliance with the requirements of Ordinance 32/7.11.2005.
- Continuous radiation and air monitoring in the rooms and equipment of PMF has to be performed.
- In the PMF controlled areas protection clothes and gloves have to be worn
- When working in zones of possible radiation air pollution or non-fixed surface contamination, protection devices for the respiratory system should be used.

- In case of periodical shut down for cleaning and prophylactic, calibration, decontamination, maintenance of the PMF, protection clothes and respiratory masks should be worn.
- Monitoring of the health of the operation staff and maintenance and repair staff in compliance with the normative requirements of the country and Kozloduy NPP.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Operation staff, maintenance and repair staff.*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Middle-term*
Frequency of impact occurrence (permanent/temporary):	*Constant*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative*
Transboundary type of the impact:	*It is not of transboundary type*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

There are three main internationally recognized strategies for decommissioning of nuclear facilities. These are 'immediate dismantling', 'deferred dismantling (safe enclosure)' and "entombment”. IP favors immediate dismantling as preferred option for decommissioning. During the design of the PMF requirements are planned, which will facilitate the decommissioning process (use of cranes, overall dimensions of the equipment, etc.).

A). Non-radiation factors

Non-radiation physical factors to which the workers involved in the dismantling will be exposed are mostly reciprocal to the ones related to the construction and dismantling of the PMF.

Noise. During the dismantling activities some perforating and cutting instruments and devices are used, which depending on their type, could generate noise levels exceeding the noise level limits. It is needed to apply systematically the prophylactic measures proven already in practice. Noise levels above the norms may cause permanent injury of the auditory nerve and development of professional diseases. Noise impacts the nerve system and could cause sleeping disorders, development of neurotic-like conditions, and it is a risk factor for development of Arterial Hypertonia.

Vibrations. During the dismantling activities there will be no sources of common vibrations.

Occupational burden. In spite of the mechanization of a large part of the activities, part of them requires severe and hard physical work, lifting and movement of overweighed loads. Another unfavorable feature of these activities is that they will be executed in unfavorable pose and under considerable static tension of the muscles of the body and limbs. This causes micro traumas, diseases of the locomotor system and neuromuscular system.

Occupational accidents. Ratio of the labor accidents in the construction exceeds the average one for the country. This requires strict observance of the occupational safety rules during the construction and installation of the facilities. Organization of the construction activities should exclude the option for increased risk of occupational accidents in view of the other KNPP workers.

B). Radiation factors

Radiation risk will be reduced by fulfillment of the conditions stipulated in the IP:

1. The avoidance of the pollution beyond the building during the PMF dismantling, since the activities will be executed in a closed room.

2. Upon starting of the IP decommissioning activities, the last lots of waste should not be radioactive, thus reducing to some extent the radioactive contamination of the PMF.

3. Secondly, the entire algorithm of cleaning and decontamination of the facility will be followed, and then dismantling of the elements of the PMF will be done.

4. Contamination levels during the decommissioning are commensurate to activity levels of waste Category 2a and to the radionuclides existing in the RAW treated at the PMF. Working in the area is a radiation risk, which could be reduced and limited when applying the respective measures.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. Dismantling activities will be executed under strict preliminary control of the already achieved dose rate, and such control will be executed during the dismantling as well;

2. Undertaking of the respective protection measures - protection clothes and gloves, and respiratory masks, if needed;

3. Execution of all medical and prophylactic measures applied in Kozloduy NPP in view of the staff working in A zones.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*There is a probability, but it is a small one*

Territorial scope of impact (geographic region; affected population):	*Workers involved in the dismantling*
Reversibility of the impact (reversible, irreversible):	*Yes*
Duration of the impact - (short term, medium term and long term):	*Middle term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative*
Transboundary type of the impact:	*Not transboundary*
Cumulative impact	*Not expected*

4.1.2.2 On the population during normal operation and decommissioning both from the social and health point of view

A). Social aspect

From the social and economic point of view the possible impacts on the population and economy on the investigated territory during the normal operation of the PMF would have positive effect. On the other hand, some social and economic aspects are related to the observance of security and safety rules during decommissioning in order to avoid social and economic impacts on the environment such as environmental pollution. Possible impacts from the social and economic point of view during the operation of the PMF could be the following:

<u>During the operation</u>

Non-radiation impacts

- Use of some of the discharged qualified staff taking part in the operation of Units 1-4 and the experience and knowledge gained by these experts will be applied in PMF. This will provide social security and confidence both for the PMF staff and the rest of Kozloduy NPP staff, as well as for the population of the adjacent territory.
- Operation activities and the ones related to the decommissioning of the PMF will require opening of new jobs for highly qualified staff, practically allowing achievement of high employment rate. According to the good practice of the KNPP management described in the "Updated strategy for decommissioning of Units 1-4 of Kozloduy NPP", the highly qualified staff and experienced experts, who have previously serviced the shutdown reactors, will be re-directed to the new decommissioning activities. Thus practically a lot of positive social and economic effects will be achieved - keeping of the existing jobs and provision of new jobs for experts discharged from the operation of the shutdown Units 1-4, utilization of their rich experience and knowledge, achievement of higher professional and social effectiveness in the new activities in the PMF, provision of succession, reduction of the unemployment and provision of constant incomes for the families of 23 staff members, which will be involved in the PMF, e.g. all this will lead to new values of the cumulative effect.

- Achievement of higher employment means social security for the staff, which will increase the effect of the economic productivity.
- Staff, which will be involved in the PMF operation, will pass through special Training Program, which will increase the social security of the people employed on the site of the PMF, Kozloduy NPP as well as for the population of the adjacent territory.
- Technology selected for the PMF, which will practically be an "isolated system", which will guarantee during normal operation the avoidance of uncontrolled emissions of gaseous, liquid and solid pollutants into the environment, which will not only be environmental protective, but will have a social aspect as well.
- The operation of the PMF will ensure higher capacity of the RAW storage facilities existing on the site of the power plant, which will have a positive social and economic effect.
- Operation of the PMF (e.g. reduction of the stored waste volume) will lead to an increase of the storage capacity of the existing RAW storage facilities at the plant site, which will have a positive social and economic effect.
- The PMF operation, which will lead to a serious reduction of the volume of generated RAW and RAW which will be generated in the KNPP production activity, will have positive economic and social effect not only for the power plant, but for the population and the environment as well. Effect will be expressed in the provision of higher opportunities such as capacity of the facilities for storage of RAW and in the reduction of the costs for final disposal of the conditioned RAW.
- PMF will operate in normal operation conditions, not causing any dose rate on the operational and maintenance staff, exceeding the dose rates as specified for Kozloduy NPP. This means that there will not be any negative effect on the social and health status of the rest staff of the power plant as well as on the population of its adjacent territory.
- Planned technological measures during the PMF operation in view of the gaseous, liquid and solid waste, which will be generated during the RAW treatment in normal operation conditions, will not cause any environmental pollution. This means that the operation of the PMF will not have any negative environmental effect. Moreover, the operation of the facility will have positive social and especially economic effect.
- Positive economic effect will be a result of the use of the already existing building and facilities allowing safe RAW treatment.
- For achievement of higher technological and social security during the operation the PMF the application of the "defense in depth" principle will contribute, including the system of consecutive physical barriers preventing the distribution of the radioactive substances in the work rooms and into the environment. System will include protective technological and organizational

measures and activities in order for the barriers to keep their efficiency during all operational conditions of the facility.

- A systematic control of the operation mode and generated RAW doses and quantities will be provided by the authorities and the radiation control system on the site of Kozloduy NPP as well as control of all decommissioning activities of the PMF.
- Implementation of the intention for application of the best available techniques during the operation and decommissioning of the PMF is not only of critical importance for its operation, but it also guarantees that the possibility for negative impact on the environment, the population and economy on the territory adjacent to the facility and respectively to Kozloduy NPP, will be minimized.

Compliance with the technological norms and safety rules on the PMF site and on the territory of the electric power plant during the operation would ensure the elimination of negative non-radiation impacts on the population of the adjacent territory of the Bulgarian side in the 30-km area of Kozloduy NPP.

Based on the above it is considered that in the social and economic aspect negative non-radiation impacts should not be expected on the population living on the territory of the Romanian side.

No measures for avoidance, reduction or compensation of considerable negative impacts are needed.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Locally; no negative impact is expected on the population in the 30-km area of Kozloduy NPP.*
Reversibility of the impact (reversible, irreversible):	*Reversible for the population; for the industrial site it is irreversible.*
Duration of the impact - (short term, medium term and long term):	*For the employees in the PMF it is long term one;* *For the industrial site it is long term one*
Frequency of impact occurrence (permanent/temporary):	*For the employees it is temporary; for the industrial site it is permanent*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Positive; direct*
Transboundary type of the impact:	*Not expected*
Cumulative effect	*Positive cumulative effect is expected based on the employment growth*

Radiation impacts

Installation of PMF in BK301 room of AB-2 will be a prerequisite for trouble-free operation of the facility in view of the environment. This argument is supported by the fact that the PMF and AB-2 are located in the Controlled area of Kozloduy NPP, which is practically an "isolated area". In normal operation conditions PMF will operate in a manner avoiding any dose rate exceeding the adopted dose limits for the operation and maintenance staff of Kozloduy NPP. Gaseous, liquid and solid RAW, which will be generated during the normal operation of the PMF, will be managed in compliance with the RAW management program, and will not be discharged outside the controlled area of Kozloduy NPP.

Application of the best technologies during the PMF operation as well as the strict observance of ALARA principle are precondition for avoidance of radioactive pollution on the PMF and Kozloduy NPP sites. Based on the above, radiation impact on the population of the investigated territory should not be expected.

Both during the operation and in emergency situations the possible radioactive emissions will be caught by the systems existing in AB-2 and auxiliary systems constructed under the PMF Design. Expectations are that this will allow to avoid or to reduce the consequences of the emergency discharges and their distribution. Besides, in such situations the approved Program for Radiation Protection on the territory of Kozloduy NPP will be applied. In order to avoid any emergency situations an important condition is to observe the requirements in this field both of the Bulgarian and European legislation.

Compliance with these conditions gives no reason to expect radiation impacts on the population and economy during the PMF operation within the 30-km KNPP area both on Bulgarian and Romanian territory.

In* Appendix *10, according to the MEW additional recommendations (Letter – No. OBOC 277/2012 - Appendix 6), "Analysis on the dose rate from gas aerosol and liquid releases to the environment from the Units 1-4 decommissioning process and the emissions from the plasma melting facility (PMF) operation, incurred by the public within the 30-km supervised area surrounding Kozloduy NPP" is presented. A modeling program code based on the EU approved methodology CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 –Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclide to the Environment has been used for modeling the pollutants distribution, considering the following:

- To assess the public dose due to liquid discharges - program code DARR-CM has been adapted to the hydrology of the KNPP area and uses a conservative assessment of the dose exposure of a critical group of the public.
- To assess the public dose within the monitored area due to gas-aerosol discharges - program code LEDA-CM, Normal Operation Shield has been adapted to the geographical and meteorological characteristics of the KNPP area. The methodology considers both the external and the internal impact of the radioactive releases and estimates the annual individual effective dose, the

annual individual dose equivalent, and the critical group dose, as well as the collective dose for the population, per age groups.

The modeling program codes used to estimate the individual and the collective effective doses to be incurred by the population from radioactive discharges to the environment, have been verified and validated.

The dose distribution map for the population within the 40-km area and as a function of the distance to the emission source are presented on fig. 4.1.2.2-1 and fig. 4.1.2.2-2. The selected 40-km area includes the monitored 30-km area, but the model is able to provide information on a range wider than 40 km.

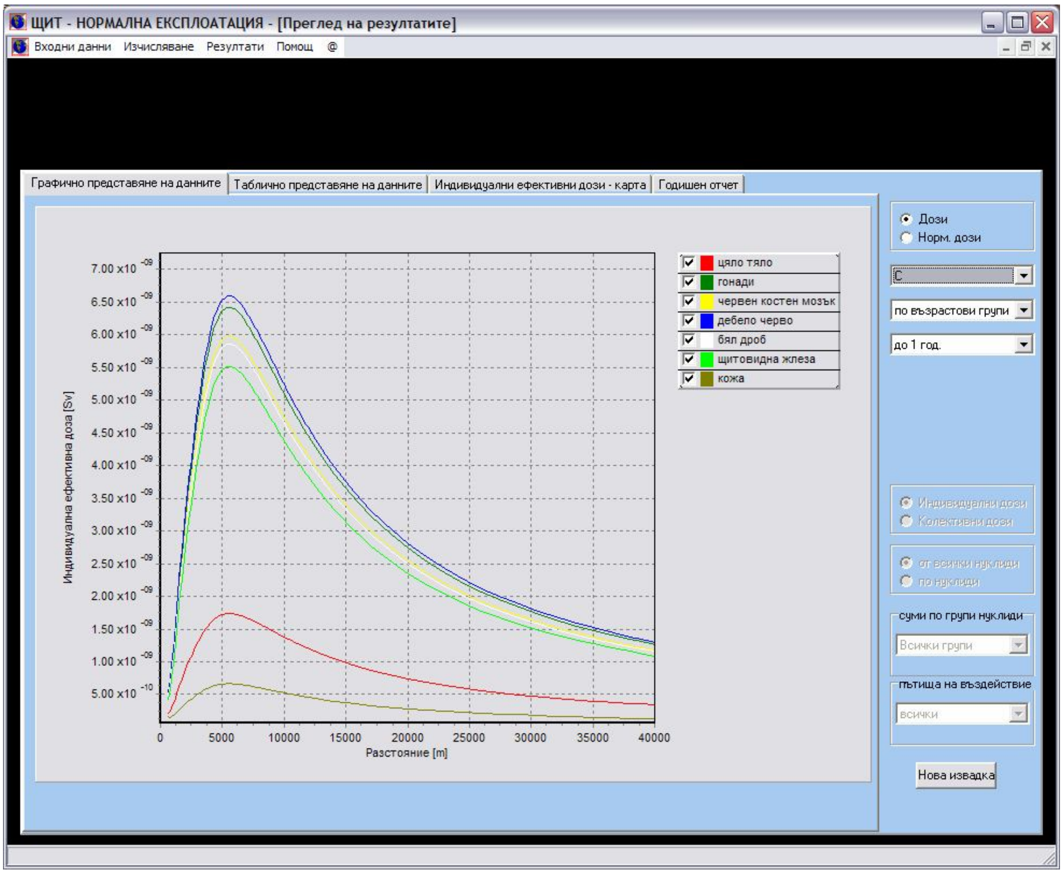
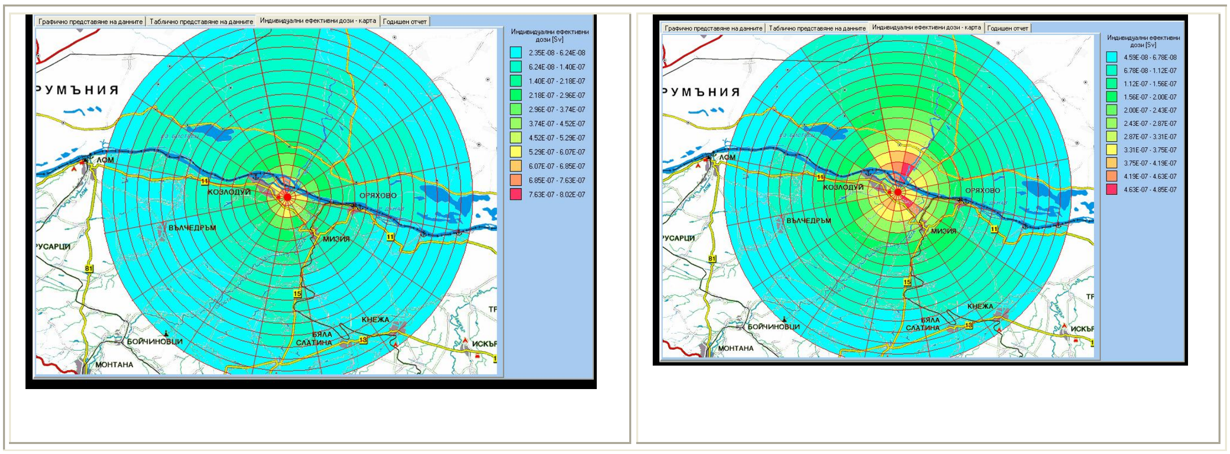


Fig. 4.1.2.2-1 Individual effective dose as function of the distance to the source

The maximum values of the individual effective dose were calculated within the 5-6 km Kozloduy NPP area.



a) <u>with meteorological data for 2010</u> b) <u>with micro climate data for 2001–2010</u>

Fig. 4.1.2.2-<u>2</u> Distribution of the individual effective dose from external exposure to RNGs, LLAs, ^{131}I + (^{3}H, ^{14}C) within the area of Kozloduy NPP, 2010.

Based on the performed analysis the following conclusions for the population dose during Decommissioning of KNPP Units 1-4 and normal operation of the Plasma Melting Facility (Project 5c) can be made:

1. The maximum annual effective dose per individual of the critical group of the population living within the 40-km area around KNPP, resulting from the liquid and gas-aerosol releases to the environment, was conservatively calculated at 5.05 μSv/a, which is a much lower value than the quota of 250 μSv/a for exposure from radioactive emissions from NPP (Ordinance on the Ensuring the Safety of NPPs) and the norms determined for the population of 1 mSv/a (ONRZ-2012, Basic Norms for Radiation Protection).
2. The additional dose that might be incurred is about 500 times lower than the natural radiation background (2.33 mSv).
3. The calculation of the cumulative effect added to the effect of KNPP normal operation, due to emissions from the decommissioning of KNPP Units 1-4 and the normal operation of the Plasma melting facility (PMF) (Project 5c) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %.
4. The maximum annual effective dose of the population within the 40-km area around KNPP, due to aerosol emissions only, 6 MBq under normal operation of the Plasma melting facility (PMF), was estimated at $5.47.10^{-10}$ Sv/a, which is barely 0.01 % from the total exposure resulting from all activities on the KNPP site.

The comparisons of the collective effective dose values for the population around KNPP with the respective data for many other nuclear power plants with PWRs (WWERs) reactor type proved comparable with the practice worldwide. The cumulative effect added to the effect of KNPP normal operation, due to emissions from the decommissioning of KNPP Units 1-4 and the normal operation of the Plasma melting facility (PMF) (Project 5c) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %. Therefore, recalculation of the already established special statute areas at KNPP is not necessary. This clarification is made in regard to the MEW recommendations (letter – Ref. OBOC 277/2012-***Appendix 6)***.

Measures for avoidance, reduction or compensation of considerable negative impacts, supplemented in accordance with MEW letter (letter - Ref. OVOS-277/2012 - Appendix 6**):**

1. To ensure that during normal operation, expected operational states, and design accidents in the facility the established dose limits under art. 9, items 1 and 2, and item 3, will not be exceeded for the period after closure of the facility, according to the Regulation for safety during RAW management. For this purpose sensors should be installed providing "on-line" control of the gamma background.
2. To develop and execute a Program for in-house radiological monitoring, as a part of the overall Program for radiological monitoring at the plant site.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Locally; no negative impact is expected on the population in 30-km area of Kozloduy NPP.*
Reversibility of the impact (reversible, irreversible):	*Reversible for the population; for the industrial site it is irreversible.*
Duration of the impact - (short term, medium term and long term):	*For the employees in the PMF it is long term one;* *For the industrial site it is long term one*
Frequency of impact occurrence (permanent/temporary):	*For the employees it is temporary; for the industrial site it is permanent*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Positive; direct*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During decommissioning</u>

Non-radiation impacts

After termination of the production activity of the PMF in compliance with the developed and approved Concepts and Plan for Decommissioning of the PMF the dismantling activities will be carried out.

From the social and economic point of view the execution of the dismantling activities means increase of the employment of qualified staff and provision of social security for them and their families, e.g. the constituted cumulative effect will continue to find application. In this case the most important issue, which is not subject to consideration of the present development as well as of the other developments of Kozloduy NPP, will occur after completion of the dismantling facilities and discharge of staff taking part in the dismantling. In our opinion, it would be good for the foreseen measures of Management of RAW and Kozloduy NPP to keep them as a staff of the power plant in view of their involvement in the following activities related to the future decommissioning of Units 5-6. Thus a positive social and economic effect will be achieved, because it will not be needed to look for qualified staff again, because the available experts will be well-prepared and experienced and no training will be needed for them, their production experience will ensure social security and confidence among the population and staff of the power plant etc.

During the decommissioning of the PMF no negative radiation impacts from the social and economic points of view are expected on the population of the Bulgarian part of the 30-km area around Kozloduy NPP.

No negative non-radiation impacts are expected from the social and economic point of view on the population and economy in the 30-km area around Kozloduy NPP in Bulgaria and Romania.

Radiation impacts

Activities for execution off the Plan for decommissioning of the PMF will not cause radiation pollution, if the foreseen measures and activities related to the safety of the staff and the population will be strictly observed and the pollution of the environmental components will be avoided. Due to this reason no radiation impacts related to the social and economic status and economy would be expected both on the territory of Bulgaria as well as of Romania, within the 30-km area of Kozloduy NPP.

Measures for avoidance, reduction or compensation of considerable negative impacts, supplemented in accordance with MEW letter (letter - Ref. OVOS-277/2012 - Appendix 6**):**

To develop and execute a Program for in-house radiological monitoring, as a part of the overall Program for radiological monitoring at the plant site.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Locally; no negative impact is expected on the population in 30-km area around Kozloduy NPP.*
Reversibility of the impact (reversible, irreversible):	*Reversible for the population; for the industrial site it is irreversible.*
Duration of the impact - (short term, medium term and long term):	*For the employees in the PMF dismantling it is short term one;* *For the industrial site it is long term*

	one
Frequency of impact occurrence (permanent/temporary):	*For the employees it is temporary; for the industrial site it is permanent*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Positive; direct*
Transboundary type of the impact:	*Not expected*
Cumulative effect	*Positive, based on the employment growth*

B). Health aspects

<u>During the operation</u>

A). Effect caused by non-radiation factors

Toxic substances and dust from the PMF emissions. During the operation the flue gases from the PMF will be released through ventilation stack 2 (VS-2) together with the waste gases of Units 3 and 4 and the waste gases from AB-2 ventilation system. The declared expected values of common dust, CO, SO2, NOx, HC, HF and TOC are much below the permissible norms. This allows us to conclude that these gases will not have any irritating and toxic impact on the environment in 30-km area.

Cumulative effect. Share of the flue gases emitted from the PMF is only 0.17 % of the total emissions of the pollutants through VS-2. This shows that no cumulative effect on the population would be expected.

Dust and toxic substances from the transportation vehicles. Until the construction of the National Repository for RAW the PMF will be serviced mostly by in land transport - delivery of RAW stored on the sites of Kozloduy NPP and their transportation after treatment to the SD RAW Kozloduy for storage. Operation of the equipment in this period will not cause increase of the transportation traffic and respectively pollution of atmospheric air. Transportation traffic after construction of the PMF will be insignificantly increased and there will be no unfavorable health effect by the non-organized dust emissions caused by this slight increase. The same is valid for the spent gases emitted by the motor vehicles.

Noise. No increase of the noise from the transportation flow crossing the populated areas of 30-km zone is expected.

B). Effect caused by radiation factors

Limit of the annual effective dose on the population is 1mSv. For the past 10 years the values of the maximal effective dose for the population vary from 2.5 – 5 µSv/a. Dose rate of the population of 30-km area is many times lower than the one caused by the natural radiation background. Total outgoing radioactivity from the PMF will be negligible – 6.03E+6 Bq annually equal to 1.25 Bq/Nm³, which will not change the negligible radiation risk for the population in the region of the power plant.

Selection of the system for purification of the flue gases complies with Section 2.5 of the reference "Systems applied for purification and control of the flue gases" specified in BREF "Waste Incineration", July 2005.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. Continuation of the continuous monitoring of the radioactive discharges from the AB-2 ventilation stack.
2. Update of the Plan for avoidance of disasters, accidents and catastrophes including the PMF.
3. Preventive activity for information of the population for occurred incidents and accidents.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Negligible*
Territorial scope of impact (geographic region; affected population):	*Population in the region of 30-km area around the Kozloduy NPP*
Reversibility of the impact (reversible, irreversible):	*Irreversible*
Duration of the impact - (short term, medium term and long term):	*Middle term*
Frequency of impact occurrence (permanent/temporary):	*Constant*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*None*
Transboundary type of the impact:	*None*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

All activities related to the decommissioning and dismantling of the PMF will be made in the building AB-2 on the site of Kozloduy NPP. Hypothetically, at this stage impacts on the population could be/could not be expected caused by:

A) Non-radiation factors

- **Noise.** Transportation traffic through the populated areas will not be increased and the unorganized noise emissions from it will not be increased neither.

  Site for dismantling will not be organized noise source as far as the activities will be executed in the room.

- **Dust emissions from the transportation** traffic will not be increased**.**

B) Radiation factors

- During the dismantling there will not be any pollution beyond the building, because the dismantling will be performed in the respective confinements after the cleaning and decontamination.

- Contamination levels of the dismantled elements during the decommissioning are commensurate to activity levels of waste **Category 2a** and to the radionuclide existing in the RAW treated at the PMF.

Measures for avoidance, reduction or compensation of considerable negative impacts:

No additional measures are needed, because it is not expected that the intensity and quantities of these factors will increase. No unfavorable health effect caused by the non-radiological and radiological factors is expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Negligible*
Territorial scope of impact (geographic region; affected population):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Direct*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*None*

4.1.2.3 On the atmospheric air and atmosphere during the normal operation and decommissioning

<u>During the operation</u>

Organized emissions

During the operation of the PMF one controlled source emitting hazardous emissions will operate. The purified flue gases will be discharged through the 150 m ventilation stack. Generation of harmful emissions will be take place in two chambers - for plasma melting and for secondary melting.

