ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE DECOMMISSIONING OF UNITS 1 TO 4 AT KOZLODUY NPP

NON-TECHNICAL SUMMARY

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LIST OF ABBREVIATIONS

AB	Auxiliary Building
ALARA	As Low As Reasonably Achievable
a.d.w	Air-dry weight
BAS	Bulgarian Academy of Sciences
BNRA	Bulgarian Nuclear Regulatory Agency
BNRP	Basic Norms of Radiation Protection
CA	Controlled Area
CED	Collective Effective Dose
CPS	Circulation Pump Station
DGS	Diesel Generator Station
DSS	Decay Storage Sites for Transitional RAW (Sites for Safe Temporary Storage of I Category I RAW and tRAM from Decommissioning)
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment-Report
EP-1	Electricity Production 1
EPA	Environmental Protection Act
EU	European Union
EWN	Energiewerke Nord
IAEA	International Atomic Energy Agency
IP	Investment Proposal
KGR	Greifswald NPP
KIDSF	Kozloduy International Decommissioning Support Fund
KNPP	Kozloduy Nuclear Power Plant
KPMU	Kozloduy Project Management Unit
LLA	Long Lived Aerosols
MA	Monitored Area (Surveillance Zone)
MIV	Main Isolation Valve
MEW	Ministry of Environment and Water
NPP	Nuclear Power Plant
NDF	National Disposal Facility for shortlived low and intermediate radioactive waste
NSI	National Statistical Institute

PA	Protected Area as per Biodiversity Act
PAZ	Precautionary Action Zone
RAM	Radioactive Materials
RAW	Radioactive Waste
RB	Reactor Building
RCMIW	Repository for Conventional Municipal and Industrial Waste
RNG	Radioactive Noble Gases
SZ	Surveillance Zone
SB	Sanitary Building
SE	Safe Enclosure
SE"RAW"	State Enterprise RAW
SFP	Spent Fuel Pool
SFSF	Spend Fuel Storage Facility
SG	State Gazette
SNF (SF)	Spent Nuclear Fuel
SRDW	Size Reduction and Decontamination Workshop
SWD	Site for Conventional Waste from Decommissioning (Site for Temporary Storage of Non-Radioactive Waste and Materials from Decommissioning)
SWT	Special Water Treatment
TG	Turbine Generator
TH	Turbine Hall
TLD	Thermoluminiscent Dosimeter
ToR	Terms of Reference
VS	Ventilation Stack
WWER	Water-Water Energy Reactor

CONTENTS

1. INTRODUCTION

In November 1999, the Bulgarian Government and the European Commission signed a Memorandum of Understanding in which the Bulgarian Government made a commitment to shut down and decommission Units 1 to 4 of Kozloduy Nuclear Power Plant (KNPP) at the earliest possible date, beginning with the closure of Units 1 and 2 at the end of 2002. A commitment for closure of Units 3 and 4 at the end of 2006 was signed later on. In consequence all four Units were shut down at the agreed time.

Taking into account the financial consequences of early closures, as well as the need of a competitive energy sector, the European Commission has offered a multi-annual assistance package for Bulgaria's energy sector, dedicated for assistance to the nuclear energy sector for the decommissioning of Units 1 to 4 of Kozloduy NPP (KNPP), as well as for assistance to the energy efficiency field. In connection therewith the Kozloduy International Decommissioning Support Fund (KIDSF) was established in June 2000, administered by the European Bank for Reconstruction and Development.

In connection with this obligation, the Original Decommissioning Strategy (the Original Decommissioning Strategy was developed in the frame of the Technical Design for decommissioning of KNPP Unit 1 and 2 [3]) was revised to include the decommissioning of Kozloduy NPP Units 3 and 4, in order to reflect:

- The commitment by the Republic of Bulgaria for the earlier shutdown of Units 1&2 and 3&4;
- The application of international decommissioning experience;
- The legislation applicable in the Republic of Bulgaria;
- The considerations related to the socio-economic consequences of the earlier shutdown of Units 1&2 and 3&4.

Units 3 and 4 of Kozloduy Nuclear Power Plant EAD were declared as RAW Management Facility subject to decommissioning and their property is entrusted for management to SE “RAW” by Decision of the Council of Ministers (DCM) of Republic of Bulgaria (DCM 1038/19.12.2012)

Currently Units 1 and 2 have a license issued by the Bulgarian Nuclear Regulatory Agency (BNRA) as RAW Management Facilities subject to decommissioning. On 26.02.2013, the BNRA issued licenses to the State Enterprise "Radioactive Waste" for operation of Units 3 and 4 as facilities for radioactive waste management which are subject to decommissioning and terminate the licenses of "Kozloduy" NPP of the two Units from operation mode “E”. The site of Units 3 and 4 not keep nuclear fuel.

Currently the SNF from Units 1-4 has been removed from the Units and is placed at the SNF Storage Facility (SNFSF).

The license for decommissioning of Units 1 and 2 is expected to be obtained in mid-2013, and for Units 3 and 4 – at the end of 2013, as RAW Management Facilities with the goal to prepare the necessary documentations and technical equipment for decommissioning.

Taking into account all technical, economic and social aspects considered in the assessment and evaluation process, and in reference of the international experience, in the Updated Decommissioning Strategy of KNPP Units 1 to 4 [4] a choice was made for the Continuous Dismantling Alternative of Decommissioning.

This alternative includes the following stages of the decommissioning process:

- Pre-decommissioning stage [PDS];
- Decommissioning stage;
- Closure and land restoration stage.

The activities during the Pre-Decommissioning Stage (from reactor shutdown to the beginning of Stage 1) include:

- *Preparation of the documentation for issuance of a decommissioning permit* (e.g. elaboration of a Decommissioning Plan, EIA Report, update of the Safety Analysis Report, the Technical Rules and Operation Instructions).
- Pre-decommissioning activities (provision and construction of suitable infrastructure for dismantling, cutting, fragmentation, sorting, size reduction, decontamination and free release measurement; removal of flammable and hazardous materials, conventional waste, thermal insulation, operational RAW, retrieval and conditioning of spent ion-exchange resins, system isolation and draining).

The information of these preparatory projects for decommissioning (pre-decommissioning activities) is given later in this document. Supporting projects, necessary for the completion of these stages are planned and the basic ones are as follows:

- The Size Reduction and Decontamination Workshop;
- Sites for Safe Temporary Storage of Materials generated by the decommissioning activities of Units 1-4 at Kozloduy Nuclear Power Plant
- Facility for Treatment and Conditioning of RAW with High Volume Reduction Factor at Kozloduy Nuclear Power Plant.

An important project, related to the decommissioning is the planned national RAW repository named National Disposal Facility for short-lived low and medium RAW (NDF) near the KNPP site. For this project an individual EIA report approved by Ministry of the Environment and Water has been established.

According the chosen alternative, the Decommissioning stage is separated on two stages:

Stage 1: Preparation and Operation of the Safe Enclosure (SE) of the Reactor Buildings (RB) and dismantling of the equipment outside the SE area;

Stage 2: Deferred dismantling of the equipment within the SE area and release of buildings for use for other purposes.

The decommissioning activities corresponding to this alternative will be of continuous nature, e.g. will start immediately, beginning with non safety related equipment and will encompass also the equipment related to the nuclear safety in 2013.

The last stage will be Closure and land reclamation stage.

The long-term state of the industrial site where KNPP Units 1-4 are being decommissioned is defined as "brown lawn".

The Environmental Impact Assessment (EIA) Procedure and specifically the positive verdict on the Environmental Impact Assessment Report for the Decommissioning of KNPP Units 1 to 4 is an important precondition of the licensing procedure for issuance of decommissioning permit of Units 1 and 2, respectively of Units 3 and 4 following the Updated Decommissioning Strategy for KNPP Units 1 to 4 [4]. The EIA procedure was initiated by Kozloduy NPP through KPMU which is responsible for the management, coordination and monitoring of the decommissioning, financed by the Kozloduy International Decommissioning Support Fund (KIDSF).

The procedure of the Environmental Impact Assessment (EIA) for the Decommissioning of KNPP Units 1–4 is implemented according to the Bulgarian Environmental Protection Act (EPA) [5] and the Regulation on the Terms and Procedure for Implementing Environmental Impact Assessment [6] and in compliance with the provisions of the Bulgarian legislation, harmonized with the EU law (EIA Directive) and according the specific EBRD requirements.

The scoping process of the EIAR started in 2008. The information about the Investment Proposal was submitted to the attention of the public and the non-governmental organisations (NGOs) in the period 10 March – 10 April 2008. In accordance with the Environmental Protection Act and the EIA Regulation, the Proponent of the Investment Proposal (IP) had submitted a Data sheet for the IP in order to consider the Terms of Reference (ToR) on the scope, the content and the form of the EIA-Report on this IP, expecting statements, recommendations or standpoints on the necessary actions to be undertaken related to its elaboration, to the following specialized institutions: Ministry of Environment and Water (MEW); Ministry of Health (MH), Regional Inspection of Environment and Water – Vratsa, Municipal Council – Municipality of Kozloduy and for information to the following stakeholders: Ministry of Economy and Energy, Mayor of the town of Kozloduy, Bulgarian Nuclear Society.

The received statements and recommendations, made in the course of the scoping consultations, were used as a basis in the further establishment of the EIA ToR for the Investment Proposal. The Romanian government decided, after notification, for participation in the EIA process. The specific requirements of the Romanian side were considered and addressed in this EIAR, in the separate volume "Transboundary aspect of the IP".

The EIA ToR [7] submitted by the Proponent, with the associated scope and content lise at the basis of the EIA Report elaboration.

The purpose of this assessment is the analysis and evaluation of the impacts on the environment and people, resulting from the decommissioning of Kozloduy NPP Units 1 to 4, based on studying the decommissioning alternatives defined in the EIA ToR and the alternative chosen.

For some of the planned supporting projects related to the units decommissioning, e.g. "Facility for Treatment and Conditioning of Radioactive Waste with a High Volume

Reduction Factor" and "Heat Generation Plant Construction", separate EIA procedures are carried out.

Presently the Environmental Impact Assessment is in the process of implementation by a Consortium between EWN from Germany and Energy Institute from Bulgaria. EWN participates in a continuous dismantling process since 1995 at the Greifswald NPP; the Energy Institute is a company with large experience in the nuclear field with detailed local knowledge of the Kozloduy Nuclear Power Plant.

Methodology

The elaboration of the Environmental Impact Assessment of the Decommissioning of the KNPP Units 1 to 4 complies with the provisions of the Bulgarian regulations and follows the EIA Terms of Reference [7]. The methodology is described in detail in chapter 5 of the EIAR.

The main method for assessment of the environmental factors is the systematic environmental analysis and synthesis of data, facts and desk information on the problems related to the investment proposal implementation. For the data synthesis and the respective conclusions were applied up-to-date regulatory documents, (laws, ordinances, rules methods etc) of the Bulgarian legislation as well as the EC and international regulatory documents, guidance and guidelines, related to the specific features of the decommissioning of nuclear facilities, taking into account also the principles of EBRD environmental policy. In this connection the following action were undertaken: visits and field study; analysis of relevant maps and diagrams; analysis of the available design documentation at this moment regarding the projects, included in the Updated decommissioning strategy for Units 1 to 4 at Kozlody NPP; analysis of scientific reference sources; comparative analysis with the regulatory documents and recognized methodlogies; synthesis of the analyses results and preparation of expert assessment.

The Environmental Impact Assessment of the Decommissioning of the KNPP Units 1 to 4 benefits of a widely applied experts' team background in EIA as well as of the EWN experience in EIA of nuclear facilities. The experience accumulated during the Greifswald NPP decommissioning project, which is 88 % completed so far, forms the foundation for the estimation of the impacts from the decommissioning of the KNPP Units 1 to 4. This experience is summarized in the EWN Environmental Impact Register [8] and provided in Appendix 11.4.2. The estimation of the environmental impacts from the decommissioning is based on the comparison of the Greifswald NPP specific conditions with the KNPP site conditions, because the Units from Greifswald NPP are the same as Units 1 to 4 of Kozloduy NPP, therefore we use their experience in decommissioning of our Units. The simultaneous consideration of the national and international law and regulatory framework, directives and methodology in the nuclear and environmental field as well as the recognized practices of evaluation, contributed to adopt an impartial and up-to-date assessment approach in the frame of the present EIAR. The environmental impacts are assessed in the appropriate chapters of the EIAR by EIA licensed experts' team and the results are given in the summary below.

The methods used by the experts in connection with the different specific fields are described in chapter 5 of the EIAR. The results from the experts' evaluation led to the

specification minimization and mitigation measures and mitigation plan in reference to the anticipated significant adverse impacts, and last but not least to the justification of the chosen alternative.

An important part of the EIA is the public participation (public hearing). The respective activities related to the public consultations and disclosure of the Investment Proposal are described in the Stakeholders Engagement Plan (SEP) [17] . This document gives accessible information for efficient Public Participation.

2. PROPOSED ACTIVITY

Decommissioning of Units 1 - 4 at Kozloduy Nuclear Power Plant.

3. PROPONENT

As Proponent of the Investment Proposal for the Decommissioning of Units 1- 4 at Kozloduy NPP is considered the State Enterprise "Radioactive Waste" (SE "RAW"), pursuant to the MEW letter related to the EIA procedure.

State Enterprise "Radioactive Waste" (SE "RAW") was established under the requirements of the law for safe use of nuclear energy for radioactive waste management in the country outside the premises where are generated. Radioactive waste resulting from the activities contributing to the benefit of society as nuclear energy and the use of sources of ionizing radiation in medicine, industry, agriculture, science and education, and in this sense can not be avoided. Appropriately managed they can be controlled and minimized in order to protect people and the environment from the negative influences that now and in the future, without burdening future generations. Another activity of the company is involved in managing the process of decommissioning of nuclear installations, including Units 1-4 of Kozloduy NPP. The main policy SE "RAW" is to follow the national policy on the management of spent nuclear fuel and radioactive waste (RAW), which is based on internationally accepted principles for waste management namely:

- Priority to nuclear safety and radiation protection over all other aspects of the management of radioactive waste;
- Maintain as low as reasonably achievable level of influence of ionizing radiation and other negative impacts on the personnel, population and environment;
- Effective interaction with the government, with other organizations for waste management and waste generators;
- Ensuring continuity and reporting of current trends, by enhancing international cooperation and implementation of internationally recognized expertise.

In pursuance of the national policy on waste management and environmental management SE "RAW" has the following main objectives:

- Construction of a national repository for the disposal of low and intermediate level radioactive waste.
- Modernization of existing facilities in specialized divisions RAW to improve the management of radioactive waste, reduce environmental impact and improve the security of the facilities.
- Maintain the qualification of plant personnel.
- Planning and implementation of activities to improve the safety culture and promotion of personnel critical to the work in order to achieve the intended results.

