Environmental Impact Assessment Report

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

CHAPTER 1

ANNOTATION OF THE INVESTMENT PROPOSAL FOR IMPLEMENTATION/INSTALLATION, ACTIVITIES AND TECHNOLOGIES OF PMF AT KNPP SITE

CONTENTS

1. ANNOTATION OF THE INVESTMENT PROPOSAL FOR IMPLEMENTATION/INSTALLATION, ACTIVITIES AND TECHNOLOGIES OF PMF AT KNPP SITE

The purpose of the KNPP PLC investment proposal is to build a “Facility for treatment and conditioning of radioactive waste with high volume reduction factor” at KNPP by using of plasma technology, which will help to reduce the volume of low and intermediate level radioactive waste (RAW) stored at different locations at KNPP site.

RAW is stored at several locations at KNPP site.

Some of these locations include buildings that will become part of the Safe Enclosure (SE) Area at the site, where monitoring and maintenance will be minimized during the SE preparation and operation. In order to minimize monitoring and maintenance at these locations, it is recommended that waste should be transferred and processed. The Plasma Melting Facility (PMF) will also help to ensure that there is enough capacity in the existing RAW storage facilities at the KNPP site until the National RAW Storage Facility is built.

The selected technology for this Facility is a high energy technology able to treat radioactive waste. The technology uses a thermal plasma field which is created by directing an electric current through a low pressure gas stream. The following groups of RAW will be treated and conditioned at the PMF:

- RAW generated during operation of Units 1-6 and currently stored at the KNPP site;
- Additional amounts of RAW that are expected to be generated during the stages of the SE Preparation and Operation and as result of dismantling activities during decommissioning of Units 1-4;
- Waste expected to be generated during the on-going operation of Units 5 and 6 as well as during their preparation for future decommissioning.

The Plasma Melting Facility will operate in accordance with the ALARA principles ensuring:

- Protection of the people and minimizing of the occupational dose for the operational and maintenance personnel;
- Environmental protection.

Using the best available technologies (BAT) and the existing experience in this area, the PMF will represent an expansion of the existing NPP activities for RAW treatment and conditioning.

The requirement to use BAT is essential for minimizing the possibility of negative PMF impact on the environment and to ensure environmental protection.

1.1 General description of the PMF and installation location

1.1.1 Designated area for PMF installation within the KNPP site general plan

The investment proposal for a Plasma Melting Facility (PMF) will be implemented within KNPP. Figure 1.1.1-1 shows KNPP location.

Figure 1.1.1-1 KNPP location

“Kozloduy” NPP has been constructed in north-western Bulgaria on the right bank of the Danube River near the town of Kozloduy. The site is located 120km away from the city of Sofia in a direct line, and 200km by road. The area within a 30-km radius around the site includes municipalities with the following centers: Kozloduy, Valchedrum, Hayredin, Mizia (entirely) and Lom, Byala Slatina and Oryahovo (partially). The 30-km area around the site also includes a sparsely populated part of the territory of Romania where a total of 23 settlements is located, of which 2 towns – Dabuleni and Bechet, and 21 villages - Nedeia, Gighera, Zaval, Ostroveni, Sarata, Calarasi, Listeava, Piscu Sadovei, Sadova, Gangiova, Macesu de Jos, Macesu de Sus, Sapata, Plosca, Bistret, Brandusa, Goicea, Barca, Horezu Poenari, Toceni, Valea Stanciului.

The closest settlements to KNPP are: Kozloduy town located 2.6 km southwest, Hurletz village located 3.5 km southeast, Glozhene village 4.0 km southeast, Mizia 6.0 km southeast, Butan village 8.4 km south and Oryahovo town located 8.4 km east of the site.

KNPP site is located at the 694th km from the Danube estuary at a distance of 3.7 km from the river midstream and the state border with Romania. The NPP is located in the northern part of the first non-flooded (loess) terrace of the Danube River where Units 1-6 have been built. The site has been marked with construction coordinates

A=200 to A=1200 and B=400 to B=1500. In this area the loess terrace has terrain elevations of +35.00 to +37.00 m.

The total area of the site is approx. 3.2 km^2 and together with the channels for circulation and technical water supply reaches 5.2 km^2.

The proposed PMF will be installed at the KNPP site and the proposed location is within Auxiliary Building-2 (AB-2) (fig. 1.1.1-2), in Room BK301 at elevation level +6.30 m and Room BK039/3 at elevation level +0.00 m.

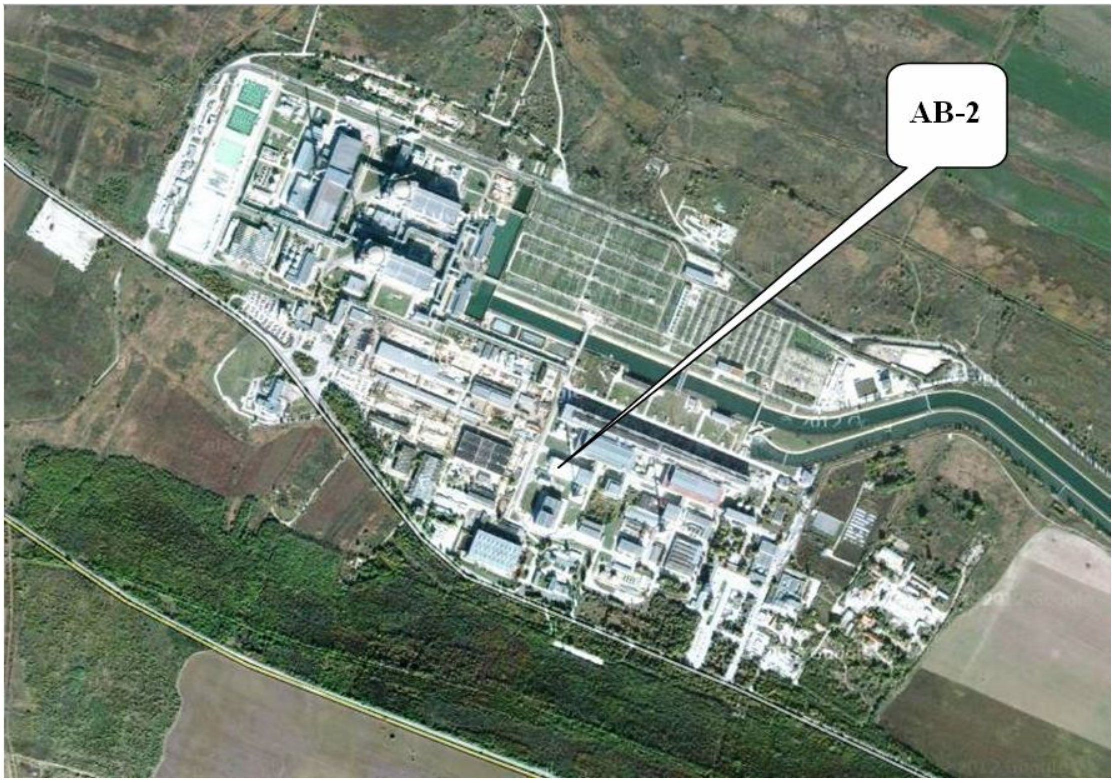

Figure 1.1.1-2 Location of AB-2 at KNPP site

1.1.2 Relations to other existing activities approved by a territory regulation or other plan.

The designated location for PMF layout is within the Auxiliary Building – 2 (AB-2), elevation +6.30 m, Room BK301.

The Room is connected to the site systems providing:

- Electricity
- Steam
- Compressed air
- Demineralized water
- Cooling water
- Nitrogen
- Ventilation

The PMF will be built in respect to the operation of Units 5 and 6 of KNPP and to the decommissioning of Units 1 to 4 of the same plant. The purpose of the facility is a significant reduction in RAW volume for disposal, which should also reduce the costs of managing the RAW. The construction of the facility is part of a five-year schedule of the "Comprehensive Program for RAW management at KNPP"

The PMF as part of KNPP site is protected by the system of physical protection of NPP "Kozloduy". Therefore, no additional physical protection or changes of the existing one are planned.

Fire risk analysis has been performed for the PMF [2] based on the PMF design, the instructions and requirement included in the KNPP fire and accidents protection procedures.

The construction of the PMF will not lead to changes in the existing program for non-radioactive waste management within the NPP "Kozloduy".

The transport of RAW to and from PMF will be reconciled with the existing transportation scheme for transporting of non-processed and processed RAW at KNPP site. Scheme of the transport is given in section 1.2.4.2.

PMF will be built in the existent building AB-2 and no additional provision of utilities and ancillary infrastructure is required.

1.2 General characteristics of the PMF

1.2.1 General Plan of the PMF

AB-2 is a building designed to service KNPP Units 3 and 4, and Room BK301, where PMF will be located, is currently unused.

The room is approximately 71.3 m in length, 36.4 m in width and approximately 8.45 m in total height and the floor area is served by three cranes of lifting capacities 6.30 t, 4.00 t and 2.00 t. (fig. 1.2.1-1).

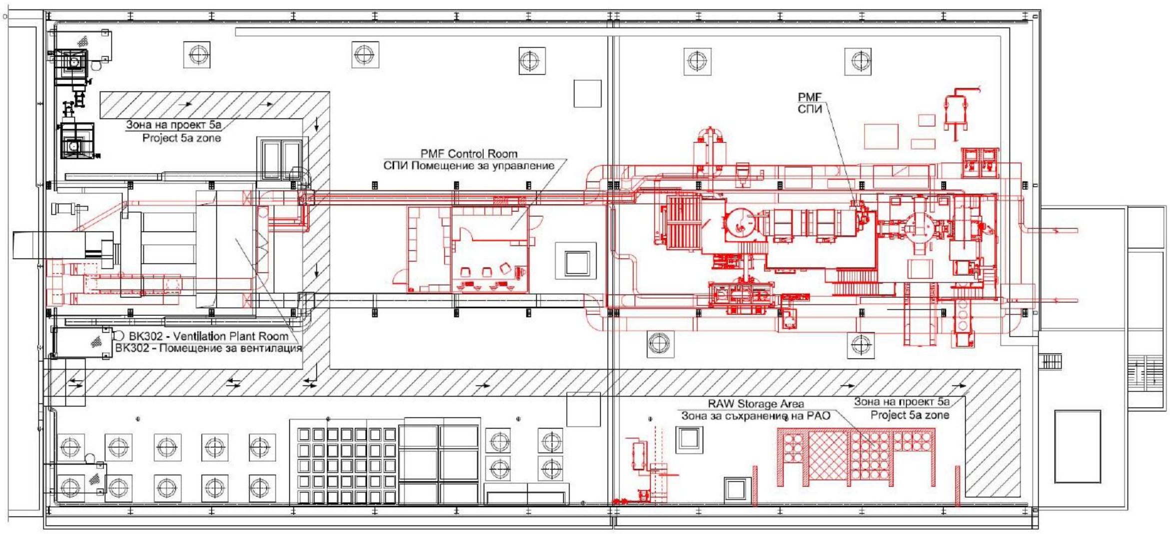

Figure 1.2.1-1 Plan of AB-2, elevation +6.30 m

The following is considered with reference to the layout of PMF and its components in this room:

- The range of the existing cranes in view of their use for the needs of the PMF design;
- The location of the protruding floor parts in Room BK301 (between axes 13 to 19);
- The roof structure support columns;
- The ventilation air ducts of the intake-extraction ventilation system at room BK301;
- The proximity of the existing transportation hatchway in the floor of room BK301, through which RAW will be loaded and unloaded.

Taking into account the existing conditions and infrastructure, the PMF design envisages partial reconstruction of room BK301. Such reconstruction is required due to the overall height of some of the PMF modules and the need to provide conditions for installation, maintenance and dismantling activities.

The reconstruction height (fig. 1.2.1-3 and fig 1.2.1-4) is optimized and covers:

- Elevation of the middle part of the roof structure of room BK301 (between rows B and V) in the section from axis 14 to axis 19 and limitation of the way of the existing 2.0 t crane that services this section to axis 14;
- Installation of a new suspension single-girder crane (with a lifting capacity of 5 t) for PMF servicing, whose way covers the area below the elevated part of the roof structure of room BK301;
- Reconstruction of the air-ducts of the existing common exchange extraction ventilation system of room BK301;
- Implementation of additional fire protection engineering and technical measures.