Plasma melting will be carried out in the plasma treatment chamber (PTC, also called primary treatment chamber), where the plasma torch is installed. PTC is high temperature (1100°C – 1500°C) tilting furnace. In the PTC the organic material is evaporated in the form of volatile hydrocarbons, carbon oxide etc., while the non-flammable and other non-organic compounds are melted and converted in vitrified slag. The furnace operates under negative pressure and is well sealed.

As far as no additional incoming air enters the furnace, the organic waste will not burn, but rather convert into gases.

Chamber for secondary treatment (STC) The unburned gases, hydrocarbons, soot particles, CO, hydrogen and fly ash flow from the primary treatment chamber (PTC)

Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38, E- mail: office@eninbg.com

to the secondary treatment chamber (STC) in order to obtain a complete combustion of primary oxidized components such as CO_2, SO_2 and H_2O. The STC is sized to provide a minimum of two seconds residence time at the design waste feed rate and at a minimal temperature of 850°C. The STC is equipped with a secondary burner. It operates with diesel oil and varies between high and low flame and regulates the STC exit temperature.

After the STC the flue gases enter the flue gas treatment system. After cooling down the flue gases enter the bag house, where particulate matter is captured by surface filtration of membrane filter bags of Polytetrafluoroethylene (PTFE). The filter medium is cleaned by means of pulsed jets of compressed air, triggered by a differential pressure indicator. The collected particles are shaken off from the surface of the bags. The hopper at the bottom of the bag house receives the released particulate matter and emptying is accomplished through a rotary discharge valve at the vibrating tube. In order to retain radioactive particles, the gases enter the HEPA filters.

The wet gas scrubbing assembly consists of a quencher tower for the cooling down of gases and counter current scrubbing tower with caustic liquid for removal of HCl and SO_2, and a demister. Two extraction fans in parallel ensure the evacuation of flue gases.

After heating of the flue gases the NOx concentration will be reduced in catalytic manner in $DeNO_X$ system.

In the Investment proposal it is declared that the HEPA filters have efficiency of 99.97 %, and after the scrubber system efficiency of 99.99 % can be assumed, considering the activity captured in the solid products (slag and ash) and liquid products (scrubber water).

In compliance with the PMF design the retaining of radioactivity in the PMF is provided from the borders of the equipment and confinements as well as by the negative pressure of the system towards the building. Besides that, the zones fenced with confinements where the maintenance activities are carried out, will be periodically cleaned, thus preventing the accumulation of radioactive pollution during the entire operation period. In addition, to avoid excessive accumulation of contamination and to facilitate maintenance, the following is planned:

Periodical cleaning of the necessary components inside the PMF will be carried out with a specially adapted vacuum cleaner to minimize spread of contamination

These activities will minimize the residual radioactive contamination inside the equipment, thus reducing the risk of spreading of the pollution.

In all cases regarding manholes or covers, which have to be opened for maintenance or inspection and are considered critical in terms of potential spread of contamination, temporary confinements consisting of aluminium frames and plastic foils will be installed (e.g. on top of PTC during refractory replacement).

The facility will be equipped with control systems and systems for management of separate processes and the respective signalizations are foreseen in order to avoid any emergency situations.

Under the set characteristics of the facility:

- Capacity: 250 tons per year or 6.25 tons per week with 40 weeks per year;
- Specific waste activity: Maximal - 5.17E+5 Bq/kg;
- Flow rate of the flue gases: Nominal 1200 -1400 Nm^3/h in the atmospheric air,

It is expected that the following conventional pollutants given in table 4.1.2.3.-1 will be released.

Table 4.1.2.3-1 Concentration of non-radioactive pollutants generated from the operation of PMF at off-gases flow rate of 15000 m3/h [55]

Pollutant	**Average daily values [mg/Nm^3]**
Total dust	< 1
CO	< 5
TOC	< 1
HCl	< 1
HF	< 1
SO_2	< 5
NO_x	<100
Heavy metals [mg/Nm^3]	**Average values for sample period: Minimum 30 min.- maximum 8 hrs**
∑ Cd, Tl	<0.005
Hg	<0.005
∑ Sb,As, Pb, Cr; Cu, Mn, Ni, V, Sn	<0.05
Dioxins and furans [ng/Nm^3]	**Average values for sample period: minimum 6 h –maximum 8 h**
Dioxins and furans	<0.01

Radioactive pollution

Radionuclide will be generated mainly during the treatment and transfer process and will be released through the flue gas purification system. The total outgoing activity of the PMF is expected to be: 6.03E+6 Bq/year, equal to 1.25 Bq/Nm^3.

Flue gases will be emitted through a 150 m stack together with the waste gases from Units 3 and 4 of KNPP and the waste gases from the ventilation system of AB-2. The share of the flue gases from the PMF in the total emission from the ventilation stack of AB-2 is 0.17 %, and the released activity is 6.03 MBq according to the 2011 data (see table 4.1.2.3-2), which is much lower than the values for 2009 and 2010, and with a decreasing trend. Based on experimental measurements in testing facilities it is assumed that the share of isotopes such as Co, Ag, Nb, Mn and Fe retained in the slag is more than 90 %, while that of semi-volatile isotopes as Cs is around 70 %. The rest 30 % of the Cs is retained in the bag filters system and can be found in the gathered fly ash. The results from the ZWILAG operation prove that these values are very conservative; however, they are used in the accidents analysis.

The results from the measurements of the activity from γ aerosols released through VS-1 and VS-2 (EP-1) for 2011, according to [45], show that the activities of long-lived aerosols released through the VS of Units 1-4 is 0.09 % from the admissible level, and the value is three times lower than that in 2010. (see table 4.1.2.3-2).

Table 4.1.2.3-2 Released activity from the ventilation stacks of EP-1 KNPP Units 1-4

Gaseous aerosol emissions	2009	2010	2011	% of the limit
Radioactive noble gases, TBq	0.0	0.0	0.0	
Iodine-131, GBq	0.0	0.0	0.0000078	
Total activity Radioactive aerosols, MBq	55.3	19.9	5.48	
^{3}H, GBq	NA	NA	269	9.9
% of the 6GBq limit of the total activity by radioactive aerosols	0.92	0.33	0.09	
^{14}C, GBq	NA	NA	671	0.33

According [35] the released Strontium 90 (^{90}Sr) activity in 2011 is nine times lower than that of 2010, and is the lowest for the last five years.

The release of gaseous α-emitters has decreased about seven times compared to the previous year.

Tritium (^{3}H) and ^{14}C releases through the VS of Units 1-4 in 2011 are 0.36 % and 0.33 % respectively, from the annual limits.

The measurement of ^{85}Kr through VS-2 started in 2011, and the measured values were below the detectable minimum.

The summarized data from the gaseous releases from EP-1 in 2011 show that tritium has the main share, the ^{14}C releases are ten times lower than those of tritium, while the activity of the releases from γ-aerosols is four times lower than those of tritium.

Although the off- gases from the PMF are negligible percentage of the total flue gases released through the stack, the installation of an Emission Control System (ECS) is planned. The Emission control system will be measure the content of the following substances: CO, SO_2, NOx, HCl, O_2, H_2O, NH_3 and TOC (total organic carbon). Temperature, pressure and flow rate will be determined as well. The system is designed to be built into a separate cabinet, and sampling lines are also foreseen. A sampling system for measurement of the radioactive releases will be provided.

Gases passing through the flue gas system and suction ventilation of the PMF will be controlled before the connection with the ventilation stack in order to measure their activity.

Dust quantities in the flue gases are also controlled by the dust monitor containing four instrument devices combined in one. It has only one measurement point (one single outlet in the duct) and measures simultaneously the temperature, flow and pressure in addition to the dust concentration. In compliance with the experience in similar facilities such as CILVA, the total dust is normally below the detection limit (<1mg/Nm³).

According to design data the expected harmful emissions will not exceed the permissible norms (Ordinance for radiation protection during activities with sources of ionizing radiation).

In Appendix *10*, according to the MEW additional recommendations (Letter – No. OVOS-277/2012 - Appendix 6), "Analysis on the dose rate from gas aerosol and liquid releases to the environment from the Units 1-4 decommissioning process and the emissions from the plasma melting facility (PMF) operation, incurred by the public within the 30-km supervised area surrounding Kozloduy NPP" is presented. A modeling program code based on the EU approved methodology CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 –Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclide to the Environment has been used for modeling the pollutants distribution, considering the following:

1. To assess the public dose due to liquid discharges - program code DARR-CM has been adapted to the hydrology of the KNPP area and uses a conservative assessment of the dose exposure of a critical group of the public.
2. To assess the public dose within the monitored area due to gas-aerosol discharges - program code LEDA-CM, Normal Operation Shield has been adapted to the geographical and meteorological characteristics of the KNPP area. The methodology considers both the external and the internal impact of the radioactive releases and estimates the annual individual effective dose, the annual individual dose equivalent, and the critical group dose, as well as the collective dose for the population, per age groups.

The modeling program codes used to estimate the individual and the collective effective doses to be incurred by the population from radioactive discharges to the environment, have been verified and validated.

The dose distribution map for the population within the 40-km area and as a function of the distance to the emission source are presented on fig. 4.1.2.3-1 and fig. 4.1.2.3-2. The selected 40-km area includes the monitored 30-km area, but the model is able to provide information on a range wider than 40 km.

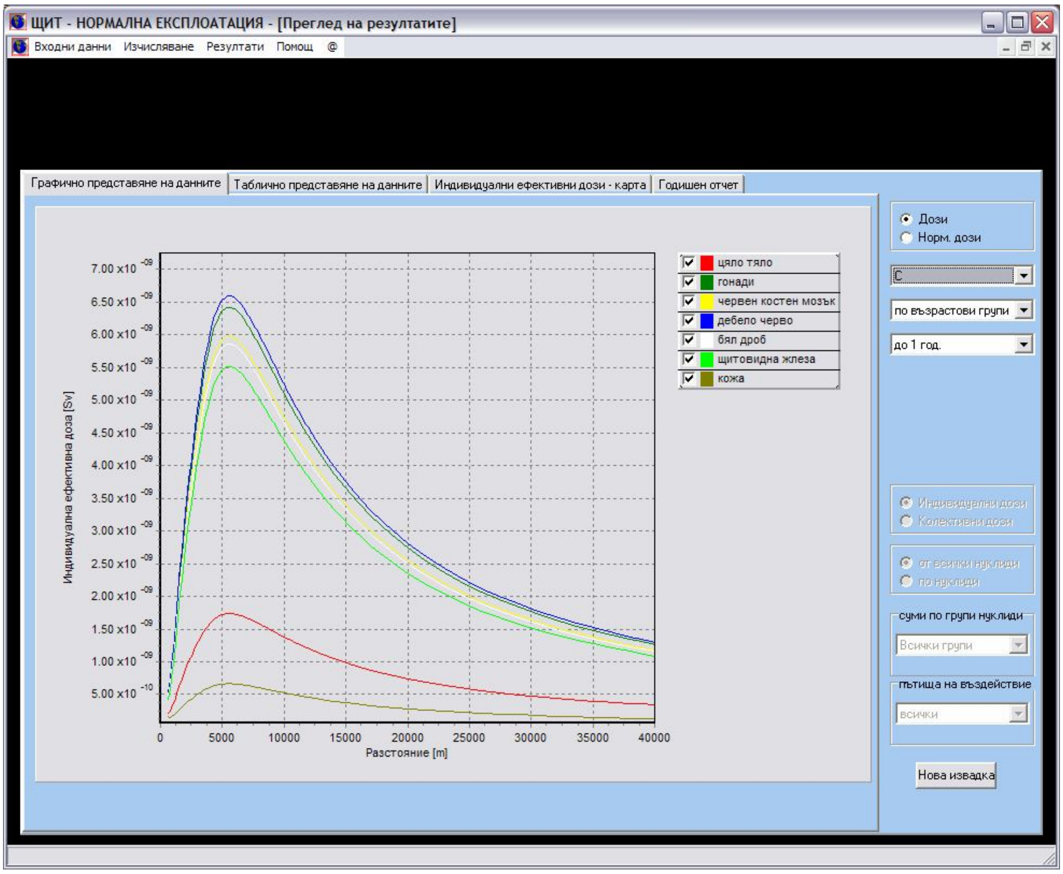
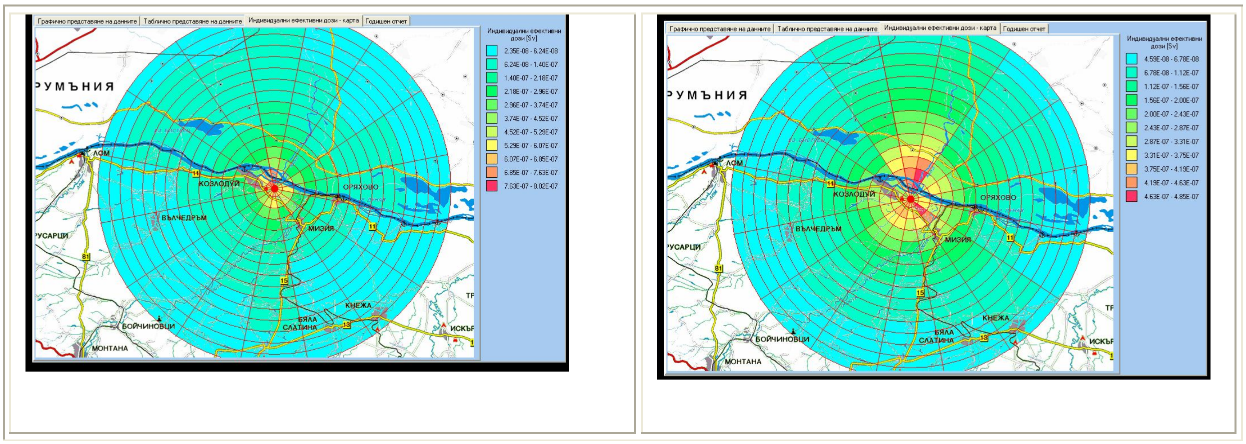


Fig. 4.1.2.3-1 Individual effective dose as function of the distance to the source

The maximum values of the individual effective dose were calculated within the 5-6 km Kozloduy NPP area.



a) with meteorological data for 2010 b) with micro climate data for 2001–2010.

Fig. 4.1.2.3-2 Distribution of the individual effective dose from external exposure to RNGs, LLAs, ^{131}I + (^{3}H, ^{14}C) within the area of Kozloduy NPP, 2010.

Based on the performed analysis the following conclusions for the population dose during Decommissioning of KNPP Units 1-4 and normal operation of the Plasma Melting Facility (Project 5c) can be made:

1. The maximum annual effective dose per individual of the critical group of the population living within the 40-km area around KNPP, resulting from the liquid and gas-aerosol releases to the environment, was conservatively calculated at 5.05°µSv/a, which is a much lower value than the quota of 250µSv/a for exposure from radioactive emissions from NPP (Ordinance on the Ensuring the Safety of NPPs) and the norms determined for the population of 1 mSv/a (ONRZ-2012, Basic Norms for Radiation Protection).
2. The additional dose that might be incurred is about 500 times lower than the natural radiation background (2.33 mSv).
3. The calculation of the cumulative effect added to the effect of KNPP normal operation, due to emissions from the decommissioning of KNPP Units 1-4 and the normal operation of the Plasma melting facility (PMF) (Project 5b) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %.
4. The maximum annual effective dose of the population within the 40-km area around KNPP, due to aerosol emissions only, 6 MBq under normal operation of the Plasma melting facility (PMF), was estimated at $5.47.10^{-10}$ Sv/a, which is barely 0.01 % from the total exposure resulting from all activities on the KNPP site.

Unorganized emissions

The assessment of the expected emissions from transport activities related to the PMF has been made under the following assumptions:

- used emission factor for diesel fuel for transportation equipment: NO_x – 5 g/kWh and PM 10 - 0.16 g/kWh.
- 30 kW for transportation of 1 ton of waste, 2 h time for transportation of 1 ton of waste supplied to the PMF (includes time for transportation of the slag).

Based on these assumptions the emissions from transportation of 1 ton of waste are assessed at 300g NO and 10g PM10. With annual quantity of 250 t the total emissions from the transportation activities are estimated at about 75 kg NO annually and 2.5 kg PM10 annually. Based on the presented data the quantity of nitrogen oxides and PM10 generated annually by the transportation activities is negligible.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. Control over the incoming waste;
2. Maintenance of the separate facilities of the off-gas cleaning system in order to achieve better effect from its activity.
3. Maintenance of the emission control system in good working condition.
4. To ensure that during normal operation, expected operational states, and design accidents in the facility the established dose limits under art. 9, items 1 and 2, and item 3, will not be exceeded for the period after closure

of the facility, according to the Regulation for safety during RAW management. For this purpose sensors should be installed providing "on-line" control of the gamma background.

5. To develop and execute a Program for in-house radiological monitoring, as a part of the overall Program for radiological monitoring at the plant site.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Site region*
Reversibility of the impact (reversible, irreversible):	*Irreversible*
Duration of the impact - (short term, medium term and long term):	*Long-term*
Frequency of impact occurrence (permanent/temporary):	*Constant*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative /direct/cumulative*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*It is expected, because on the KNPP site there are other controlled and uncontrolled emissions. The calculation of the cumulative effect added to the effect of KNPP normal operation, due to emissions from the decommissioning of KNPP Units 1-4 and the normal operation of the Plasma melting facility (PMF) (Project 5b) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %.*

<u>During the decommissioning</u>

During the decommissioning period no conventional pollutants will be generated by the operation of the Plasma Melting Facility, because its activity will be terminated.

Unorganized gas emissions of the welding works are expected to be generated by applying thermal cutting methods. These emissions will not impact the quality of the atmosphere air in the region and they have significance only in regard to the occupational hygiene.

During the decommissioning period there will be some radiation pollution and unorganized emissions generated by the transportation activities.

Radiation contamination During the decommissioning activities the ventilation system of AB-2 with HEPA filter will operate. Expected emissions are insignificant and negligibly low. Conclusions are made based on the Assessment of the

Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38,
E- mail: office@eninbg.com

radioactivity of the metal surfaces as presented by the Investor – 64 MBq, as well as of the refractory materials – 3 GBq.

Transportation activities Total quantity of solid waste is 373 t.

During the transportation of these materials by diesel trucks gaseous and dust emissions will be generated. Taking into consideration the emission factor applied for diesel trucks the following quantities are received:

- NO_x 5 g/kWh.
- PM 10 0.16 g/kWh.

Emissions related to transportation activities could be assessed based on average transportation distance with calculated duration of the transportation activity. Data for the transportation distances are not available and such estimation could not be made.

Air pollution during the decommissioning of the facility will not impact the air quality in the adjacent areas.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. Dismantling activities will be executed in strict preliminary control of the already achieved dose rate and such control will be executed during the dismantling as well.

Cumulative impact

The cumulative impact of the conventional pollutants can be expected in relation of the dust and PM emissions, NOx, CO, hydrocarbons emissions in result of the increased intensity of the transport traffic and the use of construction equipment on the territory of KNPP site during the implementation of the present investment proposal together with other IPs, such as the “Decommissioning of Units 1-4” and the “Construction of the National Disposal Facility for low and intermediate level RAW”.

The IP for the Construction of the National Disposal Facility for low and intermediate level RAW is not related to emissions of radioactive gases or aerosols in the atmospheric air.

A cumulative impact is possible, related to the radioactive aerosols during the implementation of the present IP and of the activities on the decommissioning of KNPP Units 1-4. The share of the off-gases from PMF from the total releases by the stack is 0.17 %.

In the performed modeling included in Appendix 10 it is stated that the comparison of the collective effective doses for the population from KNPP with the indicators of many other NPPs with PWR (WWER) reactors show compatibility with the international practice. The calculation of the cumulative effect added to the effect of KNPP normal operation, due to emissions from the decommissioning of KNPP Units 1-4 and the normal operation of the Plasma melting facility (PMF) (Project 5b) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %. Therefore, recalculation of the already established special statute areas at

KNPP is not necessary. This clarification is made in regard to the MEW recommendations (letter – Ref. OVOS-277/2012- ***Appendix 6)***.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Probability of occurrence:	*There is a probability, but it is small*
Territorial scope of impact (geographic region; affected population):	*NPP site*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative /direct/cumulative*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*It is expected in relation with the conventional pollutants – dust and PM, NOx, CO and hydrocarbons, as result of the increased transport traffic and use of construction equipment on the KNPP site.* *The calculation of the cumulative effect from the gaseous aerosol radioactive releases added to the effect of KNPP normal operation, due to emissions from the decommissioning of KNPP Units 1-4 and the normal operation of the Plasma melting facility (PMF) (Project 5b) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %.*

4.1.2.4 On the water during the normal operation and decommissioning

During the operation

Non-radiation impacts

Plasma Melting Facility PMF is designed to use water for industrial and residential water supply, and the sources are the ones available at the moment according to the issued water use permits, as follows:

- Permit No 562/14.03.2005 for water use from the river of Danube for cooling, production of chemically demineralized water and electricity generation by HPP of HC-1;

- Permit No 11530127/30.05.2008 for extraction of ground waters through shaft wells 1-6 for emergency service water supply of Units 5 and 6;
- Permit No 11530128/30.05.2008 for extraction of ground waters through shaft well “Raney-5” for industrial and fire protection purposes;
- Permit No 11590203/30.05.2008 for extraction of ground waters through shaft well ”Valiata” for hygiene-residential purposes of Units 1 to 4.

Quantity of the taken surface waters from the river of Danube for 2010 is about 51.2 % and about 52 % for 2009, compared with the permitted quantity, and of the ground waters – only 9°% in 2010 and 2 % in 2009.

Quantities assumed to be used in the PMF according to the construction design are:

- **Potable and sanitary water** – for 15 people of operational personnel at PMF. Expected nominal consumption – 246 m3 per year;
- **Service water for the scrubber and for the gas cooler of the facility**. Expected nominal consumption is 2500 m3 per year;
- **Cooling water for cooling of the equipment (plasma torch, furnace**).

Cooling water of the PMF operates in “closed circuits”, and the heat energy is discharged by heat exchangers to the existing system of “open circuits” for cooling of Kozloduy NPP. Due to this the water consumption is limited up to the amount of the possible leakages of the “closed systems” and is expected to be within 2 m^3 per year. In addition, different tanks are used according to the radioactivity levels. The use of these tanks allows controlling the flow rate according to the requirements.

On the basis of the planned PMF technology the generated wastewater – service water from scrubber and cooling water for the facility, amounting to about 2510 m^3 per year, will not be radioactively contaminated waters, but only with slight chemical pollution. If the water quality is properly maintained, it could be used for several years.

During the operation the wastewater flow will not create a problem to the site sewage system of KNPP and will not impact the wastewater treatment facilities of KNPP, subject to compliance with the treatment technology.

A negligible impact on the quantity state of the underground water body *BG1G00000 Qal005* (Quaterner pore waters – Kozloduy lowland) is expected due to the additional water intake from the existing intake systems and equipment outside the territory of the Investment Proposal. This impact will be direct, long-term and reversible, limited in scope and with low degree within the impact area around the intake facility.

An impact on the chemical state of the underground water body *BG1G00000N2034* (Neogene pore waters) is not expected, because direct or indirect discharge of wastewaters in the groundwater body is not foreseen.

An impact on the quantitative and qualitative characteristics of the other ground water bodies in proximity to the PMF site, which will not serve for potable and sanitary water consumption, is not expected

The impact on the chemical state of the water taken by the intake facilities is not expected.

In conclusion it can be summarized that the potable and sanitary water and process water consumption is within the limits of the permitted quantities pursuant to permits for water use, and the impact on the total water consumption in KNPP and water intake sources will be insignificant.

Radiation impacts

In compliance with the design technology the process of separation of the generated liquid RAW is managed in compliance with the requirement that the flow rate does not exceed 100°l/h. Scrubber water is collected in scrubber tank where purifying waters from the decontaminated 200 1 barrels will also be gathered, and then they will be evaporated in the scrubber module.

Blow down water from the scrubber and water from the cooling module after filtering will be discharged in the special drainage system (drainage system for radioactive waters) of Kozloduy NPP, where it will be treated by neutralization and evaporation. Annual quantity of 400 m^3 with total activity 400 Bq upon conservative assumption is equal to < 10 m^3 evaporation concentrate. Even under the assumption for cementing of the end product this quantity is negligibly law. Condensate of the evaporation process could be discharged in the Danube River.

Taking into consideration the treatment of the blow down water from the scrubber and the water from the cooling module in the KNPP sewage waters treatment system, it could be determined that the activity discharged in the Danube is much below 400 Bq/year, i.e. negligibly low.

The radioactive water treatment by evaporation guarantees that if the regulatory limits for radioactivity in the waste water are met, the content of harmful and hazardous substances in the discharged wastewater does not exceed the individual emission limits according to the permit issued for KNPP.

The “Analysis of the dose rate for the population from the monitored KNPP 30-km area by gaseous and liquid radioactive releases in the environment from the decommissioning of Units 1-4 and the emissions from the PMF operation under Project 5b” indicates a negligible increase of the maximal individual and collective doses by 0.5 to 1 %.