In the area of "Safety and Health at Work":

- Maintenance of appropriate working conditions and rest;

– Training of officials entrusted with the management responsibilities for safety and health at work;

Currently, the number of workers at the Kozloduy site is 4251 people and staff working in EP-1 (SE "RAW") is 695 people.

4. PURPOSE OF PROPOSED ACTIVITY

The purpose of proposed activity "Decommissioning of Units 1 - 4 at Kozloduy NPP" is to achieve the status fulfilling the criteria (in accordance with appropriate legislative regulations) for Units' site release from regulatory control for unrestricted use.

The objective of the Environmental Impact Assessment of the Investment Proposal implementation is to assess and compare the impacts of the proposed Kozloduy NPP Units 1 to 4 decommissioning, corresponding to the investigated alternatives for implementation, on the environment and on the people, in accordance with the Environmental Protection Act [5], Regulation on the Terms and Procedure for Implementing Environmental Impact Assessment [6], the EC EIA Directive [10], EBRD Environmental and Social Policy [11].

5. LOCATION OF IMPLEMENTATION OF THE PROPOSED ACTIVITY

The activities for decommissioning of Units 1 - 4 are planned to cover the territory of the said Units (fig. 1) and transport to other places. The area covered by KNPP site is about 2 km^2 and together with the network of the circulation and service water supply it reaches 4 km^2.

Fig. 1 Units 1 -4 site at Kozloduy NPP

The Kozloduy Nuclear Power Plant was erected in north-western Bulgaria on the right bank of the Danube River, 5 km to the south-east of the town of Kozloduy. The site is situated at the 694th km of the Danube River and at a distance of 3.7 km to the south of the fairway of the river and from Bulgaria's border with Romania. The site region is located in the northern part of the first non-submergible terrace of the Danube River at elevation +35.00 m. The site covers a flat country with an altitude varying from +28.00 m to +36.00 m according to the Baltic Sea levelling system. The lowland and the site are protected from the Danube River by an embankment reaching absolute elevation of +30.40 m. To the north it borders on the Danube Lowland. To the south of the site the slope of the watershed plateau is relatively high (100-110 m), to the west it is about 90 m, while to the east it is relatively less high and goes down to 30 m altitude above the sea level. The Kozloduy Nuclear Power Plant is located at a distance of 120 km (as the crow flies) and at a distance of 200 km (via motorway) from the City of Sofia. The following municipalities are included in the 30-km area around the site: Kozloduy, Valchedrum, Hairedin, Mizia (entirely) and Lom, Byala Slatina, Oryahovo (partially). A sparsely-populated part of the territory of Romania is also included in the 30-km area around the site – namely 23 villages including 2 town– Dabuleni and Bechet and 21 villages (see fig.4). The KNPP nearest populated settlements are the following: Town of Kozloduy – at 2.6 km to the south-west;

Village of Harletz – at 3.5 km to the south-east; Village of Glojene – at 4.0 km to the south-east; Town of Mizia – at 6.0 km to the south-east; Village of Butan – at 8.4 km to the south; Town of Oryahovo – at 8.4 km to the east of the site.

The Kozloduy NPP site regional location as shown on fig. 2 and fig. 3 gives the situational layout of Kozloduy NPP relative to the Danube River.

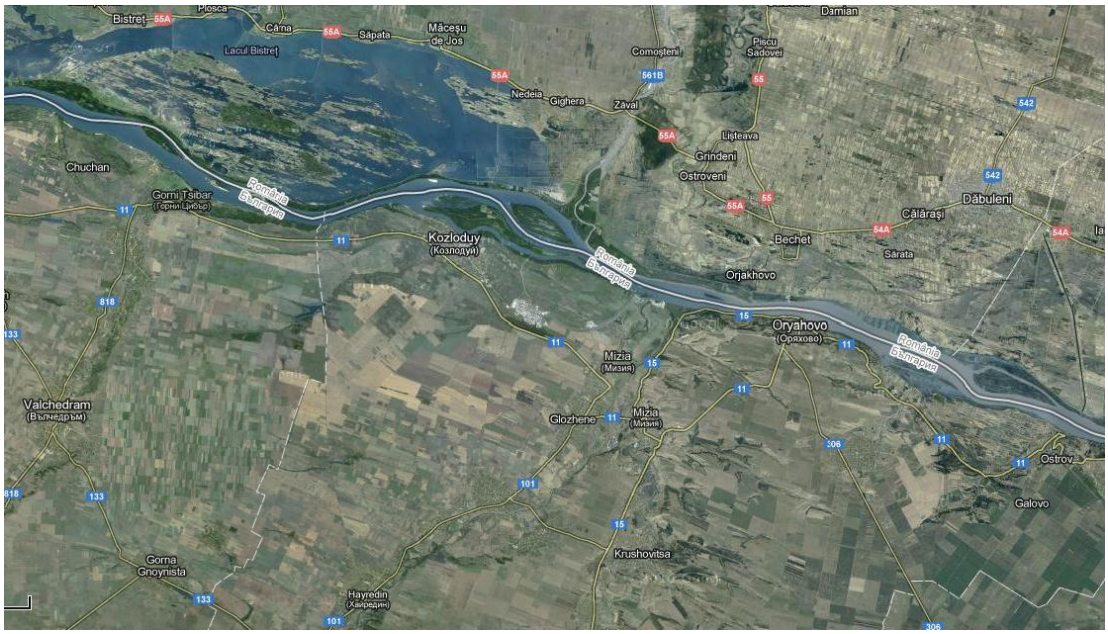


Fig. 2 Kozloduy NPP site regional location

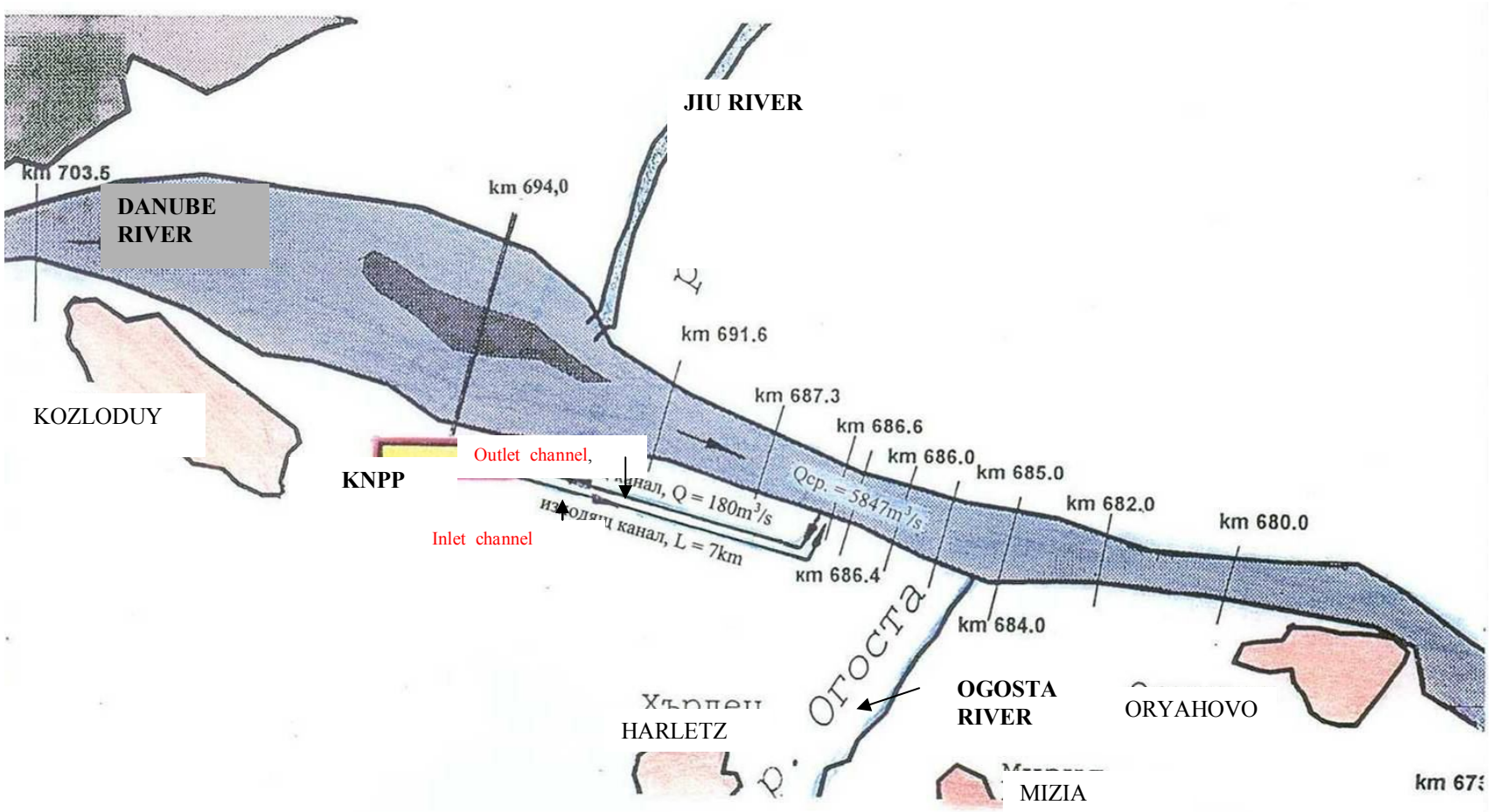


Fig. 3 - KNPP site layout relative to the Danube River

EXISTING AND FUTURE LAND USERS

The territory envisaged for the needs of the decommissioning of Kozloduy NPP Units 1 to 4 encompasses only the existing site of the said Units, in other words the area needed for the purposes of the decommissioning is already used for the purposes of Kozloduy NPP as it is. The planned activities which will be implemented during the Decommissioning are not expected to differ considerably from the activities implemented on the site of KNPP Units 1 to 4 at present. After the completion of all measures and activities associated with the decommissioning, the buildings planned to be released from regulatory control shall be used for other industrial purposes. No release of territories for agricultural and forestry purposes is expected.

The potential impacts of the proposed activities on the natural and anthropogenic components of the environment and on the population were evaluated in the affected area around Kozloduy NPP, namely within the 2 km [Precautionary Action Zone-PAZ] and the 30 km [Surveillance zone – SZ] radius (fig. 4). Map of the considered area surrounding KNPP on Romanian territory is shown in fig. 5.

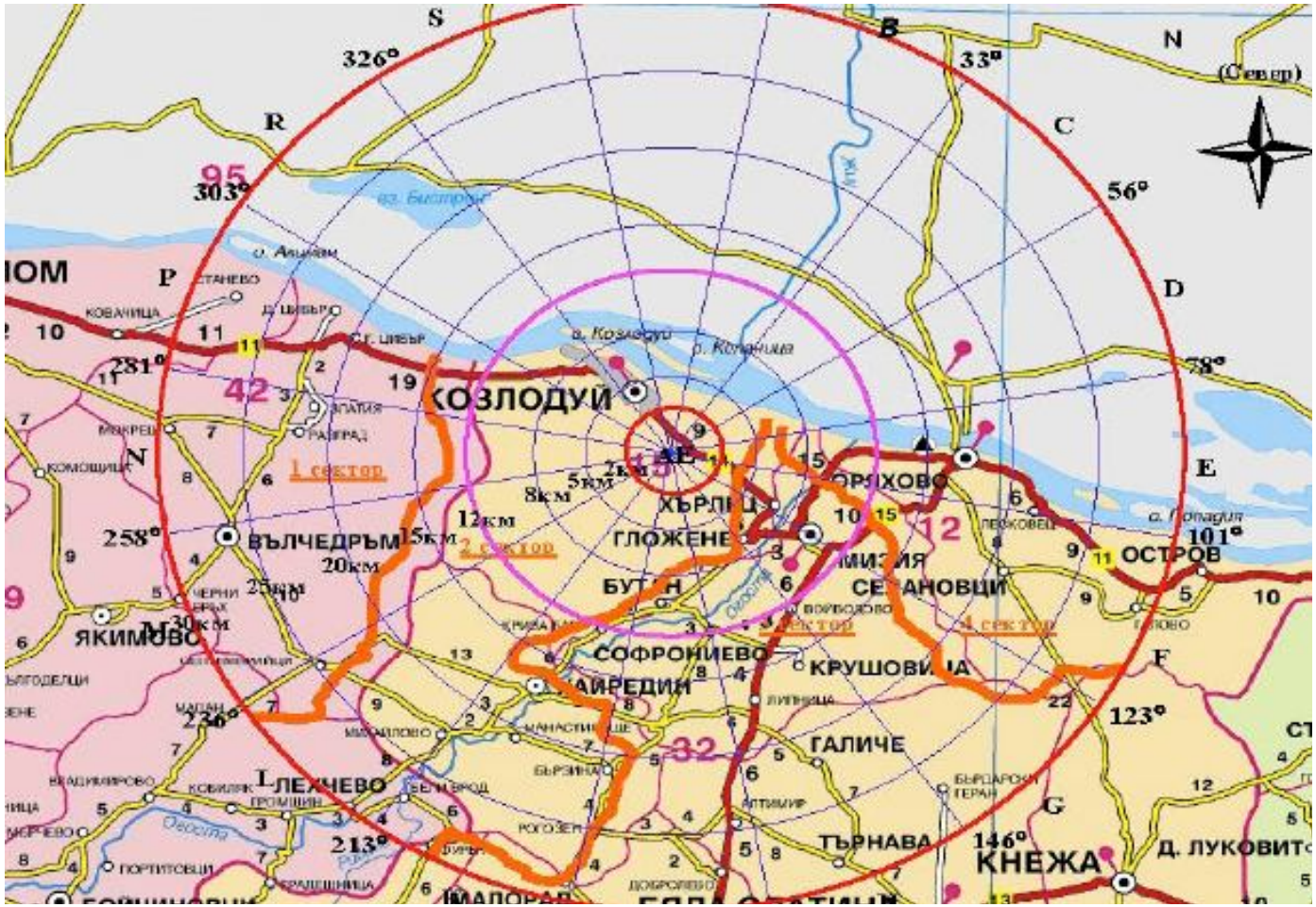


Fig. 4. Analysed affected areas around the decommissioning Units 1 to 4 site of Kozloduy NPP

Fig. 5 Map of the considered 30-km area surrounding KNPP on Romanian territory

6. DESCRIPTION OF KOZLODUY NPP UNITS 1 TO 4

The Reactor Buildings and the Auxiliary Buildings of Kozloduy NPP Units 1 to 4 are situated on an area of 1.4 km^2. The erection of KNPP Units 1 to 4 was completed in two stages – as follows:

First stage — construction of Units 1 and 2 under the project name "Kozloduy –I";

Second stage — construction of Units 3 and 4 under the project name "Kozloduy –II".