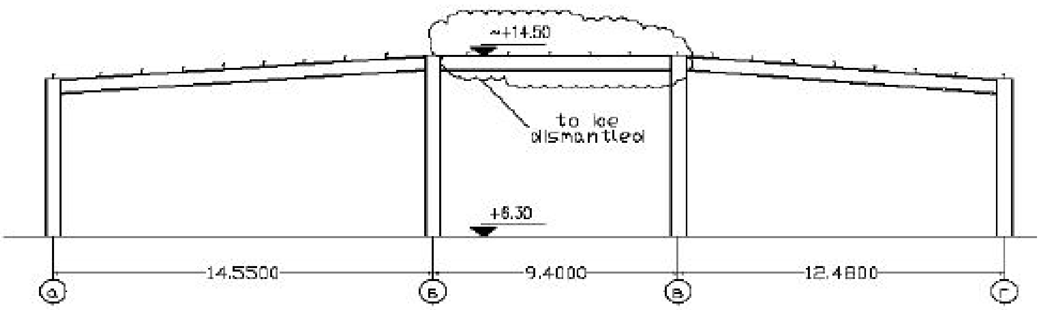

Figure 1.2.1-3 Transection of AB-2 existing situation

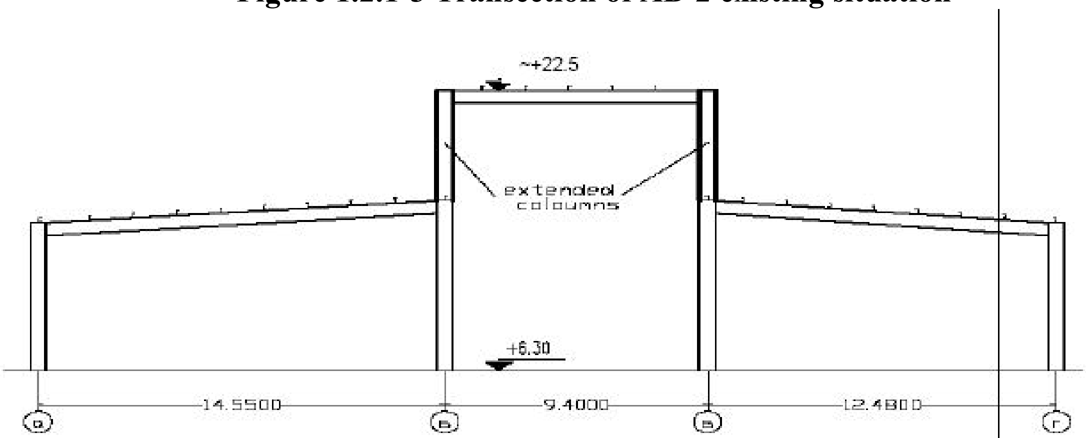

Figure 1.2.1-4 Transection of AB-2 after reconstruction

Access to the room is either possible from the Radiological Control Area (RCA) to the east of the room or via a staircase on the west side. There is also a hatchway (3.00°m x 5.00°m) on the floor in the north-eastern corner of the room. Beneath the hatchway, at the 0.00°m level, there is a loading/unloading bay capable of accommodating vehicles carrying equipment or waste. The access to the unloading bay is via a pair of doors at either end of the bay which are 4.00 m wide and 4.50°m high.

In the south-eastern bay of room BK301 covered by the 6.3 t crane, an area for temporary storage of incoming RAW, secondary waste and final drums with vitrified waste is planned.

It is expected to outline three areas designated to store 6000 kg in total of incoming RAW, which is nearly the quantity of waste needed for one week of PMF operation, and another area to store six drums with processed waste, which is the estimated production of one week of PMF operation. Considering the maximum weight of each type of waste package, the temporary storage can store 100 bags (20 kg/bag), 20 drums (100 kg/drum) or 8 pellets (250 kg/pellet).

The storage is an enclosure area provided with two labyrinth entrances and therefore waste packages will be accessible by the crane and by the pallet truck.

Figure 1.2.1-5 shows the general PMF layout in the building.

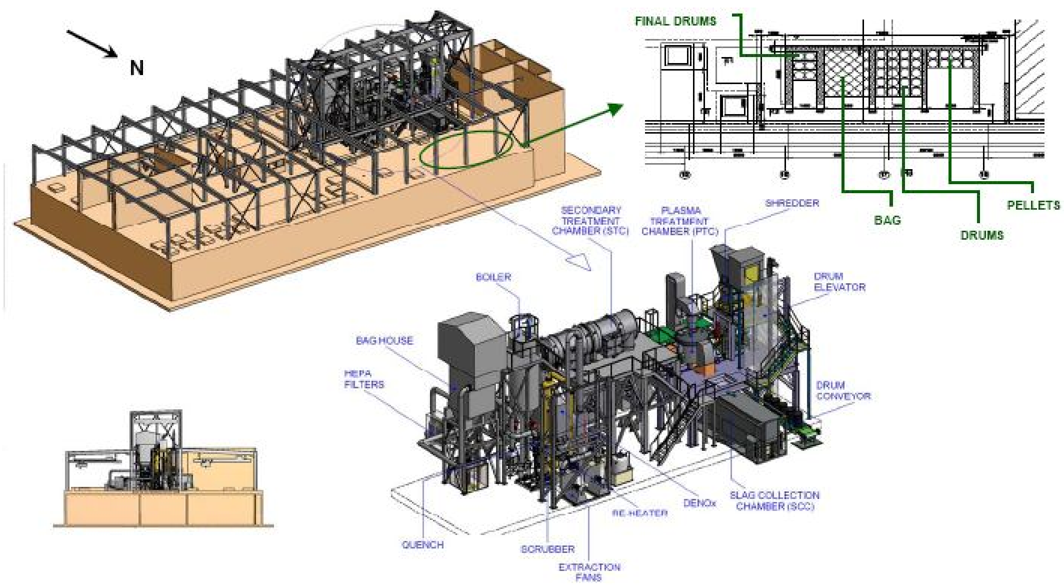

Figure 1.2.1-5 General PMF layout

1.2.2 Stages of the investment proposal

The proposed schedule for implementation of the IP is divided in five stages. The design term of operation of the facility is at least 40 years.

- **Stage 1 – 2009 – 2011** includes conceptual and technical design of PMF, including equipment for RAW manipulation, processing and conditioning, and conceptual design of the auxiliary flows, the electrical power, the auxiliary equipment and the interfaces of Auxiliary Building AB2;
- **Stage 2 – 2013** Production and testing;
- **Stage 3 – 2014** Execution of construction works;
- **Stage 4 – 2014** Delivery and installation: site interfaces management,

leading of auxiliary flows and power supply, marking and labeling;

- **Stage 5 – 2014 – 2015** Commissioning: maintenance, inspection, testing, training and completion of the facility.

1.2.3 Description of the technology and the main processes related to the PMF installation and the resources used

1.2.3.1 General description of the technology for RAW treatment and conditioning.

This section includes a brief technological description of PMF from RAW generation to the release of the processed outgoing gases into the atmosphere. Figure 1.2.3.1-1 includes a general technological scheme of the facility.

Untreated waste, pre-compacted waste in 200 l drums and super-compacted waste (called “untreated waste” from now on) arrive at AB-2 in KNPP waste containers through the existing lock in AB-2. The waste packages are unloaded from the container using a grabbing device attached to the crane hooks of the existing crane in AB-2 and are placed in temporary storage facilities.

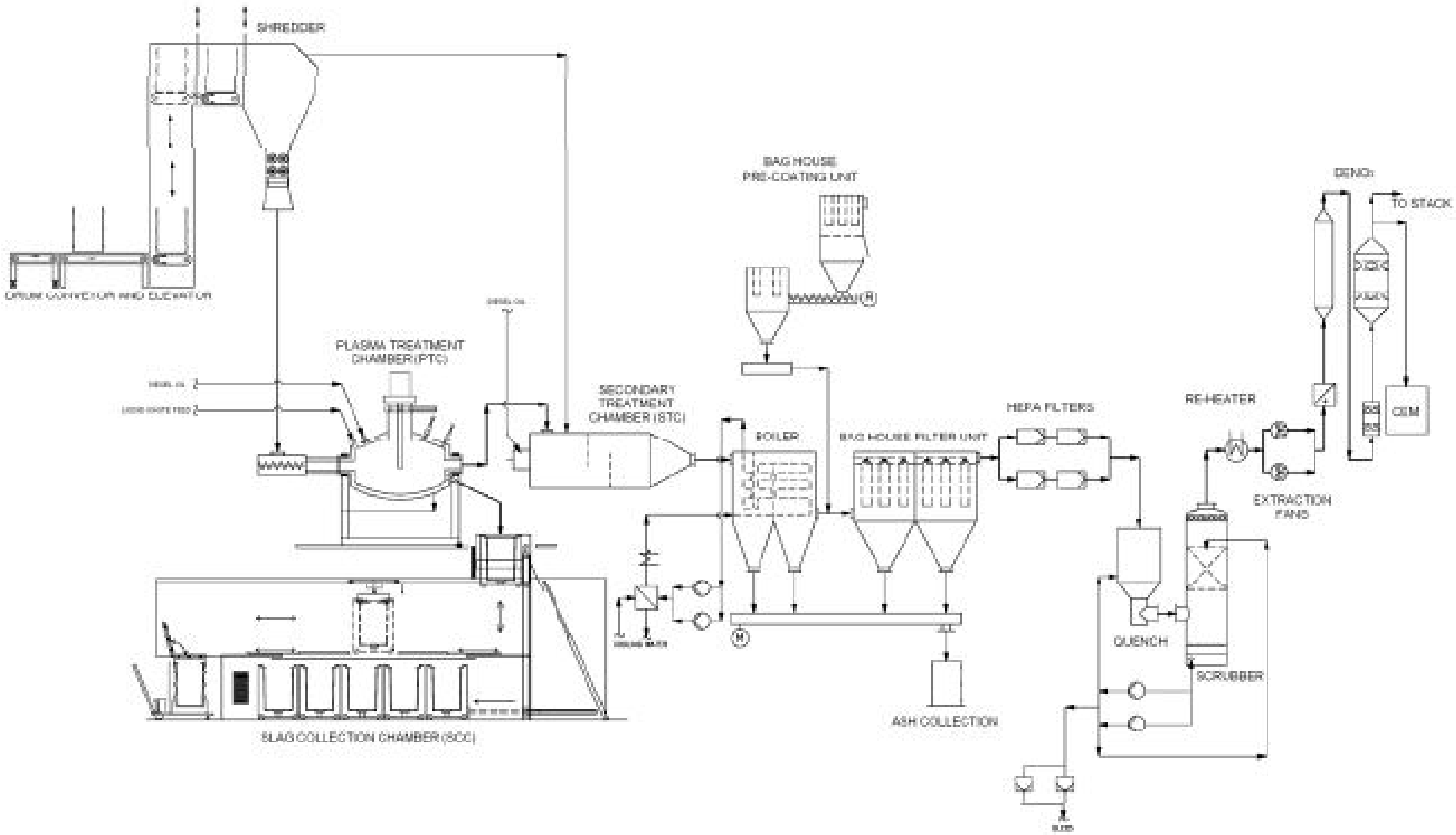

Figure 1.2.3.1-1 General technological scheme of the facility

The untreated waste is taken by the grabbing devices, moved to the transport conveyor and from there the waste is automatically transferred to the shredder unit. This system consists of semi-automatic conveyor (with a built-in balance), lifting device, airlock and a two-stage shredder with extrusion tube.

The shredder and extrusion tube process the untreated waste into small and relatively uniform material forming a continuous feed to the Plasma Treatment Chamber (PTC, also named as Primary Treatment Chamber).

The shredder unit is purged with N_2 to reduce the oxygen concentration below 4 %.

The PTC (fig. 1.2.3.1-2) is a high temperature (1100°C – 1500°C) tilting furnace. The volume of the furnace is designed to contain around 200 l of molten slag. The PTC outer diameter is approx. 2.2 m and its height is approx. 2.8 m.