The IP is not located within a water protection area, according to art. 119 a, par. 1, item 5 from the WL. The measures included in the Plan for management of the water basins for the Danube basin for achieving and preserving good state till 2015 do not provide prohibitions on the implementation and operation of the IP.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. Strict observance of the foreseen technology;
2. Avoidance of leakages on the system;
3. Control over compliance with the conditions of permits for water use and discharge of generated waste water;

4. Control over compliance with prohibitions against direct discharge of water containing hazardous and noxious substances in the areas of protection of groundwater;
5. Control over prohibitions on disposal of priority substances that can lead to their indirect discharge into groundwater;
6. Prohibitions on the abandonment, improper disposal and incineration or other form of uncontrolled waste disposal;
7. Prohibition on the use of materials containing priority substances in the construction of structures, engineering facilities, etc., where there is actual or possible contact with groundwater;
8. Control of the industrial areas for industrial and hazardous waste;
9. Monitoring and control of surface and groundwater, and of wastewater;
10. Compliance with Regulation for the assessment of environmental impact during construction and technologies, which are likely to affect the quantity and/or quality of drinking water.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*
Territorial scope of impact (geographic region; affected population):	*Local*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*For the operation time*
Frequency of impact occurrence (permanent/temporary):	*Constant*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative, direct*
Transboundary type of the impact:	*Not expected*
Cumulative impact:	*Insignificant related to the amount of the wastewater*

<u>During the decommissioning</u>

Non-radiation impacts

During the decommissioning process it is expected that the impact on the surface waters will be reduced. It will have a fading effect and will finally result in improvement of the indicators of chemical condition and total environmental condition of the water body, into which the sewage waters from Kozloduy NPP are discharged, i.e. the Danube River.

These impacts are direct, negative, temporary and reversible. They will disappear after completion of the decommissioning.

After final decommissioning of the PMF the effect on the surface waters at Kozloduy NPP will be positive. Decrease of the water consumption for potable and sanitary use, for cooling and for technological needs is expected. There will be an improvement of the state of water ecosystems due to the decreased impact on the natural environment (sedimentation, increased concentration of the pollutants).

If the technological procedures and requirements related to the decommissioning activities are observed in compliance with the best available techniques (closed water systems, purification of sewage waters, and control of the discharged waters), the quantity of the discharged sewage water will be less and they will be considerably less contaminated during the decommissioning than during the operation. After the completion of the decommissioning no more sewage waters will be generated.

Impacts after the termination of the operation will be assessed as direct, positive and with long-term effect, and are related to the water quality, water resources quantities, hydrological regime, aquifers and water pollution.

Radiation impacts

During decommissioning of the PMF application of wet decontamination method is not planned. Some small quantities of low activity water may be discharged from the cooling during the activities of mechanical cutting.

Another emission source of radionuclide into the water is the scrubber water with a concentration of radionuclide <1Bq/l. These waters pursuant to the foreseen technology are discharged in the specialized sewage system of NPP and are treated by evaporation. ***Therefore, during the decommissioning, no emissions are expected in the waters.***

In case of accidents

Potential impact sources occur only in case of accidents. Probability of pollution of the waters from such accidents is negligible due to the indoor execution of the activities.

In cases when the emergency includes territory outside the PMF, the supposed impacts will be negative, local, and temporary - until the accident is under control. Theoretically, some cumulative effects are possible, if the accident coincides with other sources of radioactive pollution.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. Strict observation of the measures, stipulated in the Decommissioning program and the radiation protection procedures.
2. Immediate notification of the relevant authorities in emergency situations that create opportunities for contamination of the water body.
3. Strict observation of the measures and procedures stipulated in the Emergency Action Plan.
4. Regulation for action in case of major accidents.
5. Strict observation of the established program for monitoring of surface, ground and waste water.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Negligible*
Territorial scope of impact (geographic region; affected population):	*Local*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Short term*
Frequency of occurrence of the impact (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected in normal operation mode*

4.1.2.5 On the soils and earth bowels during the normal operation and decommissioning

A). Soils

<u>During the operation</u>

Non-radiation impacts

Requirement for the operation of the PMF (TS, item 3.4 – Operation conditions) is the compliance of maximal limits of chemical discharges with the effective normative documents, and this is also valid for the possible emergency situations. Analysis of the investment proposal shows that the operation of the PMF will comply with all requirements of the Bulgarian and European legislation, and that means that during the normal operation the PMF will not impact the soils. Even in cases of possible occurrence of impacts on the soils, they are expected to be within the admissible limits.

During the period of normal operation of the PMF negative non-radiation impact on the soils are not expected in 30-km area around the Kozloduy NPP, including the territory of Romania. In this regard no measures are needed for avoidance, reduction

Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38, E- mail: office@eninbg.com

or compensation of considerable negative impacts on the soils since such impacts are not expected.

Radiation impacts

The normal operation of the PMF is not expected to be a source of radioactive contamination of the soils on the territory of KNPP and close to it. It is planned for the PMF to be connected to the existing ventilation and drainage systems of AB-2. This means that the existing norms and restrictions applied in the Controlled area and on KNPP site will be observed. Their values are lower than the ones stipulated in the regulations of the Republic of Bulgaria.

During the normal operation of the PMF small quantities of operational radioactive waste will be generated, including liquid waste, but it will not be discharged outside of the controlled area and they will not exceed the value specified in item 1.3.6 of the TS. A system for control of liquid RAW will also be in operation.

Transportation of RAW on the territory of Kozloduy NPP is typical for the company activity and is regulated in the existing license for operation of Kozloduy NPP in compliance with the Ordinance for the terms and procedure for transportation of radioactive materials, Article 2, paragraph (2) – 2.

The radionuclide amounts in the water are expected to be lower than the minimal detectable activity – 1 Bq/l. Emissions of polluted waters in the Danube will be negligibly low and therefore no pollution of the soils and alongside the river bank is expected.

It could be assumed that the operation of the investment proposal has some favorable consequences for the environment - reduction of the volume of radioactive waste and as a result smaller areas will be needed for its storage.

During the operation of the PMF no radiation impact is expected on the soils within 30-km area around the power plant, including the territory of Romania.

In this regard no measures are needed for avoidance, reduction or compensation of considerable negative impacts on the soils since such impacts are not expected.

The analysis of the EIA-R on the Decommissioning of Units 1-4 at KNPP and of the National Disposal Facility for Low and Intermediate Level Short-Lived RAW (NDF RAW) shows absence of radiation impact during their operation, which allows the conclusion that a cumulative impact on the soils from the PMF operation is not expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact – (short term, medium term and long term):	*Not expected*

Frequency of occurrence of the impact (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

Non-radiation impacts

Possible non-radiation impacts are expected to be related only to the occupational hygiene. Temporarily, some gas emissions could be generated during the welding works as well as from transportation vehicles. No impact on the soils and lands adjacent to the power plant and on the Romanian territory is expected.

In this regard no measures are needed for avoidance, reduction or compensation of considerable negative impacts on the soils since such impacts are not expected.

Radiation impacts

Transportation of RAW on the territory of Kozloduy NPP is typical for the company activity and is regulated in the existing license for operation of Kozloduy NPP in compliance with the Ordinance for the terms and procedures for transportation of radioactive materials, Article 2, paragraph (2) – 2; therefore, no pollution from this source is expected.

During the decommissioning the expected radionuclide emissions in the air and water are expected to be insignificant and negligibly low, and therefore pollution of the soils on the NPP site and next to it both on Bulgarian and Romanian territory is not expected.

In this regard no measures are needed for avoidance, reduction or compensation of considerable negative impacts on the soils since such impacts are not expected.

The expected emission from the Decommissioning of Units 1-4 at KNPP and of the National Disposal Facility for Low and Intermediate Level Short-Lived RAW (NDF RAW) are insignificant and due to this cumulative impact from the PMF decommissioning is not expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact – (short term, medium term and long term):	*Not expected*
Frequency of occurrence of the impact	*Not expected*

(permanent/temporary):	
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

B). On the earth bowels

<u>During the operation</u>

Non-radiation impacts

Impacts by the non-radiation factors includes possible pollution of the adjacent territories with conventional waste - domestic, liquid and industrial, pollution with oil products from overflows, from maintenance of adjacent facilities or of the building of the PMF itself. This pollution is traditional for every industrial site and will affect the own site of NPP.

During the normal operation impact on the earth bowels by non-radiation factors is not expected.

Radiation impacts

During the normal operation of the PMF no pollution of the earth bowels is expected both on the own site of Kozloduy NPP and on the adjacent grounds.

In case of accident

For the earth bowels only the accidents that could occur outdoors are relevant. Impact on the earth bowels could be expected during earthquakes and the following damages.

Region of NPP location is seismic active one, but without active tectonic faults. The design includes 7-mark maximum design earthquake and 6-mark design basis earthquake under MSK. All buildings are designed in compliance with the norms for design of such type of facilities, taking into consideration the seismic activity of the region and the specific geological and engineering conditions. There is no probability for damage of the rooms and storage pits and pollution of the earth bowels. However, it is possible that some cracks may occur on the asphalt layer covering the polluted ground. In such case some measures should be undertaken for restoration of the cover layer.

Impacts will only be local and temporary, until the emergencies are contained, and by taking adequate procedure actions the transboundary impact and negative effect on the earth bowels of the neighboring Romanian territory will be avoided

In normal operation of the PMF no radiation impact on the earth bowels and geological environment is expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*

Reversibility of the impact (reversible, irreversible)::	*Not expected*
Duration of the impact – (short term, medium term and long term):	*Not expected*
Frequency of occurrence of the impact (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*

<u>During the decommissioning</u>

Non-radiation impacts

Negative impact on the earth bowels from non-radiation factors is not expected during the decommissioning, subject to strict compliance with the Decommissioning program and radiation protection procedures.

Sources of non-radiation impact on the earth bowels are related mostly to the activities for demolition of buildings, conservation etc. and in such cases no impact on the earth bowels is expected.

Radiation impacts

Negative impact on the geological environment and earth bowels is not expected during the decommissioning, subject to strict compliance with the Decommissioning program and the radiation protection procedures.

It could be concluded that no negative impact is expected on the earth bowels during the decommissioning.

In case of accident

Potential impact sources occur only in case of accidents. Probability of pollution of the earth bowels from such accidents is negligible due to the indoors execution of the activities.

In case when the emergency covers territory outside the PMF, the supposed impacts will be negative, local and temporary - until the accident is under control. Theoretically, some cumulative effects are possible, if the accident coincides with other sources of radioactive pollution.

Measures for avoidance, reduction or compensation of considerable negative impacts:

- Strict observation of the Waste Management and Control Program;
- Strict observation of the measures, stipulated in the Decommissioning program and radiation protection procedures;
- Strict observation of the measures and procedures stipulated in the Emergency Action Plan.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact – (short term, medium term and long term):	*Not expected*
Frequency of occurrence of the impact (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.2.6 On the landscape

<u>During the operation</u>

Non-radiation impacts

During the operation of the investment proposal no impact is expected on the vertical and horizontal structure of the landscapes, because the operation of the PMF will take place indoors on the territory of Kozloduy NPP.

No pollution of the landscape components with emissions of the pollutants is expected. Control of radiological characteristics of gaseous emissions will be performed after the extraction fans of the off-gas system and in the outlet pipe of the PMF extraction system. The non-radiation emission parameters are controlled by Emission Monitoring System (EMS).

Sewage waters will be drained into the existing special sewage system of AB-2 and subject to proper operation no pollution of certain landscape components such as soils, vegetation etc. is expected.

Operation of the PMF is not related to chemical pollution, so it is not a danger for pollution of the landscape elements.

During the operation of the PMF non-radiation effects are not expected on the KNPP territory and next to it.

Non-radiation impacts on the landscape of the neighboring Romanian territories are not expected.

Radiation impacts

Since the PMF operation will be executed indoors in the controlled KNPP area, the period of operation of the PMF is not related to radiation contamination of the landscape. If the requirements of the Terms of Reference are observed, no pollution with liquid RAW is expected, because they will not be continuously generated, and the emissions will comply with the normative requirements. Circulation of the substances in the landscape will not be changed. Social and economic functions of the landscape on the power plant territory and next to it will be kept.

In danger of accidents the Radiation Protection Program will be applied.

No radiation impacts are expected on the landscape components at the stage of operation of the PMF.

No radiation impacts on the natural and territorial complexes within 30-km area around Kozloduy NPP and the neighboring Romanian territories are expected. Cumulative effect related to the activities for Decommissioning of Units 1-4 at KNPP and for the National Disposal Facility for Low and Intermediate Level Short-Lived RAW (NDF RAW) is not expected.

No measures for avoidance, reduction or compensation of considerable negative impacts are needed.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

Non radiation impact

During the decommissioning no negative impacts are expected on the horizontal and vertical landscape structure. Entire equipment of the PMF will be dismantled and removed. These activities will be executed in compliance with prepared in advance Concept and Plan for decommissioning of the PMF.

No radiation impacts are expected on the landscape components at the stage of decommissioning of the PMF. No radiation impacts on the natural territorial complexes on the neighboring Romanian territories are expected.

Radiation impact

Stage of closure of the PMF is not related to radiation impacts on the landscape and no negative impact on its structure is expected.

RAW generated during the decommissioning activities will be classified and sorted according to their physical, chemical and radiation characteristics. RAW management will be executed in compliance with the regulations, so no impact on the landscape components is expected.

No radiation impacts on the landscape of the neighboring Romanian territories are expected; cumulative impacts on the landscape components are not expected neither.

No measures for avoidance, reduction or compensation of considerable negative impacts are needed.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.2.7 On the mineral diversity

<u>During the operation</u>

Non-radiation impacts

PMF will operate in the existing building. During the operation stage no use of minerals is foreseen.

Radiation impacts

During the normal operation of the PMF no impact on the mineral variety as environmental component is expected.

No measures for avoidance, reduction or compensation of considerable negative impacts are needed.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*

Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

Non-radiation impacts

The decommissioning of the PMF is not related to any impact on the mineral variety as environmental component.

Radiation impacts

The decommissioning of the PMF is not related to any impact on the mineral variety as environmental component.

No measures for avoidance, reduction or compensation of considerable negative impacts are needed.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Not expected*
Territorial scope of impact (geographic region; affected population):	*Not expected*
Reversibility of the impact (reversible, irreversible):	*Not expected*
Duration of the impact - (short term, medium term and long term):	*Not expected*
Frequency of impact occurrence (permanent/temporary):	*Not expected*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Not expected*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.2.8 On the flora and vegetation

<u>During the operation</u>

Radiation impacts

There may be some potential possibility for impact on the flora and vegetation during the RAW transfer if there are deviations from the standards accepted in Kozloduy NPP in the physical and radiation characteristics of the waste containers, which will be supplied to the PMF. In this regard it is recommended to measure the radiation characteristics of the containers before their transportation to the PMF.

In case of normal course of the processes in the PMF related to the treatment and supply of shredded waste in the Primary Treatment Chamber with plasma torch and passing of the non-combusted gases, hydrocarbons, slag, CO, carbon and fly ash from the Primary Treatment Chamber to the Secondary Treatment Chamber and before the release of the flue gases into the stack, they pass through the emission control system (ECS), which controls chemical parameters such as CO, SO_2, NO_x, HCl, NH_3, O_2, H_2O and TOC, no negative impact is expected on the KNPP site and outside it.

No negative impact is expected on the flora and vegetation in case of normal implementation of the cycle of slag pouring into forms, transportation and measurement of the weight of final drums and determination of the characteristics of the end products. At the end of the technological process well-conditioned product is produced, which does not contain liquids, organic materials and radioactive pollution from outside sources. The final drums will contain vitrified waste in stable form. It is expected that these drums will be further immobilized with cement into bigger containers in order to meet the acceptance criteria for immobilized products established by Bulgarian Regulation. The Radiation Protection Program will be based on the assessment of operational dose rates to the staff working at AB-2, to the public and the environment, considering the magnitude and location of the sources of ionizing radiation in the PMF, as described in previous sections.

Cumulative effect related to the activities for Decommissioning of Units 1-4 at KNPP and for the National Disposal Facility for Low and Intermediate Level Short-Lived RAW (NDF RAW) is not expected.

Measures for avoidance, reduction or compensation of considerable negative impacts:

1. Observance of the best practices for implementation of the technological processes and maintenance of normal technological mode of the PMF.

2. Measurement of the radiation characteristics of the containers at the entrance of the PMF and after reduction of their volume, i.e. at the exit of the PMF.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact (geographic region; affected population):	*Locally on the NPP territory.*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Short term*
Frequency of impact occurrence ((permanent/temporary)	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Non-direct, secondary*

Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

During the decommissioning activities related to the removal of the existing components or systems, decontamination of components, as well as cutting and processing of big parts of equipment some potential impacts on the flora and vegetation are possible in case of some risky situations.

In line with the option for immediate dismantling of the equipment outside of the safe enclosure area in the updated Strategy for the decommissioning of KNPP Units 1-4, the immediate dismantling is considered as preferred option for the PMF decommissioning

The availability of waste management infrastructure for treatment and conditioning of the decommissioning waste, as well as the availability of the Radioactive Waste National Repository at the time of decommissioning of the PMF as stipulated in the updated Decommissioning Strategy of Units 1-4 of Kozloduy NPP also provides grounds for determination of immediate dismantling as preferred option for decommissioning of the PMF.

End objective of the PMF Decommissioning activities is to restore the area where the PMF is located to a state as close as possible to the initial one, while protecting the human health, environment and complying with the regulatory requirements. All incoming radioactive waste and end waste produced in the PMF are classified as Category 2a. Therefore, contamination levels during the decommissioning are commensurate to this waste category.

During the treatment of RAW generated during the decommissioning of nuclear facilities in compliance with the regulations related to the RAW management, negative impacts on the flora and vegetation on the KNPP site and adjacent territories are not expected.

In view of the flora and vegetation during the decommissioning no special measures are recommended for avoidance, reduction or compensation of considerable negative impacts on them besides compliance with the best practices for implementation of the decommissioning activities.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact (geographic region; affected population):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Short term*
Frequency of impact occurrence ((permanent/temporary):	*Temporary*
Type of the impact (positive/negative;	*Non-direct, secondary*

direct/non-direct; secondary; cumulative and synergy):	
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.2.9 On the fauna

<u>During the operation</u>

Transportation of RAW on the territory of Kozloduy NPP is typical for the company activity and is regulated in the existing license for operation of Kozloduy NPP in compliance with the Ordinance for terms and procedure for transportation of radioactive materials, Article 2, paragraph (2) – 2. There may be some potential possibility for impact on the fauna during the RAW transportation, if there are deviations from the standards accepted in Kozloduy NPP for the physical and radiation characteristics of the waste containers, which will be supplied to the PMF. In this regard it is recommended to measure the radiation characteristics of the containers before their transportation to the PMF.

In the course of the technological process of the PMF with normal technological regime based on the project decisions for treatment of the waste gases through the system of treatment facilities, as well as supply of sewage waters into the existing sewage system, negative impact on the fauna of the site of Kozloduy NPP and outside it is not expected

Measures for avoidance, reduction or compensation of considerable negative impacts:

Observance of the best practices for implementation of the technological processes and maintenance of normal technological mode of the PMF.

Measurement of the radiation characteristics of the containers at the entrance of the PMF and after reduction of their volume, i.e. at the exit of the PMF.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Negligible*
Territorial scope of impact (geographic region; affected population):	*Locally on the KNPP territory.*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Short term*
Frequency of impact occurrence ((permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy):	*Non-direct, secondary* *Combined impact - partial fragmentation of habitats of secondary importance in the region of the PMF. Chasing of the individuals due to the*

	noise pollution.
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

During the activities of the decommissioning related to the removal of the existing components or systems, decontamination of components, as well as cutting and processing of big parts of equipment, some potential impacts on the fauna are possible in the form of chasing away individuals due to the intensive human presence.

In line with the option for immediate dismantling of the equipment outside of the safe enclosure area in the updated Strategy for the decommissioning of KNPP Units 1-4, the immediate dismantling is considered as preferred option for the PMF decommissioning. The availability of waste management infrastructure for treatment and conditioning of the decommissioning waste of the Decommissioning, as well as the availability of the Radioactive Waste National Repository at the time of PMF as stipulated in the updated Decommissioning Strategy of Units 1-4 of Kozloduy NPP also provide grounds for determination of immediate dismantling as preferred option for decommissioning of the PMF.

Noise pollution, increased anthropogenic presence during the decommissioning of the PMF leads to chasing of some individuals and respective damage of the normal population structure.

Based on the EWN experience the increase of the noise and human presence will not have any negative impact on the fauna.

In view of the fauna during the decommissioning no special measures are recommended for avoidance, reduction or compensation of considerable negative impacts on it besides compliance with the best practices for implementation of the decommissioning activities.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact (geographic region; affected population):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Short term*
Frequency of impact occurrence ((permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy):	*Non-direct, secondary* *Temporary damage of the quality of the neighboring habitats during execution of the decommissioning activities.* *Possible cumulative impact in case of potential accidents and incidents by*

	pollution of the air, waters and soils.
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

4.1.2.10 On the cultural heritage

<u>During the operation</u>

In case of observance of the normal technological mode of the PMF no impact on the cultural and historical heritage is expected on the territory of Kozloduy Municipality as well as in 30-km area around Kozloduy NPP.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Observance of the best practices for implementation of the technological processes and maintenance of normal technological mode of the PMF.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*None*
Territorial scope of impact (geographic region; affected population):	*None*
Reversibility of the impact (reversible, irreversible):	*None*
Duration of the impact – (short term, medium term and long term):	*None*
Frequency of occurrence of the impact (permanent/temporary):	*None*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*None*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During the decommissioning</u>

During the decommissioning activities related to the removal of the existing components or systems, decontamination of components as well as cutting and processing of big parts of equipment potential impacts on the cultural and historical heritage are not possible.

In line with the option for immediate dismantling of the equipment outside of the safe enclosure area in the updated Strategy for the decommissioning of KNPP Units 1-4, the immediate dismantling is considered as preferred option for the PMF decommissioning

The availability of waste management infrastructure for treatment and conditioning of the decommissioning waste during the decommissioning as well as the availability of the Radioactive Waste National Disposal Facility at the time of decommissioning of the PMF as stipulated in the updated Decommissioning Strategy of Units 1-4 of

Kozloduy NPP, also provide grounds for determination of immediate dismantling as preferred option for decommissioning of the PMF.

End objective of the PMF Decommissioning activities is to restore the area where the PMF is located to a state as close as possible to the initial one, while protecting the human health, environment and complying with the regulatory requirements. All incoming radioactive waste and final waste produced in the PMF is classified as Category 2a. Therefore, contamination levels during the decommissioning are commensurate to this waste category.

During the treatment of RAW generated during the decommissioning of nuclear facilities in compliance with the regulations related to the RAW management, no negative impacts on the cultural and historical heritage in the adjacent territories to Kozloduy NPP are expected.

In view of the cultural and historical heritage during the decommissioning no special measures are recommended for avoidance, reduction or compensation of considerable negative impacts on it besides compliance with the best practices for implementation of the decommissioning activities.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*None*
Territorial scope of impact (geographic region; affected population):	*None*
Reversibility of the impact (reversible, irreversible):	*None*
Duration of the impact – (short term, medium term and long term):	*None*
Frequency of impact occurrence ((permanent/temporary)	*None*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*None*
Transboundary type of the impact:	*Not expected*

4.1.2.11 From generation and disposal of conventional and other types of waste related to all stages of normal operation as well as during the decommissioning.

A). Conventional waste

<u>During the operation</u>

During the operation of the investment proposal generation of the following waste is expected, according to the classification specified in table 4.1.2.11.-1, in compliance with Ordinance No 3/2004 for classification of the waste (promulgated SG issue 44/2004).

Table 4.1.2.11-1 Classification of the waste generated during the operation

No	Name	Code
	Production waste	

Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38,
E- mail: office@eninbg.com

1.	Paper and cardboard packaging	15 01 01
2.	Plastic packaging	15 01 02
	Hazardous waste	
3.	Packaging, containing remains of hazardous substances or contaminated with hazardous waste	15 01 10*
4.	Fluorescent pipes and other waste containing mercury	20 01 21*
	Domestic waste	
5.	Mixed domestic waste	20 03 01

During the process of operation of the PMF the generation of the following types of waste is expected:

Production waste: typical conventional production waste from the technological processes will not be generated and mainly waste from packaging will be generated after the use of reagents and auxiliary materials. It is recommended for them to be returned to the supplier under the principle "full for empty" If this is not possible, since the most parts of these wastes are suitable for recycling, they have to be submitted for further treatment to companies holding permit pursuant to Article 12 of the Waste Management Law. It is expected to separate the waste with code 150101 and 150102 from the delivery of reagents – hydralime $Ca(OH)_2$ and sodium bicarbonate $NaHCO_3$, , which are used for neutralizing of the flue gases.

Hazardous waste: In view of the hazardous waste generation of packaging containing remains of hazardous substances or polluted with hazardous substances is expected. Use of ammonia solution (25 %) and sodium hydroxide solution (30 %) for the technological process is planned. In order to minimize the packaging of these chemical reagents, the packaging should not be subject to radioactive radiation, and the rule "full for empty" has to be implemented. Hazardous waste will be temporary stored on the territory of Kozloduy NPP at especially detached places, and after accumulation of certain quantities they will be submitted for further treatment by specialized companies holding permit pursuant to Article 35 of the WML from the respective Regional Inspection for Environment and Waters or by the MEW. Luminescent and mercury lamps (20 01 21*) should be stored at an indoor site, fenced, marked and equipped with separate vessels for their temporary storage.

Since most of the waste is suitable for recycling and regeneration, it is foreseen for them to be submitted for further treatment by companies holding Permit pursuant to Article 35 of the Waste Management Law.

Domestic waste: KNPP should expand its system for separate collection of waste, pursuant to Article 35 of the Waste Management Law. Mixed domestic waste, generated by the service staff in the process of operation will be about 7.5 t/a. They will be treated together with the total flow of domestic waste from Kozloduy NP and will be stored at KNPP Repository for conventional municipal and industrial waste (RCMIW).

The existing sites for temporary waste storage have enough capacity to be used during the IP implementation. However, since it will coincide in time with the decommissioning of Units 1-4, in order to increase their capacity, a site for temporary storage of waste before their transfer for utilization, including recycling, is planned to be constructed.