The data concerning the operational history of Units 1 to 4 is given in table 1.

Table 1 Operational data corresponding to the operational history of KNPP Units 1 - 4

Characteristic	Unit 1	Unit 2	Unit 3	Unit 4
Beginning of the construction	April 1970	April 1970	October 1973	October 1973
Physical start-up – minimum controllable level	30 June 1974	22 August 1975	4 December 1980	25 April 1982
Energetic start-up	24 July 1974	24 August 1975	16 December 1980	17 May 1982
Start-up: First TG Second TG	30 July 1974 2 August 1974	24 August 1975 26 September 1975	17 December 1980 11 January 1981	17 May 1982 23 May 1982
Bringing the Reactor to full power	25 October 1974	7 November 1975	27 January 1981	17 June 1982
Realized fuel cycles until and including year 2000 for Units 1 and 2 and until 2006 for Units 3 and 4	18	19	22	21
Number of equivalent full power days till the end of year 2000	5474.0	5416.87	4832.75	4735.8
Average factor of the output usage during Unit operation till the end of year 2000	82.46 %	80.45 %	83.86 %	84.3 %
Quantity of the electrical power produced for the time of operation till the end of 2002 for Units 1 and 2 and till the end 2006 for Units 3 and 4 (MWh)	66 675 000	68 905 000	68 703 000	66 711 000

Units 1 to 4 are equipped with WWER-440/230 type reactors and were put into operation in the period from 1974 (Unit 1) to 1982 (Unit 4).

The general characteristics of the nuclear power Units are as follows:

- The source of the heat energy at Units 1 to 4 of the KNPP is the WWER-440 type reactor. Slightly enriched uranium with Uranium-235 (^{235}U) content of up to 3.6 % is used as fuel for the reactor.
- The primary circuit is radioactive and includes 1 (one) power reactor and 6 (six) circulation loops. Each loop consists of: Main Circulation Pump (MCP), Steam Generator (SG), two Main Isolation Valves (MIV) with motor actuators and DN 500 mm Circulation Pipelines made of austenitic stainless steel. The steam generators generate saturated steam at a pressure of 4.7 MPa.
- Each of the WWER-440 reactors and the primary circuit lies in a concrete structure composed of hermetic rooms.
- The secondary circuit is not radioactive and consists of the following: steam supply part of the steam generator, a turbine and auxiliary equipment of the Turbine Hall.
- Each NPP power Unit is equipped with two Turbine Generators (TG) of K-220-44 type, each of them of 220 MW output. They operate with steam under a pressure of 4.4 MPa.
- The voltage of the TBB-220-2 type generators is 15.75 kV, the power factor is 0.85; with water cooling of the stator and hydrogen cooling of the rotor.
- The service water supply is provided by direct flow with water taken from the Danube River.

Units 1 and 2 and Units 3 and 4 respectively were built as twin-units. Some of the installed systems are shared by two different Units, whereas other installed systems are shared by all WWER-440 Units. Basic specifics of this type of construction are the design layout of two reactors in a common building with a shared Central Hall. There is a single Turbine Hall (TH) for the 4 (four) WWER-440 Units. The Reactor Building (RB) structures from elevation -3.35 m to elevation +10.50 m, which serve for biological protection, are mainly of cast-iron reinforced concrete. The foundations of the turbine generators in the TH are also of cast-iron reinforced concrete. The covers of the roof and between the floors of the Main Building are large reinforced concrete slabs.

The civil structures of the hermetic rooms of the RB are calculated to withstand an overpressure in the hermetic rooms equal to 0.1 MPa. The Auxiliary Building (AB) is designed for decay storage of liquid and solid radioactive waste and contains facilities for processing of liquid and gaseous radioactive waste, gas purging systems, ventilation systems of the AB and equipment for preparation of boron solutions. Auxiliary Building-1 (AB-1), Auxiliary Building-2 (AB-2) respectively, is connected via a gallery to the Reactor Building. The general ventilation extraction duct from the Reactor Building to the stack is at elevation +10.50 m and passes through the upper half of the cross-section of the gallery.

A common Ventilation Stack (VS) is built for each pair of Units and has a height of 150 m. Fig. 6 shows the Units 1 to 4 main buildings and equipment layout.

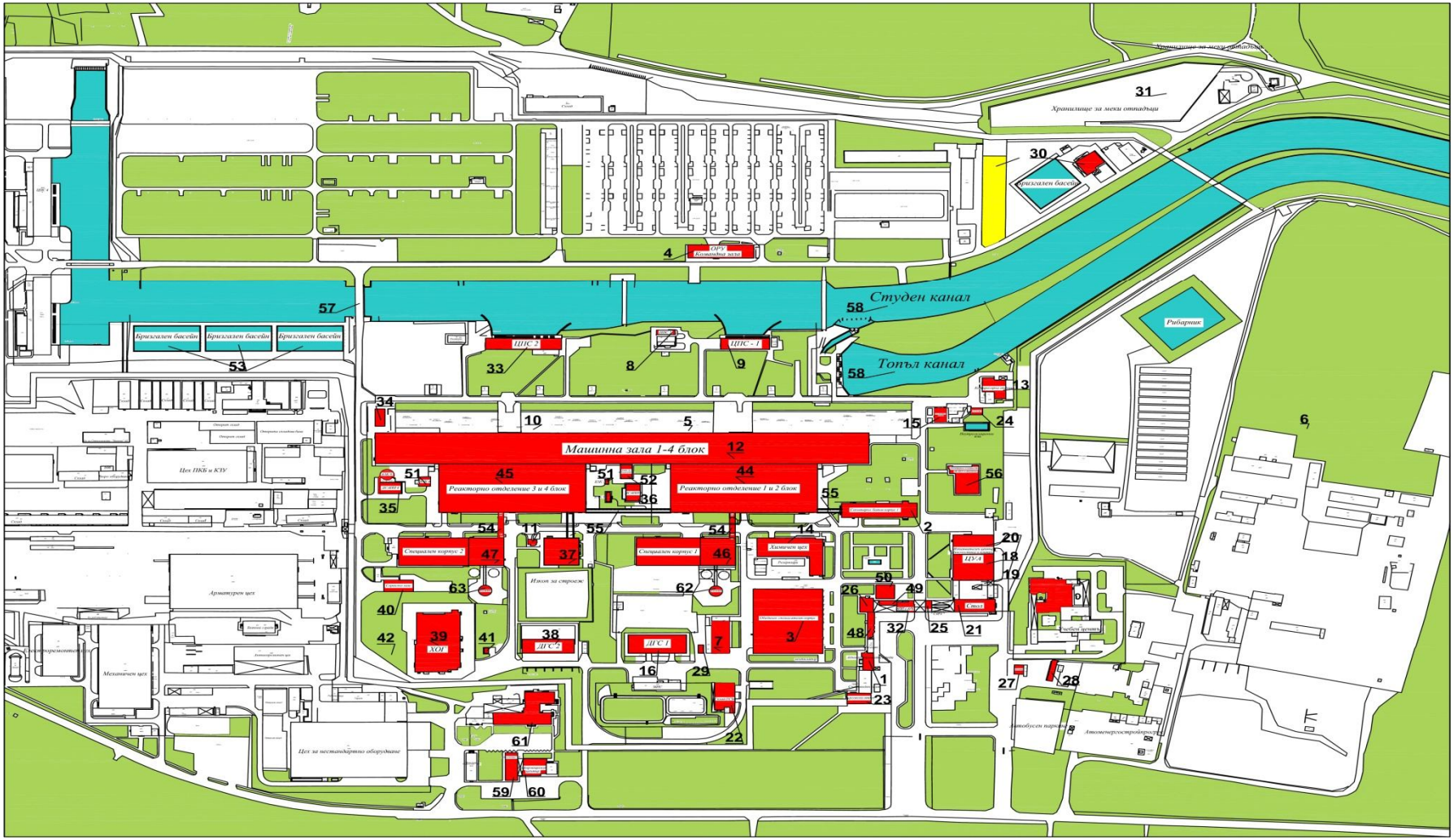


Fig. 6 - KNPP Units 1 to 4 General Layout

7. ALTERNATIVES OF PROJECT IMPLEMENTATION, CONSIDERED IN THE EIA REPORT

The alternatives of decommissioning of KNPP Units 1 to 4 considered in the assessment are according to the Terms of Reference for EIAR and are considered also from the point of view of the potential environmental impacts, namely:

- Alternative 0 (No Dismantling, Without decommissioning);
- Alternative 1 (Deferred Dismantling);
- Alternative 2 (Continuous Dismantling).

Brief description and comparison of the above alternatives is given below and the main advantages and disadvantages of each alternative are outlined. Alternatives 1 and 2, described below, are compared with the so called "Zero" alternative, which considers the possibility and the consequences of no decommissioning of Units 1 to 4, respectively no Units dismantling. Therefore this alternative represents the situation arising if Units 1 to 4 decommissioning is postponed indefinitely. The assessment of the alternatives is made in the context of the Updated decommissioning strategy (chapter 2, table 2.1-1) and in compliance with the legal provisions, using multicriterial analysis (chapter 11.2.1).

Alternative 0: Non Dismantling – without decommissioning

The zero Alternative is the status that would arise after KNPP Units 1 to 4 final shutdown and the subsequent consequences if the proposed decommissioning activity does not take place.

The Alternative 0 does not require availability of decommissioning financing but financing of the maintenance of the Units will nevertheless be required. Site release for further use would be postponed for the indefinite future. In addition, the risk of possible leakage of radioactive substances into the environment will be increased (the tanks where the RAW are presently stored are not designed for long-term storage). This is not an advantageous alternative with regard to the costs for maintenance, reconstruction of buildings and equipment and institutional control needed for an indefinite period of time.

In accordance with the national legislation and regulatory requirements, the nuclear power Units must be operated in a manner that ensures that their radiation safety will be guaranteed and continuously monitored after the reactor final shutdown. Thus, under Alternative 0 some systems will have to be permanently operated and maintained.

All these concerns (increased radiological risks and related costs) compromise the Alternative 0 concept for decommissioning of the nuclear facilities.

Alternative 1: Deferred Dismantling

A basic feature of this Deferred Dismantling Alternative is the Safe Enclosure (SE) of the equipment of the primary circuit for a predetermined time period (35 years) and after that the dismantling works shall start up.

The spent fuel shall be removed from each Unit in the frame of the valid operational license.

This alternative is investigated in the last revision of the Decommissioning Design from year 2005 [3] and consists of the following 3 Stages:

Stage 1: 5-year transition period including:

- Post operation;
- Preparation of Safe Enclosure.

Stage 2: Safe Enclosure under surveillance and monitoring for 35 years

Stage 3: Deferred dismantling.

These three stages are consecutive, i.e. are performed sequentially. The first two phases of Stage 1 of the post-operational period and the Safe Enclosure Preparation are partly overlapping.

The Safe Enclosure Area according to Alternative 1 - Deferred Dismantling includes the two Reactor Buildings (RB-1 and RB-2), the two auxiliary buildings (AB-1 and AB-2), the two ventilation stacks (VS) and the interconnecting passageways.

The deferred dismantling shall begin after the long lasting (35 years) Safe Enclosure. When the 35 years period of SE under surveillance expires the facilities shall be dismantled thanks to the decreased radiation because of the isotopes spontaneous decay.

The key features of this alternative are:

− Decrease of dose levels;

− Development of new techniques for dismantling;

− Accumulation of financial resources;

A significant issue associated with Alternative 1 is that it shall create a heavy impact on the local community in terms of the very low employment during the 35 years of Safe Enclosure. In addition the operational experience necessary for planning of the decommissioning shall be lost and the radioactive waste treatment infrastructure will be idle for an extensive period of time between the end of Units 1 to 4 operation and the deferred dismantling. In practice this would require re-building of the waste treatment infrastructure, hiring of new workers and full training of the operating staff.

Alternative 2: Continuous Dismantling

The main feature of this alternative is continuous dismantling of equipment and facilities and uninterrupted waste management as well as Operation of the Safe Enclosure that meets all the requirements of environmental and radiation protection. During SE stage dismantling works of the equipment shall be performed outside the SE Area. The subsequent stage shall cover deferred dismantling inside the Safe Enclosure and the release of the site and the buildings for use for other industrial purposes.

The Continuous Dismantling is a selective combination of two possible options:

- Immediate dismantling for some facilities or equipment;

– Deferred dismantling for other facilities or equipment.

The stages of Safe Enclosure Preparation and Safe Enclosure Operation from the Original Decommissioning Strategy are combined together into the single Stage 1.

Under this alternative the preparatory works shall start earlier and shall be followed by the continuous dismantling. The work load of the equipment involved in the waste treatment shall be more uniform.

A shortening by 2 years of the preparatory activities such as removal of combustible and flammable materials, removal of asbestos and other hazardous materials is possible. Potentially, these activities can be extended by other pre-decommissioning activities.

The Continuous Dismantling Alternative shall progress in three stages:

– Stage 1: Safe Enclosure of Reactor Buildings and dismantling of equipment outside of the Safe Enclosure Area;
– Stage 2: Deferred Dismantling of the equipment within the Safe Enclosure and release of the site and buildings from regulatory control for reuse for other purposes.
– Stage 3: Closure and land reclamation.

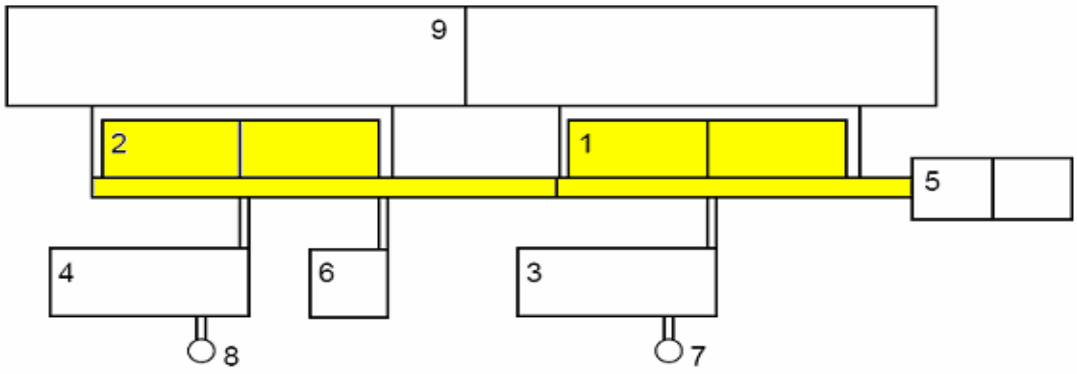
For the implementation of these stages, the necessary projects are planned. The most important are:

– Size Reduction and Decontamination Workshop;
– Sites for Safe Temporary Storage of Materials generated by the decommissioning activities of Units 1-4 at Kozloduy Nuclear Power Plant.

During the continuous dismantling, reclaiming of any contaminated soils may be carried out.