The PTC is designed to process approx. 80 kg/h and nominally 65 kg/h shredded organic waste during 100 hours per week, starting from Monday morning until Saturday morning inclusive. The volume of molten slag produced daily is 170 l; the slag is poured into 190 l forms.

Two types of burners are provided. A diesel-oil burner of 300 kW is used to dry-out or to reheat a cold furnace as well as to keep the furnace warm, and a Plasma Heating System (Plasma Torch).

Into the PTC, equipped with a plasma torch acting as a heat source, the organic material is vaporized in volatile hydrocarbons, carbon monoxide, etc., while non-combustible and other inorganic constituents are melted and transformed into glassy slag. The Plasma System is a high energy technology able to treat a large range of waste. In plasma technology a thermal plasma field is created by directing an electric current through a low pressure gas stream (air used as plasma gas). The extremely high temperatures in the arc can be used to completely decompose all organic materials to their chemical components by injection in the plasma or using plasma arc as a heating source for burning or pyrolysis.

When the PTC is filled up with the treated product (molten slag) the feeding process can stop and the process of slag pouring in moulds can start . The slag pouring cycle is semi-automatic. When the mould for the slag is positioned the tap hole is opened by remote control. In the same time the furnace is tilted for starting the molding process. In result the available slag is emptied through nozzle or funnel into the slag mould which is preliminary put in a cooling mould. The final residues are further cooled in separate Slag Collection Chamber.

The ventilated confinement consists in conveying unit where slag is cooled down, pouring location (including lifting device for reaching the pouring nozzle) and loading station where, after cooling, through an airlock with double cover, the slag mould is transferred into a 200 l drum. The drum, which has practically no external contamination, is transported to a temporary storage facility waiting for the final disposal at the facility of SE RAW.

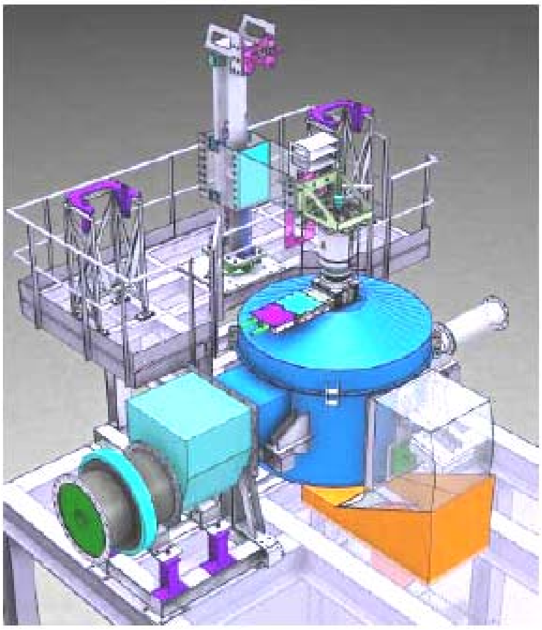

Figure 1.2.3.1-2 Primary Treatment Chamber with a burner and console

The plasma furnace is designed with refractory concrete lining with high melting point. It will minimize refractory maintenance, and maximize the lifetime of the system. Concrete layers are selected because they can be repaired instead of replaced, thus minimizing the volume of generated waste.

The furnace has a water cooled casing in order to obtain normal surface temperatures of the primary chamber and to extend the lifetime of the refractories.

The furnace operates at negative pressure of about 250 Pa and has a good air-tightness so that almost no cold air is entering the furnace. As no additional air is added to the furnace, organic waste will not burn but rather gasify. A secondary treatment chamber (STC) will burn those gases.

The STC is a camber with refractory casing, which takes in the technological gases from PTC. The unburned gases, hydrocarbons, soot particles, CO, hydrogen and fly ash flow from the primary treatment chamber (PTC) to the secondary treatment chamber (STC). According to the design, the off-gases from the PTC will enter the STC with rated temperature of about 1300°C, while their maximum temperature will not exceed 1500^{o}C. The gases are mixed with more air to obtain a complete combustion to primary oxidized components such as CO_2, SO_2 and H_2O. The additional amount of air is controlled by a controlling oxygen analyzer at the STC exit to maintain the minimum level of 6 %.

The STC is sized to provide a minimum of two seconds residence time at the design waste feed rate and at a minimal temperature of 850°C. The normal working temperature is between 900 and 1000°C. This temperature window is a good compromise between the possibility of achieving complete combustion at a temperature considerably higher than 850°C and the power consumed for that purpose. The STC is equipped with a secondary burner. It operates with diesel oil and varies between high and low flame and regulates the STC exit temperature. The high flame of the burner is also used to heat up the system during the preliminary heating cycle.

The STC inner coating layer is designed to withstand a maximum temperature of 1650°C.

After the STC the flue gases enter the flue gas treatment system.

The flue gases are at first cooled down in a three pass radiant heat boiler, and then enter the bag house, where particulate matter is captured by surface filtration of membrane filter bags of Polytetrafluoroethylene (PTFE). The filter medium is cleaned by means of pulsed jets of compressed air; the collected particles are shaken off from the surface of the bags. The hopper at the bottom of the bag house receives the released particulate matter and emptying is accomplished through a rotary discharge valve at the vibrating tube.

In order to retain radioactive particles, the gases enter the HEPA filters downstream the fabric filters chamber (consisting of two parallel compartments - one compartment serves as standby). Two pre-filters with 90 % efficiency and two absolute filters with 99.97 % efficiency for particles larger than 0.3 µm are also installed.

The wet gas scrubbing assembly, installed after the HEPA filters, consists of a quencher tower for the cooling down of gases and counter current scrubbing tower with 99.99 % efficiency with caustic liquid for removal of HCl and SO_2, and a demister. The HEPA filters have efficiency of 99.97 %, and after the scrubber system efficiency of 99.99% can be assumed, considering the activity captured in the solid products (slag and ash) and liquid products (scrubber water).

Downstream the scrubber assembly two extraction fans in parallel ensure the evacuation of flue gases (one fan is stand-by). The negative pressure in the whole system is controlled by frequency controlled motors of the above mentioned extraction fans.

Downstream a fan module a DeNOx - system is installed, aiming to reduce NOx concentration; this systems includes heating unit aiming to reach the necessary temperature of the flue gases and reduce catalytically their NOx concentration.

Upstream the cleaning gases are evacuated to ventilation stack 2 (VS2) a continuous emission monitoring system will be installed for controlling the chemical parameters such as concentration of CO, SO_2, NOx, HCI, O_2, H_2O, NH_3 and TOC. A dust controlling device will also be installed. A sampling system for determining of the radioactive releases on 24-hour basis will also be provided.

The ammonia containing tank capacity necessary for the DeNOx system is 500 l (25% NH_3).

Table 1.2.3.1-1 includes the main PMF characteristics.

Table 1.2.3.1-1 Main PMF characteristics

Performance	250 t/year
Feeding rate (per hour)	65 kg solid waste, or 55-60 kg solid waste and 5-10 kg liquid waste

Flow of flue gases	Nominal value: 1200-1400 Nm^3/h
Effective operation	4000 h/year
Specific radioactivity (incoming waste)	Maximal value: 5.17E+05 Bq/kg

In terms of radiation protection the following considerations are taken into account in PMF ISAR [2]:

- Protection against radiation exposure by shielding and containment;
- The control of access to areas for waste processing and storage and the control of movement between radiation zones and contamination zones;
- Control of waste packages dose rate and removable contamination;
- Minimum operator interventions;
- The control of liquid and gaseous effluents;
- Ventilation and filtration of airborne releases;
- Provisions for easy and low frequency maintenance;
- Fire protection and the prevention of explosions;

The Radiation Protection Program will be based on the assessment of operational dose rates to the personnel working at AB-2 and to the public considering magnitude and location of sources of ionizing radiation in the PMF, as described in previous sections. It should cover:

- The classification of working areas and access control;
- Local rules and supervision of work;
- Monitoring of individuals and the workplace;
- Work planning and work permits;
- Protective clothing and protective equipment;
- Facilities, shielding and equipment;
- Health surveillance;
- Application of the principle of optimization of protection;
- Removal or reduction in intensity of radiation sources;
- Training;
- Arrangements for emergency response.

In order to optimise as much as possible the radiation exposure to workers, the following design provisions or improvements are considered in the PMF:

- High degree of automation in the design of the PMF operations and use of remote handling technologies or indirect tools resulting in lower radiation exposure of personnel during operations.
- Provision of shielding structures for areas with higher dose rates (e.g.: waste temporary storage) and appropriate shielding for equipments that house considerable amount of radioactive waste in order to minimize personnel exposure.
- Reduction of equipment maintenance time by use of reliable equipment that requires less frequent maintenance.
- Provisions of sufficient space for inspection/maintenance to facilitate the execution of these activities.

- Choice of materials and space for access to dismantle equipment for the purpose of facilitating decontamination and removal.
- Adequate radiation monitoring of the workplace and the environment and exposure monitoring of the workers and the public.

The following activities are foreseen to optimise the radiation exposure during maintenance:

- Installation of temporary boxes to prevent the spread of radioactive contamination;
- Before internal maintenance of the vessels, cleaning operations will be carried out by means of an special adapted vacuum cleaner
- There is the option that the last waste batch, fed to the system, can be non radioactive waste or very low activity radioactive waste. By this procedure the residual radioactivity of the different components decreases and is in fact “flushed out”. Therefore, the dose uptake and the risk for contamination dispersion are reduced.

1.2.3.2 Stages of the installation process, description of the main activities, proposed methods for PMF installation

The 5 separate stages of construction and PMF installation are shown in section 1.2.2.

No major construction works are planned, since the facility will be installed in the existing building. The planned construction works include increasing the height in the middle of the building to provide enough space for all the equipment which is part of the facility, and the construction works related to the fuel supply system.

Within the pre- feasibility study based on the existing data an analysis has been made for the building, taking into consideration the weight and size of the cranes [1], the new equipment to be installed and other possible loads that need to be considered due to the new use of the structure. The conclusion may indicate that only certain strengthening must be done to absorb the planned load.

In order to provide enough space for the facility equipment, the Contractor proposes to remove the roof and to increase the height in the middle of the building to 12 m. In addition, a bridge will be installed mainly for maintenance purposes. Table 1.2.3.2-1 presents the main PMF construction activities.