Measures for avoidance, reduction or compensation of considerable negative impacts:

- Packaging and chemical substances contained in them should not be subject to radioactive contamination.
- Conclusion of contract with a supplier of the chemical substances, who will be obliged to provide service under the principle "full for empty " packaging.
- Transfer of the waste, which are not serviced under the principle "full for empty" to companies holding permit pursuant to Article 35 of the Waste Management Law.
- The requirements of WML for separate collection of waste according to art. 33, par. 4 from WML should also be implemented.
- Updating of the account books of the waste is done in accordance with Regulation 2/2013 on the procedures and forms for providing information on waste management activities and the procedures for conduct of public records (prom. SG 10/05.02.2013).

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact (geographic region; affected population):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Long-term, for the operation period*
Frequency of occurrence of the impact (permanent/temporary):	*Constant*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative*
Transboundary type of the impact:	*Not expected*
Cumulative effect	*Not expected*

During the decommissioning

In line with the option for immediate dismantling of the equipment outside of the safe enclosure area in the updated Strategy for the decommissioning of KNPP Units 1-4, the immediate dismantling is considered as preferred option for the PMF decommissioning

At the decommissioning stage it is expected that some construction waste (reinforcement etc.), domestic waste, hazardous waste from spent oils to be generated. It is foreseen to collect the construction waste at especially detached sites for temporary storage on the territory of Kozloduy NPP, to which they have to be transported by a company holding the necessary permit documents, pursuant to the Waste Management Law (prom. SG 53/2012). Classification of the waste, which will be generated during the decommissioning, is specified in table 4.1.2.11-2.

Table 4.1.2.11.-2 Classification and quantity characteristics of the waste during the decommissioning

Code	Name	Quantity
	Hazardous	
13 01 13*	Other hydraulic oils	1 m^3
	Construction	
17 01 01	Concrete	148.1 t
17 04 03	Lead	7.0 t
17 04 05	Iron and steel	171.1 t
17 04 11	Cables different than the ones specified in 17 04 10	3.164 t
	Domestic	
20 03 01	Mixed domestic waste	5.4 t

Hazardous waste expected to be generated during the decommissioning stage is from the maintenance and operation of the PMF. It is recommended to put the oil drainage in packaging prepared in advance.

Construction waste suitable for recycling should be submitted to companies holding the necessary permit documents for waste activities. If lead waste is produced, which is not activated, it could be used on the territory of Kozloduy NPP.

Domestic waste generated as a result of the everyday activity of the staff will be collected in special containers and will be submitted for disposal in KNPP Repository for conventional municipal and industrial waste (RCMIW).

Measures for avoidance, reduction or compensation of considerable negative impacts:

- Inspection of the waste for radioactivity and, if they comply with the norms, they will be treated as conventional waste.
- Compliance with the existing procedures for Waste Management on the territory of Kozloduy NPP.
- Storage of generated waste on sites for temporary storage, which comply with the regulation, until their submission for following treatment.
- Conclusion of contracts with companies holding permits pursuant to Article 35 of the Waste Management Law for transportation of the waste generated at this stage.
- Metal construction waste has to be submitted to a company with permit pursuant to Article 67 of the WML.
- Temporary storage of the waste until its secondary use or transportation on the sites on the territory of Kozloduy NPP regulated for this purpose.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact (geographic region; affected population):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Short term*
Frequency of occurrence of the impact (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

B). Radioactive waste

The purpose of the Investment proposal is to construct and operate a facility for treatment and conditioning of radioactive waste resulting in their high volume reduction factor. This step is extremely important, because in this way the volume of waste for temporary treatment and disposal is minimized.

Transportation of RAW on the territory of Kozloduy NPP is typical for the company activity and is regulated in the existing license for operation of Kozloduy NPP in compliance with the Ordinance for terms and procedure for transportation of radioactive materials, Article 2, paragraph (2) – 2.

On the territory of the industrial site in the south-eastern part of room BK301 an area for temporary storage of incoming RAW, secondary waste and final drums with vitrified waste is planned. The following zones will be detached:

- Storage of approximately 6000 kg incoming RAW - quantity needed for one-week operation of the PMF;
- Storage of 6 drums with treated waste, which is the production expected for one week of operation. Considering the maximum weight of each waste package type, the temporary storage facility can store 100 bags (20 kg/bag), 20 drums (100 kg/drum) or 8 pellets (250 kg/pellet).

Quantitative assessment of the direct impact of the operation of the PMF based on the information provided by the investor is:

- Capacity: 250 t annually or 6.25 t weekly during 40-week annual operation An average of 65 kg/h solid waste with 18 MJ/kg caloric value or 55 kg to 60 kg/h solid waste and 5 to 10 kg/h liquid waste
- Specific waste activity: Maximal 5.17E+5 Bq/kg.

<u>During the operation of the PMF</u>

As a result of the PMF operation generation of some radioactive waste is expected. They will be managed in compliance with Ordinance for safety management of the radioactive waste (Accepted with Decree of the Council of Ministers *N 198 from 3*

August 2004, promulgated in SG, issue 72 from 17 August 2004.), and the Investor foresees in compliance with the normative requirements for minimization of the radioactive waste, a part of them to be treated in the PMF in order to reduce their volume. Thus, the requirement for application of measures for minimizing of RAW subject to disposal, in view of volume and activity is fulfilled by application of suitable technologies for treatment and temporary storage for radioactive decay. As a result timely RAW treatment is provided until the waste reaches the form ensuring its safe storage and disposal. Waste, which will be treated in the PMF, is:

- abrasive materials and components;
- dust, electrodes, bag filters and other waste (safety gloves, shoes, foil).

Thus, the radionuclides in this waste are finally immobilized in the slag generated by the plasma treatment.

Another group of waste, which will not be returned to the PMF for further treatment, is:

Waste from the scrubber

Annual quantity of 400 m^3 with total activity 400 Bq upon conservative assumption is equal to < 10 m^3 evaporation concentrate. Even when assuming that the end product will be cemented, this quantity is negligibly low.

Refractory materials of the PTC

The annual quantity is 4 tons. The specific activity of the most highly exposed lower elements with quantity of 2 t is with activity equal to that of the incoming waste, the lower elements with quantity of 2 t are with activity equal to 10 % of the activity of the incoming waste. Total average activity of this waste is calculated as 1.13E+9 Bq annually.

This waste will be transported for further treatment.

Transportation of RAW on the territory of Kozloduy NPP is typical for the company activity and is regulated by the existing license for operation of Kozloduy NPP in compliance with the Ordinance for conditions and order for transportation of radioactive materials, Article 2, paragraph (2) – 2.

Measures for avoidance, reduction or compensation of considerable negative impacts:

- Establishment of RAW management procedures depending on the type, manner of generation and following treatment.
- Elaboration of RAW working instructions for the key points, where the waste is generated and temporarily stored.
- Implementation of reporting documents for the quantities of the received temporarily stored and treated waste on the territory of the PMF as well as the waste submitted for further treatment.
- Observance of the legislation for occupational safety conditions and conduction of regular instructions of the staff for work with RAW.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	Minor, subject to observance of the normal technological regime and preventive work with the staff servicing the PMF
Territorial scope of impact (geographic region; affected population):	Locally
Reversibility of the impact (reversible, irreversible):	Irreversible
Duration of the impact– (*short term, medium term and long term*):	Long-term, for the whole operation period
Frequency of impact occurrence (*permanent/temporary*):	Permanent, daily
Reversibility of the impact: (positive/negative; direct/non-direct; secondary; cumulative and synergy);	Direct Negative In long-term aspect it is cumulatively positive, because it reduces considerably the volume of the low activity waste stored in different forms on the site of Kozloduy NPP, as well as RAW generated during the decommissioning of Units 1-4 of Kozloduy NPP. This respectively leads to reduction of the impact on the population and environmental factors. Besides, this will result in sharp decreasing of the costs for final storage of the conditioned waste.
Transboundary type of the impact:	None
Cumulative effect	None

<u>During the decommissioning</u>

Assessment of the impacts at this stage is made based on the descriptions of the Decommissioning Concept of the PMF, the quantities of the used materials, flow of the incoming waste, decontamination measures during the operation and maintenance.

Table 4.1.2.11-3 below shows the quantity and type of the materials from the material balance based on the data from the ISAR:

Table 4.1.2.11-3 Quantity and type of the materials during the decommissioning of the PMF which are RAW

Type of materials	**RAW, [kg]**
Metal material	32115
Concrete	16400
Cables	330

Total	**48845**

Additionally, secondary waste will be generated from the decommissioning activities such as dust and ash from cleaning activities, metal pieces from cutting activities, and technological waste (protective clothes, plastic foil etc.) Substances: NH3 -200 l; hydraulic oils -1 m3; NaOH solution – 1 m3; lead – 7 t, if activated, are also considered as RAW.

Transportation of RAW on the territory of Kozloduy NPP is typical for the company activity and is regulated in the existing license for operation of Kozloduy NPP in compliance with the Ordinance for conditions and order for transportation of radioactive materials, Article 2, paragraph (2) – 2.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Development of Project for decommissioning and closure of the PMF. This project should include procedures for determination of the waste radioactivity in order to execute further treatment.

If the waste is not radioactive, it will be managed in compliance with the Waste Management Law and respective by-laws. Key moment is the conclusion of contracts with companies holding permit pursuant to Article 35 and, if needed, pursuant to Article 67 of the Waste Management Law, to which the non-radioactive waste is transferred for further treatment.

If the waste is radioactive, instructions for their further treatment should be prepared (secondary use, decontamination, and disposal) in compliance with the Ordinance for RAW management.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*High*
Territorial scope of impact (geographic region; affected population):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Irreversible*
Duration of the impact– (short term, medium term and long term):	*Middle term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative, direct* *Cumulative and synergy impacts are not expected*
Transboundary type of the impact:	*None*
Cumulative effect	*Not expected*

4.1.2.12 From possible radiation impacts related to the operation of the facility and its decommissioning

<u>During the operation</u>

Radiation exposure, collective effective dose (CED)

Radiation exposure of the operation staff is specified in section 4.1.2.1. Taking into account the use of the best protection techniques and consequent use of ALARA principle, the dose rate due to inhalation and absorption is negligibly low. Total CED for operation staff and maintenance staff regarding the radiation background of AB-2 will be calculated as 18.984°mSv/annually from:

- Operational storage activities 8.108 mSv/annually
- Operation and maintenance of the PMF 10.449 mSv/annually
- Radiation background in AB-2 0.427 mSv/annually

Individual dose rate varies as follows:

- Operational storage activities (2 operators) 4.1 mSv/annually
- Operation of PMF (9 operators) 0.6 mSv//annually
- Technical maintenance of the PMF (2 operators) 2.4 mSv/annually.

Measures for avoidance, reduction or compensation of considerable negative impacts:

Classification of the work places and radiological zones in the PMF, strict control of entering and leaving of the staff.

Execution of regular individual dosimetric control of the operation staff and staff for maintenance and repair of the PMF in compliance with the requirements of Ordinance 32/7.11.2005.

Continuous radiation and air monitoring in the rooms and equipment of PMF should be performed.

In the PMF controlled areas protection clothes and gloves should be worn.

When working in the zones with possible radioactive contamination of the air or non-fixed surface pollution protective devices for respiratory system should be used.

In case of periodical shut down for cleaning and prophylactic, calibration, decontamination, maintenance of the PMF protective clothes and respiratory masks should be worn.

Monitoring of the health of the operation staff and maintenance and repair staff in compliance with the normative requirements of the country and Kozloduy NPP.

Monitoring of the waters according to the elaborated program.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Exists*

Territorial scope of impact (geographic region; affected population):	*Operation staff, maintenance and repair staff.*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact– (short term, medium term and long term):	*Middle term*
Frequency of impact occurrence (*permanent/temporary*):	*Constant*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Negative, minimal in case of observance of the regulation requirements* *Positive - reduces considerably the volume of the low activity waste stored in different forms on the site of Kozloduy NPP as well as RAW generated during the decommissioning of Units 1-4 of Kozloduy NPP. This respectively leads to reduction of the impact on the population and environmental factors. Besides, this will result in sharp decreasing of the costs for final storage of the conditioned waste.*
Transboundary type of the impact:	*It is not of transboundary type*
Cumulative effect	*Not expected*

<u>During the decommissioning</u>

Radiation exposure, collective effective dose (CED)

Assessment of the CED for the whole decommissioning period is made based on the following assumptions made as a result of:

Dose rate is similar to the one during the outage (maintenance) of the PMF;

For the assessment purposes the highest calculated value in case of non-operating facility is taken into account: 0.16 μSv/h;

Total quantity of materials: 373 t;

Loading in case of dismantling works of the auxiliary building in man-hours per ton: 170 man-hours/t;

Loading during the activities for waste management from the dismantling in man-hours per ton: 116 man hours/t.

Calculation is made as follows: quantity of materials x loading during dismantling activities (waste management) x dose rate and the result is 17 mSv for the entire decommissioning process. This value is very approximate and determines the magnitude of this value.

During the dismantling there will not be any pollution outside the building, because the dismantling will be done in the respective boxes after the cleaning and decontamination.

Contamination levels of the elements dismantled during the decommissioning are commensurate to activity levels of waste **Category 2a** and to the radionuclide existing in the RAW treated at the PMF.

Measures for avoidance, reduction or compensation of considerable negative impacts:

No additional measures are needed, because the intensity and quantity of these factors are not expected to increase. No unfavorable health effect caused by the non-radiation and radiological factors is expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Negligible*
Territorial scope of impact (*geographic region; affected population*):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Direct*
Transboundary type of the impact:	*Not expected*
Cumulative effect	*Not expected*

4.1.3 Possible impacts resulting from accidents

Results of the Safety analysis of the PMF are presented in details by the Investor in the document ISAR [2] and include identification of all potential radiation sources and assessment of the radiation doses, which may affect the population and PMF staff as well as the possible environmental impacts. Based on the safety analysis an assessment is made of the operation of the facility during:

- Expected operation events (reported in the ISAR [2]);
- Possible accidents and incidents
- Sequences of events, which could lead to unforeseen accidents.

Results of the safety analysis prove with high authenticity that the facility will function in compliance with the project and will meet the design criteria for acceptability for the different operation and emergency conditions at all stages of its operation life. Acceptability criteria for the operation and emergency conditions are defined in the ISAR [2].

ISAR includes analyses of the impacts on the people and the environmental factors, resulting from the commissioning, operation and decommissioning of the PMF. Impacts from the following initiating events are examined:

- Disturbances or failures of the technology or equipment;
- Transport incidents;
- Internal flood, fire and explosion;
- Natural disasters (e.g. earthquake, floods);
- Others.

Analyses in the ISAR [2] are made based on conservative assumptions both for the initiating conditions and for the development of the accident in compliance with the regulations. The following events are analyzed in details, because probability of their occurrence is high and there are consequences for the staff and population:

- Fire in temporary storage facility;
- Dropping of a waste package;
- Fire in the flue gas system;
- Explosion in the shredder;
- Fire in the PMF.

Results from the analysis of the other events including natural disasters, floods, earthquake, and extreme meteorological conditions show that the probability of their occurrence is very low and also the impact on the staff, population and environment are negligible.

Results from the analysis of the above events show that the determining event from the point of view of the impact on the people and environmental factors is fire in the PMF building. Other events do not have such considerable impact on the people and environmental factors.

Dispersion calculation methodology of KNPP radionuclide releases and fields of contaminations in the ground atmosphere layer as well as methodology for calculation of personnel and population dose rates are presented below.

Dispersion calculation methodology of KNPP radionuclide releases and field of contaminations in the ground atmosphere layer

The fields of contamination are defined using the methodology by the concentrations at ground level and by depositions, based on the models GAS_E (for gases) and AER_E (for aerosols – dust), elaborated and implemented in NIMH at Bulgarian Academy of Scince BAS. The models are designated for use by means of a PC and comprise a sophisticated (detailed) version of representation of the so-called Gaussian plume. It is being described in a most general way using the Gaussian plume formula proposed by EPA-USA, introduced in the "Methodology for the calculation of the height of the discharging facilities, the dispersion and the expected concentrations of polluting substances in the ground atmosphere layer" approved in 1998 by the MEW, MRDPW and MH:

$$C(x,y,0)=\frac{Q}{2\pi\sigma_y\sigma_z U}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\exp\left[-\frac{1}{2}\left(\frac{H+\delta H}{\sigma_z}\right)^2\right],$$

where C - the concentration of a pollutant at ground level (z=0), generated by a single point source at constant meteorological and emission conditions (as such can be considered the conditions within 1 hour);

Q - source capacity;

x, y – spot coordinates;

U - wind speed;

H – stack (chimney) height;

δH – thermodynamic lift force;

σx, σy - dispersion functions, depending on atmospheric stability.

The main characteristics of the GAS_E and AER_E models are defined as follows:

- *Stability.* It is defined in accordance with the meteorological conditions based on the Pasquil classification in 6 classes - A, B, ..., F. Class A corresponds to strong instability, D - to neutral stratification, and F - to strong stability. For better precision intermediate classes AB, BC, ..., EF are also introduced. The determination of the stability classes is made using tables, charts or formulas based on various meteorological parameters, most often measured close to ground level. In this case, when using the models for the estimation of pollutants from NPP Kozloduy the stability class is determined with measuring devices and is included into the complete set of meteorological parameters, including wind, temperature, rainfalls.
- *Dispersion functions σ_x and σ_y.* The Briggs formulas are used in the models. They are derived from abundant experimental material and are accommodated to account for urban and rural conditions.
- *Thermodynamic lift.* Proposed by Briggs formulas are used for the lift of the plume over the stack opening as a result of the inertial and Archimedes forces.

The temperature at stack level is determined by the ground level temperature, using vertical temperature gradients, typical for the various stability classes.

- *Wind speed at the height of the stack opening*. It is determined by the ground level wind and by the proposed from EPA exponential factors, depending on the stability class.
- *Effect of the plume meandering.* A correction is considered for the time of concentration sampling and is implemented in the dispersion functions.
- *Height of the mixing layer.* The models provide the possibility to enter such information.
- *Calm weather conditions.* They are treated by averaging the plume in all directions, formed by wind speed of 0.5 m/s.
- *Height above sea level.* It is introduced optionally in the model for each point of the field.

The input information consists of 4 parts:

- Modeling area parameters - rectangular area around the polluting source, oriented by **x**-coordinate in East direction and by **y**-coordinate in north direction. The number of points, where the concentration and the deposition are calculated, depends on the area dimensions and on the preferred step in the space.
- File with meteorological parameters – height of the mast and type of the wind gauge (anemometer), date and hour, stability class, wind direction and speed, temperature at ground level, precipitation intensity, and height of mixing layer. The duration of the period of averaging and sampling is also entered.
- Source parameters - number of sources, X and Y- coordinates, stack height, elevation of its base above sea level (optional), initial horizontal and vertical dispersion (optional), diameter of opening, temperature of discharged (released) gases, discharge velocity or mass flow rate. The initial dispersions are entered in order to enable the spot (point) source to approximate area and volume sources.
- Parameters of the modeled pollutants – gas or aerosol. In case of a gaseous pollutant velocity of dry/wet deposition and speed of chemical transformation (period of radioactive half-life) are entered. In terms of the aerosols the gravitational deposition is also taken into account. A change in the spectrum of the aerosols as a result of the heavier particles deposition closer to the source is considered by means of parameterization of the specific processes in the aerosol processes, proposed by M. Galperin, and by the implementation of an average factor to reduce the aerosol mass. The wet deposition (washing) is considered by the precipitation intensity.

The deposition of the pollutants from the atmosphere (surface contamination of open areas with harmful substances, deposited on the ground surface) is determined with a numerical calculation considering the following processes of cleaning the atmosphere from pollutants:

a) flow in direction to the surface as a result of the diffusion adhesion (dry deposition), determined by the formula:

$$DD(x,y)=V_d C(x,y)$$

where Vd - dry deposition speed;

C - concentration at point (x, y).

b) washing by precipitations (wet deposition)

$$WD(x,y)=Q(x,y)HT(x,y)[1-\exp(-\gamma Rt)]$$

where Q(x,y) - the mass of pollutant in the plume in the cross-sectional area through point (x,y);

HT - mass distribution through cross-sectional area;

γ - washing factor (for gas or aerosol);

R - precipitation intensity, mm/h.

c) in case of aerosols another deposition flow is also considered, caused by gravitational precipitation

$$GD(x,y)=Q(x,y)HT(x,y)[1-\exp(-Xt)]$$

where X - average speed for atmosphere cleaning as a result of the gravitational precipitation, depending on the particle size, s^{-1}.

From the total and averaged deposition flow for the period [g/m2s]

$$FD=DD+WD+GD$$

the daily average deposition is determined by integrating for the respective period.

In case of radioactive pollutants the total decay for the period is also determined as:

$$\int_0^T FDdt=\int_0^T Fe^{-C_t t}dt=\frac{F}{c}(1-e^{-C_t T})$$

The source, or the quantity of radioactive substances discharged in the air, is usually estimated using the following main quantities: initial activity, present in the zone of the accident (Ai); the atmosphere released fraction (ARF); the inhaled (respiration) fraction (RF) and the transmittance factor (LPF).

$$A=\sum_i^n A_i.ARF_i.RF_i.LPF$$

Where:

Ai - the initial quantity of radioactive substances, subject to risk during the accident, accessible for physical impact.

ARF - factor, used for estimation of the quantity of radioactive substances, released in the air as aerosol, and thus being accessible for transportation due to physical influences by specific accident.

RF - fraction of transmittable though the air (airborne) radionuclide, as particles that can be transmitted through the air and inhaled into the human respiratory system, and in general is assumed to contain particles with aerodynamic equivalent diameter (AED) of 10-µm and less.

LPF - fraction of radionuclide in aerosol form, passing through some capturing environment, deposition or a filtration mechanism.

LPF for the HEPA filters of the ventilation system of AB-2 is not applicable for the estimation of the source which will be used for the calculation of the doses of radiation exposure of the personnel (staff).

Methodology for calculation of personnel and population exposure in emergency cases

Input data

The initial amounts of radioactive substances causing risk for the personnel and the population in case of accident development.

Model for the calculation of the exposure dose

The inhalation dose, which corresponds to the discharged radioactivity, for the population and for the personnel regarding every isotope is calculated.

The aerial path is of major importance for the non-reactor nuclear installations. This position is also supported by the publication NUREG-1140, "A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Issuing of Licenses for Work with Other Radioactive Materials", according to which "for all materials of greatest interest for the fuel cycle and for the issuing of licenses for use of other radioactive materials, the dose from the inhalation pathway dominates in the overall dose".

For emergency conditions causing discharge (release) of radionuclide in the air, the doses caused by radiation from the soil as well by radiation from the clouds should be added to the inhalation dose, in order to obtain the total individual dose. Only the inhalation doses are calculated, since the doses from the other radiation sources are usually lower by orders of magnitude than the inhalation doses. The dose at a certain point is calculated as the sum of the results, obtained for the inhalation doses for all isotopes.

For a given isotope, the inhalation dose is calculated using the atmospheric dispersion factor (X/Q), the dose conversion factors (DCF), and the volume of inhaled air per unit time. The dose at a certain point is calculated as the sum of the results obtained for all isotopes.

Effective dose of the personnel (staff)

The inhalation dose for a given isotope or organ is calculated in the following way:

$$D_{inh} = \sum \frac{A_i}{V}.BR.T_e.DCF_{inh}$$

The meaning of the parameters in these equations is the following:

A = released activity of a given isotope (Bq).

V = room (premise) volume (m^3)

T_e = time of stay in the room (s)

DCFinh = dose conversion factor of inhaled dose of a given isotope (Sv/Bq) for a staff member.

BR = breathing rate (volume of the inhaled air per unit time for a staff member) (m^3/s).

The computer code for performing the dose calculations of the staff is MICROSHIELD 6.20.

Models to calculate the population exposure dose

According the ISAR [2], the following models are used for calculation of the radiation exposure of the population:

For a given isotope and organ, the inhaled doses are calculated as follows:

Effective population dose

$$D_{inh} = A_i.\frac{X}{Q}.BR.DCF_{inh}$$

The meaning of the parameters in these equations is the following:

Ai = released (discharged) activity of a given isotope (Bq);

X/Q = atmospheric dispersion factor (s/m^3), calculated according to 9.3.4.1

BR = breathing rate - volume of the inhaled air by a member of the population (m^3/sec);

DCF_{inh} = conversion factor for inhaled dose for a given isotope (Sv/Bq) for population members of the group of adults (>17 years).

The doses are calculated for the closest population and for the critical distance, where the deposition of particles is bigger due to the dispersion by the wind. In accordance with this and considering the atmospheric dispersion, the doses are calculated in the PAZ of NPP „Kozloduy" (2.2 km from AB-2) and at 5.5 km.

The dose conversion factors (DCF) are taken from the recommendations of ICRP (International Commission on Radiological Protection):

PUBLICATION 68 OF ICRP: Dose factors for absorption of radionuclide by the personnel.

PUBLICATION 72 OF ICRP: Absorption doses of radionuclide depending on the age of the individuals of the population, part 5, combination of dose factors from digestion and inhalation.

These are the latest, internationally recognized values, adopted in Directive 96/29 of Euratom. These factors are included in tables B and D of this Directive.

The inhalation dose factors (Sv/Bq) for the populations are presented for six age groups (0-1 year; 1-2 years; 2-7 years; 7-12 years; 12-17 years; over 17 years) based on the radioactivity of inhaled particles with a median aerodynamic diameter 1 µm.

In order to determine which group is critical, it is necessary to analyze the combination of the inhaled air volume (BR - Breathing Rate) per unit time and the dose conversion factor DCF for each group. Higher values of the product of DCF and BR for the nuclides of greater practical importance in the Plasma melting facility (PMF) (^{60}Co and ^{137}Cs) correspond to the group of the adults. Therefore, the doses factors of the inhalation dose of adults are used, and this age group is considered to be critical for the estimation of the inhalation doses. The dose factors of the ICRP for the inhalation dose of the personnel are given as activity median aerodynamic diameter (AMAD) 1 µm to 5 µm. In the calculations dose factors for conditions of slow solubility (type S) and AMAD, equal to 5 µm are used, as prescribed by ICRP in case of lack of specific information.