Upon commissioning of the National Repository for Disposal of Low and Intermediate Level RAW (NRD RAW), the stream of conditioned radioactive waste will be directed to the National Repository enabling removal of the RAW from the site.

During Stage 2, dismantling of the equipment in the SE Area, i.e. of the primary circuit contaminated equipment shall start. It shall be followed by the dismantling of the reactors and surrounding activated components. At the end of this stage the site and buildings shall be released from regulatory control for further industrial use. In this last stage the site and the building will be refurbished in order to reach highest efficiency and better environmental indices.



1 – Reactor Building I (Units 1 & 2)
2 – Reactor Building II (Units 3 & 4)
3 – Auxiliary Building 1
4 – Auxiliary Building 2
5 – Laboratory/sanitary building 1
6 – Laboratory/sanitary building 2
7 – Ventilation Stack 1
8 – Ventilation Stack 2
9 – Turbine Hall

**The yellow area is the SE area including SB=51.*

Fig. 7 - Planned Safe Enclosure area under Alternative 2 - Continuous Dismantling of Units 1 - 4

Comparison of the alternatives and justification of the Alternative for Continuous Dismantling

The comparison is made for the three alternatives in reference of different factors.

The increased radiological risks and related costs for risks limitation and for Units safety maintenance make Alternative Zero unsuitable as alternative for decommissioning of nuclear facilities.

Consequently the comparison is made basically between Alternative 1 and Alternative 2.

The substantial difference between the schedules of decommissioning of the Original Decommissioning Strategy [3], (Alternative 1 - Deferred Dismantling) and of the Updated Decommissioning Strategy [4] (Alternative 2 - Continuous Dismantling) is that in the case of Alternative 1 there is a time lag of 35 years which is not the case according to Alternative 2.

The comparison of the two alternatives is made based on the assessment of the economic, social and radiological consequences and the environmental impacts.

The justification of the choice of the appropriate alternative for decommissioning of Units 1 to 4 is based on a number of advantages in comparison with the other alternatives, namely.

- Under Alternative 2 the preparatory works shall start immediately after the reactor shutdown including: Units' radiological inventory and removal of the hazardous and other operational waste from the Units; activities on collection, sorting, processing and transportation of the decontamination waste; RAW management activities and subsequently the dismantling is operated without considerable interruption.

- The time schedule for implementation of the decommissioning activities is distributed uniformly for the sake of the efficient utilisation of the highly-skilled work force. The complexity of the tasks will be increasing gradually and thus experience will be accumulated on a step-by-step basis for the decommissioning of ever more complex unit components from a radiation standpoint.
- This alternative is more suitable from a technical point of view as well, because it takes into account the current status of the technical procurement of equipment for the decommissioning process.
- An important aspect is the preservation of the experience and knowledge of the current personnel, which can be effectively used for the development of specific working procedures for specific tasks associated with the decommissioning (continuity in knowledge of equipment and areas).
- Another advantage offered by Alternative 2 is the gradual, uniform and continuous utilization of human and financial resources throughout the entire process of decommissioning of the Units, as well as of the waste treatment facilities (because of which this alternative is called „Continuous Dismantling“).
- The implementation of the selected alternative provides a reasonably long period for supply of the necessary equipment for RAW treatment, as well as uniform use of the RAW treatment capacities during the entire project, thanks to the uninterrupted RAW management process.

In conclusions, because of the advantages of Alternative 2 and the disadvantages of the other two alternatives, Alternative 2 is considered as the most appropriate for the implementation of the decommissioning project for Kozloduy NPP Units 1 to 4.

8. MAIN FEATURES OF THE PROJECT FOR DECOMMISSIONING OF KOZLODUY NPP UNITS 1 to 4

Description of the decommissioning stages and activities

The entire preparation and decommissioning process according to the adopted Continuous Dismantling Alternative can be sub-divided into the following three main stages encompassing the respective activities:

Pre-decommissioning Stage (Transitional Stage)

- Preparation of the documentation for issuance of a decommissioning permit (Decommissioning Plan, EIA Report, updated: Safety Analysis Report, Technological Specification and Operating Instructions) and
- Pre-decommissioning activities (provision and construction of suitable infrastructure for dismantling, cutting, fragmentation, sorting, volume reduction, decontamination and free release measurement; removal of flammable and hazardous materials and conventional waste, thermal insulation, operational radioactive wastes, retrieval and conditioning of spent ion-exchange resins, system isolation and draining).

Decommissioning Stage

This stage is subdivided in two stages:

Stage 1 of the Decommissioning

- Preparation of Safe Enclosure
- Safe Enclosure of the Reactor Buildings (the RB of Units 1 and 2 and the RB of Units 3 and 4 and the interconnecting passageways are included in this area) and
- Dismantling of the equipment outside the Safe Enclosure Area.

Stage 2 of the Decommissioning

- Deferred dismantling of the equipment within Safe Enclosure and
- Release from regulatory control of the site and the buildings for use for other industrial purposes.

During the implementation of the abovementioned stages: transitional (pre-decommissioning) stage, Stage 1 and Stage 2 of the decommissioning, different types waste management activities will be carried out.

After sorting of the dismantled materials, depending on their contamination rate the wastes can be:

- Free released and transported outside the KNPP site without or after decontamination;
- Stored temporarily for natural decay;
- Handed over as a RAW for further treatment and conditioning.

Closure and land reclamation Stage

Upon termination of the decommissioning process the site and the buildings will be refurbished in order to achieve higher efficiency level and environmental indices. At the end of the closure stage the strategy foresees to reach a long-term state of the industrial site where KNPP Units 1-4 are being decommissioned defined as "brown lawn". It will be achieved by performance of the following activities: dismantling of the equipment not intended for further use; free release of the buildings and facilities remaining in operation; processing and taking out of all RAW from the site and bringing it to a condition suitable for nuclear purposes or other economic activities. The buildings and underground infrastructure will remain for auxiliary use by the operating Units 5 and 6.

Decommissioning activities plan

The activities during the Pre-decommissioning Stage include:

- Pre-decommissioning activities – including radiological backlog in order to enable removal of hazardous and other wastes generated by the Units operation;
- Activities on collection, sorting, treatment and transportation of decontamination waste;
- RAW management activities;
- Decontamination.

Activities during the Decommissioning Stage

These activities are performed in the following sub-stages:

Activities during Stage 1 of the Decommissioning:

- Activities on units' RB Safe Enclosure (SE) preparation;
- Activities on SE Operation;
- Activities outside the SE, dismantling of Turbine Hall (TH);
- Activities on SE waste transportation and processing.

Activities during Stage 2 of the Decommissioning:

- Dismantling of the equipment within the SE;
- Release from regulatory control of the site and the buildings for use for industrial purposes.

Activities during the Closure and land reclamation Stage

Within this stage the site and the buildings will be refurbished in order to achieve higher efficiency level and environmental indices. Before the construction works a Concept for closure and reclamation up to a "brown lawn" state will be developed. This means the removal from the site of the active equipment keeping it under regulatory control up to its decontamination and its final disposal. The buildings and underground infrastructure will remain for auxiliary use by the operating Units 5 and 6.

Supporting projects related to the Decommissioning of Units 1 to 4 of Kozloduy Nuclear Power Plant

During the pre-decommissioning stage in support to the decommissioning activities on the Units a group of preparatory projects is planned to be implemented, basically defined as: Projects for removal of the hazardous materials, Projects for processing of the collected operational RAW, Projects for pre-dismantling activities and Projects for construction of an auxiliary infrastructure.

The most important projects, which are presently planned to be implemented during the abovementioned stages (Pre-Decommissioning Stage, Decommissioning Stages 1 and 2) and for some of which the EIAR will provide an assessment concerning the probability to have or not to have impacts on human beings and on the environment are described below.

Size Reduction and Decontamination Workshop (SRDW)

It is planned to use the Workshop for size reduction and decontamination of the dismantled contaminated materials from Turbine Hall, AB-1 and AB-2 and the RB.

Facility for Treatment and Conditioning of RAW with High Volume Reduction Factor at Kozloduy NPP

This project shall provide a high volume reduction factor (HVRF) facility for the processing of low level radioactive waste currently stored on the KNPP site. The project envisages a separate EIAR.

Design and Construction of Sites for Safe Temporary Storage of Materials generated by the decommissioning activities of Units 1-4 at Kozloduy Nuclear Power Plant

By this project a safe temporary storage of solid radioactive materials (RAM), subject to clearance procedure is provided, generated by the decommissioning activities of Units 1-4 on two dedicated sites. The RAM (transitional RAW) will be temporary stored in containers on these sites over a period not longer than 5 years, where their specific activity will decrease below the free release levels. In the frame of this project the selection of a Site for conventional waste from decommissioning of the units is foreseen.

Construction of a Heat Generation Plant

The purpose of this project is the design, construction and commissioning of a Heat Generation Plant as a back-up source of steam and central heating water to the consumers at Kozloduy NPP in case of simultaneous outage of KNPP Units 5 and 6. According to MEW Letter Ref. No B-1214/29.07.2009 the Investment Proposal is subject to a mandatory EIA and namely this project requires the elaboration of a separate EIAR.

National Disposal Facility for short-lived low and intermediate RAW

This project shall provide disposal of short-lived low and intermediate RAW generated. This project is in phase of technical design and elaboration of the safety analysis report. This project has been subject to separate EIA procedure finalized with positive statement by the competent authority – MEW. The national repository is an

installation with multi-barrier protection for long-term storage of waste that has been preliminary processed, safeguarded and packed in reinforced concrete packages. The repository will be at the ground surface, trench type, with capacity of 138 200 m^3. The commissioning of the NDF will finalise the cycle of radioactive waste management in Bulgaria, providing their safe and permanent insulation from the environment and people.

Spent Fuel Dry Storage Facility

The KNPP Spent Fuel Dry Storage Facility (SFDSF) will store spent nuclear fuel assemblies in specially designed storage casks. The design life of the facility is at least 50 years. Fuel assemblies will be sealed into purpose-built storage casks which will ensure their safety during the storage period. For this project a separate EIAR was drafted and there is a positive decision from the MEW on it.

Liquid Radioactive Waste Treatment Facility

This project shall provide equipment for the treatment of low contaminated water from active laundry, hot showers and floor drains from KNPP Units 1 to 4, and the possible conditioning of the generated radioactive waste. Currently, this waste is being treated by the operating KNPP SWT-3 of Units 1 to 4 which will become non-operational upon completion of the treatment of all operational liquid RAW.

Supply of Mobile Equipment for Water Decontamination and Treatment Equipment

The project shall provide the supply of mobile equipment for surface decontamination of the Reactor Refuelling Pool (RRC), Spent Fuel Storage Pond (SFSP), SFSP racks and other similar open or closed storage vessels, for tanks' water treatment and for secondary RAW conditioning. According letter Ref.No26-00-2555 of MEW the project cannot be associated to the IP listed in Annexes 1 and 2 to the EPA and subsequently is not subject to mandatory EIA.

Ion exchange Resins Retrieval and Conditioning Facility

The Project shall ensure the supply of equipment for the retrieval and treatment of spent ion-exchange resins from the existing storage facilities.

Facility for Retrieval and Processing of the Solidified Phase from Evaporator Concentrate Tanks currently stored in tanks in Auxiliary Buildings 1 and 2

This project shall provide the supply and installation of a facility for Retrieval and Processing of the Solidified Phase from Evaporator Concentrate Tanks currently stored in tanks in Auxiliary Buildings 1 and 2.

Free Release Measurement Facility

This project shall ensure the supply of equipment able to measure the γ-activity for the purpose of releasing dismantled equipment and other materials from regulatory control. This project covers the provision of equipment for radiological inventory allowing the free release of the dismantled equipment and materials.

Supply of equipment for Liquid and Gaseous Discharge Monitoring System

The purpose of this project is to meet the requirements of the European Commission that are listed in the European Commission Recommendation 2004/2/EURATOM and by the NRA concerning the KNPP Discharge Monitoring System. These requirements will be met by upgrading the existing monitoring system for the liquid and gaseous emissions of KNPP Units 1 to 4. The intended purpose of this system is to improve and optimize the existing system for monitoring (surveillance) of the liquid and gaseous emissions from KNPP Units 1 to 4.

9. SUMMARIZED EIA PROCEDURE PROCESS

The EIA procedure in Bulgaria is regulated by the Environment protection act and the EIA Regulation and regarding this project it includes the following stages:

- Notification of the Competent Authority and the affected population from the respective municipality, in this case the Municipality of Kozloduy, about the IP
- Assessment of the need for EIA
- Development of Terms of Reference for determining the scope and content of EIA
- Assessment of the impacts and preparation of EIA Report
- Public discussion of the EIA Report
- EIA Decision by a Council of Environmental Experts of the Competent Authority

Notification of the Competent Authority and the affected population from the respective municipality, in this case the Municipality of Kozloduy, about the IP

Kozloduy municipality has been notificated together with the Competent Authority about the KNPP IP. Consultations have been held at the notification stage. These initial consultations have outlined the possible substantial impacts from the project, their spatial distribution (area of impact) and duration, the presence of specific sensitive receptors, etc. Based on the information gathered in the process of these consultations, Terms of Reference for determining the scope and content of EIA Report have been developed.

Assessment of the need for EIA

The present EIA Report, including the CA report, is developed according to the MEW assessment of the need for EIA and CAR for the Decommissioning of Units 1 to 4 at Kozloduy Nuclear Power Plant.

Determining the scope and content of EIA

The EIA quality depends to a great extent on the successful and timely determination of the scope of the investigation. Regarding the project at this stage consultations have been held with a wide range of stakeholders: the Competent Authority taking the EIA decision, specialized state organizations, departments and agencies, the affected public and NGOs.

The Terms of Reference for determining the scope and content of EIA presents the vision of the Contracting Authority regarding the nature of the IP, as well as the potential impacts on the environment. Thus, the Contracting Authority consults with the Competent Authority, specialized state organizations, departments and agencies, the affected public and NGOs what is planned to be considered in the EIA and how, in terms of factors and components of impact on the environment. The consulting letters to the above mentioned authorities indicate the key factors, which should be reviewed, analyzed and assessed in the EIAR.

The Terms of Reference have been submitted to the Competent Authority for review and comments. Thus, the MEW will also perform intermediate control in the process of EIA.

NPP decommissioning is described in Appendix I of the ESPOO convention. In this regard an EIA Procedure in Transboundary context is initiated and the IP is notified to Republic of Romania, as concerned party according the EIA convention in Transboundary Context. Upon receipt of the relevant notification, the Romanian government decided to participate in the EIA procedure. In the course of the scoping process Republic of Romania has formulated its general and specific considerations which have been considered in the present EIAR.