Table 1.2.3.2-1 Main PMF construction activities

1	***Dismantling activities*** o The middle roof installations are removed (between rows “b” and “v”). o The roof panels are removed. o The middle roof rafters are removed. o The horizontal middle roof ties are removed (between rows “b” and “v” /and axes 14-15 and 18-19, Figure 1.2.3.2-1). o The transverse collar beams in the middle are removed.
2	***Temporary strengthening of the steel construction*** o Installation of temporary vertical and / or horizontal connections between the columns in rows “b” and “v” (before dismantling of the collar beams)
3	***Strengthening of the existing elements and installation of new ones*** o The superstructure of the columns (the new part) is installed.

	o Additional (new) steel strengthening connections are installed. o Additional (new) steel horizontal strengthening connections in the middle are installed. o The roof collar beams are installed. o The roof longitudinal girders are installed. o The facades of the superstructure are installed. o The roof panels are installed. o New crane way in the middle is installed. (Figure 1.2.3.2-2)
4	***Installation of supporting steel construction and reinforced concrete foundations for the main and additional equipment*** o Supporting steel constructions for the equipment are installed. o Steel platforms and stairs are installed for maintenance purposes. o Supports for pipelines and cables.
5	***Disposal of the construction waste and building of the inner infrastructure*** o Waste disposal o Building of special drainage channels o Steel casing of the decontamination area o Building of lead protective walls o Placing of epoxy coating on the floor

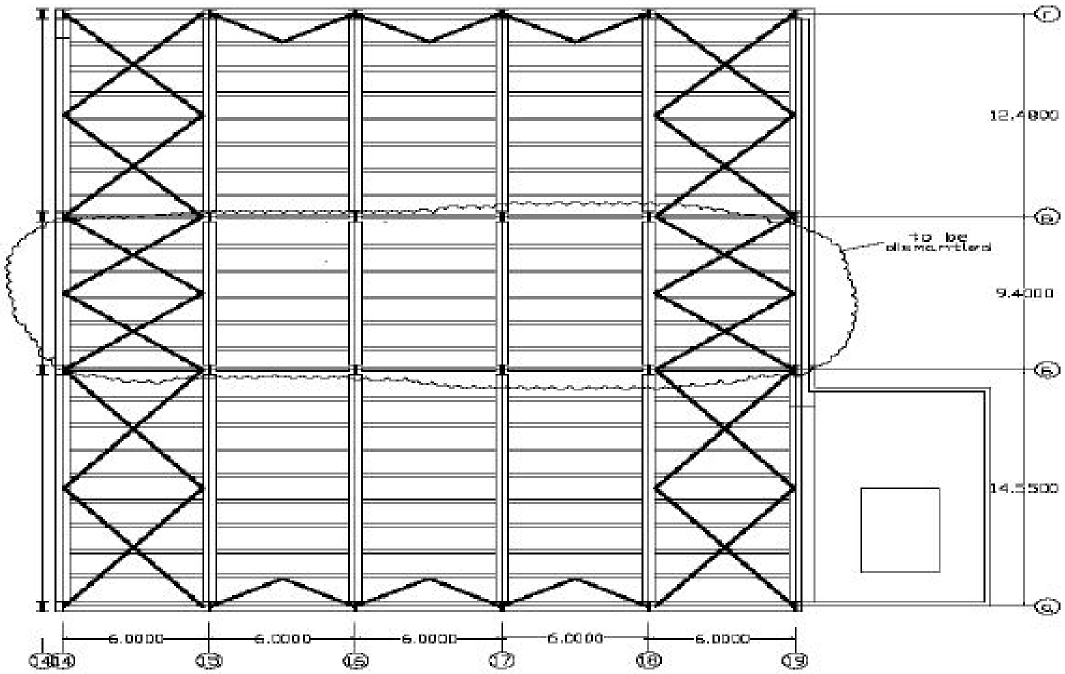

Figure 1.2.3.2-1 Existing auxiliary building – roof plan

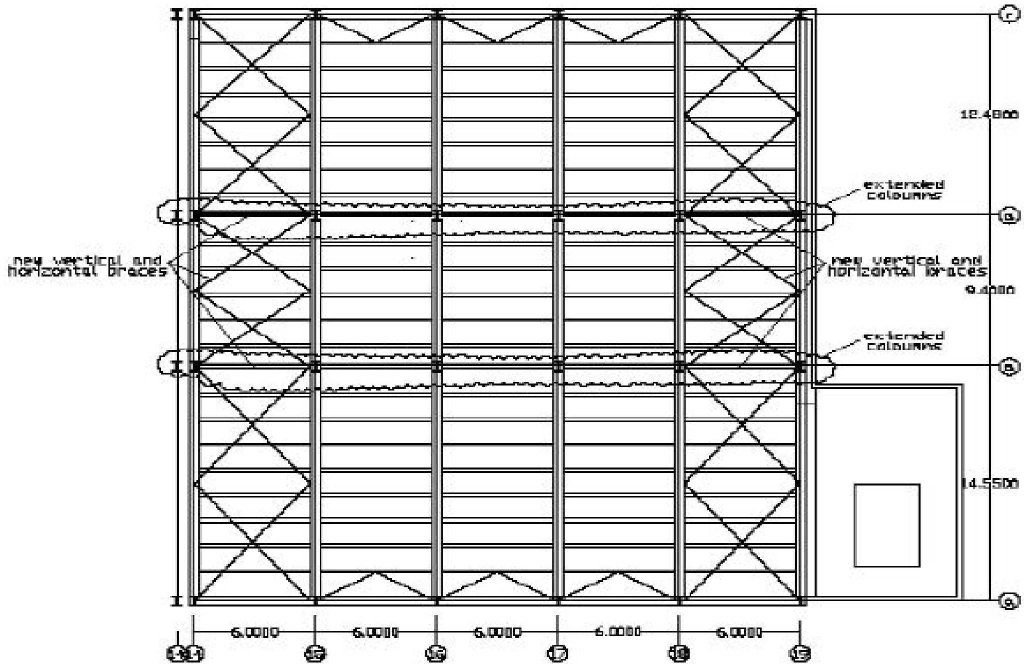

Figure 1.2.3.2-2 Auxiliary building reconstruction– roof plan

1.2.3.3 Main resources and other materials necessary for the implementation/installation activities

According to the information provided water will be the only natural resource that will be used during the project implementation.

1.2.3.4 Necessary personnel for the implementation/installation activities

During PMF construction 40 workers per day will be necessary, and the total number of workers will be 400 (employed at various stages of construction).

1.2.3.5 Information regarding the provision of offices and contractor services related to the proposal

During PMF construction suitable offices and services for the contractors will be provided.

1.2.4 Description of the main processes during PMF operation and decommissioning phases as well as the utilized resources

The information about the main processes during PMF construction, operation and decommissioning are described in detail in the EIA-input report [1] and in parts of the ISAR [2]. The waste acceptance criteria were taken accordingly from the document “Technical Specification of a Facility for Treatment and Conditioning of Radioactive Wastes with High Volume Reduction Factor at Kozloduy” [3].

1.2.4.1 Operation modes

During PMF operation different normal operation process cycles are implemented with a high degree of automation. Both normal and redundant equipments need to be operable and available to operate the PMF. By selecting on the screens, the different blocks of the system can be operated manually.

Pre-heating cycle

The function of the pre-heating cycle is to heat up the system to operation temperatures so that proper combustion of organic waste can take place. When the STC temperature and the temperature after the bag filter house have reached respectively 850°C and 150°C, the system can process the waste. The following main components/functions are in operation mode:

- Extraction fan - in operation.
- Off gas system - in operation.
- Pressure in the PTC, set point: -250 Pa.
- Combustion air fans for burners - in operation.
- Combustion air damper for secondary air is closed.
- Secondary burner is regulated.
- Plasma torch with compressed air is stopped.
- Auxiliary burner in PTC - in operation.
- Feeding of solid waste is not permitted.

Processing waste

When the normal conditions are reached, processing of the waste can start. The following main components/functions are in operation mode:

- Extraction fan - in operation.
- Off gas system - in operation.
- Pressure in the PTC, set point: -250 Pa (g).
- Combustion air fan for burner in operation.
- Combustion air damper for secondary air is regulated.
- Secondary burner is regulated.
- Plasma torch with compressed air is in operation.
- Auxiliary burner in PTC is out of operation.
- Feeding of solid waste is permitted.

Hot stand-by

This cycle is used in order to keep the temperature into the system at a high level. The temperature is kept by functioning of the burners into the PTC and STC and adding as less as possible air into the system.

- Extraction fan - in operation.
- Off gas system - in operation.

- Pressure in the incinerator, set point: -250 Pa.
- Combustion air fans for burners in operation.
- Combustion air damper for secondary air is closed.
- Secondary burner is regulated.
- Plasma torch with compressed air is stopped.
- Auxiliary burner in PTC in operation.
- Feeding of solid waste is not permitted.

Cold stand-by

The time required to reach the cold stand-by status after activation of a Safety Shut-Down (SSD) will be maximum four (4) days depending on the PTC temperature at the time the SSD is activated.

This cycle is activated when the PMF has to be stopped and when a low temperature of about 60°C is reached. The system will be kept under negative pressure.

- Extraction fan in operation.
- Off gas system - out of operation, except for the control and measuring devices.
- Pressure in the PTC, set point: -150 Pa.
- Combustion air fans for burners - out of operation.
- Combustion air damper for secondary air is closed.
- Secondary burner is stopped.
- Plasma torch with compressed air is stopped.
- Auxiliary burner in PTC in stopped.
- Feeding of solid waste is not permitted.

1.2.4.2 Main processes during PMF operation

Reception of RAW

Figure 1.2.4.2-1 shows the scheme of transporting unprocessed RAW from KNPP site.

The incoming waste packages are transported within the standard KNPP 6 m^3 waste containers, which are placed at AB-2 at elevation of 0.00 m. From there the container is lifted up by means of the existing 6.3 ton crane to AB-2 at elevation of 6.30 m through the access hatch.

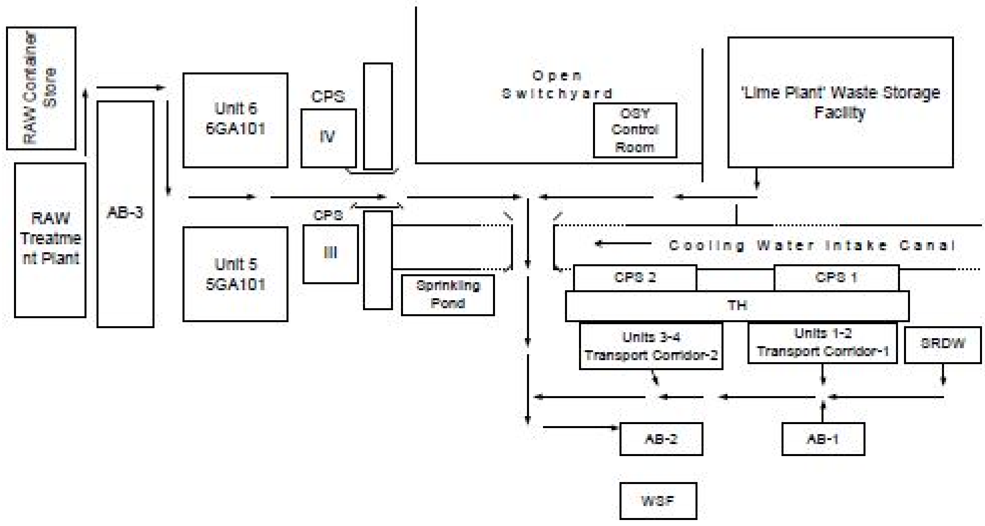

Figure 1.2.4.2-1 Scheme of route for incoming unprocessed RAW

The incoming packages will be unloaded from the container to the storage with special grabbing tools, which can be installed on the hooks of the existing crane.

Waste packages shall be properly characterized before they arrive at AB-2. KNPP shall provide information about the physical and radiological characteristics of each package which is going to be treated in the PMF. Administrative control will be established to survey the waste packages from their arrival in AB-2 until the PMF treatment starts.

RAW will be temporarily stored in a reception area where a dose rate control of the RAW packages shall be performed before the treatment in the PMF starts.

Feeding of RAW

Untreated waste, pre-compacted waste in 200 l drums and super-compacted waste is taken by the grabbing devices, moved to the transport conveyor and from there the waste is automatically transferred to the shredder unit via an airlock with a lifting device.

The waste in the bags, the compacted and super-compacted waste in the 200l drums is processed by the shredder and tube extrusion. The result is small and relatively uniform material which can enter the Primary Treatment Chamber (PTC). The shredder is equipped with a pre-programmed auto-reversing sequence which will clear most material cloggings. The shredder's teeth reduce the waste and the drum into small pieces, which then fall down into the integral tube extrusion and from there the PTC is continuously fed.

Primary Treatment Chamber with plasma torch

The plasma torch is installed in the Plasma Treatment Chamber (PTC, also called Primary Treatment Chamber), which is designed for treating about 80 kg/h (20 kg for the weight of the steel drum plus 60 kg organic waste) of shredded waste during 100 hours per week (Monday morning until Saturday morning).

The PTC is a high temperature (1100°C - 1500°C) tilting furnace. The volume of the furnace is designed for around 200 l of molten slag. The outer diameter of the primary treatment chamber is about 2.2 m, and its height is about 2.8 m.

Two types of burners are provided. A diesel-oil burner of 300 kW is used to dry-out or to reheat a cold furnace as well as to keep the furnace warm. A Plasma Heating System (Plasma Torch) mounted on top of the furnace is required to achieve the high process temperatures.

Organic material is vaporised in volatile hydrocarbons, carbon monoxide, etc. in the PTC, which is equipped with a plasma torch acting as a heat source. Non-combustible and other inorganic constituents are melted and transformed into glassy slag.