Model of atmospheric dispersion

Atmospheric dispersion factors (X/Qs) are calculated in accordance with the criteria defined in NUREG/CR-5164. Calculations of X/Q factors are based on the theory that the substances released into the atmosphere have normal (Gaussian) distribution around the center line of the torch. A straight trajectory is assumed between the point of release and all points for which X/Q values are calculated.

When released in the atmosphere, the radioactive gases and aerosols will follow the prevailing winds and will dissipate due to the cumulative effects of atmospheric turbulence. The projections of the dispersion are executed using an expression based on the Gaussian model of the torch.

$$\frac{X}{Q}=\frac{1}{\overline{U}.2\pi.\sigma_y.\sigma_z}\exp\left(\frac{-y^2}{2\sigma_y^2}\right).\left[\exp\left(\frac{(z+h)^2}{2\sigma_z^2}\right)+\exp\left(\frac{(z-h)^2}{2\sigma_z^2}\right)\right] \quad (1)$$

This expression is used in the calculations related to accidents, taking into account the fact that in cases when the ventilation system is out of operation, the equation is derived, considering the ground release through building penetrations and openings in walls.

Ground releases

Dispersion coefficients (X/Q) are calculated using the following expression, which is applicable to discharges through building openings, when the height of the point of discharge is 2.5 times smaller than the height of the adjacent hard structures.

The expression is derived from equation [1], recognizing that diffusion is in the prevailing wind direction and that this is a ground release.

$$\frac{X}{Q}=\frac{1}{\overline{U}.\pi.\sigma_y.\sigma_z} \quad [5]$$

The parameters in these equations are the following:

X /Q = atmospheric dispersion factor (s/m^3).

$\overline{U}$ = wind speed at 10 meters height (m/s).

$\sigma_y, \sigma_z =$ lateral and vertical distribution of plume (m) as defined for discharges through the ventilation tube.

The values of the X/Q factor are calculated for two distances: the distance to the KNPP site border (SB) and the distance to the outside border of the Area for preventive protection measures (APPM). The distance to SB and the outside border of APPM for calculation of X/Q will be defined as the minimal distance from the ventilation tube in each sector.

The minimal distance from AB-2 to the APPM is 2200 m, based on the selection of Kozloduy for center of the settlement it is determined that the APPM border is at 2.0 km from AB–2 (Table 2.3 of KNPP SAR).

When the release is through the ventilation tube, maximal concentration at ground level may occur outside the site borders or beyond the distance to the outside border of APPM, and depends on the height of the ventilation tube.

Therefore, X/Q factors are calculated for different distances beyond the site border in order to define the distance of maximal concentration at ground level. The critical distance for the releases from the ventilation tube is 5500 m.

After that, an assessment of the doses for the critical distance and for the distance to the outside border of APPM is performed.

For ground releases the atmospheric dispersion is calculated for the minimal distance from the closest point of the building to the SB for each sector and for the distance to the outside border of APPM (in western direction).

Release through the ventilation tube

In scenarios 1 and 2 it is assumed that the AB-2 ventilation system is in operation.

The room is under negative pressure, and therefore, the release is through the ventilation system connected to the ventilation tube of Units 3-4, which is 150 m high.

Considering equation [1] and the fact that the diffusion is in the prevailing wind direction, and that the critical member of the population is at ground level, the equation that should be used for ground-level relative concentration in the central torch line for release through the ventilation tube is as follows:

$$\frac{X}{Q} = \frac{1}{\overline{U}.\pi.\sigma_y.\sigma_z} \exp\left(\frac{-(h)^2}{2\sigma_z^2}\right) [2]$$

where:

X/Q = atmospheric dispersion factor (sec/m^3).

$\overline{U}$ = wind speed considering the conditions at the release height m/s,

h = effective height of the ventilation tube in m. $h = h_s - h_t$;

h_s = initial torch height (in this case, the height of the ventilation tube) above the plant elevation, in m

h_t = maximal height of the area above the plant elevation (assumed $h_t = 0$).

σ_y = lateral spread of the torch (m). It is a function of the atmospheric stability and the distance and is calculated by the following expression (Ref. [28]):

$$\sigma_y = \exp\left(sy_0 + sy_1 Ln(x) + sy_2 Ln(x)^2\right) \text{ [3]}$$

σ_z = vertical spread of the torch (m). It is a function of the atmospheric stability and the distance and is calculated by the following expression (Ref [28]):

$$\sigma_z = \exp\left(sz_0 + sz_1 Ln(x) + sz_2 Ln(x)^2\right) \text{ [4]}$$

According Ref. [2] the empirical coefficients for the evaluation of the lateral and vertical spread of the torch are the following:

Input data

Assessment data for the volume of the inhaled air per unit time (BR), according to the Regulation for the Basic Norms for Radiation Protection, considering that the volume of the air inhaled for one year by an adult member of the population older than 17 years is 8100 m^3 and by a member of the personnel is 2400 m^3:

- BR population =2.57E-4 m^3/s
- BR personnel = 3.92 E-4 m^3/s
- The volume of room BK301 is assumed to be 23700 m^3 (Ref. [2]).

The minimal distance from AB-2 to APPM is 2200m, based on the selection of Kozloduy for center of the settlement it is determined that the APPM border is at 2.0 km.

When the release is through the ventilation tube, maximal concentration at ground level may occur outside the site borders or beyond the distance to the outside border of APPM, and depends on the height of the ventilation tube.

Therefore, X/Q factors are calculated for different distances beyond the site border in order to define the distance of maximal concentration at ground level. The critical distance for the releases from the ventilation tube is 5500 m.

After that, an assessment of the doses for the critical distance and for the distance to the outside border of APPM is performed.

For ground releases the atmospheric dispersion is calculated for the minimal distance from the closest point of the building to the SB for each sector and for the distance to the outside border of APPM (in western direction).

Initial quantity of radioactive substances during the accident

The worst condition for the accident development is to assume that at the time of the accident occurrence the waste gas passing through the system is equivalent to all waste gases generated from the production of 200 l of slag. It will also be assumed that the ash container under the bag filter is full of fly ash.

Based on experimental measurements in testing facilities it is assumed that the share of isotopes such as Co, Ag, Nb, Mn and Fe retained in the slag is more than 90 %, while that of semi-volatile isotopes as Cs is around 70 %. The rest 30 % of the Cs is retained in the bag filters system and can be found in the gathered fly ash. The results from the ZWILAG operation prove that these values are very conservative; however, they are used in the accidents analysis.

The isotope composition considering the radioactivity balance during PMF operation is presented in section 4.1.2.0.

Based on the presented methods, the analyses of the limiting initial events in the PMF ISAR [2] are performed.

Dose calculation in case of fire in the off-gas system

Since this accident has the most serious consequences for the population, a short description of the three scenarios is presented, and the summary of the results is presented in table 4.1.3-1 below.

Scenario description

For the calculation purposes it is assumed that a fire has been initiated in one of the burnable off-gas devices in room BK301. The fire extinguishing system prevents spreading of the fire to other sub-systems from the technological process, affecting only the bag filter, HEPA filter and the scrubber. It is assumed that before the accident the facility is in normal operation mode.

Scenario 1: AB-2 ventilation system is in operation. HEPA filters are not saturated and their efficiency is preserved.

All of the activity in the PMF off-gas system included in the accident is released in the building. Part of this activity is suspended in the air and is inhaled by the personnel. The activity in the air is directed through the ventilation system and is retained by the HEPA filter with 99.97 % efficiency [1], before it is released in the atmosphere through the ventilation tube of Units 3-4 at 150 m height. Therefore, only a small part is released in the environment causing potential exposure of the population.

Scenario 2: Ventilation system operates, HEPA filters are saturated and their efficiency is below the project efficiency.

The calculation assumes that the activity in the building is released, because the HEPA filters in the common exchange extraction ventilation system of room BK301 are damaged and have lost their retaining function. It is therefore assumed that 100 % of the activity in the air accessible for breathing is released in the environment through the ventilation tube of Units 3-4 at 150 m height. The assumptions in occupational dose calculations are the same as in Scenario 1.

Scenario 3: Ventilation system does not work due to which the discharge is made through the construction outlets and openings in the walls.

The assumptions in occupational dose calculations are the same as in Scenarios 1 and 2, but for dose calculation outside the site release at ground level with no filter retention is assumed. 100°% of the activity in the air accessible for breathing is released in the environment.

Table 4.1.3-1 presents the results from the three scenarios of this accident, namely the doses for the population and the personnel.

EWN Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38,
E- mail: office@eninbg.com

Table 4.1.3-1 Results of the analysis of all three scenario of the accident

Indicator	**Staff**	**Population**					
		Scenario 1		**Scenario 2**		**Scenario 3**	
	Room BK 301	APPM	Critical distance	APPM	Critical distance	To SB	APPM
Inhalation dose mSv	3.24E-03	3.16E-10	1.05E-9	6.33E-7	2.11E-6	9.30E-02	1.29E-04

Results presented in the table show that the most dangerous is Scenario 3, but nevertheless the dose rates for the population and staff are far below the permissible values.

In the PMF ISAR [2] analyses of the limiting initiating events have been performed and a summary of the results is presented in table 4.1.3-2.

Table 4.1.3-2 Results of the analysis of the limiting initiating events in the PMF

Events	**Respiratory dose (mSv/year)**		
	Staff	Population at the site border	Population within the APPM
Fire in temporary storage facility	3.2E-03	7.62E-02	1.05E-04
Dropping of packaging with waste	1.15E-05	3.31E-04	4.58E-07
Fire in the flue gas system	2.39E-05	9.10E-04	1.26E-06
Explosion in the shredder	3.24E-03	9.30E-02	1.29E-04
Fire in the PMF	1.07E-02	2.55E-01	3.52E-04

Table 4.1.3-2 includes summary of the results for the inhalation doses for the four analyzed design-bases accidents (DBA) and for beyond design-basis accidents (BDBA). It shows the inhalation doses for the personnel and the population in the most conservative scenario (Scenario 3 - Ventilation system does not work due to which the discharge is made through the construction outlets and openings in the walls).

According to the results presented in the table the most severe accident in terms of exposure of the personnel and the population is fire in the PMF, because in this case all of the PMF radioactive material is released, including the sources in the temporary storage. The doses in Scenario 3 are higher, when damage to the ventilation system is considered, resulting in releasing all of the activity in the environment at ground level. In this border case the maximal dose outside the site is obtained at the SB, where the effective dose is 0.255 mSv, and the maximal dose for a member of the personnel is 0.01 mSv, which is lower than the acceptance criterion.

In the accidents analysis conservative data and hypotheses are assumed; therefore, there is a high degree of confidence that the determined acceptance criteria are fulfilled.

The acceptance criteria according to the Regulation of the Basic Norms for Radiation Protection are the following:

- The limit of the occupational effective dose is 100 mSv for 5 consecutive years, and the maximal effective dose for each year cannot exceed 20 mSv.
- The limit of the annual effective dose for each member of the population is 1mSv.

The radiation criteria for acceptance of the dose rate for the population in cases of accidents are defined as normative limits of the accident doses, in accordance with the Regulation for safety during RAW management, and are as follows:

- The annual individual effective dose for the critical group of members of the population resulting from the normal operation of one or more RAW management facilities located on the same site should not exceed 0.3mSv;
- The annual individual effective dose for the critical group of members of the population resulting from DBA in RAW management facility should not exceed 5°mSv;
- The annual individual effective dose for the critical group of members of the population resulting from the existence of a Facility for RAW disposal after its closure should not exceed 0.3 mSv.

Based on the results of the accident analysis a conclusion could be drawn that the radiation dose rates of the staff and population received as a result of the analyzed accidents are much below the acceptability radiation criteria stipulated in the Regulation of the Basic Norms for Radiation Protection and the Regulation for safety during RAW management.

Therefore, it can be concluded that the PMF has an acceptable safety level in cases of DBA and BDBA.

4.1.4 Possible impacts on sites of NATURA2000 on Romanian and Bulgarian territory

<u>During construction</u>

Non-radiation impacts

During the execution of the main activities at the stage of construction of the PMF related to dismantling works, removal of roof panels, removal of roof beams in the medium part, removal of horizontal roof connections in the medium part, removal of transverse collar beams in the medium part, temporary reinforcement of the steel structure, reinforcement of the existing elements and installation of new ones; installation of carrying steal structure and execution of reinforcement foundations of the main and auxiliary equipment, collection of the construction waste and construction of the internal infrastructure **no impact on the protected territories and protected areas is expected.**

Radiation impacts

Commissioning of the Plasma Melting Facility is only related to the installation works in the existing building on the territory of KNPP, which are not source of the radiation contamination. No radiation impact is expected on the protected areas in 30-km area on the neighboring territory of Romania.

Radiation impact on the protected areas and territories during the construction period is not expected.

In view of the protected territories and protected areas during the construction period no special measures are proposed for avoidance, reduction or compensation of considerable negative impacts on them besides compliance with the best practices for implementation of these activities.

No cumulative impact related to the decommissioning activities for KNPP Units 1-4 and construction activities for the National Disposal Facility for Low and Intermediate Level Short-Lived RAW (NDF RAW) is expected.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Minor*
Territorial scope of impact (geographic region; affected population):	*Locally, on the IP site*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact - (short term, medium term and long term):	*Short term*
Frequency of impact occurrence (permanent/temporary):	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Indirect, secondary*

Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

During operation

There may be some potential impact on the protected territories and protected zones during the RAW transfer, if there are some deviations from the standards accepted in Kozloduy NPP for the physical and radiation characteristics of the waste containers, which will be supplied to the PMF. In this regard it is recommended to measure the radiation characteristics of the containers before their transportation to the PMF. Transportation of RAW on the territory of Kozloduy NPP is typical for the NPP activity and is regulated in the existing license for operation of Kozloduy NPP in compliance with the Ordinance for conditions and order for transportation of radioactive materials, Article 2, paragraph (2) – 2.

During the normal technological mode of the PMF **no negative impact on the protected territories and protected zones is expected.**

Also, no negative impact on the protected territories and protected zones is expected in normal course of the cycle of slag pouring in forms, transportation and measurement of the weight of the final drums as well as upon determination of the characteristics of the end product. At the end of the technological process well-conditioned product is obtained, which does not contain any liquids, organic materials and radioactive pollution from outside sources. The final drums will contain vitrified waste in a stable form. It is expected that these drums will be further on immobilized with cement into bigger containers in order to meet the acceptance criteria for immobilized products established by Bulgarian Regulation.

In the performed modeling included in Appendix 10 it is stated that the comparison of the collective effective doses for the population from KNPP with the indicators of many other NPPs with PWR (WWER) reactors show compatibility with the international practice. The calculation of the cumulative effect added to the effect of KNPP normal operation, due to emissions from the decommissioning of KNPP Units 1-4 and the normal operation of the Plasma melting facility (PMF) (Project 5b) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %. Therefore, recalculation of the already established special statute areas at KNPP is not necessary. This clarification is made in regard to the MEW recommendations (letter – Ref. OVOS-277/2012- Appendix 6).

Cumulative effect related to the activities for Decommissioning of Units 1-4 at KNPP and for the National Disposal Facility for Low and Intermediate Level Short-Lived RAW (NDF RAW) is not expected.

Measures for avoidance, reduction or compensation of considerable negative impacts:

The Radiation Protection Program will be based on the assessment of operational dose rates to the staff working at AB-2 and to the population considering magnitude and location of sources of ionizing radiation in the PMF, as described in previous sections.

Observance of the best practices for implementation of the technological processes.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact (geographic region; affected population):	*Locally*
Reversibility of the impact (reversible, irreversible):	*Reversible*
Duration of the impact – (short term, medium term and long term):	*Short term*
Frequency of impact occurrence ((permanent/temporary)	*Temporary*
Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Indirect, secondary*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

<u>During decommissioning</u>

During the decommissioning activities of the IP related to the removal of the existing components or systems, decontamination of components as well as cutting and processing of big parts of equipment some potential indirect impacts on parts of the protected areas and protected territories are possible in case of some risky situations.

In line with the option for immediate dismantling of equipment outside of the safe enclosure area in the updated Strategy for the decommissioning of KNPP Units 1-4, the immediate dismantling is considered as preferred option for the PMF decommissioning.

The availability of waste management infrastructure for treatment and conditioning of the decommissioning waste during the Decommissioning as well as the availability of the Radioactive Waste National Repository at the time of PMF decommissioning, as stipulated in the updated Decommissioning Strategy of Units 1-4 of Kozloduy NPP also provide grounds for determination of immediate dismantling as preferred option for decommissioning of the PMF.

End-point of the PMF decommissioning activities is to return the area where PMF was located as close as possible to the pre-installation condition, while protecting human health, the environment, and meeting regulatory requirements.

All incoming radioactive waste and final waste produced in the PMF is classified as Category 2a. Therefore, contamination levels during the decommissioning are commensurate to this waste category.

During the treatment of RAW generated during the decommissioning of nuclear facilities in compliance with the regulations related to the RAW management, no negative impacts on the protected territories and protected areas in the adjacent territories to Kozloduy NPP are expected.

In view of the protected territories and the protected areas during decommissioning no special measures are recommended for avoidance, reduction or compensation of considerable negative impacts on them besides compliance with the best practices for implementation of the technological processes.

In conclusion, the following forecast regarding the impacts at this stage can be made:

Occurrence probability:	*Low*
Territorial scope of impact: (geographic region, affected population)	*Locally*
Reversibility of the impact: (reversible, irreversible)	*Reversible*
Duration of the impact: (short-term, middle-term and long-term)	*Short term*
Frequency of impact occurrence: (constant/temporary)	*Temporary*
Type of the impact: (positive/negative; direct/non-direct; secondary; cumulative and synergy);	*Indirect, secondary*
Transboundary type of the impact:	*Not expected*
Cumulative impact	*Not expected*

Detailed analysis of the impact on the protected areas is made in the attached to the EIA-R Compatibility report of the IP with the subject and objectives related to the protected areas.

Concerning the possible impacts in case of accident the conclusion of section 4.1.3 is valid.

The assessment of NATURA 2000 sites on the Romanian territory are given in a separate section of the EIA-R (section 11.5) presented as a separate document.

4.1.5 Possible impacts in transboundary aspect

All parts of the transboundary aspects for the Romanian territory are assessed and presented in a separate document (section 11.5 of this EIAR).

The main result from the assessment of the assumed impacts on people and environment during the implementation of the PMF (construction, operation and decommissioning) presented in the above parts of this chapter is that **no transboundary impacts are expected**.

In Appendix *10*, according to the MEW additional recommendations (Letter – No. OVOS-277/2012 - Appendix 6), "Analysis on the dose rate from gas aerosol and liquid releases to the environment from the Units 1-4 decommissioning process and the emissions from the plasma melting facility (PMF) operation, incurred by the public within the 30-km supervised area surrounding Kozloduy NPP" is presented. A modeling program code based on the EU approved methodology CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 –Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclide to the Environment has been used for modeling the pollutants distribution, considering the following:

To assess the public dose due to liquid discharges - program code DARR-CM has been adapted to the hydrology of the KNPP area and uses a conservative assessment of the dose exposure of a critical group of the public. To assess the public dose within the monitored area due to gas-aerosol discharges - program code LEDA-CM, Normal Operation Shield has been adapted to the geographical and meteorological characteristics of the KNPP area. The methodology considers both the external and the internal impact of the radioactive releases and estimates the annual individual effective dose, the annual individual dose equivalent, and the critical group dose, as well as the collective dose for the population, per age groups. The modeling program codes used to estimate the individual and the collective effective doses to be incurred by the population from radioactive discharges to the environment, have been verified and validated. The effective doses for the population from liquid emissions in the Danube during normal operation of KNPP are presented below.

Table 4.1.5-1 Range of the individual effective dose and of the respective maximum values for the public within the 30-km area, generated by liquid emissions from the KNPP

Population	Max dose, w/o ^{3}H, Sv/a	Max dose, ^{3}H, Sv/a	Max dose, Total, Sv/a
30-km area	$1.40.10^{-11} – 8.96.10^{-10}$	$3.21.10^{-7} – 6.00.10^{-7}$	$3.22.10^{-7} – 6.00.10^{-7}$
Critical group	$4.43.10^{-9}$	$4.22.10^{-6}$	$4.23.10^{-6}$

The population critical group includes settlements located downstream along the Danube – the town of Oryahovo, and the villages Leskovets, Ostrov, and Gorni Vadin.

Table 4.1.5-2 Estimated collective effective dose values for the Bulgarian side of the Danube, considering the above settlements

Population	Collective dose w/o ^{3}H, manSv/a	Collective dose, ^{3}H, manSv/a	Collective dose, Total, manSv/a
Critical group	$8.05.10^{-6}$	$4.42.10^{-3}$	$4.43.10^{-3}$

The normalized collective dose per unit of generated electrical energy amounts to **$2.54.10^{-3}$ man.Sv/GW.a**. The data are fully comparable with the results for a great number of PWRs worldwide (UNSCEAR–2000, 2008).

The average annual values during the entire period of decommissioning of Units 1-4 are presented in table 4.1.5-3.

Table 4.1.5-3 Range of the individual effective dose and respective maximum values for the public within 30-km area, generated from liquid emissions from the KNPP

Population	Max dose w/o ^{3}H, Sv/a	Max dose, ^{3}H, Sv/a	Max dose, Total, Sv/a
30-km area	$3.56.10^{-12} – 5.50.10^{-10}$	$7.07.10^{-10} – 1.32.10^{-9}$	$8.30.10^{-10} – 1.48.10^{-9}$
Critical group	$2.31.10^{-9}$	$9.30.10^{-9}$	$1.16.10^{-8}$

The population critical group includes settlements located downstream along the Danube – the town of Oryahovo, and the villages Leskovets, Ostrov, and Gorni Vadin.

Table 4.1.5-4 Collective effective dose values for the Bulgarian part along the Danube River, taking into account the population of the town of Oryahovo, and the villages Leskovets, Ostrov, and Gorni Vadin

Population	Collective dose w/o ^{3}H, manSv/a	Collective dose, ^{3}H, manSv/a	Collective dose, Total, manSv/a
Critical group	$5.01.10^{-6}$	$9.73.10^{-6}$	$1.47.10^{-5}$

The effective doses for the population in total from liquid and gaseous emissions, including cumulative effect in case of various release sources are given in tables 4.1.5-5 and table 4.1.5-6.

Table 4.1.5-5 Individual effective doses from liquid and gaseous releases

Description of source	Max dose from gas-aerosol emissions, Sv/a	Max dose from liquid emissions, Sv/a	Max dose, Total, Sv/a
Operation Units 5&6 KNPP	$7.18.10^{-9} – 8.02.10^{-7}$	$3.22.10^{-7} – 6.00.10^{-7}$	*** $5.03.10^{-6}$
	$8.02.10^{-7}$	*** $4,23.10^{-6}$	

Description of source	Max dose from gas-aerosol emissions, Sv/a	Max dose from liquid emissions, Sv/a	Max dose, Total, Sv/a
Operation Units 5&6 + Decommissioning Units 1-4	$7.33.10^{-9}$ - $8,04.10^{-7}$	$3.23.10^{-7}$ – $6.01.10^{-7}$	*** $5.04.10^{-6}$
	$8.04.10^{-7}$	*** $4.24.10^{-6}$	
Operation Units 5&6 + Decommissioning Units 1-4 +operation PMF	$7.36.10^{-9}$ – $8.05.10^{-7}$	$3.23.10^{-7}$ – $6.01.10^{-7}$	*** $5.05.10^{-6}$
	$8.05.10^{-7}$	*** $4.24.10^{-6}$	

****The dose estimates apply to critical groups of the population within the 40-km area around KNPP.*

Table 4.1.5-6 Collective effective dose for population in 40 km area around KNPP

Description of source	Collective dose from gas-aerosol emissions, manSv/a	Collective dose from liquid emissions, manSv/a	Collective dose, Total, manSv/a
Operation Units 5&6 KNPP	$1.47.10^{-2}$	$4.43.10^{-3}$	$1.91.10^{-2}$
Operation Units 5&6 + Decommissioning Units 1-4	$1.48.10^{-2}$	$4.44.10^{-3}$	$1.92.10^{-2}$
Operation Units 5&6 + Decommissioning Units 1-4 +operation PMF	$1.49.10^{-2}$	$4.44.10^{-3}$	$1.93.10^{-2}$

The obtained dose estimates refer to the population on the Bulgarian side (72416 people, year 2007). Taking into account the population in the respective part of Romania – another 75 150 people, the collective effective dose for the entire area can be approximately doubled. These are data fully comparable with the practice adopted for PWRs worldwide.

Based on the performed analysis for population dose during Decommissioning of KNPP Units 1-4 and normal operation of the Plasma Melting Facility (Project 5b), the following conclusions can be made: The maximum annual effective dose per individual of the critical group of the population living within the 40-km area around KNPP, resulting from the liquid and gas-aerosol releases to the environment, was conservatively calculated at 5.05µSv/a, which is a much lower value than the quota of 250µSv/a for exposure from radioactive emissions from NPP (Ordinance on the Ensuring of Safety of NPPs) and the norms determined for the population of 1 mSv/a (ONRZ-2012, Basic Norms for Radiation Protection). The additional dose that might be incurred is about 500 times lower than natural radiation background (2.33 mSv).