Assessment of the impacts and preparation of EIA Report

The assessment of the impacts is based on detailed knowledge of the current state of the environment in the project impact area. A detailed study of the existing conditions has been performed, which includes review of the available information and data about the state of the environment and field research for gathering additional project specific data and verification of the existing information.

The project impact on the environment has been assessed based on the gathered information and in compliance with the unified project methodology. The assessment is an iterative process, during which the impacts are initially assessed without the application of mitigation measures, thus identifying the impacts that need mitigation. For these impacts specific measures for prevention, mitigation or elimination where possible of the project impacts are developed and then the impacts are assessed again, this time considering the application of the mitigation measures. Thus, the residual project impacts are also identified and assessed.

Based on the performed impact assessment, the planned mitigation measures and the results of the consultations with the stakeholders, an Environmental Management Plan has been developed for the project (see Section 6.2 from the EIAR). The results from the consultations held in the process of impact assessment have been taken into account in the EIAR and are summarized in Chapter 7 of the report.

Public discussion of the EIA Report

The consultations regarding the EIAR Terms of Reference will continue during the EIAR development. The opinions and statements of the above mentioned participants in the EIA procedure will also be addressed in the stage of public access to EIAR, as well as during the public discussion.

If questions arise or new statements regarding the IP are received during the stage of public discussion, in the normatively regulated term, the Contracting Authority will answer these opinions and statements by presenting its answer to the Competent Authority, so that it can be considered during the taking of the EIA decision by the Expert Environmental Council.

EIA Decision

It is taken by the Council of Environmental Experts of the Competent Authority.

10. ASSESSMENT OF THE ANTICIPATED IMPACTS ON THE ENVIRONMENT AND ON PEOPLE RESULTING FROM DECOMMISSIONING OF UNITS 1 TO 4 AT KOZLODUY NPP UNDER THE PROPOSED ALTERNATIVE

The experience of EWN during the Greifswald NPP (KGR) decommissioning project, which is currently 88 % complete, as well as the experience of the team of licensed experts making the assessment, forms the basis for the EIA of the decommissioning of the KNPP Units 1 to 4. The experience of EWN is summarized in the EWN Environmental Impact Register. The considered values of the direct impacts are based on preliminary estimates, which should be made more specific and detailed in the framework of the planned implementation of the activities, for example in the project for radiological survey of the Units 1 to 4. This greater level of detail and specificity is important for the detailed planning of the dismantling activities.

The comparison of the Greifswald NPP (KGR) and the Kozloduy NPP (KNPP) is made in terms of different indicators and data regarding the anticipated impacts as follows:

- Estimation of the different types of waste;
- Estimation of the discharges of radioactive nuclides into the atmosphere and into the water as a result of the decommissioning of the KNPP Units 1 to 4;
- Estimation of the Collective Effective Dose from dismantling of the KNPP Units 1 to 4;
- Estimation of the non-radiation impacts during the decommissioning period (emissions into air, emissions into water, thermal discharges, noise, vibrations and water, electricity and thermal energy consumption).

Some output data by indicators is presented below:

Technological materials (without building structures): appr. 75 000 t

Of them:

- Conventional waste (material category 1 and material category 2 and 3 after free release): 65 000 t;
- RAW: 10 000 t (solid RAW from dismantling).

Based on the comparison of the emissions during the operational period and the post-operational period and on the 14-year EWN experience from the Greifswald NPP (KGR) decommissioning, the gas-aerosol emissions from the stacks of Units 1+2, Units 3+4 and AB-1 and AB-2 were estimated and the conclusions were presented in chapters 1 and 4 of the EIAR. The estimated values are under the admissible discharge limits:

Emissions into the atmosphere:

20 MBq LLA is the average annual value over the entire decommissioning period. This value includes the emissions from the planned projects: SRDW and Sites for

Safe Temporary Storage of Materials generated by the decommissioning activities of Units 1-4.

Emissions into the water (water discharge points of the Units 1–4):

Nuclides (without ^{3}H): 120 MBq average annual values over the decommissioning period; ^{3}H: 50 GBq average annual values over the decommissioning period.

Based on the comparison of the CED from the EWN experience during the decommissioning, the CED can be estimated for the period of decommissioning of the KNPP Units 1 – 4, including the activities in the SRDW and the Decay Storage Facility: CED: 200 mSv average annual value over the decommissioning period for 350 exposed persons.

In comparison to the operational period, the thermal discharges are negligible, because after the shutdown of the reactors there will be no thermal emissions from these Units into the Danube River. Small residual thermal discharges shall be caused mainly by cooling of spent fuel and the operation of the evaporation plants for the water purification systems.

The activities associated with the highest noise levels are the demolition of building structures (not envisaged at present), the reconstruction of existing buildings by using hydraulic chisels and the construction of new facilities by using excavators (e.g. for the projects SRDW and Heat Generation Plant).

According to the EWN experience, there are no indications of high vibration levels from the demolition of old buildings and the construction of new ones.

As for the impacts from water, electricity and thermal power consumption during the decommissioning activities, based on the EWN experience it can be stated that no changes compared to the post-operational phase are expected. The main share of the water consumption is the consumption for sanitary purposes for the personnel. The main consumers of electrical and thermal power are the systems which shall remain operational in the post-operational period (e.g. the ventilation systems of the reactor buildings).

Based on the detailed description and analysis of the environmental components and factors and the key interactions between them on the site of the investment proposal, the following expert conclusions were formulated:

Air quality

After the removal of the nuclear fuel from the Units, no emissions of Radioactive Noble Gases - RNG (Kr, Xe isotopes), nor of short-live iodine isotopes (^{131}I, ^{133}I, ^{135}I) are expected.

The radiological impact on the critical individuals as a result of radiation by noble gases or inhalation of ^{131}I will be negligible compared to the impact resulting from the respective discharges during normal operation.

Long-live aerosols emissions from activities that will be carried out during the Preparation of Safe Enclosure could be compared more or less with the ones during the period of long outage, with a reduction of the maintenance/inspection activities,

but with an increase of the cleaning/decontamination activities and activities for conditioning of the radioactive waste.

If the technology is strictly adhered to and the decontamination and dismantling processes are strictly monitored, the emissions of radioactive gas aerosols can be expected to be within the permissible limits and the air pollution in the NPP area can be expected to be less than the pollution during normal operation and therefore the decommissioning can be implemented in a manner that is safe for the environment and for the public.

The following facilities are expected to be source points of harmful emissions into air during the decommissioning: the Facility for Treatment and Conditioning of Solid Radioactive Waste with a High Volume Reduction Factor (Plasma Melting Facility) and the Size Reduction and Decontamination Workshop, but they will be equipped with adequate filtration systems and for these reason the impact will be insignificant.

Diffuse source emissions (fugitive emissions) of dust are expected from the earth works and of gas aerosols from the internal combustion engines of the construction and transport equipment, generated during the construction period. These emissions are assessed to be short-time, temporary and localized as impact. These impacts are commonly with an extent radius of 50 m from the construction site borders at maximum.

Other emissions from conventional sources are expected to be generated in result of metal cutting and waste transportation (CO_2, NOx and PM10).

Based on the assessments made of the planned decommissioning activities and based on the experience of EWN [8], a conclusion can be drawn that the emissions of non-radioactive substances into the air during the processes of decommissioning of Kozloduy NPP Units 1 to 4 will not exceed the levels permitted by the legislative regulations.

Transboundary transfer of pollutants is not expected.

Atmosphere

Given the strict control on the compliance of the decontamination processes with the good engineering practice and the adopted technology for decommissioning of Units 1-4 of NPP Kozloduy and the implementation of the measures to prevent, reduce or eliminate adverse environmental impacts, negative impact on the atmosphere in the respective territory in result of the IP implementation is not expected.

In the area of construction activities, especially during the earth works and the subsequent land reclamation, there will be minor microclimatic changes due to the increased dust emissions in the natural light and thermal atmospheric characteristics within the working day, which will be present till the termination of the construction phase. The impact will be of local extent (within the KNPP site), short duration, and without cumulative effects on the atmospheric processes.

The dismantling activities within the reactor building and then the transportation of the dismantled materials to the Size Reduction and Decontamination Workshop will be carried out in closed spaces, equipped with filter ventilation system so that the impact on the atmosphere will be negligible.

The analysis of the Investment Proposal and the likelihood of atmosphere contamination within the 30-kilometer area around KNPP on Romanian territory shows that during the construction and operation of the Size Reduction and Decontamination Workshop (SRDW), the Sites for temporary safe storage of materials (RAW 1 category and conventional waste) from the decommissioning, it is expected that the generated amount of waste will be comparable to the amount generated during KNPP Units normal operation. In this respect, major changes of the meteorological elements and the atmosphere values are not expected. Given the frequency of prevailing winds in the area, the probability of transmission of aerosols towards the Romanian territory is negligible. In conclusion it can be stated that in case all regulatory and technological requirements are meet, the impact on the atmosphere in the region, related to the treatment and conditioning of radioactive waste, is evaluated as negligible. Transboundary transfer of harmful substances to the neighbouring countries is not expected. The implementation of the design safety measures will ensure the protection of the surface layer of the atmosphere above the plant site and adjacent areas.

Surface and Ground Waters

The liquid discharges into the environment consist of purified service water from the decontamination process before and after the dismantling, as well as water from bathrooms and laundries, from floor and corridor cleaning and from the laboratories. Some of these waters meet the criteria for free release directly into the environment after measurement of their activity.

Potential impacts on surface and groundwater during the execution of the planned activities in the Pre-decommissioning stage of KNPP Units 1-4 are associated with an increase in water consumption, mainly for technological purposes related to these activities, such as cleaning activities and activities on the construction sites (wet processes, etc.). Yet quantities will be limited and will not pose a problem for the KNPP water supply system, as currently used, and water levels are less than 50 % of the permitted discharges, which means that water-supply will remain from the same sources and without changing conditions of permits for water use. The extent of this impact will be local, within the water intake facilities (groundwater). Despite the insignificance of the impact, it will be negative and direct, limited in spatial range and low range in the area of influence around the water intake facilities. It will be temporary (for the duration of the stage of preparation for output) and short.

During the Pre-decommissioning stage wastewater will be generated mainly by cleaning activity. It will be mainly contaminated with suspended solids. Wastewater will not be a problem for the sewerage at KNPP or for the purification facilities at the plant. Generated waste streams will be collected and transferred for purification at the required extent in the wastewater treatment station, northward Units 1 - 4 and in the treatment complex at the industrial site of EP-2 and then will be discharged by the main discharge channel into Danube river. Therefore, it is not expected further impact of the activities at this stage on the water quality of the Danube river. Impact on the chemical status of groundwater body BG1G00000N2034 (pore water in the Neogene) is not expected by the activities related to the Decommissioning of Units 1 to 4. Eventual small infiltrations of contaminated water will be retained in the powerful and

with relatively low permeability aeration layer wouldn't reach the level of the water table.

Under Stage 1 of the decommissioning, the activities are related to the preparation of the Safe Enclosure (SE), the operation of the SE and the dismantling of the equipment outside the SE area.

Stage 2 of the decommissioning includes dismantling of the equipment within the SE area and the release of the buildings and site from the regulatory control for other industrial applications. Before the beginning of the SE preparation a number of actions are undertaken to minimize the risks related to the SE implementation.

The activities associated with the removal of the liquid and solid RAW from their original storage places will contribute considerably to minimization of the impacts resulting from radioactive materials handling. The subsequent activities - transportation, temporary storage in adapted storage areas and premises and transfer to the facilities for treatment and ultimate conditioning - shall be done by means of equipment which is pre-tested for impermeability in terms of RAW leaks. Assuming that there is no damage at the storage area caused by the mechanisms for transfer of the RAW from their present storage locations, the impact on the surface and ground waters resulting from the radioactive materials handling can be considered as insignificant. In case of damage in the storage level measures for localization and repair of the damaged place is necessary.

The provision of suitably engineered RAW leak-proof mobile equipment for treatment and ultimate conditioning of the solid and liquid RAW, supplied to the decontamination site, reduces the probability of leaks during transportation of the RAW and additionally contributes to the reduction of the impact on the hydrosphere.

The effluents from the decontamination and washing of the equipment and buildings are considered to be liquid RAW which shall be concentrated and treated by cement-hardening conditioning.

Provided that compliance with all technological and regulatory requirements is ensured, the impact from RAW treatment and conditioning on the surface and ground waters will not endanger the ecosystems and public health in the concerned region.

For the protection of the surface and ground waters, the process wastewater discharged into the hydrosphere must be made consistent with the fixed standards for water purity in terms of the content of non-radioactive and radioactive pollutants. At the time of finalization of the decommissioning activities, an improvement of the surface and ground waters quality will be observed in the concerned region. Providing respect of the technological standards and regulatory provisions related to the decommissioning and the adherence to the best available techniques (closed water systems, wastewater treatment, and controlled discharge), the discharged wastewater stream will be significantly less contaminated during the decommissioning than during the operational period.

As a whole, the liquid discharges into the environment resulting from the decommissioning of KNPP Units 1 to 4 will be of small quantity. The resulting annual radiation rates will be within the allowable limits with a sufficient safety margin. The decreased impact on the surface and ground waters can be considered as

positive effect from the decommissioning of nuclear power Units compared to their operation.

Among the positive impacts associated with the decommissioning, special attention must be paid to the elimination of the thermal output pollution of the Danube river resulting from the discharge of cooling water during operation. Upon decommissioning completion amelioration of the surface and ground waters quality in the affected region will be observed.

The environmental impact from the decommissioning on Bulgarian territory is assessed as negligible and transboundary impact is not expected.

Land and Soils

The soils on the Kozloduy NPP territory and within the 30-km area are black-earth, alluvial, diluvial and grey forest soils. The most widespread are the black-earth soils. Their resilience to withstand anthropogenic impact is dependent on the nature of the activities undertaken. With regard to mechanical impacts such as civil works, earth works, etc. their resistance is very low. With regard to pollution caused by inorganic and organic pollutants, however, they possess very strong resistance. Their buffer property is due to the favourable reaction of the soil dilution, the high content of the carbonates and their heavy mechanical composition. With regard to their resistance to radiation contamination, the favourable content of potassium plays an important role here. The grey forest soils are also classified as resistant.

The activities on the border of the SE area will be carried out in closed premises and do not represent a threat for the soils of the NPP site as well as the adjacent lands. Considerable part of the activities within the SE area is not related to the generation of sources of the impact on the soils. The decontamination shall be carried out in closed premises. In case of efficient execution of the foreseen decontamination activities no impact is expected on the soils at KNPP site as well as on the adjacent territories. After execution of the decontamination the possible sources for contamination of the soils are different waste, slurry and wastewater effluents from process activities.