The plasma furnace is designed with refractory concrete lining with high melting point. It will minimize refractory maintenance, and maximize the lifetime of the system. Concrete layers are selected because they can be repaired instead of replaced, thus minimizing the volume of generated waste. The furnace has a water cooled casing in order to obtain normal surface temperatures in the primary chamber and to extend the lifetime of the refractories.

The furnace operates at negative pressure of about 250 Pa and has a good air-tightness so that almost no cold air is entering the furnace. As no additional air is added to the furnace the organic waste will not burn but rather gasify. Those gases will be burned in the secondary treatment chamber (STC). Therefore, the atmosphere in the furnace will be reduced preventing the metals to oxidize and result in a bigger Volumetric Reduction Factor (VRF).

After pouring the slag there is still some liquid slag in the furnace. This remaining slag acts as fly wheel for the thermal treatment process and protects the refractory from the heat of the plasma plume for the next batch of waste. To obtain optimal VRF of the waste and suitable process for slag forming, the furnace should treat a mixture of organic and inorganic waste.

Secondary Treatment Chamber (STC)

The STC is a refractory lined chamber that receives the process gases from the PTC. The unburned gases, hydrocarbons, soot particles, CO, hydrogen and fly ash particles are transported from the primary treatment chamber to the secondary treatment chamber (STC). The gases are mixed with additional air to complete oxidation to primary components such as CO_2, SO_2 and H_2O. The additional air supply is controlled by an oxygen analyzer-controller at the outlet of the STC to a minimal level of 6 %.

The STC is sized to provide a minimum of two seconds residence time at the design waste feed rate and at a minimal temperature of 850°C. The normal working temperature is between 900 and 1000°C. This temperature window is a good compromise between the possibility of achieving complete combustion at a temperature considerably higher than 850°C and the power consumed for that purpose. The STC is equipped with a secondary burner. It operates with diesel oil and varies between high and low flame, and regulates the STC exit temperature. The high flame of the burner is also used to heat up the system during the preliminary heating cycle. The STC inner coating layer is designed to withstand a maximum temperature of 1650°C. The STC has two refractory lined doors with net openings of 0.5 m by 0.5 m for performing inspections and maintenance.

Fuel system

Diesel fuel is provided for the primary and secondary burner. Diesel fuel is a mixture of medium and heavy petroleum fractions that has an operating calorific value of 42.3 MJ/kg and a density of 0.83 kg/l.

The primary burner (300 kW) operates for heating up the PTC or keeping the PTC in a hot stand-by. During processing of waste this burner is shut off.

The secondary burner (350 kW) operates for heating up the STC and the off gas system. During processing of waste this burner varies between high and low flame. With typical organic waste this burner runs at low flame.

The diesel fuel supply system consists of an existing diesel fuel tank, pumps, fuel feeding pipeline to the PTC and STC burners and I&C for maintaining the system performance parameters (valves, flow rate meters, pressure gauges, etc.). The diesel fuel tank of the Auxiliary Steam Generators Emergency Feed Water System will be used.

Off gas cleaning system

The off gas cleaning system consists of following main components:

- Cooling down the flue gases;
- Filter bags for radioactivity and dust elimination
- Hydrated lime unit to inject hydrated lime in the filter bags;
- Filtration system via pre-filtering module and HEPA filter
- Scrubber unit with pH control for removal of gaseous contaminants such as HCI, SO_2;
- Oxygen (air) absorption rate control
- Electrical heater for heating up the flue gases and DeNOx system with a catalyst for transforming nitrogen oxides to nitrogen gas;
- Continuous Emission Monitoring (CEM) and radioactivity control at at PMF exit upstream the connection to the existing ventilation system of AB-2.

After the STC the flue gases enter the flue gas treatment system. The flue gases are first cooled down to about 190°C in a two pass radiant heat boiler. Hot water is circulating in a closed circuit and the waste heat is transferred to the cooling water circuit of KNPP via intermediate heat exchangers.

Further on, the flue gases enter the bag house, which consists of two compartments with 50 filter bags per compartment. Particulate matter is captured by surface filtration of membrane filter bags of PTFE. The bags can withstand operating temperatures of

250 °C. The filter medium is cleaned with pulsed jets of compressed air triggered by a differential pressure switch. The collected particles are shaken off of the surface of the bags.

The hopper at the bottom of the bag house receives the released particulate matter and emptying is accomplished through a rotary discharge valve at the vibrating tube. After passing the fabric filter, the gases enter the HEPA filters, consisting of two parallel compartments. One compartment serves as stand-by.

The wet gas scrubbing assembly consists of a quench tower for the cooling down of gases to about 50°C, a counter current scrubbing tower with caustic liquid for removal of HCl and SO_2, and a demister. Two extraction fans in parallel ensure the evacuation of flue gases into the atmosphere. One fan is stand-by. The negative pressure of the whole system is controlled by frequency controlled motors.

After heating up of the flue gases by recuperating heat from the boiler circuit and an additional electrical heater, NO_X concentration is reduced catalytically into the DeNOx system.

Before the cleaned gases are evacuated to the stack, they are monitored by the Continuous Emission Monitoring (CEM) system for controlling the chemical parameters such as CO, SO_2, NO_X, HCl, NH_3, O_2, H_2O and TOC. Results are available on real-time basis. Half hourly and daily values will be presented, corrected to temperature 273 K (0^{O}C), pressure 101.3 kPa, 11 % oxygen and dry gas for comparison with emission limits, evaluation and corrective actions.

The gases that pass through the off-gas system are also controlled before entering the chimney duct in order to measure their activity. The measurement is done by means of a sample that is taken and sent over a paper filter. Each 24 hours the filter is changed and put into a counter of α and β particles, which will be located in BK301 in an area with low radiation background.

Slag collection and cooling chamber

When there are around 200 l of slag in the PTC, the cycle of pouring the slag into moulds will start.

When the furnace is ready for discharging, the waste feed is stopped, the tap hole opened and the furnace is tilted. The available slag is emptied into the slag mold underneath. When the mould is filled up, the furnace is tilted back. The tap hole is closed and the feed restarted.

Tilting of the furnace is carried out by means of a hydraulic cylinder and allows a good control of the pouring, which can be interrupted at any time. Into the rotating axis of the furnace rotating devices are mounted for making leak tight connection with the lined duct to the STC on one side and the extrusion tube on the other side.

The slag is collected in the slag collection and cooling chamber, which should be considered as a sealed box. The Slag Collection chamber is beneath the PTC and holds the slag moulds until they are filled and conveyed to the cooling chamber.

The hot slag is poured into a 5 mm thick steel mould, which is placed on an iron cooling mould of at least 100 mm thickness in order to absorb the heat.

Through an airlock, the slag moulds are transferred into the box, where they are put into the cooling mould by a small bridge crane. The cooling mould moves on an internal conveyor towards the pouring position of the slag. When the mould is filled up, it moves further for cooling down and a new empty mould is put again on the pouring position. After cooling down, the cooling mould is moved to the emptying position where the slag mould with its content is taken by a small crane and transferred into a 200 l drum. This drum is placed near the insulating jacket, where its cover is removed automatically and closed again when the mould is put into the 200 l drum. Then a new slag mould is put in the empty cooling mould and then it is returned to the pouring position.

The Cooling System is equipped with an air circulating system to speed up the cooling of the moulds. Cooling down of the moulds takes about 48 h, so six of the cooling moulds are sufficient to provide continuous operation for one week.

Transportation and weight measurement of the finally processed drums

After the transfer of the slag mould with its content into the final 200 l drum, it is transported by a pallet truck from the STC to the temporary storage.

A weighing device (weighing sensors technology, range 0-1000 kg) is integrated in this pallet track lifter used to load/unload the Slag Moulds (SMs) within the 200 l drums. This device will be used to weigh the final drums and this measurement is needed during product characterization.Figure 1.2.4.2-2 shows the scheme of transportation of RAW processed in the PMF.

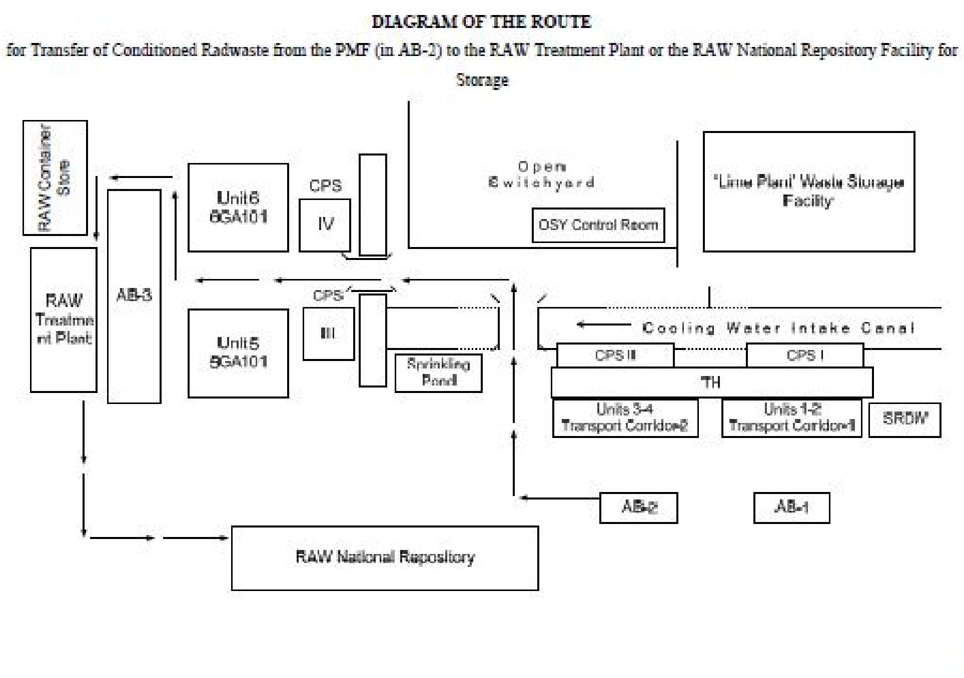

Figure 1.2.4.2-2 Schematic route for transportation of RAW processed in the PMF

Characterization of the PMF final products

When the treated waste mould is already within a 200 l drum, the final drum is characterized to ensure whether it is suitable for storage at the PMF temporary storage area, and to verify that the radioactive waste resulting from the PMF process is Category 2a - – short-lived low and intermediate level waste containing mainly short-lived radionuclide (half-life shorter or equal to the ^{137}Cs half-life), and long-lived alpha-radionuclide with a specific activity that is lower than or equal to 4E+06 Bq/kg per package and lower than or equal to 4E+05 Bq/kg in the whole radioactive waste volume [5], by:

- Dose rate measurement at contact and at one meter distance, caused by gamma photons, by means of a dose rate meter.
- Measurements of removable surface alpha and beta contamination in order to ensure that the surface of the drum is not contaminated and it can be handled safely.
- Use of the radiological characterization method Dose to Becquerel (DTB). This means the average dose rate is taken (e.g. average of four measurements at 90° over the circumference of the drum) and with a certain isotope vector the Bqs of all the different isotopes into the waste can be calculated. This method gives fairly accurate results as we are dealing with typical NPP waste, which contains significant gamma emitters (^{60}Co and ^{137}Cs).

At the end of the technological process a robust conditioned product is obtained, free from liquids, organic material and free from external contamination, and ready to be transferred to the standard 6 m^3 container for further conditioning.

The final PMF drums transferred to KNPP comply with the following requirements, which are part of the immobilized waste acceptance criteria:

- The free water content should not exceed 1% by weight.
- No explosive or pyrophoric substances, materials and ingredients should be present.
- No biological waste should be present.
- No organic solvents, oils, grease or other oil-containing materials should be present.
- The solid material should be packed in a secure, waterproof, corrosion-resistant and mechanically rigid package.

The rest of requirements are fulfilled after final drums conditioning, when they are embedded with concrete and put into KNPP containers.

The final drums will be transported from the outlet of the slag collection chamber to the PMF storage area with a pallet truck or with the special grabbing device designed for drums. After that they will be loaded in the KNPP containers using the above mentioned grabbing device hooked on the crane in building AB-2.