The calculation of the cumulative effect added to the effect of KNPP normal operation, and due to emissions from the decommissioning of KNPP units 1-4, and the normal operation of the plasma melting facility (PMF), Project 5b) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1%. The maximum annual effective dose of the population within the 40-km area around KNPP due to aerosol emissions only, 6 MBq under normal operation of the plasma melting facility (PMF), was estimated at 5.47.10-10 Sv/a, which is barely 0.01% from the total exposure resulting from all activities on the KNPP site. The comparisons of the collective effective dose values for the population around KNPP with the respective data for many other nuclear power plants with PWRs (WWERs) reactor type proved comparable with the practice worldwide.

4.1.6 Matrices for assessment of potential impacts on the people and environment

Possibilities for occurrence or non-occurrence of radiation or non-radiation impact on the people and environmental components as a result of the PMF activities (implementation, operation, decommissioning and accidents) are specified and assessed in the "Matrix for identification and assessment of radiation or non-radiation impacts on the people and environment".

Three matrices are prepared:

- “Matrix for identification and assessment of potential **radiation impact** on the people and environmental factors during PMF commissioning, operation and decommissioning”- table 4.1.6-1
- “Matrix for identification and assessment of potential non-**radiation impact** on the people and environmental factors during the commissioning of the PMF, operation, decommissioning and accidents”- table 4.1.6-2
- “Matrix for identification and assessment of potential **radiation impact** on the people and environmental factors in case of emergency at the PMF”- table 4.1.6-3
- Matrices are elaborated for the selected technology, which will be used in the PMF as specified in Alternative 2.

The information in the matrices of tables 4.1.6-1 and 4.1.6-2 is based on the analysis of the main radiaiton and non-radiaiton factors that impact the environmental components, made in sections 4.1.1, т. 4.1.2, т. 4.1.4 for all environmental components and for all stages of the IP implementation. The methodologically justified (section 5.2 of EIAR) analyses and assessments of the potentially possible impacts by environmental components and factors include:

1. Measures for avoidance, reduction or compensation of considerable negative Impacts
2. Estimation of the expected and potentially possible impacts providing the information on each environmental component and factor in tables for:
   - Occurrence probability;
   - Type of the impact (positive/negative; direct/non-direct; secondary; cumulative and synergy);
   - Territorial scope of impact: (geographic region, affected population);

- Frequency of impact occurrence (constant/temporary);
- Duration of the impact (short-term, middle-term and long-term);
- Reversibility of the impact (reversible, irreversible);
- Transboundary type of the impact.

TABLE 4.1.6.-1

MATRIX FOR IDENTIFICATION AND ASSESSMENT OF POTENTIAL RADIATION IMPACTS ON THE ENVIRONMENTAL FACTORS DURING IMPLEMENTATION, OPERATION AND DECOMMISSIONING OF THE PMF

		CHARACTERIZATION OF IMPACTS																STATEMENT				EVALUATION			
		Positive	Negative	Direct	Indirect	Synergy/ Accumulation		Temporary	Permanent	Localized	Extensive	Recoverable/Modifiable	Irrecoverable/Definitive	Reversible/Unstable	Irreversible/Stable	Affects protected resources (1)		Minimization /mitigation measures required	Probabilities of occurrence (2)	Acceptable	Not acceptable	Compatible	Moderate	Severe	Critical
						yes	no									yes	no								
Env. factor	Impact																								
Air	Construction/Installation works		x	x			x	x		x		x		x			x	x	B	x			x		
	Incineration treatment of RAW		x	x			x	x		x		x		x			x	x	B	x			x		
	Conditioning of RAW		x	x			x	x		x		x		x			x		B	x			x		
	Emissions in the atmosphere		x	x		x			x		x		x		x		x	x	B	x		x			
Noise	Construction/Installation works		x	x			x	x		x			x		x		x	x	A	x			x		
	Volume reduction and conditioning of RAW		x	x			x		x	x			x		x		x	x	A	x			x		
	Transport of materials		x	x			x	x			x		x		x		x	x	A	x			x		
Water	Non-radioactive emissions in waste water		x		x	x			x	x			x		x		x	x	A	x		x			
Flora	Emissions in waste gases		x		x		x												B	x					
Fauna	Emissions in waste gases		x		x		x												B	x					
Landscape	Modifications of industrial buildings			x	x		x		x	x		x		x			x		A	x		x			
Land Use	Modifications of industrial site			x			x		x	x		x					x	x	B						
	Storage of conditioned RAW			x			x		x	x		x					x	x	B						
Population (Health)	Transport of materials		x	x			x	x			x		x		x		x	x	A	x			x		
	Handling of hazardous materials	x			x		x		x	x			x		x		x	x	B	x		x			
	Non-radioactive releases into air and water		x		x		x		x		x		x		x		x	x	B	x		x			
	Ceasing of risk of contamination releases	x			x		x		x		x		x		x		x		A	x		x			
Population/ Economy	Increase in level of occupation	x		x			x		x	x	x	x		x			x	x	B	x			x		
	Modification of the industrial site	x		x		x			x	x			x		x		x		A	x		x			

(1) Protected areas (2) A=high, B=low, M=average

TABLE 4.1.6.-2

MATRIX FOR IDENTIFICATION AND ASSESSMENT OF POTENTIAL NON-RADIATION IMPACTS ON THE ENVIRONMENTAL FACTORS DURING PMF IMPLEMENTATION, OPERATION, DECOMMISSIONING AND ACCIDENTS

Env. factor	Impact	CHARACTERIZATION OF IMPACTS: Positive	Negative	Direct	Indirect	Synergy/ Accumulation: yes	Synergy/ Accumulation: no	Temporary	Permanent	Localized	Extensive	Recoverable/Modifiable	Irrecoverable/Definitive	Reversible/Unstable	Irreversible/Stable	Affects protected resources (1): yes	Affects protected resources (1): no	STATEMENT: Minimization /mitigation measures required	Probabilities of occurrence (2)	Acceptable	Not acceptable	EVALUATION: Compatible	Moderate	Severe	Critical
Air	Construction/Installation works		x	x			x	x		x		x		x			x	x	B	x			x		
Air	Incineration treatment of RAW		x	x			x	x		x		x		x			x	x	B	x			x		
Air	Conditioning of RAW		x	x			x	x		x		x		x			x		B	x			x		
Air	Emissions in the atmosphere		x	x		x			x		x		x		x		x	x	B	x		x			
Noise	Construction/Installation works		x	x			x	x		x			x		x		x	x	A	x			x		
Noise	Volume reduction and conditioning of RAW		x	x			x		x	x			x		x		x	x	A	x			x		
Noise	Transport of materials		x	x			x	x			x		x		x		x	x	A	x			x		
Water	Non-radioactive emissions in waste water		x	x		x			x				x		x		x		A	x		x			
Flora	Emissions in waste gases		x		x		x												B	x					
Fauna	Emissions in waste gases		x		x		x												B	x					
Land scape	Modifications of industrial buildings			x	x		x		x	x		x		x			x		A	x		x			
Land Use	Modifications of industrial site			x			x		x	x		x					x	x	B						
Land Use	Storage of conditioned RAW			x			x		x	x		x					x	x	B						
Population (Health)	Transport of materials		x	x			x	x			x		x		x		x	x	A	x			x		
Population (Health)	Handling of hazardous materials	x			x		x		x	x			x		x		x	x	B	x		x			
Population (Health)	Non-radioactive releases into air and water		x		x		x		x		x		x		x		x	x	B	x		x			
Population (Health)	Ceasing of risk of contamination releases	x			x		x		x		x		x		x		x		A	x		x			
Popul./ Econ.	Increase in level of occupation	x		x			x		x	x	x	x		x			x	x	B	x			x		
Popul./ Econ.	Modification of the industrial site	x		x		x			x	x			x		x		x		A	x		x			

(1) Protected areas (2) A=high, B=low, M=average

TABLE 4.1.6.-3

MATRIX FOR IDENTIFICATION AND ASSESSMENT OF POTENTIAL RADIATION IMPACTS ON THE ENVIRONMENTAL FACTORS DURING OPERATION OF THE PMF IN CASE OF EMERGENCIES

			CHARACTERIZATION OF IMPACTS																STATEMENT				EVALUATION				
			Positive	Negative	Direct	Indirect	Synergy/Accumulation		Temporary	Permanent	Localized	Extensive	Recoverable/Modifiable	Irrecoverable/Definitive	Reversible/Unstable	Irreversible/Stable	Affects protected resources (1)		Minimization/mitigation measures required	Probability of occurrence (2)	Acceptable	Not acceptable	Negligible	Compatible	Moderate	Severe	Critical
Env. Factor	Impact	Emergency Case					yes	no									yes	no									
Air	Emissions and contamination	Fire temporary storage site		x	x		x					x			x			x		C	x					x	
		Off-gas Fire		x	x		x					x			x			x		C	x					x	
		Shredder explosion		x	x		x					x			x			x		C	x					x	
		Fire in PMF facility		x	x		x					x			x			x		C	x					x	
Water	Emissions and contamination	Fire extinguishing water in temporary storage site		x	x		x				x				x			x		C	x					x	
		Fire extinguishing water Off-gas		x	x		x				x				x			x		C	x					x	
		Fire extinguishing water in PMF facility		x	x		x				x				x			x		C	x					x	
Soil, flora, fauna	Emissions and contamination	Fire in Temporary Storage		x	x		x					x			x			x		C	x					x	
		Off-gas Fire		x	x		x					x			x			x		C	x					x	
		Shredder explosion		x	x		x					x			x			x		C	x					x	
		Fire in PMF facility		x	x		x					x			x			x		C	x					x	
Personnel/Population	Absorption of radionuclides	Fire temporary storage site		x	x		x					x			x			x		C	x					x	
		Off-gas Fire		x	x		x					x			x			x		C	x					x	
		Shredder explosion		x	x		x					x			x			x		C	x					x	
		Risk of contaminated escapes		x	x		x					x			x			x		C	x					x	
		Discarded packaging waste		x	x		x				x				x			x		B	x					x	

(1) Protected areas (2) A=high, B=low, M=average, C=very low

4.1.7 Analysis and assessment of the expected potential impacts

Information specified in the matrices of tables 4.1.6-1 and 4.1.6-2 is based on the analysis of the main radioactive and non-radioactive factors impacting the environmental components, which is made in items 4.1.1, 4.1.2 and 4.1.4 for all environmental components and for all stages of implementation of the investment proposal. Methodologically (chapter 5, section 5.2 of the EIAR) justified analyses and assessments of potential possible impacts by components and environmental factors include:

1. Measures for avoidance, reduction or compensation of considerable negative impacts:

2. Estimation of the expected and potential possible impacts and the information for each impact factor and environmental component is shown as a table for:

- Probability of occurrence:
- Type of the impact (positive/negative; direct/non-direct; secondary; cumulative);
- Scope of the impact - geographic region; affected population;
- Frequency of occurrence - permanent/temporary:
- Duration - short term, middle term and long term;
- Reversibility - reversible/irreversible;
- Transboundary type of the impact

4.1.8 Non-radiation impact

4.1.8.1 Used natural resources

During the operation of the PMF the only natural resource which will be used is the water.

Plasma Melting Facility PMF is designed for use of water for industrial and residential water supply and the sources are the ones available at the moment according to the granted water use permits as follows:

- Permit № 0562/14.03.2005 for water use from the river of Danube for cooling, production of chemical demineralized water and electricity generation by HPP of HC-1
- Permit № 11530127/30.05.2008 for production of underground waters through shaft well for emergency service water supply of Units 5 and 6;
- Permit № 11530128/30.05. 2008 for production underground waters through shaft well „Raney-5” for industrial and fire protection purposes;
- Permit № 11590203/30.05.2008 for production of underground waters through shaft well ”Valiata” for hygiene-residential purposes of Units 1 to 4.

Quantity of the taken surface waters from the river of Danube for 2010 is about 51.2 % and about 52 % for 2009, compared with the permitted quantity, and of the ground waters – only 9% in 2010 and 2 % in 2009.

Quantities assumed to be used in the PMF according to the construction design are:

- **Service water** for the scrubber and for the gas cooler of the facility. Expected nominal consumption is 2500 m^3 per year;
- **Cooling water** for cooling of the equipment (plasma torch, furnace).

Cooling water of the PMF operates on “closed circuits”, and the heat energy is discharged by heat exchangers to the existing system of “open circuits” for cooling of Kozloduy NPP. Due to this the water consumption is limited up to the amount of the possible leakages of the “closed systems” and is expected to be within 2 m^3 per year.

Low water consumption is a result of its treatment with corrosion prevention products for reduction of the corrosion of the pipes, thus achieving longer period for water change. In addition, different tanks are used according to the radioactivity levels. The use of these tanks allows controlling the flow rate according to the requirements.

Water quantities foreseen for use are within the limits of the permitted ones pursuant to permits for water use.

Water consumption from the underground waters is insignificant in view of the total quantity used by Kozloduy NPP. For potable residential needs mainly water from the town water supply network of Kozloduy will be used as well as from own water sources.

Conclusion could be drawn that the water quantities used for residential potable water supply and for production needs are within the permitted quantities.

4.1.8.2 Generation of non-radioactive waste

In order to minimize the negative impact of waste on the environment, the application at company level of the accepted hierarchy in the methods for waste management, specified in the National Program for waste activity management (2009-2013) based on the regulations existing in Bulgaria should be continued.

In Article 4 of the Waste Management Law the hierarchy of the waste management is regulated, which determines the following consequence of the priorities:

- Prevention of the waste generation or their minimization at the generation source.
- Utilization of the waste by secondary utilization and/or recycling.
- Final decontamination of the waste by disposal.

The hierarchy given above is included in the KNPP Program for management of the conventional waste, in force 2010-2013. During the operation waste specified in item 4.1.2.11 will be generated, A) Conventional waste. If needed, when the specified waste is not a part of the managed waste, KNPP shall elaborate work sheets for classification of the waste before the implementation of the investment proposal, agreed with the Regional Inspection for Environment and Waters - Vratsa. After the

Agreement of the Work Sheets for classification the above mentioned Waste Management Program has to be updated and also be agreed by the Regional Inspection for Environment and Waters - Vratsa.

The organization for collection and storage on temporary sites of the waste and their transfer for transportation and following treatment is company obligation, and is described in the KNPP Program for management of the conventional waste. Waste Monitoring System is elaborated in compliance with the requirements of Ordinance 3/2004 for waste classification, Regulation 2/2013 on the procedures and forms for providing information on waste management activities and the procedures for conduct of public records (prom. SG 10/05.02.2013), and the Ordinance for requirements to the treatment and transportation of production and hazardous waste (accepted with Decree of the Council of Ministers N53 from1999, SG, issue 29/1999).

Companies, to which the waste will be transferred, will need a Permit pursuant to Article 35 of the Waste Management Law and/or complex permit and those accepting metal waste - Permit pursuant to Article 67 of the Waste Management Law.

Domestic Waste as well as the Waste from packaging is also subject to separate collection and transfer for recycling based on the regulations in force in the country. This measure will minimize the quantities of residential waste for disposal, according art. 33 from the WML.

4.1.8.3 Noise

No increasing of the noise from the transportation flow crossing the populated areas of 30km area is expected.

4.1.8.4 Vibrations and micro climate

Vibrations - In view of the staff on the site of the PMF general vibrations could be generated by the cranes. In the IP similar option is not specified. It is clear that they will operate remotely and any possible vibrations will not have any direct impact.

Micro climate - PTC and STC will be lined outside with refractory and insulation materials, they will be serviced remotely and the operators will be remote. Nevertheless, it is needed to detect the infrared radiation emitted by the facilities. It is one of the main components of the micro climate; it could penetrate the tissues in depth and warm them up. Besides that, together with the rest of the components of the micro climate, it causes heat exhaustion and overheating, and could also cause heat stroke.

Maintenance and repair workers could also be exposed to levels of infrared radiation exceeding the norm.

4.1.8.5 Dust

Until the construction of the National Repository for RAW the PMF will be serviced mostly by in land transport - delivery of RAW stored on the sites of Kozloduy NPP and their transportation after treatment to the SD RAW Kozloduy for storage. Operation of the equipment in this period will not cause increase of the transportation traffic and respectively pollution of atmospheric air. Transportation traffic after construction of the PMF will be insignificantly increased and there will be no

Energy Institute JSC
20, Fr. Joliot – Courie Str.1113 Sofia, Bulgaria Tel:(+359 2) 963 45 76, Fax: (+359 2)963 40 38, E- mail: office@eninbg.com

unfavorable health effect by the non-organized dust emissions caused by this slight increase. The same is valid for the spent gases emitted by the motor vehicles.

4.1.8.6 Impact on the soils

Requirement to the operation of the PMF (TS, item 3.4 – Operation conditions) is the compliance of maximal limits of chemical discharges with the effective normative documents, and this is also valid for the possible emergency situations. Analysis of the investment proposal shows that the operation of the PMF will comply with all requirements of the Bulgarian and European legislation, and that means that during the normal operation the PMF will not impact the soils. Even in cases of possible occurrence of impacts on the soils, they are expected to be within the admissible limits. Cumulative effect is not expected.

During the period of normal operation of the PMF negative non-radiation impact on the soils are not expected in 30-km area around the Kozloduy NPP, including the territory of Romania. In this regard no measures are needed for avoidance, reduction or compensation of considerable negative impacts on the soils since such impacts are not expected.

4.1.8.7 Social and economic impact

Activities for installation, operation and decommissioning of the PMF do not assume any negative social and economic effect. It is expected the implementation of the PMF to mitigate the negative social and economic effect from the decommissioning of Units 1-4 of Kozloduy NPP.

4.1.9 Radiation impact

4.1.9.1 Radioactive waste flows

<u>During the operation of the PMF</u>

All secondary RAW generated during the operation of the PMF excluding the refractory materials and water from the scrubber will be retreated in the PTC.

Water from the scrubber will be supplied to the system for sewage radioactive waters of Kozloduy NPP and the refractory waste will be placed in drums, which after that could be super compacted.

Assessment of the generation of secondary RAW during a one-year period is specified below, including maintenance. All this secondary RAW has to be packed in polyethylene bags or in drums taking into consideration the restrictions for waste packages.

Radioactive sewage waters

According to the description provided in chapter 1, blow down water from the scrubber (400°m^3/annually) and the water from the cooling module (2100 m^3/annually) after sampling and filtering will be drained into the sewage system for radioactive waters of Kozloduy NPP, where they are treated by neutralizing and evaporation. Condensate of the evaporation process could be discharged in the

Danube River, because it complies with the emission category of the river. Activity of the sewage water is expected to be lower than the minimal detectable activity (MDA) – 1 Bq/l. On condition that the annual quantity is 400 m^3, then in the sewage waters treatment system of Kozloduy NPP 400 Bq/annually will be discharged.

As taking into consideration the treatment of the blow down water from the scrubber and water from the cooling module of the sewage water treatment system of Kozloduy NPP, the result is that the activity discharged in the Danube River is much below 400 Bq/annually, and is negligibly low.

Solid RAW

Secondary waste from the operation and maintenance of the PMF could be grouped as waste from the operation of the PMF and abrasive materials and components. From the environmental point of view it has to be noted that the types of secondary waste: dust, electrodes, bag filters and other waste (safety gloves, shoes, foil) are recycled as incoming in the PMF. Thus the quantity of the radionuclides in this waste is immobilized in the slag generated by the plasma treatment.

An important issue is related to the secondary waste, which will not be returned as re-coming into the PMF, and this waste is as follows:

Waste from the scrubber

Annual quantity of 400 m^3 with total activity 400 Bq upon conservative assumption is equal to < 10m^3 evaporation concentrate. Even with assumption for cementing of the end product this quantity is negligibly low.

Refractory materials of the PTC

The annual quantity is 4 tons. The specific activity of the most highly exposed lower elements with quantity of 2 t is with activity equal to that of the incoming waste, the lower elements with quantity of 2 t are with activity equal to 10 % of the activity of the incoming waste. Total average activity of this waste is calculated as 1.13E+9 Bq annually.

Considering the maximum specific activity of the incoming waste, the share of isotopes in the slag (85 %), the average density and volume reduction for each type of waste package, the maximum activity estimated in a 200 l drum containing 190 l of vitrified waste is 9.1E+08 Bq (see table 4.1.9-1).

Table 4.1.9-1 Activity of vitrified waste in a 190 l module

Type of waste	Average density kg/m^3	Specific activity Bq/kg	VRF	Activity/drum Bq
Untreated waste	150	5.17E+5	81	9.10E+8
Compacted waste	350		22	5.75E+8
Supper compacted waste	1500		2	2.24E+8

The vitrified waste is assumed to have density of 2.23 g/cm^3 (pyrex glass) and their composition is shown in table 4.1.9-2.

Table 4.1.9-2 Chemical composition of the vitrified waste

Element	% of the weight
B	4.01
O	53.96
Na	2.82
Al	1.16
Si	37.72
K	0.33

According to these assumptions and considering that in all treated drums there are 5 % steel (7.86 g/cm³) and 95 % slag, the assessed weight of the slag in one drum is 427 kg, and the weight of the form has to be also taken into consideration – 76 kg. This means that the total weight is about 500 kg per one finally treated drum.

Radioactive waste during the decommissioning of the PMF

Generated liquid, gaseous and solid wastes during the decommissioning of the PMF are shown in details in section 4.1.2.11.2 of this chapter, item B) Radioactive waste.

Minimizing of the waste

Minimizing of the waste is an integral part of one wider and comprehensive culture of waste management and safety aiming to reduce the radiation impacts of the generated waste on the environment. The need of minimization of the waste is a result of the one of the main principles of RAW management "Control of the generation of radioactive waste". According to this principle, RAW generation has to be minimized both in view of the activity and regarding the volume by application of suitable design measures and practices for operation and decommissioning.

They include selection and control of the materials, recycling and secondary use of the materials and implementation of suitable operation procedures. Emphasis should be put on the segregation of different types of waste and materials to reduce the volume of radioactive waste and to facilitate its management.

Strategy for minimization of the quantity of RAW in the PMF is transformed in four main principles.

- Maintenance of minimal quantity of the generated RAW;
- Minimization of the distribution of radioactivity;
- Optimization of the options for recycling and secondary use of valuable components of the existing and potential waste flows and,
- Minimization of the RAW quantity when their generation is unavoidable by application of secondary treatment in the PMF.

The execution of these main principles in practice could be achieved by administrative and organizational measures and technical approaches.

4.1.9.2 Release from control of the RAW

Release from control of the RAW is done mainly at the stage of decommissioning. In table 4.1.9.2-1 quantities and type of materials subject to release from control during the decommissioning of the PMF are specified.

Table 4.1.9.2-1 Quantity and type of the materials during the decommissioning of the PMF

Type of material	For free release[kg]	RAW [kg]
Metal materials	171097	32115
Concrete	148100	16400
Cables	3164	330
For pressing	1992	
Total	324353	48845

4.1.9.3 Expected dose rate of the staff

During the reconstruction of the air ducts of the existing common exchange ventilation system in room BK301 of AB-2, there is a probability for the construction workers to be exposed to radiation dust particles and radionuclide to penetrate the organism. RAW generated during the reconstruction of the air ducts may increase the external and internal exposure of some other NPP staff as well.

During the operation, pursuant to the ISAR of the PMF [2], collective dose rate resulting from loading and unloading of containers of Kozloduy NPP is 8.108 manSv.10^{-3}/year. Therefore, the individual dose rate of both operators in charge of these operations is 4.054 mSv/year.

Collective dose rate for the rest of the activities during the normal operation is 5.591 manSv.10^{-3}/year. This means individual dose for each of the nine workers of 0.621mSv/year.

Collective dose rate for all activities executed during the normal operation of the PMF is 13.824 manSv.10^{-3}/year.

The estimated collective dose during the maintenance activities is 4.858 manSv.10^{-3}/year. This means that the individual dose is 2.43 mSv/year. Table 4.1.9.3-1 presents the collective doses of the staff during the operation and maintenance, and summarized for operation and maintenance.

Table 4.1.9.3-1 Collective dose of the PMF staff, (manSv.10^{-3}/year)

Types of activities	During the operation	During the maintenance	Operation and maintenance
Storage activities	8.108	-	8.108
PMF activities	5.591	4.858	10.449
Radiation background in AB-2	0.126	0.301	0.427
Total	13.824	5.159	18.984

Comparing the results with the acceptability criteria the conclusion is that the dose rate of the staff during the normal operation and during the maintenance of the PMF is below the permissible norms.

4.1.9.4 Expected dose rate of the population during normal PMF operation

According to the document ISAR of the PMF [2], the impact on the population from the PMF during the operation is assessed by the controlled gaseous radioactive environmental emissions. Incoming activity could be calculated by multiplication of the specific waste activity by the capacity. For calculation of the outgoing activity the ratio of the reduction of activity in the plasma furnace and flue gases treatment process have to be taken into consideration.

According to the document ISAR the isotope distribution in the incoming RAW and in the off-gases and the slag is presented in table 4.1.9.4-1, and the biggest share in the incoming RAW is that of ^{60}Co over 50 % and ^{137}Cs – 20 %, and respectively their share in the off-gases is 30 %.

If the results from the distribution are normalized, the isotope distribution in the slag and the off-gases is also determined.

Table 4.1.9.4-1 Isotope distribution in the incoming RAW and in the off-gases and the slag

Isotope	Isotope distribution in the incoming RAW (%)	Share in the slag (%)	Share in the o (%) off-gases	Isotope distribution in the slag (%)	Isotope distribution in the off-gases (%)
^{60}Co	57.00	51.30	5.70	60.50	37.50
^{110m}Ag	6.00	5.40	0.60	6.37	3.95
^{134}Cs	6.00	4.20	1.80	4.95	11.84
^{137}Cs	20.00	14.00	6.00	16.51	39.47
^{95}Nb	1.00	0.90	0.10	1.06	0.66
^{54}Mn	6.00	5.40	0.60	6.37	3.95
^{59}Fe	1.00	0.90	0.10	1.06	0.66
^{58}Co	3.00	2.70	0.30	3.18	1.97

Isotope	Isotope distribution in the incoming RAW (%)	Share in the slag (%)	Share in the o (%) off-gases	Isotope distribution in the slag (%)	Isotope distribution in the off-gases (%)
Total		84.80	15.20	100	100
100		100			

According to this table, the biggest amount of radioactivity remains in the slag or ash, while the rest of the activity together with the fly ash in the waste gases is almost completely captured in the bag filters and HEPA filters. Additionally, and depending on the isotopes characteristics, small part of the activity is absorbed in the scrubber water.