During KNPP Units 1 to 4 decommissioning some liquid and solid RAW will be generated. The permissible limit for the liquid effluents are admitted to be significantly lower than the limits during normal operation of KNPP Units 1 to 4 and this is fixed in the license for E-mode operation of these Units. This means that the likely impact on the soils during the decommissioning will be much lower than during the period of normal operation. Cumulative impact on soils from the decommissioning activities at KNPP and the operation of Units 5 and 6 at KNPP and the National Disposal Facility for RAW is not expected. The operation of all above mentioned facilities is conditioned by the requirement to maintain the level of all kind of releases within the limits set up by the relevant permits. Specific technical solutions providing safety and environmental protection, including for soils, are implemented.

Sources of conventional impact on the soils are mostly the activities related to the construction of new buildings: the Size Reduction and Decontamination Workshop (SRDW), the Sites for safe temporary storage of materials from the decommissioning activities for Units 1 to 4 at KNPP. Impacts are mostly mechanical – such as the excavation or embankment works, stamping, sealing, isolation. During this stage no

significant impact on the soils and the adjacent lands is expected. The impact of this type is assessed as being negative and direct and in the post-decommissioning period it will be direct, positive and long-term benefit taking into account the reclamation and recycling.

The period after the final shutdown of Units 1 to 4 is associated with the presence of gaseous and liquid emissions. It is assumed that the gaseous emissions shall not be at increased levels and that they shall not pose a threat for soil contamination. As for the residual diluted radioactivity from the decontamination of various rooms, equipment, etc., a water purification system is envisaged and the process wastewater shall not be a source of soil contamination.

The analysis of the likely sources of impacts on soils in connection with the decommissioning of Units 1 to 4 and with the post-decommissioning period allows us to make the assumption that the planned activities are not a soil contamination source. After the completion of the decommissioning process, a reduction of radiological and non-radiological emissions into the environment (atmospheric air and water) is expected. No consequences for the land and the waters are expected.

Impact on the soils and lands or transboundary transfer of pollutants in Romania is not expected.

Earth interior

In the geological section of the area different litho types are tracked including Quaternary deposits all over. Typical physical and geological phenomena and processes are subsidence associated with loess material, landslide on the slopes, typical for loess materials and swamping in the floodplains of the Danube.

The likely impact on the geological environment and its sustainability in the various stages of project is assessed. It is important to note that the impact of dismantling techniques could not be estimated at this stage in terms of the additional load to the geological environment. Overall expected impact is negative, which would change the quality characteristics of the substrate and equilibrium geotechnical position in which the geological environment is at the moment. To specify the degree of impact needs to be evaluated physical and mechanical properties of the environment in accordance with the existing seismic picture of the area of the facility. A risk of unlocking of physical geological processes and phenomena is evaluated. A possible risk is shock (spot) loading of the location resulting from disruptions in planned destructive activities or in a time of accident.

Risk of chemical and radioactive pollution of the geological environment in times of emergencies and accidents is possible. The extent of this impact is rated as low, but it still should be considered.

Impact on the geological environment is seen as negative, direct, short-term during the dismantling work.

For the protection of geological environment from radiation and non-radiation pollution is recommended strict adherence to the developed and accepted standard procedures for projects of this nature. Control for protecting groundwater and surface water would help to reduce the risk of impact on the geological environment. With

respect to the geological sustainability the development of a temporary monitoring mode during the dismantling work is recommended, thereby controlling any changes in the quality parameters of the environment. The monitoring mode must be reviewed with a view to introduction of a significant additional burden on the geological environment.

Landscape

The Kozloduy NPP territory has a complex horizontal landscape structure. Within this territory there are clearly outlined several types of landscape –"anthropogenic", "forest" and "aquatic". The resistance to impact of these landscapes is low. Their existence is determined by the human activity. The forest landscape is characterized by higher resistance thanks to the fact that it possesses capacity for self-regulation and self-recovery. In the 30-km area around the Kozloduy NPP site the landscape diversity is manifested by the following types of landscape – "forest", "meadow", "agricultural", "aquatic" and "anthropogenic". The highly resistant forest landscape and aquatic landscape is formed by the natural water flows in the water catchment basins of the rivers Danube, Skat, Ogosta and Tsibritsa.

Significant role for the substance circulation in the landscape structure is played by the loess soil-forming materials and the carbonates-containing soils, which create migration barriers for the different pollutants including the radionuclides.

The decommissioning process involves construction works on the territory of the NPP site itself which however will not disturb the anthropogenic landscape. In the 30-km area around the NPP site construction works will not be carried out.

Provided that the decommissioning activities on the KNPP Units 1 to 4 are correctly executed, the Investment Proposal can be implemented without risk of landscape components contamination. Provided that the Conventional Waste Management Program at Kozloduy NPP is correctly implemented, adverse impacts on the landscape are not expected. Cumulative impact on the landscape from the decommissioning activities at KNPP with the operation of Units 5 and 6 at KNPP and the National Disposal Facility for RAW is not expected because of absence of permanent radiation sources of contamination.

Transboundary impact is not expected.

Mineral diversity (Ores and minerals)

During the implementation of the IP mineral resources are not foreseen to be used. For this reason impact of the mineral resources is not expected. During the last stage of closure and land reclamation the non-radiation and radiation impacts to earth interior is not expected.

Biodiversity

Flora and fauna

By adopting best international working practice during decommissioning works, as referenced in the selected Alternative 2, by applying the relevant mitigation measures and complying with the KNPP Emergency Plan in the event of an incident no adverse impacts on flora and fauna are expected. Cumulative impact by the simultaneous

operation of Units 5 and 6 and the National RAW Disposal Facility (NDF) is not expected because of absence of permanent sources of contamination.

During the decommissioning of Kozloduy NPP Units 1-4 transboundary impacts to the flora and fauna on Romanian territory are not expected.

On the basis of the anticipated impacts on the fauna in consequence of the Investment Proposal implementation, they are assessed as insignificant, mainly indirect or rising in case of accidents and force majeure, which can be prevented without obligatory application of special measures, expected the respect of the best decommissioning practices during KNPP Units 1 to 4 decommissioning and to continue with the already applied prevention and monitoring activities.

Natural landmarks - Protected Territories and Protected Areas (Natura 2000)

The protected areas on both sides of Danube River are interconnected and form complex ecological system which is considered as a whole in the Compatibility Assessment Report (CAR). Concluding from the analysis presented in the CAR can be said that there is no impact from the implementation of activities under the decommissioning of Units 1-4 of Kozloduy NPP. Expected retention of radiological situation and not expect a negative impact on protected areas, as well as protected areas in Bulgaria and Romania:

- SCI BG0000533 Kozloduy Islands under the Directive on the conservation of natural habitats and of wild fauna and flora
- SPA BG0002009 Zlatiata, under the Directive on the conservation of wild birds
- SCI BG0000614 Ogosta River, under the Directive on the conservation of natural habitats and of wild fauna and flora
- SCI BG0000508 Skat River, under the Directive on the conservation of natural habitats and of wild fauna and flora
- SCI BG0000527 Kozloduy, under the Directive on the conservation of natural habitats and of wild fauna and flora
- SCI BG0000199 Tsibar under the Directive on the conservation of natural habitats and of wild fauna and flora
- ROSCI 0045 Coridorul Jiului under the Directive on the conservation of natural habitats and of wild flora and fauna
- ROSPA 0010 Bistrets and ROSPA 0023 Confluența Jiu – Dunăre under the Birds Directive.

In conclusion we can say that the potential impacts associated with emergency situations will be localized and is not expected to reach the territory of protected areas..

Cultural and historical heritage

Harmful effects on the sites of cultural and historical heritage in the 30-km area are not expected due to the fact that the decommissioning activities during all the stages and the implementation of the supporting projects (SRDW, Site for temporary safe storage of materials from decommissioning, Plasma melting facility) will take place within the Kozloduy NPP site. Transboundary impacts on the cultural monuments or

archaeological findings on the Romanian territory from the 30-km studied area are not expected.

Harmful physical factors

During the implementation of the decommissioning activities, throughout the entire period a re-allocation of the existing residual activity will take place, which will change the location, the quantities and the radiation intensity within the operational site of Kozloduy NPP and in the environment (under some specific circumstances).

Based on the analysis of the radiation status of the environment and the presented information, the impact of the ***ionizing radiation*** from the activities over the decommissioning period on the gamma background radiation can be forecasted to be insignificant provided that:

- The zones with the respective control limits and permissible values of the gamma radiation, as well as their control values and permissible limits on the external walls of the rooms containing radioactivity are preserved;
- The restrictions of the gamma radiations will be observed both in and around the newly-constructed buffer and decay storage areas, as well as the limits on the capacity of the RAW storage equipment;
- An adequate biological protection is provided for the contaminated equipment taken out from the SE area, of the RAW and during their transportation;
- Beyond the reactor site and within the statutory zones for radiation monitoring the permitted limits for emissions of radioactive substances in the sewage waters and in the ground atmosphere layer should be observed.

A conclusion can be drawn that there will be no influence from the decommissioning and dismantling activities on the gamma background radiation if the above conditions are observed. The emissions of gaseous RAW during the decontamination activities shall be limited to the permissible aerosol levels and therefore shall be negligible in terms of impact.

The impact from the ***non-ionizing radiation*** during decommissioning of the reactor will be limited within the borders of the sanitary protection zone and will be insignificant for the environment.

No additional impacts on the environment from non-ionizing radiation are expected from the implementation of the decommissioning activities according to the Decommissioning Plan, as well as based on the experience of EWN.

Noise impact in reference of the noise levels during decommissioning will be of permanent nature, progressively decreasing in time with temporary peaks.

Increase of the noise levels will be perceived when there are ongoing activities with noise source at open air. Although the levels of the generated background environmental noise at the site of EP-1 will not exceed the defined statutory limits including for the adjacent settlement of Bulgaria and Romania.

Vibrations will be generated during the overall decommissioning, produced by the working equipment and facilities. Their influence will be of permanent nature progressively decreasing in time with temporary peaks, limited within the scope of the

EP-1 site and insignificant for the environment, including for the adjacent settlement of Bulgaria and Romania.

Waste and dangerous substances

During the decommissioning activities conventional and radioactive waste will be generated (solid and liquid). Based on the performed analyses and assessments, it can be stated that, given that all technological and regulatory requirements are observed, the impact on the environment and population related to RAW treatment, conditioning and temporary safe storage will be insignificant. Transboundary impact from transfer of harmful substances in neighboring countries is not expected. The programs for management of RAW and conventional waste and the application of the safety and mitigation measures developed in the project will guarantee the protection of the environment and population and the adjacent areas.

The conventional waste generated by the implementation of the investment proposal do not differ in composition and classification from the waste generated if "zero alternative" is adopted. The existing Site (Landfill) for conventional municipal and industrial waste has sufficient capacity but especially dedicated sites for safe storage of materials from decommissioning will be organized.

Conventional waste during decommissioning is subject to segregation and handing over to licensed operators for further utilization in accordance with the legislation in force. It can be concluded that given the application of the measures planned in the updated Program for management of non-radioactive waste, the Rules for safe management of conventional waste and the proposed mitigation measures by the EIAR, significant impacts on the environmental components and factors and the human health are not expected. It is expected that if the valid permits and regulations applicable to work with hazardous substances and chemicals during execution of the decommissioning and dismantling activities are observed, the environmental impact will be insignificant. No transboundary impacts are expected.

Personnel and population health risk

All activities foreseen to be performed during decommissioning are conformed to the requirements for healthy and safe work conditions and for public health protection. Prophylactic examinations of the personnel are performed every year following strict annual time-schedule in the Occupational Medicine Service of Kozloduy NPP.

During the implementation of the activities in the preparatory stage of the decommissioning, the radiation impact on people as a result of noble gases exposure or inhalation of ^{131}I will be completely insignificant in comparison with the impact from the respective discharges during normal operation. The radioactive aerosols represent a tangible risk for internal irradiation during the dismantling works, which requires stringent personnel dosimetry control and compliance with the regulatory requirements The decommissioning activities are preliminarily planned and this includes elaboration of dismantling activities time-schedule, taking into account that for each decommissioning activity or group of activities in reference of its complexity a separate working package/procedure, containing detailed activity description is provided. Special attention deserves also the high level of safety culture in Kozloduy

NPP and systematic application of the ALARA principle, minimizing the specific risk of occupational radiation exposure.

During the installation and construction works some of the working groups will endure exposure to general and local vibrations, metal aerosols, infrared and ultraviolet irradiation (welding operations) and dust inhalation. Concerning the exposure to these conventional harmful factors there are effective individual and collective protective devices and their use shall mitigate the adverse effect on human health, which will be local and short term impact.

Concerning the health risk for the population in consequence of the KNPP Units 1 to 4 decommissioning it should be stated that the public health impact is almost 0, taking into account that the hazardous/radioactive materials, as well as the construction works, source of adverse conventional impact, will not cross the fence of the NPP site, thus in this case no special measures for mitigation of the impact on the public health in relation with the project implementation are needed.

Subsequently and at the condition of observation of all planned measures, it can be summarized that the implementation of the Investment Proposal will not have an adverse effect on the environment state and will not have a contribution to the worsening of the occupational health at KNPP site and of the population in the 30-km radius surrounding area, including on Romanian territory.

Nuisance

The construction activities during the Pre-decommissioning (PD) stage and the Stages of decommissioning of KNPP Units 1-4, the construction sites and the slightly increased transport traffic will be sources of noise, dust and toxic gases. The emissions will be much lower than the limit values for noise and the sanitary standards for dust and toxic gases. The population will not be exposed to health risks, but it is possible to experience temporary discomfort. This will be valid mainly for the settlements through which trucks will pass. The discomfort will be negligible and temporary.

Social and socio-economic aspects

According to the adopted Continuous Dismantling Strategy [4] during both stages of the Units decommissioning, the personnel consisting of highly qualified and experienced professionals, who have operated the decommissioned reactors, will be redirected to employment in the new decommissioning activities of the Units.

In this connection there is an agreement signed between Kozloduy NPP and SE "RAW" giving more detailed characteristic of the employment conditions recontracting and transfer of the personnel of KNPP– EP-1 to the new employer SE "RAW". In practice this will achieve a number of positive results - preserving jobs and providing employment for the specialists made redundant because of the operational shutdown, conservation of their social acquisitions, use of the rich experience and knowledge of these specialists, achieving greater efficiency in the new activities, ensuring continuity and last but not least the negative crisis effects will affect the unemployment level to a smaller degree. The retention of the qualified staff in the new activities on the decommissioning may also have another positive effect -

ensuring qualified personnel for the eventual construction and operation of the new Unit of Kozloduy NPP.

With respect to the adopted Continuous Dismantling Alternative for carrying out the Decommissioning of Units 1 to 4 and the application of the proposed mitigation measures it can be summarized that the adverse social and socio-economic effect will be lower compared to the expected one as a result of the implementation of the other two assessed alternatives.

The decommissioning activities for KNPP Units 1-4 are not expected to impact the socio–economic aspects of the Romanian territory in the 30-km area surrounding KNPP site..