The final drums will contain vitrified waste in a stable form. It is planned that these drums will be further on immobilized with cement into bigger containers in order to meet the acceptance criteria for immobilized products established by Bulgarian Regulation.

Cleaning and maintenance of the facility

Periodically, the PMF should be stopped for maintenance, calibration, cleaning and decontamination of components.

For the purposes of the ALARA principle and personnel safety, the Specific Procedures and the Operating and Maintenance Manuals should include requirements for maintenance, calibration, cleaning and decontamination of the equipment and components. Decontamination procedures and tools are based on current standard cleaning practices and no special reagents are foreseen for the PMF maintenance.

In addition, periodical cleaning of the necessary components inside the PMF will be carried out to avoid excessive accumulation of contamination and to facilitate maintenance. A special adapted vacuum cleaner will be used to clean the PMF to minimize spread of contamination. It will be used to clean the refractory concrete of the PTC when repaired, the insides of the STC, the boiler, the bag house, the HEPA-filters, confinement of ash collection chamber, etc., and also the surroundings during and after maintenance activities.

These activities will minimize the residual contamination in the internals of the equipment, reducing the risk of spread of contamination and the personnel doses.

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

Maintenance or inspection of confinements is normally executed with extra protective clothing and wearing of masks in order to protect the operators or the maintenance personnel from contamination. The plastic foils from maintenance activities, which are assumed to be contaminated, can be treated in the PMF.

The main equipment with residual contamination due to the processing of radioactive waste, for which operator intervention is required during maintenance periods, is the following:

- PTC: For the refractory replacement the PTC lid will be removed with the 5 t crane situated above the PMF. A frame with plastic foils will be installed above the furnace, and it will be provided with an entrance trough the maintenance platform. The confinement is in under-pressure and the air flow is directed to the internals of the PMF through the extraction fan.
- Primary and secondary shredder: The main maintenance activity will be the knives replacement. The knives wearing will depend on the hardness of the treated materials, but it is anticipated that the replacement should be carried out once every three years. The

machines are designed to be serviced from the end opposite of the hydraulic motor where a temporary confinement will be installed.

- SCC: The maintenance personnel will go into the SCC through the hatch situated in the side wall next to the conveyor. The SCC operates as a fix confinement during maintenance activities in order to avoid the spread of contamination. It is connected with the PMF extraction system, which will be in operation during maintenance works.
- Bag house: On top of the bag house filter a fixed confinement is foreseen, allowing performing of inspections or changing the bag filters without spread out of contamination in the other areas of the room. This confinement is connected directly to the PMF extraction system and will be accessible from the boiler platform.
- Boiler: On top of the boiler a temporary confinement can be installed during operator intervention for maintenance and inspections. The confinement will be composed of an aluminum frame and plastic foils, which will be installed around the working area. The higher under-pressure into the boiler provides an air flow to the internals of the PMF by means of the extraction fan.

Use of energy and materials needed for the process

Electrical power supply

The consumption of electric power is 1.45 MW. On the basis of 4000 operation hours per year and the power consumption of 875 kW the annual power consumption of the Plasma Torch is 3500 MWh.

The consumption of electric power for the rest of the systems is 573 kW.

The annual power consumption of the PMF (except the Plasma Torch) is 2292 MWh.

Diesel fuel

Diesel fuel is needed for the hot stand-by of the Plasma Treatment Chamber and for the afterburning in the Secondary Treatment Chamber. The maximum fuel consumption is 48000 l per year.

Filter coating material

$Ca(OH)_2$ and $NaHCO_3$ are used for better dust removal from the PTFE Filter Bags. Possible materials are. The required amount is about 1040 kg hydrated lime per year.

Ammonia

This chemical is used for the DeNOx system (reduction of N-oxides). The expected nominal consumption is 28000 kg (25 % solution) per year.

Sodium Hydroxide

This chemical substance (prepared as a 30 % solution) is used for the absorption of SO_2, HCl, HF and other acidic gases from the thermal treatment processes. The annual demand depends on the waste input composition (e.g. sulphur content in the ion exchange resins or PVC). The consumption of NaOH (30 % solution) is 34 kg/h. Assuming that an annual average of 10 % of the allowed limit are used, the annual consumption is about 14 t.

Process water

Process water is used for the scrubber and the quenching facility. The expected nominal consumption is 2500 m^3 per year.

Cooling water

Cooling water is needed for cooling down of the equipment (e.g. Plasma Torch). The cooling systems for the PMF are closed loops; the thermal energy is transported via heat exchangers to open loops of the existing KNPP cooling water system. Therefore, the water demand is limited to the amount of possible leakages of the closed loop systems and expected as 2 m^3 per year.

Radiation protection

The Radiation Protection Program will be based on the assessment of operational dose rates to the personnel working at AB-2 and to the population, considering the magnitude and location of the sources of ionizing radiation in the PMF, as described in previous sections. It should cover:

- Classification of working areas and access control;
- Local rules and supervision of work;
- Monitoring of people and the working places;
- Work planning and work permits;
- Protective clothing and protective equipment;
- Facilities, shielding and equipment;
- Health surveillance;
- Application of the principle of optimization of protection;
- Removal or reduction of intensity of radiation sources;
- Training;
- Arrangements for response to an emergency.

Classification of work places and marking of the radiological areas in the facility, entry and exit control of personnel in radiological areas, work planning and use of radiation work permits will be executed according to the requirements of the Regulation on radiation protection during activities with sources of ionizing radiation [4] and to KNPP radiation protection procedures.

Continuous radiation and air monitoring in the rooms of PMF will be performed. PMF operators and the radiation protection personnel will conduct periodic routine radiation and contamination surveillance around the PMF equipment and at the work places to detect occurring contamination at an early stage. Personnel dosimetric and contamination control for workers employed in the controlled area will be performed according to KNPP Radiation Protection procedures.

The radiation protection department and other KNPP facilities (changing rooms, instrument calibration and measurement laboratories, etc.) at KNPP will be used for effective radiological control during operation and maintenance of the PMF.

Protective clothes and gloves will be worn in controlled areas of the PMF to prevent personnel contamination and spread of contamination. When works have to be undertaken in areas where airborne contamination or loose surface contamination may be produced (e.g. maintenance works in equipment confinements), respiratory protective equipment will be used. According to the radiological status of the areas in which the operators will work, they will wear the corresponding protective clothes/equipment.

The operating organization shall make arrangements for appropriate health surveillance in accordance with the requirements of the Bulgarian regulations and KNPP applicable procedures.

The application of the ALARA principle and reduction of radiation sources in the PMF is planned as well.

Radiation monitoring and control

The radiation monitoring of PMF includes monitoring of incoming and final waste, monitoring of the special statute areas and monitoring of PMF emissions.

Monitoring of incoming waste will consist of dose rate control of waste packages before being transported to the temporary storage.

Control of radiological characteristics of gaseous emissions will be done after the extraction fans of the off-gas system and in the outlet pipe of the PMF extraction system. Because the radioactivity in one cubic meter flue gas is below detection limits for most detection devices, concentration of samples is needed in order to obtain a detectable signal. Therefore an isokinetic sample is taken and sent over a paper filter (e.g. diameter 10 cm).

The sample lines are heated with an electrical heater. Each 24 hours the filter is changed and put into α, β counter with low background. By subtracting the activity of a basic sample filter (air also contains natural activity, e.g. ^{224}Ra and daughter isotopes) the released activity can be calculated.

For obtaining a good flow pattern and representative measuring results, the radiological sampling will be placed eight hydraulic diameters after the last obstruction (e.g. bend) and six hydraulic diameters before the next obstruction.

For the operation of the PMF, radiological monitoring of the site within the preventive protection measures area (PPMA) with a 2-km radius and the monitored area (MA) with a 30-km radius will be developed, as required by the Regulation for Safe Management of Radioactive Waste [5].

The operators and the radiation protection technician will perform periodical radiological surveys around the PMF equipment to detect occurring contamination at an early stage. Thorough cleaning prevents the spread of contamination due to immediate decontamination activities.

The range of the control and measuring devices in the PMF area shall be such as to give a clear reading during normal operation, as well as during any of the conditions considered in the safety analysis. Extended scale instrumentation for accident conditions beyond the design basis values should also be available. The set alarm levels should be commensurate with the expected radiation levels during operation, the anticipated activities in the areas, and the general requirements for keeping radiation doses within established limits and in accordance with the ALARA principle. The Radiation Protection Program will define the method and identify the procedures to be implemented during the process to ensure that ALARA principle is achieved.

Control of the incoming RAW for processing

According to the Technical Specification [3] the radioactive waste intended to be treated in the PMF is classified as Category 2a.

The Regulation for Safe Management of Radioactive Waste [5] establishes the categorization for radioactive waste generated in Bulgaria. According to this regulation, Category 2a corresponds with low and intermediate level short-lived waste, containing mainly short-lived radionuclides (with a half-life shorter or equal to that of ^{137}Cs) and long-lived alpha emitting radionuclides with specific activity less than or equal to 4.00E+06 Bq/kg in a single waste package and less than or equal to 4.00E+05 Bq/kg for the whole volume of waste.

The waste for treatment in the PMF is two kinds: incoming waste from KNPP and secondary waste from the PMF operation, with the exception of the refractory material of the PTC and the scrubber and quenching water.

Basis for the control of incoming RAW is the PMF acceptance criteria.

Waste package restrictions

The waste packages accepted in the PMF are as follows:

- Bags containing untreated waste with a maximum capacity of 70 l, max weight of 20 kg per bag and maximum density of 300 kg/m^3. For volume reduction calculations an average density of 150 kg/m^3 is assumed.
- Standard metallic 200 l drums containing:
  - Waste compressed within the drum. The weight of empty drums is approximately 20 kg and the maximum total weight of the 200 l drum is limited up to 100 kg. For volume reduction calculations of pre-compacted waste, a density of 350 kg/m^3 is assumed.
  - Secondary RAW.
- Pellets resulting from the super compaction of standard metallic 200 l drums. Pellets should have a height up to 40 cm and a maximum density of 2000 kg/m^3.

Waste composition restrictions

Solid radioactive waste to be treated in the facility shall be classified as low and intermediate level waste of Category 2a and their radiological characteristics should be those described above (Category 2a).

Liquid radioactive waste accepted should have a specific activity less than or equal to 4.00E+04 Bq/kg.

Secondary waste can be treated by the facility taking into account the maximum specific activity accepted for solid and liquid waste defined above.

Waste that is accepted in the PMF can be divided in two groups:

- Organic waste: textile, paper, wood, polyethylene, polypropylene, polystyrene, different types of rubber, latex, plexiglass, liquids absorbed in cellulose, textile or other organic absorbent.
- Inorganic waste: glass bottles or window glass, galvanized and non galvanized steel, all type of granulates such as concrete, sand, asphalt, bricks, asbestos and asbestos containing materials (ACM). ACM should be packaged according to the local rules, i.e. packaged in nylon bags and 200 l drums. These drums should be labeled with an international sign stating that they contain asbestos. Due to the high temperature the asbestos filters are decomposed in the PMF and are turned to amorphous structure similar to glass.

Restrictions for incoming waste:

Metallic pieces

The PMF cannot process massive or solid metal parts because they can cause blockages and damage of the shredder.

Solid metallic pieces of more than 2 inches (~ 50 mm) of equivalent diameter are considered as massive or big metal parts and could not be processed by the PMF. However, the waste packages may occasionally contain the following materials:

- Mild steel pipes with a diameter up to 2 inches and wall thickness of maximum 3 mm.
- Hollow valve housing of cast iron or mild steel up to 2 inches in diameter.
- Mild steel plates up to 5mm in thickness and a maximum size of 300 x 300°mm (without any side longer than 300mm).
- Mild steel bars of 300 mm length and 10mm in diameter.

A few of these elements can be processed within one package, but one drum full of them is not accepted.

Halogenated and sulfonated polymers

For wastes containing halogenated and sulfonated polymers, traces of PVC (Poly Vinyl Chloride) and sulphur are foreseen to be respectively 0.5 % and 0.1 % from the total weight.