HEPA filters have effectiveness of 99.97 %, and after the scrubber system an effectiveness of 99.995 % can be assumed, considering the activity captured in the solid products (slag and ash) and the liquid products (scrubber water).

Based on experimental measurements in testing facilities it is assumed that the share of isotopes such as Co, Ag, Nb, Mn and Fe retained in the slag is more than 90 %, while that of semi-volatile isotopes as Cs is around 70 %. The rest 30 % of the Cs is retained in the bag filters system and can be found in the gathered fly ash. The results from the ZWILAG operation prove that these values are very conservative; however, they are used in the accidents analysis.

Considering the filtrating equipment of the process, transmittance factor (LPF) 3.00E-04 can be assumed.

Considering the normal capacity of the furnace, the isotope distribution of the incoming activity (15 % remain in the waste gases) and LPF, the released radioactivity can be assessed as follows:

- Incoming radioactivity - 1.34E+11 Bq/year.
- Outgoing radioactivity – maximal 5.17E+05 Bq/kg.
- Outgoing radioactivity per year - 6.03E+06 Bq/year.

This means that during normal operation the annual radioactive emissions for typical gamma isotopes are 6.03E+06 Bq/year, when treating 65 kg/h during 4000 effective hours of operation.

PMF will be in operation 40 weeks per year; therefore, radioactive emissions for typical beta-gamma isotopes are 2.15.10+4 Bq/day.

This value matches the acceptance criteria for annual and daily PMF emissions (0.3 GBq/year and 0.8 MBq/day).

The aerial path is of major importance for the non-reactor nuclear installations. This position is also supported by the publication NUREG-1140, “A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Issuing of Licenses for Work with Other Radioactive Materials”, according to which “for all materials of greatest interest for the fuel cycle and for the issuing of licenses for use of other radioactive materials, the dose from the inhalation pathway dominates in the overall dose". Only the inhalation doses are calculated, since the doses from the other radiation sources are usually lower by orders of magnitude than the inhalation doses.

The methods and models for calculation of the dose rate for the population are presented in detail in section 4.1.3.

Dose rates are calculated for the closest population and at critical distance, where the precipitation of the particles is higher due to the dissipation by the wind. In compliance with this and taking into consideration the factors of atmosphere dissipation, the doses are calculated in the Area for preventive protection measures (APPM) of Kozloduy NPP (2 km) and at 5.5°km. In table 4.1.9.4-2 dose rates from the inhalation of the population are presented. (DCFinh = conversion ratio for the inhalation dose of certain isotope (Sv/Bq) for population members of the adults group (>17years).

Table 4.1.9.4-2 Inhalation doses of the population during the normal operation of the PMF

Isotope	A respiratory (Bq)	DCF respiratory (Sv/Bq)	D respiratory(Sv/year) critical distance (5500m)	D respiratory (Sv/year) - APPM
^{60}Co	3.44E+06	3.10E-08	8.27E-11	2.48E-11
^{110m}Ag	3.62E+05	1.20E-08	3.37E-12	1.01E-12
^{134}Cs	3.62E+05	2.0E-08	5.61E-12	1.69E-12
^{137}Cs	1.21E+06	1.1E-07	1.03E-10	3.09E-11
^{95}Nb	6.03E+04	3.9E-08	1.82E-12	5.48E-13
^{54}Mn	3.62E+05	1.5E-09	4.21E-13	1.26E-13
^{59}Fe	6.03E+04	4.900E-0	1.87E-13	5.62E-14
^{58}Co	1.81E+05	2.10E-09	2.95E-13	8.85E-14
Total	**6.03E+06**		**1.97E- 10**	**5.92E-11**

According to the acceptability criteria described in section 4.1 of the ISAR the permissible limits of releases during the normal operation of the PMF are specified by Kozloduy NPP as taking into consideration the ALARA principle and the different emission sources of waste fluids on the site. According to Article 14 of the Basic Norms for Radiation Protection (BNRP) 2012, the limit of the effective staff dose is 20 mSv for each year. As observing the specified limit under par. 1, the limits of the annual equivalent doses for the staff are:

- 20 mSv for the eye lens;
- 500 mSv for the skin (this limit is valid for the average dose received by the surface of 1°cm^2, regardless the area of the exposed surface);
- 500 mSv for the palms, armrests of the hands, for feet and ankles.

The limit of the annual effective for each member of the population is 1 mSv.

Pursuant to the BNRP, the results for the limits of the dose rate are as follows:

- 10 µSv/h for rooms with temporary staff attendance of A category with maximal duration of the radiation of 850 h/year;

- 5 μSv/h for rooms with constant staff attendance of A category with maximal duration of the radiation of 1700 h/year;
- 1 μSv/h for the territory of the radiation protection zone and for rooms with temporary staff attendance of B category with maximal duration of 2000 hours annually.
- 0.025 μSv/h for the population in all other rooms and in the country´s territory.

According to the TOR of Kozloduy NPP, the limit of the maximal radiation dose for every member of the population as a result of the PMF is 0.01 mSv/a, i.e. 0.001 μSv/h instead of 0.025 μSv/h, with the application of the best practices in order to ensure observance of this limit. Based on this normatively specified limit, considering the ALARA principle and different emissions on the site, Kozloduy NPP offers the following permissible emission limits during the normal operation of the PMF, which are considered as criteria for radiation acceptability for normal radiation of the population caused by the PMF:

Gaseous emissions: up to 10% of the annual limits, monthly and daily control levels of releases of the radioactive aerosols through ventilation stack 2, which should not exceed the following values:

- Annual limit: 0.3 GBq;
- Daily control level: 0.8 MBq.

no individual borders and control levels are determined for tritium and 14C in the gaseous releases of the PMF, because the total content of these components in the release to the atmosphere through ventilation stack 2 is controlled.

Liquid emissions: up to 10 % of the annual limits and monthly control levels for the total activity (without tritium) and limits of the liquid releases, containing tritium from Units 1 to 4, which should not exceed the values of table 4.1.9.4-3.

Table 4.1.9.4-3 Limits of the liquid releases of the PMF

Activity	Three-month limit	Three month control level	Annual limit	Annual control level
Total activity (without tritium), GBq	11	2.2	44	8/8.
Tritium, GBq	527	74	21096	109296

Comparing the results with the acceptability criteria the conclusion is that the dose rate of the population during the normal operation and during the maintenance of the PMF is negligible.

4.1.10 Cumulative effect

The PMF implementation is an important prerequisite for the decommissioning of KNPP Units 1 – 4, as stated and justified in chapter 2 of this report. Thus, the operation of the PMF and the decommissioning activities are parallel processes within a longer time period and cumulative effects are possible.

The most important cumulative impact is the release of radionuclide from PMF operation into air via the stack of the AB-2 with a total amount of 6MBq/year. This is the same order of magnitude as the expected releases from all decommissioning activities of Units 1-4, which are expected to be 20MBq/year (information from the ongoing EIA – procedure for Decommissioning of Units 1-4).

The expected releases of radionuclide from PMF operation into water are lower than 400Bq/year, and are negligible compared with the expected release from all decommissioning activities of 120MBq/year (without T).

The emission of air pollutants and the heat releases during PMF operation are impacts with no counterparts during the decommissioning activities. The thermal releases are very negligible in comparison to the releases from the operating Units 5 and 6.

Other cumulative effects with the decommissioning activities worth mentioning are the transport related emissions.

Emissions in the water

Based on the data presented in chapter 4 of this EIAR, the emissions in the water from the PMF are negligibly low, and therefore the cumulative effect with other projects is not necessary to be assessed.

Emissions in the air

During operation the PMF is a point source of non-radioactive contamination of the air, and due to that the cumulative effect with the other projects is not necessary to be assessed (the sources from the transport activities are equal to the local emissions at KNPP site).

It is very important that the cumulative effect from the radionuclide emissions in the air is assessed. The possible cumulative effects which have to be considered regarding the PMF impact are emissions of the following other projects on KNPP site:

- Operation of Units 5 + 6;
- Decommissioning of Units 1- 4;
- PMF operation;
- Dry Spent Fuel Storage Facility (DSFSF) operation;
- Size Reduction and Decontamination Workshop (SRDW);
- And National Disposal Facility for Low and Intermediate Radioactive Waste (NDF).

These sources are assessed considering that these projects are in process of realization and Wet spent nuclear fuel storage facility is empty and is not in operation.

DSNFSF and National Disposal Facility are not of sources radioactive emissions into air, according to [51], [52]. According to the EWN experience (EWN Register of environmental impacts presented in Chapter 11 Appendix 9: Environmental impacts from the operation of SRDW) SRDW emissions to the environment are very low and are considered as emissions during decommissioning activities.

During the calculation of the cumulative effect the releases into air and into water are considered from following facilities: Operation of Units 5 + 6; Decommissioning of Units 1- 4; and emissions from PMF operation.

Input data

In table 4.1.10-1 and below the input data are presented, based on which the calculations are performed.

Table 4.1.10-1 Annual emissions of radionuclide in air

Emission source	Noble gases	^{131}J	Aerosols	Reference
Unit 5	5.5E+11	3.7E+06	4.5E+06	[52]
Unit 6	3.6E+10	7.7E+03	2.7E+05	[52]
Units 1-4			20E+06	[53]
PMF			6E+06	[2]

During normal operation of Units 5&6 Kozloduy NPP, 2010, actual emissions with the unbalanced waters from EP-1 and EP-2, as per activity and nuclides distribution are:

- Nuclides (except ^{3}H): 289 MBq.
- Tritium (^{3}H): 22,7 TBq.

Average annual values over the entire period of Units 1-4 decommissioning:

- Nuclides (except ^{3}H): 120 MBq.
- Tritium (^{3}H): 50 GBq.

Modeling of distribution of gaseous and liquid emissions into the environment is presented in the report “Analysis on the dose originating from gas aerosol and liquid releases to the environment from Units 5-6, Units 1-4 decommissioning process and the emissions from the plasma melting facility (PMF) operation, incurred by the public within the 30-km monitored area surrounding Kozloduy NPP” (Appendix 10). For calculation of cumulative effect the following computer codes and models are used:

A modeling program code based on the EU approved methodology CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 –Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclide to the Environment.

- To assess the public dose due to liquid discharges - program code DARR-CM has been adapted to the hydrology of the KNPP area and uses a conservative assessment of the dose exposure of a critical group of the public.
- To assess the public dose within the monitored area due to gas-aerosol discharges - program code LEDA-CM, Normal Operation Shield has been adapted to the geographical and meteorological characteristics of the KNPP area. The methodology considers both the external and the internal impact of the radioactive releases and estimates the annual individual effective dose, the annual individual dose equivalent, and the critical group dose, as well as the collective dose for the population, per age groups.

The modeling program codes used to estimate the individual and the collective effective doses to be incurred by the population from radioactive discharges to the environment, have been verified and validated.

The results of the population dose calculation are presented in tables below.

Table 4.1.10-2 Individual effective doses from liquid and gaseous releases

Description of source	Max dose from gas-aerosol emissions, Sv/a	Max dose from liquid emissions, Sv/a	Max dose, Total, Sv/a
Operation Units 5&6 KNPP	$7.18.10^{-9} – 8.02.10^{-7}$	$3.22.10^{-7} – 6.00.10^{-7}$	*** $5.03.10^{-6}$
	$8.02.10^{-7}$	*** $4,23.10^{-6}$	
Operation Units 5&6 + Decommissioning Units 1-4	$7.33.10^{-9}$ - $8,04.10^{-7}$	$3.23.10^{-7} – 6.01.10^{-7}$	*** $5.04.10^{-6}$
	$8.04.10^{-7}$	*** $4.24.10^{-6}$	
Operation Units 5&6 + Decommissioning Units 1-4 +PMF operation	$7.36.10^{-9} – 8.05.10^{-7}$	$3.23.10^{-7} – 6.01.10^{-7}$	*** $5.05.10^{-6}$
	$8.05.10^{-7}$	*** $4.24.10^{-6}$	

****The dose estimates apply to critical groups of the population within the 40-km area around KNPP.*

Table 4.1.10-3 Collective effective dose for population in 40km area around KNPP

Description of source	Collective dose from gas-aerosol emissions, manSv/a	Collective dose from liquid emissions, manSv/a	Collective dose, Total, manSv/a
Operation Units 5&6 KNPP	$1.47.10^{-2}$	$4.43.10^{-3}$	$1.91.10^{-2}$
Operation Units 5&6 + Decommissioning Units 1-4	$1.48.10^{-2}$	$4.44.10^{-3}$	$1.92.10^{-2}$
Operation Units 5&6 + Decommissioning	$1.49.10^{-2}$	$4.44.10^{-3}$	$1.93.10^{-2}$

Description of source	Collective dose from gas-aerosol emissions, manSv/a	Collective dose from liquid emissions, manSv/a	Collective dose, Total, manSv/a
Units 1-4 +PMF operation			

The dose estimates obtained refer to the population of the Bulgarian side (72416 people, year 2007). Taking into account the population in the respective part of Romania – another 75 150 people, the collective effective dose for the entire area can be approximately doubled. These are data fully comparable with the practice adopted for RWRs worldwide.

The dose distribution map for the population within the 40-km area and as a function of the distance to the emission source are presented on fig. 4.1.10-1 and fig. 4.1.10-2.

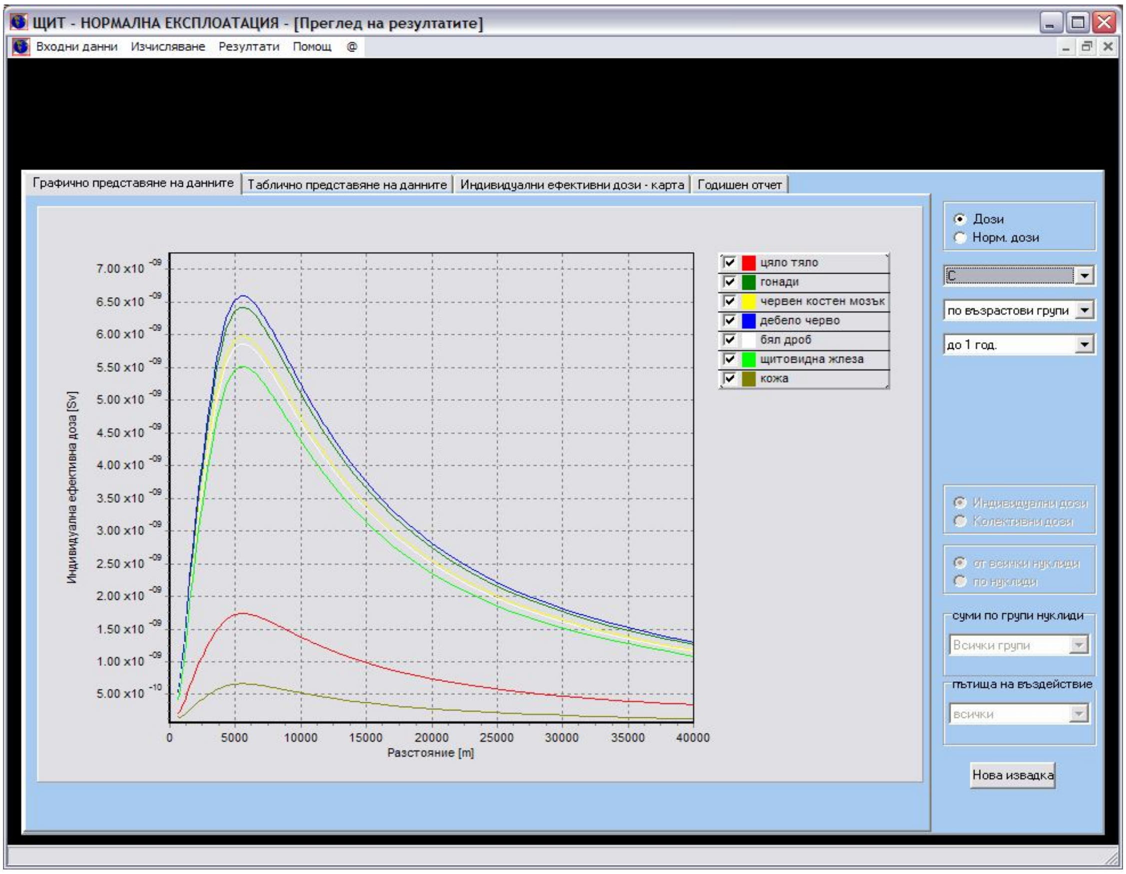
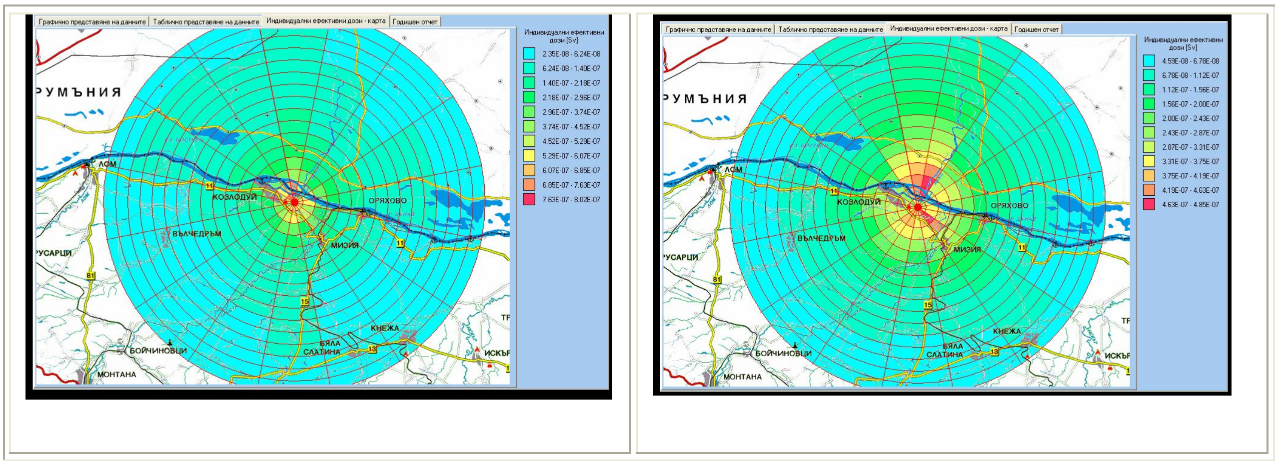


Fig. 4.1.10-1 Individual effective dose as function of the distance to the source

The maximum values of the individual effective dose were calculated within the 5-6 km Kozloduy NPP area.



a) with meteorological data for 2011 b) with micro climate data for 2001–2011.

Fig. 4.1.10-2 Distribution of the individual effective dose from external exposure to RNGs LLAs, ^{131}I + (^{3}H, ^{14}C) within the area of Kozloduy NPP, 2011.

Conclusions

Based on the performed analysis for population dose during normal operation Units 5&6 Kozloduy NPP, Decommissioning Units 1-4 KNPP and normal operation of the Plasma Melting Facility (Project 5b) the following conclusions can be made:

- The maximum annual effective dose per individual of the critical group of the population living within the 40-km area around KNPP, resulting from the liquid and gas-aerosol releases to the environment, was conservatively calculated at 5.05 µSv/a, which is a much lower value than the quota of 250 µSv/a for exposure from radioactive emissions from NPP (Ordinance on the Ensuring of Safety of NPPs) and the norms determined for the population of 1mSv/a (ONRZ-2012, Basic Norms for Radiation Protection).
- The additional dose that might be incurred is about 500 times lower than natural radiation background (2.33 mSv).
- The calculation of the cumulative effect added to the effect of KNPP normal operation, and due to emissions from the operation of Units 5-6, the decommissioning of KNPP Units 1-4, and the normal operation of the plasma melting facility (PMF), Project 5b) results in a negligible increase of the maximum individual and collective effective doses by 0.5 to 1 %.
- The maximum annual effective dose of the population within the 40-km area around KNPP, and due to aerosol emissions only, 6 MBq under normal operation of the plasma melting facility (PMF), was estimated at $5.47.10^{-10}$Sv/a, which is barely 0.01 % from the total exposure resulting from all activities on the KNPP site.
- The maximal individual effective dose for the population in the 60-km area from the KNPP releases in 2010 compared to the state in 2010 including all projects at KNPP site is practically the same. This means that the cumulative

effect is insignificant.

- The results from the modeling analyses and the EWN experience [57] show that the exposure of the population is very low and is comparable to the natural radiation background; therefore, the impact from PMF operation is insignificant.
- The comparisons of the collective effective dose values for the population around KNPP with the respective data for many other nuclear power plants with PWRs (WWERs) reactor type proved comparable with the practice worldwide.

4.2 Use of natural resources

During the operation of the PMF the only natural resource, which will be used is the water.

Plasma Melting Facility PMF is foreseen for use of water for industrial and residential water supply and the sources are the ones available by the moment according to the granted water use permits as follows:

- Permit № 0562/14.03.2005 for water use from the river of Danube for cooling, production of chemical demineralized water and electricity generation by HPP of HC-1
- Permit No. 11530127/30.05.2008 for production of underground waters through ШПС-1 for emergency service water supply of units 5 and 6 KNPP;
- Permit No. 11530128/30.05.2008 for production underground waters through shaft well „Raney-5" for industrial and fire protection purposes;
- Permit No. 11590203/30.05.2008 for production of underground waters through shaft well „Valiata" for hygiene-residential purposes of units 1 to 4 KNPP.

Quantity of the taken surface waters from the river of Danube for 2010 is about 51.2 % and about 52 % for 2009, compared with the permitted quantity, and of the ground waters – only 9°% in 2010 and 2 % in 2009.

Quantities assumed to be used in the PMF according to the construction design are:

- **Service water** for the scrubber and for the gas cooler of the facility. Expected nominal consumption is 2500 m^3 per year;
- **Cooling water** for cooling of the equipment (plasma torch, furnace).

Cooling water of the PMF operates on "closed circuits", and the heat energy is discharged by heat exchangers to the existing system of "open circuits" for cooling of Kozloduy NPP. Due to this the water consumption is limited up to the amount of the possible leakages of the "closed systems" and is expected to be within 2 m^3 per year.

Water quantities foreseen for use are within the limits of the permitted ones pursuant to permits for water use.

Water consumption from the ground waters is insignificant in view of the total quantity used by Kozloduy NPP. It is comparatively constant and is determined by the decrease of the ground water level and the desire to keep it constant.

For potable residential needs mainly water from the town water supply network of Kozloduy will be used as well as from own water sources. Recently, the water quantity spent for potable residential needs is considerably reduced, but the specific water consumption for potable residential needs is considerably high. Reasons for the big specific water consumption could be both its use for production services and failures of water supply valves and devices or damaged water metering devices.

Conclusion could be drawn that the water quantities used for residential potable water supply and for production needs are within the permitted quantities.

4.3 Harmful substances emissions during the implementation/installation, normal operation or in case of emergencies, generation of waste (examined by separate components and environmental factors). Radiological status upon commissioning

4.3.1 Generation of solid waste

<u>During the commissioning and installation of the PMF</u>

During the construction works some waste are generated by the cleaning and reconstruction of the site for construction and installation of the PMF. This is solid waste of inert construction materials (bricks, concrete parts, wooden parts, reinforcement bars), metal scrap waste, packaging waste and residential waste. In table 4.1.1.14-1 there is a classification and the quantities of the waste generated during the construction.

If after the measurement of the radioactivity of the waste, it turns out they are conventional, the available infrastructure will be used for their transportation. Disposal of the waste from construction will be made on the KNPP Repository for conventional municipal and industrial waste (RCMIW).

Service of the construction equipment will be made by external companies beyond the site, so no separation of hazardous waste is expected.

Construction and residential waste will be managed in compliance with the company Waste Management Program. During the construction of the PMF the good practice in this regard has to continue.

Commissioning of the Plasma Melting Facility is related only to the installation works in the existing building on the territory of KNPP, which are not a source of the radiation contamination.

If during the control measurement of radioactivity of the waste generated during the construction stage, it turns out that they are radioactive, they will be managed not as conventional waste, but as radioactive waste under the existing procedures for their management.

RAW as generated by the activity of Kozloduy NPP will be stored in such manner as before the implementation of the IP. No radiation impact is expected within 30-km area on the neighboring territory of Romania.

<u>During the normal operation</u>

Investment proposal aims to construct and operate facility for treatment and conditioning of radioactive waste, resulting in its high volume reduction factor. This is an extremely important step, because in this way the volume of waste for temporary treatment and disposal is minimized.

Transportation of RAW on the territory of Kozloduy NPP is typical for the company activity and is regulated in the existing license for operation of Kozloduy NPP in compliance with the Ordinance for conditions and order for transportation of radioactive materials, Article 2, paragraph (2) – 2.

On the territory of the industrial site in the south-eastern bay of room BK301 an area for temporary storage of incoming RAW, secondary waste and final drums with vitrified waste is planned. The following zones will be detached:

- Storage of approximately 6000 kg incoming RAW - quantity needed for one-week operation of the PMF;
- Storage of 6 drums with treated waste, which is the production expected for one week of operation. Considering the maximum weight of each waste package type, the temporary storage can store 100 bags (20 kg/bag), 20 drums (100 kg/drum) or 8 pellets (250 kg/pellet).

Quantitative assessment of the direct impact of the Operation of the PMF based on the information provided by the investor is:

- Capacity: 250 t annually or 6.25 t weekly during 40-week operation annually Average of 65 kg/h solid waste with 18 MJ/kg caloric value or 55kg to 60 kg/h solid waste and 5 to 10 kg/h liquid waste.
- Specific waste activity: Maximal 5.17E+5 Bq/kg
- Quantity, type and content of RAW are described in item 4.1.2.12. B) RAW.