Transboundary impact

Detailed description of the transboundary impacts during the execution of the investment proposal is shown in a separated volume. The document takes into consideration the Romanian requirements set out in the letters sent to the Romanian ministry of environment and forests to the MEW

The results of the analysis of the transboundary impact show that the transboundary impact is reduced to minimal level and is assessed as negligible.

The assessment is made in reference of all threshold releases during decommissioning and with presumption of the application of all proposed mitigation measures described in chapter 6.

The maximum annual effective dose of the population critical target group in the 40-km area around KNPP, due to liquid and gas-aerosl emissions into environment is conservatively evaluated at 5.05 μSv/a, which is much below the stated limit of 250°μSv/a for exposure to NPP releases (Ordinance on the Safe NPP Operation) and below the allowable limit for the population which is 1 mSv/a (BNRP-2012).

The calculation results presented in the EIAR section, dedicated to the transboundary aspect show that the effective dose for the population is very low and insignificant compared to the dose from exposure to the natural γ-background radiation.

The comparison of the Collective Effective Dose (CED) for the population around KNPP with many other NPP equipped with PWR (WWER) reactors show that they are adequate to the international practice, commented in the UNSCEAR Report 2000) [17].

In conclusion it can be stated that the exposure of the population in the 40-km area around the KNPP, including on Romanian territory in reference of the limiting design based accidents during the decommissioning is much bellow from the allowable limits of the international document ICPR 103 and the provisions of the ordinance on the Basic Norms of Radiation Protection (BNRP-2012).

11. ADVERSE IMPACT MINIMIZATION AND MITIGATION MEASURES

Based on the analysis and assessment of the anticipated environmental impact by the Investment Proposal implementation specific measures for the minimization and mitigation of the considerable harmful impact on the human health and the environment resulting of the Decommissioning of Units 1 to 4 of Kozloduy NPP were specified.. At first place are presented the measures related to the radiological impact to the environment and the public health and at second place – those, related to the conventional impact on the environment and the public health.

Minimisation of ionising radiation exposure of personnel and population – by consistently applying the developed Concept for radiation protection in Kozloduy NPP, applicable also for the decommissioning, by strict adherence to the regulatory administrated dose limits thresholds for the population and the occupational staff implementing continuous radiation surveillance and optimisation of the equivalent dose burdens for gamma-radiation for the respective zones of the KNPP and the controlled area. The ALARA (As Low As Reasonably Achievable) principle shall be applied by taking into consideration the whole history of the occupational radiation exposure.

Minimisation of contaminant emissions into the atmosphere – by using highly efficient filtration systems with 99.97 % of efficiency capturing emissions and dust by local dust-capturing and dust-arresting systems (e.g. by sprinkling) and by rigorous planning of the activities with high dust emissions, as well as by adequate selection corresponding to the best available techniques for of the location of the new decommissioning facilities, parameters related to the construction method, technology used, capacity, quantitative data regarding the waste and the radioactive gas emissions. Adaptation of the radiation monitoring programme, derived on the basis of the principle of conservatism during sampling of aerosols with periodic update of the sampling points and, if necessary, inclusion of new ones, consistent with the location of the decommissioning activities

Minimisation of ground and surface water pollution – by minimising the water consumption, the generation of waste water by recycling and by using the treated waste water in further processes of radioactive waste treatment and conditioning, efficient filtration systems, use of mobile decontamination equipment for liquid and solid RAW and by organizing a monitoring programme, derived on the basis of the principle of conservatism during sampling of wastewater with periodic update of the sampling points and, if necessary, inclusion of new ones, consistent with the location of the decommissioning activities. Control on the amounts and treatment process of liquid and sold RAW of the dismantling activities as well as surveillance of the sites for temporary safe storage of the waste containers as well as recording system for these data by using data base similar to the EWN Environmental Impact Register during decommissioning.

Noise reduction – by using adequate routes and a time schedule of the transportation activities in compliance with the national legislation and regulatory provisions.

Minimisation of soil pollution and land occupation (at the Kozloduy NPP site) – by minimization of land occupation needed for buffer unloading/storage sites for decommissioning waste and when applicable maximum use of the existing civil structures and built-up areas for implementation of the new decommissioning facilities; by use of technologies minimising the formation of secondary waste and preventing the contamination of the surroundings lands. Update of the sampling points for radiation surveillance of the soils in reference of the current decommissioning activities.

Mitigation of the impact on the flora – by using the vegetation sampling within the ongoing radiation monitoring analysis for determination of some non-radiological parameters such as heavy metal contents in plant samples from the 2-km area.

Mitigation of the impact on the fauna - by survey of fauna species present onsite whose habitats would be potentially disturbed (or destroyed) by construction works and by provision of a plan for their relocation, if necessary.

Mitigation of the impact on the biodiversity components– by traceability of the impact on the physiological state, behaviour reaction and reproductivity of the species as well as assessment of the risks for the protected resources from potential impacts resulting of the NPP vicinity by inclusion in the Site Emergency Decommissioning Plan. The same is valid for the closest protected areas of Natura 2000 Network

Mitigation of the occupational and public health risk – by implementation of effective individual and collective protective devices for mitigation of the adverse impact on human health: by preliminary planning of decommissioning activities, including time-schedules of the dismantling operations and provision for each dismantling activity or group of dismantling activities specific work procedure, which will contain detailed description of the activity; by strict individual dosimetry control and respect of the regulatory provisions; by systematic application of the ALARA principle, which leads to the minimization of the specific risk of personnel radiation exposure risk,

Mitigation of the socio-economic impact – by recruitment of operating personnel preferentially from Kozloduy NPP and relocation of the exempted operational personnel to the decommissioning activities; by opportune update of the developed Program for Management of the Social Consequences from the Decommissioning of Units 1 to 4 at Kozloduy NPP [16], adopted by Kozloduy NPP in 2006 and by adequate training and re-training of the personnel at all levels and work places of the organisation. The SERAW management shall provide funds aiming to keep at work the highly qualified personnel of the four shut-down units.

12. ENVIRONMENTAL MONITORING

The EIAR provides a detailed description of the existing environmental self-monitoring at the NPP site, as well as the proposed on-going monitoring of the environmental components and factors during the implementation of the decommissioning activities on Units 1 to 4 of Kozloduy NPP and after their completion according to the In-house Environmental Non-Radiological Monitoring Program and Environmental Radiological Monitoring Program.

The current non-radiological in-house monitoring at Kozloduy NPP will be in use during the implementation of the decommissioning activities on Units 1 to 4 of Kozloduy NPP. Independently of this, additional measures for some of the environmental components are recommended for implementation during the decommissioning. For the soils, for instance, it is suggested that the results from the radiation monitoring be used for determining additional non-radiation parameters of the soils (e.g. soil acidity – pH, humus and clay content (single sample) from which depends the migration of the soils elements including this of the radioactive isotopes. The following additional activities for water monitoring are recommended: to update the in-house non-radiation water monitoring programs by adapting them to the decommissioning activities including the adding of new monitoring points to the monitoring network in connection with the new decommissioning activities; monitoring for possible leaks from the locations where waste from the dismantling is accumulated.

Additional activities in connection with the Waste Monitoring according to the Conventional Waste Monitoring Program during the KNPP operation are also proposed.

The existing radiation and environmental radiological monitoring at Kozloduy NPP will continue to be applied during the KNPP Units 1 to 4 decommissioning activities implementation. The radiation monitoring of the environment will be organized and will follow the current in-house radiation monitoring of the radioactive gaseous aerosol and liquid radioactive discharges from the decommissioning, as well as of the content of anthropogenic nuclides into the environmental components and the nutrients in the Kozloduy NPP region. Fig. 8 shows the layout of the environmental radiological monitoring stations in the areas around Kozloduy NPP and fig. 9 shows the layout of the radiation monitoring stations and the Thermo Luminescent Dosimeters (TLDs) at the Kozloduy NPP site.

Independently of this, additional radiation monitoring for some of the environmental components is proposed to be performed during decommissioning. For instance: based on the conservatism principle for the soil sampling programs, regular updating of the sampling points and (if necessary) inclusion of new sampling points reflecting the location of the decommissioning activities shall be necessary. Additional soil radiation monitoring may become necessary in the case of occurrence of radioactive leakages. The existing waste radiation monitoring and the related facilities and sites during completion of the decommissioning shall continue and following additional main activities related to waste monitoring are also recommended:

- Radiation monitoring of the sites for temporary storage of the containers full of waste from the dismantling of the facilities;
- Continuation of the radiation monitoring of the Repository of Conventional Municipal and Industrial Waste (RCMIW).

The radioactive aerosols are a tangible risk for internal radiation in the process of the dismantling activities, which requires that the rigorous individual dosimetry control should continue and the regulatory requirements should be complied with. As for the exposure of the personnel and population to conventional harmful physical factors, effective devices for collective and personal protection should be used, which will minimize the adverse impact on human health.

In the area of influence of Kozloduy NPP on the Romanian territory the National Environmental Radioactivity Surveillance Network (NERSN) in Romania performs two programs of environmental radioactivity surveillance, which operate in parallel:

- Standard Surveillance Environmental Radioactivity Programme – simultaneous derulated by all SSRM. In the Standard Program all SSRM has the same sampling and analysis schedule.
- Special Surveillance Environmental Radioactivity Programme – individually derulated by every SSRM, under NEPA's coordination. The Special Programme assumes that every laboratory has its own monitoring programme within its competence area.

In Romania, the National Environmental Radioactivity Surveillance Network (NERSN) ensures the radiological monitoring in the influence area of Kozloduy NPP– Bulgaria. Under two Radiations monitoring programs the monitoring of the gamma background radiation is conducted. For this purpose 4 laboratories, called Surveillance Stations for Radioactivity Monitoring (SSRM): SSRM Bechet, SSRM Craiova, SSRM Drobeta Turnu Severin and SSRM Zimnicea, are located in the 100-km area of the considered territory. There are also 13 automatic air gamma dose rate monitoring stations in Dolj county, in Mehedinti county and in Teleorman county.

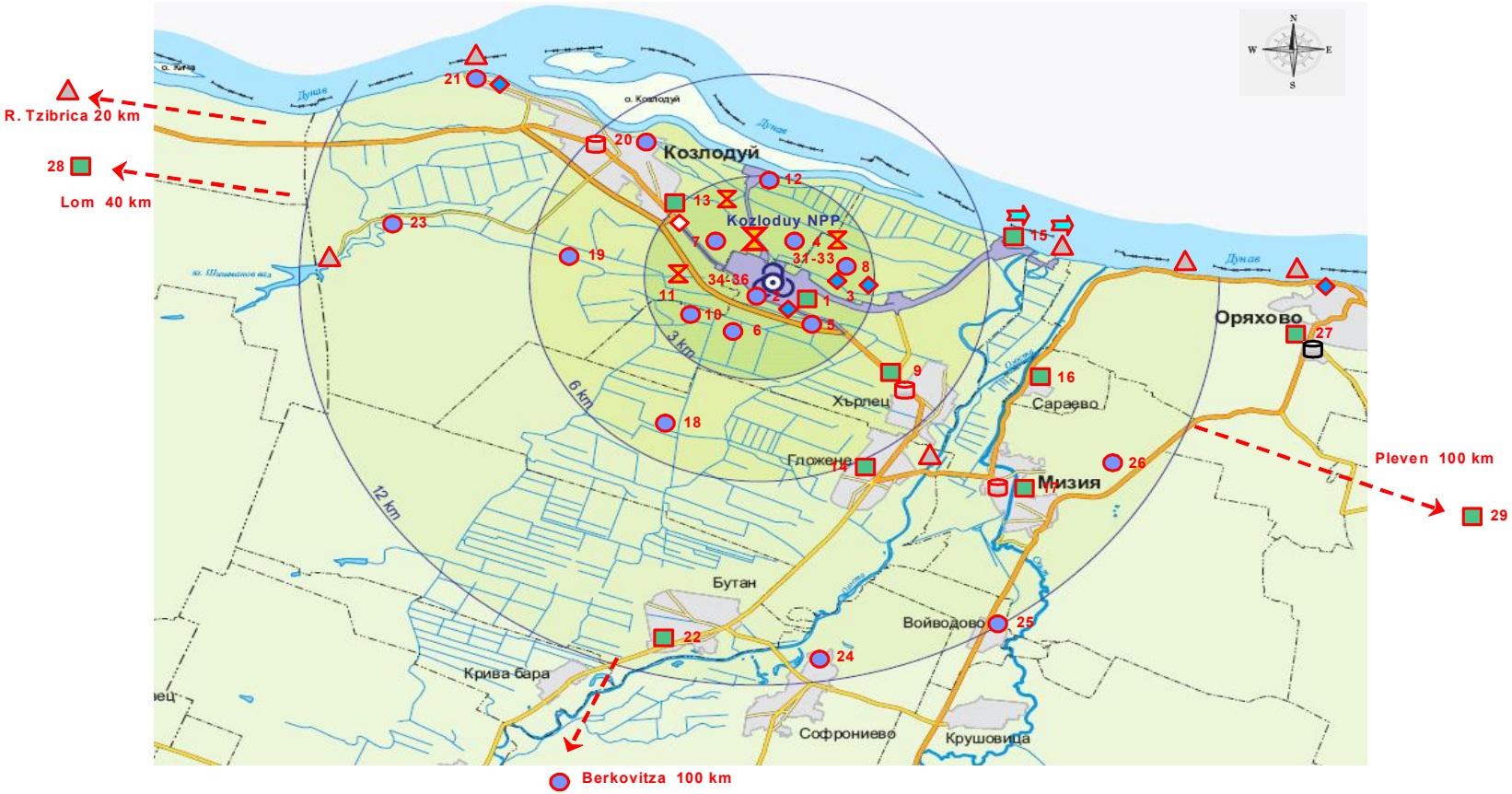


Fig. 8 Environmental Radiological Monitoring Stations in the Kozloduy NPP region.

Type "A" Monitoring Station: aerosols, atmospheric particulates, soils, vegetation, γ-background (TLD) – 11 pcs.

Type "B" Monitoring Station: atmospheric particulates, soils, vegetation, radiation γ-background (TLD) – 15 pcs.

Type "C" Monitoring Station: water, sediments, algae, radiation γ-background – 7 pcs.