Waste streams can contain a maximum of 8 % PVC and 5 % sulphur from the total weight.

Packages which contain only PVC can be occasionally accepted as long as the hourly average is lower than 8 % PVC. Corrective measures for PVC containing RAW will be implemented by control of the chlorine concentration in the scrubber water.

Aluminium

The maximum percentage of aluminium accepted in the waste is 2% from the weight. Aluminium content creates a lot of aluminium oxides which are chemical compounds with a very high melting point, and cannot be melted by the plasma system.

Concrete pieces

The maximum size of concrete granulates that are accepted is 200*200*200 mm (without any side longer than 200 mm).

Semi-volatile metals

General semi-volatile metals like Zn, Pb, etc. are accepted in the PMF.

When the waste contains low amounts of semi-volatile metals like Zn, Pb, they will be partially collected in the fly ashes by the bag house filter. When these fly ashes are treated again in the plasma furnace, part of the metals is retained in the slag and the rest will go again in the fly ashes and will be captured by the bag filters. There is a negative balance and finally these metals are expected to be retained in the slag.

If there is a high content of semi volatile metals, it is recommended not to treat the fly ashes in the plasma furnace and look for another treatment like super-compaction and conditioning with cement.

Liquids

Liquids in plastic or glass bottles of maximum 1 l can be accepted into the shredder.

Liquids are accepted as long as they have neutral pH value (7 ± 2). Mineral acids such as sulfuric acids, nitric acids, etc. are not allowed for processing.

Liquids with flash point higher than 55°C (motor oil, diesel fuel, hydraulic oil, etc.) are accepted for processing.

Flammable liquids (high volatile solvents, kerosene, etc.) are not allowed. If such liquids are brought into the shredder by chance, the risk of an explosion will be avoided by nitrogen blanketing and a purging device in the RAW feeding system.

Drums containing only one kind of material, as for example PVC or construction materials

Occasionally waste packages with only one kind of material can be processed, taking into account other restrictions (e.g. size) stated above.

Consecutive treatment of drums with one kind of material should be avoided. The best results are obtained by treating e.g. one drum with concrete pieces followed by different drums containing organic material. The best operational results from the point of view of energy consumption and formation of slag is to treat a mixture of waste with low caloric value (e.g. concrete pieces) and drums containing waste with high caloric value (e.g. organic waste).

Spent ion exchange resins

Spent ion exchange resins free from liquids or with adsorbed liquids are accepted. The spent resins have to be delivered in plastic bags with a weight up to 20 kg or in drums containing maximum 20 kg spent resins and the remainder is normal organic waste. As spent resins can contain significant amounts of sulphur, the maximum feed rate accepted is 20 kg each 4 hours of continuous operation. During feeding with resins containing sulphur, the blow down of the scrubber unit has to be raised to 1000°l/h.

For spent resins not containing sulphur the maximum feed rate is limited up to 20°kg/h.

The PMF should not be used for treatment of the following materials:

- Sludge;
- Radioactive waste categorized as high level waste;
- Reinforced concrete containers full of drums and/or pellets immobilized with cement;
- Refractory materials.

Control over the discharges into the environment

Control of the radiological characteristics of gaseous emissions will be performed after the extraction fans of the off-gas system and in the outlet pipe of the PMF extraction system. Because the radioactivity in one cubic meter flue gas is below detection limits for most detection devices, a concentration of samples is needed in order to obtain a detectable signal. Therefore an isokinetic sample is taken and sent over a paper filter (e.g. diameter 10 cm). The sample lines are heated with an electrical heater. Each 24 hours the filter is changed and put into an α β counter with low background. By subtracting the activity of a basic sample filter (air also contains natural activity e.g. ^{224}Ra and daughter isotopes) the released activity can be calculated.

For obtaining a good flow pattern and representative measuring results, the radiological sampling will be placed eight hydraulic diameters after the last obstruction (e.g. bend) and six hydraulic diameters before the next obstruction.

The non radiological emission parameters are controlled by the Continuous Emission Monitoring System (CEM). CEM is installed at the end of PMF before the connection to AB-2 ventilation system.

The measured parameters are CO, SO_2, NO_X, HCl, O_2, H_2O, NH_3 and TOC. Temperature, pressure and flow are also measured by individual and conventional instruments.

The parameters CO, SO_2, NO_X, HCl, H_2O and NH_3 are measured by a FTIR spectrometer.

O_2 is measured by a ZrO_2 oxygen sensor. A Multi Flam-ionization detector (FID) is installed for continuous measurement of the hydrocarbons (TOC).

The system is designed to be built in a separate closet, sampling lines are also planned.

Necessary calibration gases and calculation software are provided. Results are available for real-time display. Half hourly and daily values will be presented corrected to temperature 273ºK (0^{O}C), pressure 101.3 kPa, 11 % oxygen and dry gas, so that a comparison with emission limits can be done.

Control over liquid discharges into the existing special sewage system of AB-2

Water will be discharged from three sources: boiler, torch and furnace coolants. If the water is treated with anti-corrosive products to minimize pipe corrosion, then the water change period might be longer. The water will be delivered to different tanks according to the radioactivity levels. The use of these tanks allows control of the flow rate according to the requirements.

The indicated water sources are closed water systems and they will not have radiation contamination, they will only have slight chemical contamination. If the water is properly maintained, it could be used for several years.

Liquid radioactive waste is not generated continuously and discharge shall be controlled. The liquid effluents from the scrubber are sent to a scrubber tank, which assures that the flow rate will be controlled to fulfil the requirement that the flow rate discharge does not exceed 100 l/h, and prior to discharge the liquid passes through a 5°µm filter.

Fresh water is added on top of the scrubber depending on the level in the scrubber tank, and a circulation pump circulates the water through the unit.

Scrubber water is collected in this scrubber tank. Other eventual cleaning water, e.g. from the decontamination of 200 l drums can also be transferred to the scrubber tank. Part of the water evaporates into the scrubber unit and a maximum of 100 l/h is transferred to the effluent system of KNPP by means of an evacuation pump. In the pressure line of the evacuation pump a 5 µm filter unit is installed, which filters the water before it arrives at KNPP effluent system.

This filter device is a double bag filter (one in operation; one in stand-by) with disposable polypropylene filter bags of 5 µm mounted in a stainless steel housing for in line filtration. Used bags will be sent with other burnable secondary waste to the plasma furnace.

A pH-meter controls the pH value to keep it higher than 8 by adding NaOH using a dose pump. With the admissible sulphur and PVC content in the incoming waste the salt concentration in the evacuated liquid may be several grams per litre.

In case of failure of the circulating pump the evacuation pump can take over the circulation function.

Control of the quality of the immobilized radioactive waste

Considering the maximum specific activity in the incoming waste, the isotope share in the slag (85 %), the average density and volume reduction for each type of waste package, the maximum activity estimated in a 200 l drum containing 170 l of vitrified waste is 9.1E+08 Bq (see table 1.2.4.2-1).

Table 1.2.4.2-1 Activity of vitrified waste in a 190 l form

Type of Waste	Average Density (kg/m^3)	Specific activity (Bq/kg)	VRF	Activity/drum (Bq)
Untreated waste	150	5.17E+05	81	9.10E+08
Pre-compacted waste	350		22	5.75E+08
Super compacted waste	1500		2	2.24E+08

When the treated waste mould is already within a 200 l drum, the final drum is characterized to ensure its suitability for storage at the PMF temporary storage area and to verify that the radioactive waste resulting from the PMF process is Category 2a, by:

- Measurement of dose rate due to gamma photons at contact and at one meter distance by means of a dose rate meter.
- Measurements of removable surface contamination, both alpha and beta emitters, in order to ensure that the surface of the drum is not contaminated and it can be handled safely.
- Use of dose rate average value to evaluate the specter of the vitrified waste according to the following procedure:
- Use of the radiological characterization method Dose to Becquerel (DTB). This means that the average dose rate is taken (e.g. average of 4 measurements at 90° over the circumference of the drum) and with a certain isotope vector the Bqs of all the different isotopes within the waste can be calculated. This method gives fairly accurate results as we are dealing with typical NPP waste, which contains significant gamma emitters (^{60}Co and ^{137}Cs).
- Representative scaling factors of the waste stream treated in the PMF should be given by KNPP and should give the estimations of the alpha and beta emitters.
- The relation between the activity and the dose rate depends on the density of the slag, which will vary according to the composition of the incoming waste treated in the PMF. Therefore, estimate values for different slag densities should be determined.

At the end a robust conditioned product is obtained free from liquids and organic material and free from external contamination, and ready to be transferred to the standard 6 m^3 container for further conditioning.

The final PMF drums transferred to KNPP comply with the following requirements, which are part of the immobilized waste acceptance criteria:

- The free water content should not exceed 1 % from the weight.
- No explosive or pyrophoric substances, materials and ingredients should be present.
- No biological waste should be present.
- No organic solvents, oils, grease or other oil-containing materials should be present.
- The solid material shall be packed in a secure, waterproof, corrosion-resistant and mechanically rigid package.

The rest of the requirements are fulfilled after final drums conditioning where the drums are embedded with concrete and put into KNPP containers.

Personnel

The operating organization shall provide an adequate organizational structure to operate the PMF. This organizational structure shall be documented with clear identification of lines of authority and communication. The functions, duties and qualifications for each individual position in the structure shall be described properly.

PMF shall be commissioned, operated and maintained in accordance with written procedures. These procedures and instructions shall be based on the design and technical documentation (Operation Manual of the PMF), on the operational limits and conditions, and on the results of the tests conducted prior to the facility commissioning. These procedures shall cover the necessary actions to be performed for the execution of the operative activities in all operating conditions, including abnormal operating conditions.

The actions of the personnel in design and beyond-design accidents will be determined in instructions drawn on the basis of the final safety analysis report, on the operating limits and conditions, and additional analyses of installation behaviour under emergency conditions.

The potential of human errors will be reduced by proper trainings and implementation of effective procedures. Operating and maintenance personnel of the PMF shall become aware of the safety aspects of the PMF operation. They will be instructed in the functioning and proper operation of each subsystem and component of the PMF, the effects of malfunctions or errors, and the corrective measures to be taken in the event of a malfunction or error. They shall be trained in appropriate responses to abnormal events that may be encountered during the operation of the systems, with particular attention being paid to emergency preparedness procedures. The training will be in accordance to the Training Program, prepared in advance and covering theoretical and practical aspects including on-the-job training.

Besides of a shift supervisor and an assistant shift supervisor, the following personnel may be necessary:

- During the shift period (Three shifts per day): Three operators per shift for ensuring continuous process and supply of the waste conveyor. They will be assisted by a part time radiation protection officer.
- During day time: Two additional operators for receiving and unloading the waste containers. The different waste packages will be properly stored waiting their processing during the next upcoming shifts.

For the maintenance and control staff, the following man power is estimated: the equivalent of one man-year for control and measuring instrumentation and PLC control; 1/2 man-year for electrical control and 1/2 man-year for mechanical control.

During the shutdown periods, operational maintenance and cleaning is done by the operators, and they will also assist the maintenance personnel.

1.2.4.3 Main processes during PMF decommissioning

After final termination of the PMF operational phase, its decommissioning will be accomplished in a way that ensures radiation protection and safety of the personnel and the population as well as environmental protection.

Decommissioning operations may result in the removal of existing components or systems, decontamination of components and the cutting and handling of large pieces of equipment. Because these actions have the potential to create new hazards, their impacts on safety shall be assessed and managed so that these hazards are mitigated and are kept within acceptable limits and constraints.

International safety standards related to the design and operation of nuclear facilities (e.g. IAEA Safety Guide GS-G-1.2 [6]) indicate that an outlined plan for decommissioning, covering issues such as strategies to be used, expected radiation doses and the amount of waste to be produced, should be prepared at the design stage of the facility. Such information will be necessary to optimize the design of the facility in order to reduce the amount of waste, which will be produced at decommissioning stage, as well as the doses of workers that could be involved in the related tasks.

In the same way, Bulgarian legislation states in the Regulation on safety during decommissioning of nuclear facilities [7] that a Preliminary Concept and Plan for Decommissioning shall be developed during the design phase of a nuclear facility.