<u>In case of accidents</u>

It is recommended to follow the Emergency Plan. After handling of the accident the substances and materials, which are not suitable and are converted into waste have to be inspected. If they are not radioactive they are treated as conventional waste as described in item 4.1.2.12 about the conventional waste. If the waste is radioactive, it is treated according to the approved Instructions for Work with Radioactive Waste depending on the type, quantity and scope of the accident.

As preventive activity staff training for the actions in emergency situations is recommended.

4.3.2 Generation of sewage waters

<u>During the normal operation</u>

Quantities assumed to be used in the PMF according to the construction design are:

- **Service water** for the scrubber and for the gas cooler of the facility. Expected nominal consumption is 2500 m^3 per year;

- **Cooling water** for cooling of the equipment (plasma torch, furnace).

Cooling water of the PMF operates in “closed circuits”, and the heat energy is discharged by heat exchangers to the existing system of "open circuits” for cooling of Kozloduy NPP. Due to this the water consumption is limited up to the amount of the possible leakages of the “closed systems” and is expected to be within 2 m^3 per year. Low water consumption is a result of its treatment with corrosion prevention products for reduction of the corrosion of the pipes, thus achieving longer period for water change. In addition, different tanks are used according to the radioactivity levels. The use of these tanks allows controlling the flow rate according to the requirements.

Above sources due to "closed type" of the systems will not be radioactively contaminated waters, but only with slight chemical pollution. If the water quality is properly maintained, it could be used for several years.

On the basis of the planned PMF technology, the generated wastewater – service water from scrubber and cooling water for the facility - will amount to about 2510 m^3 per year.

Radioactive sewage waters

According to the description provided in chapter 1, blow down water from the scrubber (400°m^3/year) and the water from cooling module (2100 m^3/year) after sampling and filtering will be drained into the sewage system for radioactive waters of Kozloduy NPP, where they are treated by neutralizing and evaporation. Condensate of the evaporation process could be discharged in the Danube River, which complies with the emission category of the river.

Activity of the sewage water is expected to be lower than the minimal detectable activity (MDA) – 1 Bq/l. In case that the annual quantity is 400 m^3, then in the sewage waters treatment system of Kozloduy NPP 400 Bq/year will be discharged.

As taking into consideration the treatment of the blow down water from the scrubber and water from the cooling module of the sewage water treatment system of Kozloduy NPP, the result is that the activity discharged in the Danube River is much below 400 Bq/annually.

<u>In case of accidents</u>

Probability of pollution of the waters from accidents is negligible due to indoor execution of the activities.

In case the emergency covers territory beyond PMF the supposed impacts will be negative, local, and temporary - until the accident is under control. Theoretically, some cumulative effects are possible, if the accident coincides with other sources of radioactive pollution.

4.3.3 Generation of flue gases

<u>During the normal operation</u>

Generation of harmful emissions will occur in two chambers - for plasma melting and for secondary melting. After the STC the flue gases enter the flue gas treatment system.

Flue gases are preliminary cooled to approximately 190°C in a radiant heating boiler. Hot water circulates in a close (intermediate) circuit and the waste heat is discharged to the service water of Kozloduy NPP by intermediate heat exchangers.

Further the flue gases enter the bag house, which consists of two compartments with 50 filter elements in each of them. Particulate matters (aerosols) are captured by surface filtration of membrane filter elements made of polytetrafluorethylene (PTFE). Elements could sustain work temperature of 250°C. Absorbing media of the filter is cleaned by pulse jets of compacted air activated by signaling device for differential pressure.

The collected particles are removed from the surface of the bags. The hopper at the bottom of the bag house receives the released particulate matter and emptying is accomplished through a rotary discharge valve and a vibrating tube. After having passed the fabric filter, the gases enter the module of HEPA filters, consisting of two parallel compartments. One compartment serves as stand-by. The wet gas scrubbing assembly consists of a quench tower for the cooling down of gases to about 50°C, a counter current scrubbing tower with caustic liquid for removal of HCI and SO_2, and a demister. Two extraction fans in parallel ensure the evacuation of flue gases into the atmosphere. The negative pressure of the whole system is controlled by frequency controlled motors.

After heating up of the flue gases, by recuperating heat from the boiler intermediate circuit and by the additional electrical heater, NOx concentration is reduced catalytically in the DeNOx-system. Before discharge of the flue gases to the stack they are verified by the emission control system aiming to control the chemical parameters such as concentration of NH_3, CO, SO_2, NOx, HCl, O_2, H_2O, as well as TOC (total organic carbon). Results are available on real-time basis. Values will be presented every half hour as well as daily values, corrected for 273 K, pressure101.3 kPa, 11 % oxygen and dry gas in order to allow comparisons with the emission limits.

Also, sampling system for measurement of the radioactive discharges is provided.

In the IP it is declared that HEPA filters have an efficiency of 99.97 %, and after the scrubber system an effectiveness of 99.995 % can be assumed, taking into account the activity captured in the solid products (slag and ash) and in the liquid products (scrubber water).

According to the design of the PMF, retention of radioactivity in the PMF is achieved by equipment boundaries and confinement areas as well as under-pressure in the system towards the building. Furthermore, confinement areas where maintenance activities are carried out are periodically cleaned-up, preventing the accumulation of contamination during the entire operation stage.

Besides, in order to avoid accumulation of too much radioactive contamination and in order to facilitate the maintenance the following is foreseen:

- Periodical cleaning and decontamination of the necessary components in the PMF by special adapted vacuum cleaner in order to minimize the distribution of the contamination. It will be used to clean the refractory concrete of the PTC during maintenance, the insides of the STC, the boiler, the bag house, the HEPA-filters, confinement of ash collection chamber, etc. and also the surroundings during and after maintenance activities.
- Before a planned shutdown of the PMF, the last waste batch fed to the system can be very low contaminated or even not contaminated waste. By this procedure the residual radioactivity into the different components is reduced and is in fact flushed out.

These activities will minimize the residual contamination in the internals of the equipment, thus reducing the risk of spread of contamination and the staff doses.

Radionuclide will be generated mainly in the treatment and transfer process and will be released through the flue gas purification system. It is expected the output activity from the PMF to be: 6.03E+6 Bq/year equal to 1.25 Bq/Nm^3.

Flue gases will be emitted through 150 m stack together with the gases of Units 3 and 4 of KNPP and gases from the ventilation system of AB-2. Share of the flue gases from the PMF in the total emission from the stack is 0.17 %.

Although the flue gases from the PMF are a negligible percentage of the total flue gases released through the ventilation stack, Emission Control System (ECS) is planned to be installed. Emission control system is installed at the end of the system before connection to the ventilation system of the facility. The content of the following substances will be measured. CO, SO_2, NOx, HCl, O_2, H_2O, NH_3 and TOC (total organic carbon). Also, temperature, pressure and flow rate will be determined. System is designed for building into a separate cabinet, and sampling lines are foreseen.

Results are available for real-time display. Values will be presented every half hour as well as daily values, corrected to 273ºK, pressure101.3 kPa, 11 % oxygen and dry gas in order to allow comparisons with the emission limits.

Also, radiation control will be executed and total dust will be determined. Gases passing through the flue gas system and suction ventilation of the PMF are controlled before the connection with the stack/duct in order to measure their activity.

Dust quantities in the flue gases are also controlled by the dust monitor containing four instrument devices combined in one. It has only one measurement point (one single outlet in the duct) and measures simultaneously the temperature, flow and pressure in addition to the dust concentration.

In compliance with the experience in similar facilities such as CILVA, the total dust is normally below the detection limit (<1mg/Nm^3).

In case of accidents

Design has to foresee automatic closure of the PMF in order to prevent outgoing radioactivity with the flue gases.

4.3.4 Harmful physical, non-radiation emissions

4.3.4.1 Noise

It is expected that the main noise source will be the shredder. It is planned to measure the noise level during the operation.

Normative permissible noise levels will be observed. It is possible to apply some additional measures for noise insulation as well as individual noise protection devices.

Considerable additional impacts by noise load on the site of Kozloduy NPP are not expected as taking into consideration that the PMF is installed in a separate building (AB-2).

4.3.4.2 Magnetic fields

No magnetic fields are expected during the operation of the PMF.

Density of the magnetic flow from the Primary Treatment Chamber (PTC) (electrical supply of the plasma torch) is calculated at 8 µT, much below the permissible levels of the respective standards.

This complies with the declaration of the Investor that the European Directive for Electromagnetic Compatibility will be observed.

4.3.4.3 Vibrations

Expected vibrations are typical for the site, negligible in view of the staff on the site of Kozloduy NPP.

4.3.4.4 Heat discharges

They are described in details in section 4.3.5 of this chapter.

4.3.4.5 Transportation activities

The annual quantity of the total emissions from the transportation activities is estimated at 75°kg NO annually and 2.5 kg PM10 annually.

4.3.5 Heat emissions

4.3.5.1 During operation

Heat absorption is approximately equal to the heat discharge into the air and through the cooling system in the waters of the Danube River.

Heat releases from the cooling system could be roughly calculated based on the need for cooling at 785 kW. Based on the efficient operation of 4000 h/annually, the heat releases though the cooling system are equal to approximately 3000 MWh/annually, and it is transferred by the cooling water with flow rate 458400 m^3/annually.

Difference between the heat releases through the cooling system and heat absorption results in the heat release with flue gases and the ventilation system through ventilation stack 2.

Energy consumption per year is as follows:

- Input of plasma torch (PTC) – 3500 MWh (according to the data about 4000 hours annual operation)

- Consumption of diesel fuel – 474 MWh (This quantity is calculated based on the expected consumption of 48000 l/annually and caloric value of 9.87 kWh/l).

- Caloric value of incoming waste – 625 MWh. (This value is very approximate, because there is no information about the inflammable waste content in the mass received in the PMF, which allows different variants for the content of the incoming mass. Calculation is based on annual quantity of incoming waste (250 t) and caloric value of the domestic waste 2.5 kWh/kg. Therefore, this assessment is very rough and could be determined as maximal value.

Difference between the consumed energy of about 4600 MWh and heat emissions via cooling system of 3000 MWh is 1600 MWh/year through ventilation stack 2.

4.3.5.2 During decommissioning

Considerable heat emissions are not expected.

4.3.6 Hazardous chemical substances and mixtures

During the operation of the PMF some hazardous chemical substances and mixtures will be used, and this is regulated pursuant to the Law for protection against the impact of the chemical substances and mixtures. In table 4.3.6-1 the hazardous substances and mixtures are listed, which may be a matter of risk for the health of the workers during the operation of the PMF as well as their use and quantities.

Table 4.3.6-1 Characteristics of the main substances used as raw materials as well as the unfavorable effects which could be caused by them during the operation stage

Chemical substance or preparation CAS N	**Sign for danger**	**Impact on people**	**Impact on the environment**	**Use**	**Quantity**
Diesel fuel 94114-59-7	Xn Harmful	Danger of cumulative effects. Allergen Damage of the nervous system, skin, blood organs, liver, kidneys. Mutagen.	In case of emergency overflows and leakages there is possibility to pollute the soil, ground and surface waters. Contains pollutants: sulphur and heavy metals. Highly inflammable liquids. Dangerous for the environment - especially for the aquatic organisms.	For maintaining the hot stand-by and for the secondary burning in the Secondary Treatment Chamber.	Max 48000 liters per year
Calcium hydrooxide $Ca(OH)_2$ 1305-62-0	Xi Irritating	Causes irritation of the skin and respiratory tracts. Causes serious	Harmful effect in case of change of pH. In emergency situations the penetration of sewage waters or soils should be	For filter coating in order to achieve better removal of the dust from the PTFE coated filters	Between 1.2 and 14 tons

Chemical substance or preparation CAS N	Sign for danger	Impact on people	Impact on the environment	Use	Quantity
		eyes damage.	avoided.		
Sodium bicarbonate $NaHCO_3$ 144-55-8	Non-hazardous substance	Low irritating effect	To avoid release in the environment	For filter coating in order to achieve better removal of the dust from the PTFE coated filters	Between 1.2 and 14 tons
Ammonia NH_3 1336-21-6	C Corrosive effect N Dangerous for the environment	Substance with extremely strong smell. Causes burnings.	Highly toxic for water organisms. Harmful due to the change of pH. Generates toxic mixtures with water even after dilution.	For DeNOx system (reduction of N-oxides).	Nominal consumption 28000 kg (25 % solution) annually
Sodium hydroxide NaOH 1310-73-2	C Corrosive effect	Causes severe skin burnings and eyes injury. Necrosis.	In emergency situations the penetration of sewage waters or soils should be avoided.	For neutralizing of SO_2, HCl, HF and other acid gases from the thermal treatment processes.	Consumption of NaOH (30 % solution) is 34 kg/h or 14 t/y
Lubricating oils 74889-22-0	Xn Harmful	Allergens. Injure the nervous system, skin, blood organs, liver, and kidneys. Mutagen.	In case of emergency overflows and leakages there is possibility to pollute the soil, ground and surface waters.	For maintenance of machines and equipment	2 m^3

During the operation stage the Investor has to require by the Supplier information safety sheet for each of the hazardous substances used during the operation. Based on the information of these sheets Safety operation instructions have to be elaborated, which need to be placed at "key" points where the hazardous substances and mixtures are used. Initial, periodical and daily instructions of the workers should also include operation with hazardous substances and minimization of the consequences in emergency situations and incidents.

Copies of the Information safety sheets will be stored in Kozloduy NPP Data Base.

Table 4.3.6-2 Characteristics of the main substances used as raw materials as well as the unfavorable effects which could be caused by them during the decommissioning stage

Chemical substance or preparation CAS N	**Sign for danger**	**Impact on people**	**Impact on the environment**	**Use**	**Quantity**
Ammonia NH_3 1336-21-6	C Corrosive effect N Dangerous for the environment	Substance with extremely strong smell. Causes Burnings.	Highly toxic for water organisms. Harmful due to the change of pH. Generates toxic mixtures with water even after dilution.	For re- use	200 l
Lubricating oils 74889-22-0	Xn Harmful	Allergens. Injure the nervous system, skin, blood organs, liver, and kidneys. Mutagen.	In case of emergency overflows and leakages there is possibility to pollute the soil, ground and surface waters.	For re-use	1 m^3
Sodium hydroxide NaOH 1310-73-2	C Corrosive effect	Causes severe skin burnings and eyes injury. Necrosis.	In emergency situations the penetration of sewage waters or soils should avoided.	For re- use	1 m^3
Lead Pb 7439-92-1	Non-hazardous substance or mixture according to Regulation (EO) No. 1272/2008	Heating may cause release of poison gases. Dust generation to be avoided. Avoid contact with the skin and eyes. Do not inhale the vapors/dust. Accumulating in the organism	Ecological damages are not known and such are not expected during the normal use. In principle it is not biologically decomposable.	For re-use	7 t

4.4 Radiation doses for the staff and population

4.4.1 Expected dose rate of the staff during the operation of the PMF

In the IP it is declared that HEPA filters have an efficiency of 99.97 %, and after the scrubber system an effectiveness of 99.995 % can be assumed, taking into account the activity captured in the solid products (slag and ash) and in the liquid products (scrubber water).

Radiation exposure of the operation staff and the maintenance staff could occur during servicing of the storage activities, during operation and maintenance of the PMF, maintenance activities, by the radiation background. Taking into account the use of the best protection techniques and consequent use of the ALARA principle, the dose rate due to inhalation and absorption is very low. The total collective Effective Dose Rate of the operational staff and the maintenance staff based on the radiation background in AB-2 is forecasted at 18.984 mSv/year. This radiation background is a result of:

- Operation of storage facilities – 8.108 mSv/annually;
- Operation and maintenance of the PMF - 10.449 mSv/annually
- Radiation background of AB-2 – 0.427 mSv/annually.

Individual dose rate of the staff varies as follows:

- Two operators involved in storage facilities – 4.1 mSv/annually.
- Nine operators from the PMF operation - 0.6 mSv/annually.
- Two operators from the maintenance of the PMF - 2.4 mSv/annually.

Forecast data about the radiation dose rate of the staff are lower than the permissible levels; the effective dose limit for the personnel is 20 mSv for each year. These forecast data provide **avoidance of stochastic and non-stochastic effects** as a result of radiation damage.

Stochastic effects depend linearly on the absorbed dose rate. In that case the dependence dose/effect is considered as statistically probable occurrence of damage and increasing of their frequency among certain group, but is not related to the increase of the severity of the diseases.

For non-stochastic effects, in case of exceeding of certain dose rate all exposed persons will be injured, and the increase of the dose rate raises the severity of the injury. Non-stochastic effects are the acute and chronic radiation sickness, radiation skin burnings, injuries of the embryo, etc.

Acceptability criteria

According to the acceptability criteria described on the national normative documents the permissible limits of releases during the normal operation of the PMF are specified by Kozloduy NPP as taking into consideration the ALARA principle and the different emission sources of waste fluids on site. Pursuant to the Basic Norms for Radiation Protection – 2012 (Article 14 and Article 15), acceptability criteria are as follows:

- Effective dose rate of the staff is 20 mSv for each separate year.

When the limits pursuant to par. 1 are observed, the annual equivalent doses for the staff are:

- 20 mSv for the eye lens;
- 500 mSv for the skin (this limit is valid for the average dose received by the surface of 1 cm^2, regardless the area of the exposed surface);
- 500 mSv for the palms, armrests of the hands, for feet and ankles.

The limit of the annual effective for each member of the population is 1 mSv.

Pursuant to the BNRP, the results for the limits of the dose rate are as follows:

- 10 μSv/h for rooms with temporary staff attendance of A category with maximal duration of the radiation of 850 h/year;
- 5 μSv/h for rooms with constant staff attendance of A category with maximal duration of the radiation of 1700 h/year;
- 1 μSv/h for the territory of the radiation protection zone and for rooms with temporary staff attendance of B category with maximal duration of 2000 hours annually.
- 0.025 μSv/h for the population in all other rooms and in the country´s territory.

According to the TOR of Kozloduy NPP, the limit of the maximal radiation dose for every member of the population as a result of the PMF is 0.01 mSv/a, i.e. 0.001 μSv/h instead of 0.025 μSv/h, with the application of the best practices in order to ensure observance of this limit.

Radiation dose of the staff during the operation of the PMF

During the operation, pursuant to the ISAR of the PMF, collective dose rate resulting from loading and unloading of containers of Kozloduy NPP is 8.108 manSv.10^{-3}/year. Therefore, the individual dose rate of both operators in charge of these operations is 4.054mSv/year. Collective dose rate for the rest of the activities during the normal operation is 5.591 manSv.10^{-3}/year. This means individual dose for each of the nine workers of 0.621 mSv/year.

Collective dose rate for all activities executed during the normal operation of the PMF is 13.824 manSv.10^{-3}/year.The estimated collective dose during the maintenance activities is 4.858 manSv.10^{-3}/year. This means that the individual dose is 2.43 mSv/year. Table 4.4.1-1 presents the collective doses of the staff during the operation and maintenance, and summarized for operation and maintenance.

Table 4.4.1-1 Collective dose for the staff of PMF, (manSv.10^{-3}/a)

Types of activities	During the operation	During the maintenance	Operation and maintenance
Storage activities	8.108	-	8.108
PMF activities	5.591	4.858	10.449
Radiation background in	0.126	0.301	0.427

Types of activities	**During the operation**	**During the maintenance**	**Operation and maintenance**
AB-2			
Total	13.824	5.159	18/984

Comparing the results with the acceptability criteria the conclusion is that the dose rate of the staff exposure during the normal operation and during the maintenance of the PMF is below the permissible norms.

4.4.2 Expected dose rate of the population during the operation of the PMF

According to the document ISAR of the PMF [2], the impact on the population from the PMF during the operation is assessed by the controlled gaseous radioactive environmental emissions. Incoming activity could be calculated by multiplication of the specific waste activity by the capacity. For calculation of the outgoing activity the ratio of the reduction of activity in the plasma furnace and flue gases treatment process have to be taken into consideration.

The biggest amount of radioactivity remains in the slag or ash, while the rest of the activity together with the fly ash in the waste gases is almost completely captured in the bag filters and HEPA filters. Additionally, and depending on the isotopes characteristics, small part of the activity is absorbed in the scrubber water.

HEPA filters have effectiveness of 99.97 %, and after the scrubber system an effectiveness of 99.995 % can be assumed, considering the activity captured in the solid products (slag and ash) and the liquid products (scrubber water).

Considering the filtrating equipment of the process, transmittance factor (LPF) 3.00E-04 can be assumed.

Considering the normal capacity of the furnace, the isotope distribution of the incoming activity (15 % remain in the waste gases) and LPF, the released radioactivity can be assessed as follows:

- Incoming radioactivity - 1.34E+11 Bq/year.
- Outgoing radioactivity – maximal 5.17E+05 Bq/kg.

This means that during normal operation the annual radioactive emissions for typical gamma isotopes are 6.03E+06 Bq/year, when treating 65 kg/h during 4000 effective hours of operation.

PMF will be in operation 40 weeks per year; therefore, radioactive emissions for typical beta-gamma isotopes are 2.15.10+4 Bq/day.

This value matches the acceptance criteria for annual and daily PMF emissions (0.3 GBq/year and 0.8 MBq/day).

The aerial path is of major importance for the non-reactor nuclear installations. This position is also supported by the publication NUREG-1140, “A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Issuing of Licenses for Work with Other Radioactive Materials”, according to which “for all materials of greatest interest for the fuel cycle and for the issuing of licenses for use of other radioactive materials, the dose from the inhalation pathway dominates in the overall dose". Only the inhalation doses are calculated, since the doses from the other radiation sources are usually lower by orders of magnitude than the inhalation doses.

Dose rates are calculated for the closest population and at critical distance, where the precipitation of the particles is higher due to the dissipation by the wind. In compliance with this and taking into consideration the factors of atmosphere dissipation, the doses are calculated in the Area for preventive protection measures (APPM) of Kozloduy NPP (2 km) and at 5.5°km. In table 4.4.2-1 dose rates from the inhalation of the population are presented. (DCFinh = conversion ratio for the inhalation dose of certain isotope (Sv/Bq) for population members of the adults group (>17years).

- Table 4.4.2-1 Inhalation doses of the population during the normal operation of the PMF

Isotope	**A respiratory (Bq)**	**DCF respiratory (Sv/Bq)**	**D respiratory(Sv/year) critical distance (5500 m)**	**D respiratory (Sv/year) - APPM**
^{60}Co	3.44E+06	3.10E-08	8.27E-11	2.48E-11
^{110m}Ag	3.62E+05	1.20E-08	3.37E-12	1.01E-12
^{134}Cs	3.62E+05	2.0E-08	5.61E-12	1.69E-12
^{137}Cs	1.21E+06	1.1E-07	1.03E-10	3.09E-11
^{95}Nb	6.03E+04	3.9E-08	1.82E-12	5.48E-13
^{54}Mn	3.62E+05	1.5E-09	4.21E-13	1.26E-13
^{59}Fe	6.03E+04	4.900E-0	1.87E-13	5.62E-14
^{58}Co	1.81E+05	2.10E-09	2.95E-13	8.85E-14
Total	**6.03E+06**		**1.97E-10**	**5.92E-11**

4.4.3 Expected dose rate in case of accidents in the PMF

The following events are analyzed in details, because probability of their occurrence is high and there are consequences for the staff and population:

- Fire in temporary storage facility;
- Dropping of a waste packaging;
- Fire in the flue gas system;
- Explosion in the shredder;
- Fire in the PMF.

Results from the analysis of the other events including natural disasters, floods, earthquake, and extreme meteorological conditions show that the probability of their occurrence is very low and also the impact on the staff, population and environment are negligible.

Results from the analysis of the above events show that the determining event from the point of view of the impact on the people and environmental factors is fire in the

PMF building. Other events do not have such considerable impact on the people and environmental factors.

Summary of these results is shown in table 4.4.3-1.

Table 4.4.3-1 Results of the analysis of the determining events in the PMF

Events	**Respiratory dose (manSv.10^{-3}/year)**		
	Staff	**Population at the SB**	**Population within the APPM**
Fire in temporary storage facility	3.2E-03	7.62E-02	1.05E-04
Dropping of packaging with waste	1.15E-05	3.31E-04	4.58E-07
Fire in the flue gas system	2.39E-05	9.10E-04	1.26E-06
Explosion in the shredder	3.24E-03	9.30E-02	1.29E-04
Fire in the PMF	1.07E-02	2.55E-01	3.52E-04

Based on the results in the table a conclusion could be drawn that the radiation dose rates of the staff and population received as a result of the analyzed accidents are much below the acceptability radiation criteria stipulated in the Regulation of the Basic Norms for Radiation Protection and the Regulation for RAW management in case of emergencies.

It is mandatory to supplement the Emergency Action Plan with measures for their avoidance as a result of the operation of the PMF, and after that it has to be agreed with the respective authorities.

4.4.4 Dose rate during the decommissioning of the PMF

Assessment of the CED for the entire decommissioning period is made based on the following assumptions made as a result of:

- Dose rate is similar to the one during the outage (maintenance) of the PMF;
- For the assessment purposes the highest calculated value in case of non-operating facility is taken into account: 0.16 µSv/h;
- Total quantity of materials: 373 t;
- Loading in case of dismantling works of the auxiliary building in man-hours per ton: 170 man-hours/t;
- Loading during the activities for waste management from the dismantling in man-hours per ton: 116 man hours/t.

Based on these data the expected occupational dose rate during PMF decommissioning is 17°mSv for the entire decommissioning process. This value is very approximate and determines the magnitude of this value.

Dose rate for the population is not expected during the execution of the decommissioning of the PMF.