Food stuff *Potable water* *milk;* *fish* *Cereals*

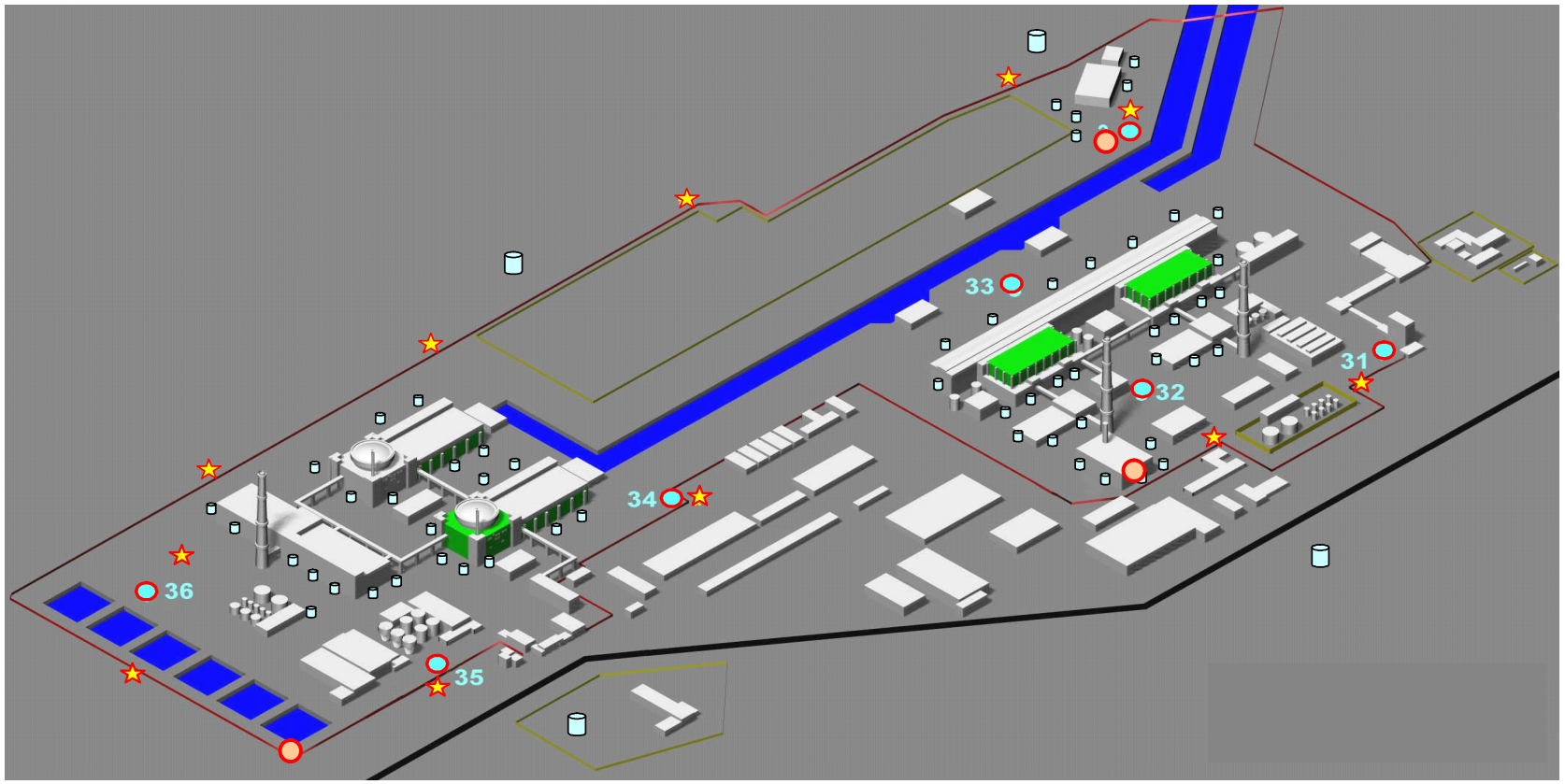


Fig. 9 Layout of the Radiation Monitoring Stations and the Thermo Luminescent Dosimeters (TLDs) at Kozloduy NPP Site.

Type "B" Monitoring Station: atmospheric particulates, soils, vegetation, radiation γ-background – 7 pcs.

TLD (type: TLE-4), located at KNPP site fence – 10 pcs.

More than 180 test-pits for groundwater monitoring on the KNPP site + 4 reference drill holes outside the KNPP site

Aerosol monitoring station – 3 pcs.

13. GENERAL CONCLUSIONS

Based on the results from the EIAR and the experts' conclusions, in summary it can be stated that the assessed impacts on the environment and on people as a result of the Decommissioning of Units 1 to 4 of Kozloduy NPP during Pre-decommissioning phase, Stage 1, Stage 2 and Closure and land restoration Stage and as a result of the new preparatory projects implementations can be assessed as very low, taking into account that:

- The radiological impacts will limited to significantly lower levels than those immediately after the KNPP Units 1 to 4 final shutdown and will be considerably reduced compared to the Units' operational phase. The radiological impacts can be reduced to even lower levels through consistent application of the ALARA principle, which is successfully applied to all previous activities performed on the Kozloduy NPP site. Transboundary radiological impacts are not expected.
- The non-radiological impacts of the decommissioning activities such as generation of conventional waste and harmful emission have been assessed as very low, local in terms of impact and short-term in terms of duration. Transboundary non-radiological impacts are not expected.

In conclusion it can be summarized that the impacts on the environment and the people in the process of implementation of the decommissioning activities for Units 1 to 4 of Kozloduy NPP are expected to be very low and will be reduced further by application of the proposed minimization and mitigation measures and the performed environmental monitoring.

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15. GLOSSARY

"Accident" means sudden technological failure of machines, facilities and units involving stopping or serious disturbance of the technological process, explosions, occurrence of fire, excessive environmental pollution, destruction, casualties or hazard to human life and public health.

"Closure" means the completion of all operations following the emplacement of spent fuel or radioactive waste in a disposal facility. This includes the final engineering or other work required to bring the facility to a condition that will be safe in the long term.

"Construction and demolition waste" shall be waste resulting from construction activity on construction sites, as well as waste from the demolition or remodelling of buildings and facilities.

"Controlled (access) area" means an area designated for the purposes of physical protection, enclosing an area around the protected area of a nuclear facility or another facility with sources of ionizing radiation, to which access is controlled.

"Decommissioning" means all administrative and technical actions taken to allow the release of a nuclear facility from regulatory control under the Act on the Safe Use of Nuclear Energy (ASUNE), including closure of a radioactive waste disposal facility or of a spent nuclear fuel storage facility. These actions include the processes of decontamination and dismantling

"Disposal" (in repository) means emplacement of spent fuel or radioactive waste in an appropriate facility or a given location without the intention of retrieval at any time in the future.

"Emergency preparedness" means the capability to take immediate actions that will effectively mitigate the impact of a possible accident on human health, the environment and property.

"Emission" means the direct or indirect release of substances, vibrations, heat or noise by point or fugitive sources within a specific installation into the air, water or soil.

"Environmental monitoring" means the collection, evaluation and summarizing of environmental information by means of continuous or periodic observation of certain qualitative and quantitative indicators characterizing the state of the environmental media and the changes therein resulting from the impact of natural and anthropogenic factors.

"Event" means any deviation from the standard mode of operation, including one or more equipment failures, operating error or errors and/or deficiency of instructions and procedures, which has led or could have led to release of radioactive substances into the working or surrounding environment or to unwarranted public or occupational exposure, or to breach of nuclear safety or radiation protection requirements, rules and standards.

"Exposure" means the impact of ionizing radiation in the course of passing through an exposed medium.

"Grave natural disaster of an exceptional character" (force major) means a catastrophic, unforeseeable and unavoidable natural disaster

"Hazardous waste" shall be waste whereof the composition, amount and properties present risks to human health and the environment, which possesses one or more properties which define it as hazardous, and/or which contains components which render it into hazardous waste and/or which is designated as such according to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

"Impact" means any effect on the environment that may be caused by the implementation of an investment proposal for construction, activity or technology, including the effect on human health and safety, flora, fauna, soil, air, water, climate, landscape, historical monuments and other material assets or the interaction among these factors.

"Incident" means a technical event or anomaly which, although not directly or immediately affecting nuclear safety and/or radiation protection, is liable to lead to a subsequent re-evaluation of the provisions for nuclear safety and/or radiation protection

"Industrial waste" means waste resulting from the industrial activities of natural and juristic persons.

"Ionizing radiation" means the transfer of energy in the form of particles or electromagnetic waves of a wavelength of 100 nanometers or less or a frequency of 3 x 1015 Hertz or more capable of producing ions directly or indirectly.

"Municipal waste" means waste resulting from the life activities of people at home and at office, social and public buildings. Waste from distributive-trade establishments and accessory handicraft activities, recreational and entertainment establishments shall be subsumed under household waste where not having the nature of hazardous waste and where, concurrently, the amount or composition thereof will not impede their treatment together with municipal waste.

"Nuclear facility" means a facility and its associated land, buildings and equipment in which nuclear material is produced, processed, used, handled, stored or disposed of on such a scale that consideration of nuclear safety and radiation protection is required. Any radioactive waste management facility shall likewise qualify as "nuclear facility."

"Nuclear fission chain reaction" means a series of nuclear reactions of fission of atomic nuclei which is sustained by neutrons liberated in the process of fission

"Nuclear fuel" means any special fissionable material capable of producing energy by a nuclear fission chain reaction.

"Nuclear material" means source material, special fissionable material and other materials designated by an act of the Council of Ministers.

"Nuclear power plant" means a power plant for power generation from one or more nuclear power units, including all auxiliary facilities for RAW and spent nuclear fuel management, localized at one site with common physical protection and accident planning.

"Nuclear reactor" means any nuclear installation containing nuclear fuel in such an arrangement that a nuclear fission chain reaction can occur in the installation without an additional source of neutrons.

"Nuclear safety" means the state and the capability of a nuclear facility and of its systems and personnel to achieve appropriate operation conditions, the prevention of incidents and accidents, and the mitigation of any effects in a way to ensure at a maximum level the occupational and public protection from ionizing radiation of the nuclear facility.

"Occupational exposure" shall be all exposure incurred by persons occupationally engaged in activities subject to regulatory control under this Act, and in the activities associated with regulatory control.

"Physical protection" means a set of all technical and organizational requirements, measures, means and methods intended to effectively prevent unauthorized tampering or interference with, or unauthorized removal of, nuclear material, nuclear facilities and radioactive substances (theft, intrusion into the site of a nuclear facility, unauthorized access to areas vital to the safety of the nuclear installation, sabotage, terrorist actions), their timely detection, and recovery of misappropriated nuclear material.

"Protected areas" (Protected Sites) as per Biodiversity Act (Natura 2000) are sites subject to appropriate special protection and conservation regime according to the requirements set up by two EU's two Directives - Directive on the conservation of wild birds (Birds Directive) and Directive on natural habitats and of wild fauna and flora (Habitats Directive). These EU directives require from the member-states to put under special protection and conservation regime wildlife and nature habitats, as well as rare European species. In order to be applied in Bulgaria, texts of these two directives were transposed in the Bulgarian Biological Diversity Act (Biodiversity Act), where the Natura 2000 network sites are called Protected Areas. The Protected Areas (Special Areas of Conservation) as per art. 3 (1), p. 1 are designed for protection and recovery of the favourable conservation status of the hosting natural habitats as well as of the species in their natural living areas. In the Protected Area can be implemented human activities which do not deteriorate the habitats, subject to a protection in the area.

"Public exposure" means the exposure incurred by members of the public as a result of lawful or unlawful practices with sources of ionizing radiation, excluding any occupational exposure, medical exposure and the normal local natural background radiation typical of a specific working or living environment.

"Radiation accident" means an unintended event that leads or may lead to exceeding the limits or to violation of the conditions of the radiological impact on humans and the environment as established in the nuclear safety and radiation protection standards and rules.

"Radiation monitoring" means the measurement of radiation or other parameters for reasons related to the assessment or control of exposure to radiation, as well as the interpretation of the results.

"Radiation protection" means a totality of organizational and technical measures intended to protect people from exposure to ionizing radiation, including ensuring the safety of sources of ionizing radiation and the activities with such sources, i.e. minimization of the risk of unwarranted exposure, of the number of persons exposed, or of the exposure incurred by humans without exceeding the statutory dose limits, prevention of a radiological emergency, and mitigation of its effects.

"Radioactive source" means a source whereof the properties to emit ionizing radiation are attributable solely to the contained radionuclide.

"Radioactive waste management" means all activities involved in the handling, pre-treatment, treatment, conditioning, storage and disposal of radioactive waste, excluding their transportation out of the site. It could include also the admissible releases.

"Radioactive waste" means a radioactive substance in a gaseous, liquid or solid form for which no further use is foreseen by the licensee or permit holder and which is controlled as radioactive waste by the Agency according to this Act, including a radioactive source for which the safe operating lifetime has ended according to the design documentation.

"Release from regulatory control" is a regulatory activity, as per the ASUNE, performed by the licensee or permit holder, in view of exemption of further activities (disposal in repository, recycling, reuse etc) related to handling of radioactive substances or materials, from the regulatory control under this act and under the relevant regulatory acts on its application.

“Safe enclosure” means a strategy in which a facility or part of it is placed into a safe condition and in which decontamination and dismantling are delayed for certain time period. During this time, a surveillance and maintenance programme is implemented for the facility.

"Safety assessment" means a review of all aspects of the design and operation of a nuclear facility or another source of ionizing radiation which is relevant to its safety and to the protection of persons, including an analysis of the provisions for nuclear safety and radiation protection and of the risks associated with normal operation and with accidents.

"Source of ionizing radiation" or "source" means any apparatus, radioactive substance, unit, product, installation or facility capable of emitting ionizing radiation or of releasing radioactive substances (with the exception of nuclear facilities)

"Special fissionable material" means Plutonium-239, Uranium-233; uranium enriched in the isotope ^{235}U or ^{233}U, and any other material containing one or more of these isotopes.

"Spent fuel management facility" means any facility in which the primary purpose is spent fuel management, including the nuclear facility in decommissioning if it was defined under the law as a facility for RAW management.

"Spent nuclear fuel" or "spent fuel" means nuclear fuel that has been irradiated in a reactor core and that has been permanently removed from the core.

"Storage" (nuclear) means the holding of nuclear material or radioactive substances, including spent fuel or radioactive waste, in a facility that provides for their containment, with the intention of retrieval.

"Temporary storage" means an operation related to the storage of waste at the place of generation or upon collection for a regulatory fixed time period.

"Treatment of waste" shall be the collection, storage, recovery or disposal of waste and all intermediate operations, as well as the reuse, recycling and reclamation of waste, or production of energy or extraction of materials from waste.

"Waste landfilling" (disposal) is a method which does not envisage further treatment of the waste and consists in storage of waste for a period longer than three years (applicable to waste destined for recovery) and one year (applicable to waste destined for disposal) in a manner which does not present risks to human health and the environment

"Waste management" shall be the operations comprehended in the collection, transport, recovery and disposal of waste, including the supervision of such operations and after-care of treatment installation sites.

"Waste" means any substance, object or part of an object which the holder discards or intends or is required to discard.

16. EIAR CONTACT PERSON DATA

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