This Decommissioning Concept should be submitted in support of the Design Approval application for the PMF, compliant with the requirements of Regulation on safety during decommissioning of nuclear facilities [7].

The primary purpose of the Decommissioning Concept is to ensure that facility designers are familiar with the decommissioning during the initial design of a facility. Thus, where design choices that would enhance decommissioning are available for types of materials and system components, these choices should be made.

A Decommissioning Concept [8] has been prepared for the PMF. A summary of this is included in the following sections.

Decommissioning Concept

There are three main internationally recognized strategies for decommissioning of nuclear facilities. These are “immediate dismantling”, “deferred dismantling” and “entombment”.

In general, entombment is not a recommended decommissioning option, and strategy selection is a choice between immediate and deferred dismantling.

There are a number of factors to be considered when deciding on the preferred decommissioning strategy, but at present the emerging international trend is more towards immediate dismantling. According to Principle No 5 of the Radioactive Waste Management Principles [9], the period of decommissioning shall be such that it “does not impose undue burdens on future generations” in terms of both additional health and safety risks and financial requirements. This principle favours early dismantling as preferred option for decommissioning.

Considering the expected residual activity in the PMF during decommissioning, deferral of decommissioning activities may not significantly reduce the activity of the remaining nuclides or radiation exposure of workers during decommissioning activities. In line with the option for immediate dismantling of equipment outside of the safe enclosure area in the updated Decommissioning Strategy for KNPP Units 1-4, immediate dismantling is considered as the preferred option for the PMF decommissioning.

The availability of waste management infrastructure for treatment and conditioning of decommissioning waste, as well as the availability of the Radioactive Waste National Repository at the time of PMF decommissioning, assumed in the updated Decommissioning Strategy for KNPP Units 1-4, has been also considered when selecting PMF decommissioning strategy.

End-point of the PMF decommissioning activities is to return the area where PMF was located as close to the pre-installation condition as possible, while protecting human health, the environment, and meeting regulatory requirements.

The decommissioning process is divided into three phases with different duration of implementation according to ISAR [2], as follows:

- Preparatory activities - 5 weeks;
- Decontamination, dismantling and waste management activities - 18 weeks;
- Final inspection - 2 weeks.

Facility characteristics with regard to decontamination and dismantling activities

Provisions that facilitate decommissioning activities are foreseen in the PMF design.

During the design of the PMF facility, materials are chosen to facilitate decontamination and to avoid the spread of contamination. The facility design provides enough space for access to the main equipment during maintenance activities and also for equipment dismantling.

Based on the PMF characteristics, the following conclusions with regards to decontamination and dismantling activities can be made:

- Activated materials will not exist due to the nature of the PMF and the type of waste treated.
- Contamination levels during decommissioning are commensurate to activity levels of waste category 2a and to the radionuclides existing in the RAW treated at the PMF.
- According to the design of the PMF, containment of radioactivity in the PMF is achieved by equipment boundaries and confinement areas, as well as by keeping under-pressure in the system with respect to the building. Furthermore, confinement areas where maintenance activities are carried out are periodically cleaned-up, preventing the accumulation of contamination during operation.
- Periodical cleaning and decontamination of the necessary components in the PMF will be carried out during the operation phase, avoiding contamination accumulation and maintaining very low levels of contamination in the facility.
- Confinement areas prevent spread of contamination in other areas of the room during operation and maintenance activities, which would complicate or reduce the effectiveness of future decommissioning activities.
- A special adapted vacuum cleaner is used to clean the PMF, especially the off-gas system and its surroundings, before internal maintenance, thus minimizing spread of contamination.
- Considering that after termination of the PMF operational phase, all operational waste will be removed from the facility, only minor quantities of activity entrained in the PMF itself will be present.
- Many types of PMF equipment re not directly involved in the waste treatment process (electrical equipment, cooling units, control devices, etc.) and are not in contact with radioactive waste materials and sources of ionizing radiation.
- Equipment which is part of the waste treatment process (shredder, feeder, PTC, STC, off-gas equipment until HEPA filter, ash and pouring confinement) will have different residual contamination levels according to their function in the facility process and will be subject to decommissioning activities.

- Contamination on the platforms and other structures such as temporary storage areas and AB-2 is not expected.
- The last waste batch fed to the PMF before its shutdown, should be non-radioactive waste. By this procedure the residual radioactivity into the different components is reduced and is in fact "flushed out".
- Final cleaning and maintenance activities will be carried out after shut-down of the facility, reducing the activity levels during decommissioning to levels similar to those during PMF maintenance activities. Therefore, it is expected that only the internal parts of the equipment are contaminated and other surfaces outside the process boundaries are potentially clean.

Prognostic inventory of radioactive and other dangerous materials in the facility

All incoming radioactive waste and final waste produced in the PMF is classified as Category 2a. Therefore, contamination levels during decommissioning are commensurate to this waste category.

The estimation is based on several assumptions regarding the following factors:

- Dust loading (g/m^3): that is the concentration of dust in air, and thus available for surface deposition.
- Deposition coefficient for aerosols and reactive gases: that is the coefficient used to estimate the amount of radioactive material deposited on the system surface.
- Radioactivity decay over the course of the operation period according to waste radionuclide content and their decay periods.
- Cleaning factor: that is the part of surface contamination removal due to cleaning.

For estimation purposes, the facility can be divided in five parts depending on the radiological characteristics of the accepted waste during PMF operation. The estimation of activity deposited in each one is as follows:

- Shredder system: 106.7 Bq/cm^2
- Refractory:
  - PTC 2.5510+9 Bq
  - STC 3.6210+8 Bq
  - Elbow 2.0710+7 Bq
- Metal off-gas equipment until bag house: 18.5 Bq/cm^2.
- Ash confinement: negligible
- Pouring confinement: negligible

Assuming an internal surface of 25 m^2 in the shredder system and of 200 m^2 in the metal off-gas equipment, the total inventory results:

- Metal waste susceptible to be decontaminated: 64 MBq.

- Refractory: 3 GBq

Regarding hazardous materials coming from PMF decommissioning, they are preliminary estimated as follows:

- NH_3: 200 l
- Oils: 1033.6 l
- NaOH: 1000 l
- Lead: 7000kg

RAW management during decommissioning

Management of RAW generated during nuclear facility decommissioning shall be performed in accordance to the legislation on RAW management [5]. In particular, the required radioactive waste acceptance criteria specified in Attachment 3 of the Technical Specification for the PMF [3] will be considered.

RAW produced in the decommissioning activities will be classified and sorted according to their physicochemical and radiation characteristics.

Criteria for clearance, reuse-recycle and/or management as conventional waste of materials generated during decommissioning will be defined according to applicable Bulgarian regulations.

Generation of radioactive waste shall be kept to the possible minimum, in terms of both its activity and volume, by appropriate design measures and operating and decommissioning practices. This includes the selection and control of materials, the recycle and reuse of materials, and the implementation of appropriate operating procedures. Emphasis should be put on the segregation of different types of waste and materials to reduce the volume of radioactive waste and facilitate its management.

According to their residual activity, the materials resulting from the decommissioning activities can be classified into the following groups:

1) Clean materials - Materials located outside the Radiation Controlled Area and not susceptible to decontamination. Clean materials, which are not hazardous or toxic, will be managed as conventional waste and disposed of in conventional urban or industrial waste dumps.

2) Waste materials able to be cleared - Materials located in the Radiation Controlled Area, but with low probability of containing residual radioactivity.

Solid materials classified as "able to be cleared", in their initial state or after a decontamination process, will be transferred to the free release measurement facilities at KNPP site in order to verify the compliance with applicable clearance levels.

3) Radioactive Waste Materials - materials containing radiological activity or with externally contamination:

- Category 1 - transitional waste that can be cleared from regulatory control after appropriate processing and/or temporary storage for a period not longer than five years, while the waste specific activity is reduced below clearance levels;

Radioactive waste classified as Category 1 will be transferred to the on-site interim storage area for this kind of waste to wait for decay and reach clearance levels.

- Category 2a - low and intermediate level short-lived waste.

Metal materials will be placed in 6 m^3 containers or 200 l drums and will be transferred to the existing decontamination facilities to reduce residual contamination and reclassify the materials as able to be cleared.

PTC and STC refractory removed during the decommissioning phase will be placed in 200 l drums and super-compacted, as foreseen for refractory removed in maintenance activities during the operation stage.

Compactable waste, as technological waste, will be placed in 200 l drums and further pre-compacted and super-compacted in the waste processing facilities.

Dust and ashes produced in the cleaning of PMF during the decommissioning phase, especially of the off-gas system, will be collected in 200 l drums and subsequently super compacted.

Insulation of the cables can be stripped and granulated with a cable treatment machine, and placed in 200 l drums; the remaining metal material is clean.

Toxic or hazardous waste, although not containing radiological activity, must be managed by an authorized agent, and disposed of in specific sites, because of its toxic or hazardous character.

Considering the qualitative classification of the groups described above and the different types of materials, the amount of radioactive waste and materials able to be cleared has been estimated and presented in table 1.2.4.3-1.

Table 1.2.4.3-1 Amount of radioactive waste and materials able to be cleared (kg)

Type of material	**For free release**	RAW
Metal materials	171097	32115
Concrete	148100	16400
Cables	3164	330
Compactable	1992	
TOTAL	**324353**	**48845**

In addition to the primary waste generated directly during the PMF decommissioning, some secondary waste will be produced as a consequence of the implementation of the decommissioning activities:

- Dust and ashes from PMF cleaning;
- Metal debris from cutting activities;
- Technological waste such as protective clothes, polyethylene plastic (PE) foils from temporary confinements for decontamination activities, etc.

Actions, systems and equipment of the facilities for decontamination and dismantling

During the decommissioning stage all the equipment in the PMF will be dismantled and removed. The PMF is a modular facility, therefore it will be disassembled into its main components for further material management. Cranes and handling devices in AB-2 can be used for the dismantling activities and also to transfer the disassembled components of PMF out of the building through the equipment hatch in room BK301.

A basic prerequisite in this Decommissioning Concept is that the facilities for volume reduction and decontamination, for free-release measurement, for waste processing and the required temporary storage areas will be available at KNPP site during PMF decommissioning activities. These facilities will allow further management of the materials removed during PMF dismantling.

The following activities for decontamination and/or dismantling of the PMF facility are planned:

1. Preparatory works

Initial characterization of the equipment and components to determine their physic-chemical characteristics and radiological characteristics is planned.

Liquid RAW in the PMF will be transferred to the effluent system of KNPP and processed in the liquid radioactive waste system within AB-2.

The drainage system in AB-2 will collect potential leaks during the decommissioning activities.

Power equipment will be isolated.

Remaining oils in the hydraulic systems, diesel in the fuel system and other liquids in the PMF tanks will be removed.

Temporary confinements (frames with plastic foil) will be installed for decontamination/disassembling activities in areas with potential airborne contamination to prevent spread out of contamination to clean areas.

Clean-up/decontamination of the inner surfaces of equipments and components with residual contamination will be performed aimed at reducing contamination levels.

Removal of materials accumulated in the shredder system will be performed.

Removal of ashes accumulated in the off-gas system with the PMF adapted vacuum cleaner. After that, bag house filters and HEPA filters will be removed.

Removal of residual slag and contaminated refractory in the PTC, STC and elbow will be performed.

2. Removal of equipment

Due to the size of some equipment, these will be cut on spot, so that all the pieces have dimensions suitable for transport and manipulation. Waste materials will be transferred to the temporary waste processing facilities existing at the site for their subsequent management according mainly to type and size of the material and the level of contamination.

During the dismantling of the equipment, it is important to take into account that the equipment with a higher level of radiation shall be dismantled first in order to minimize the occupational dose. After that, the larger components will be dismantled to make the subsequent tasks easier inside the room.

3. Removal of auxiliary equipment and platforms

The platforms, auxiliary systems such as lighting, fire protection system, compressed air system, radiation monitoring system, ventilation system and AB-2 existing cranes are required to continue operation during decommissioning tasks. Therefore, these systems should be removed at the end of the decommissioning process.

4. Final radiological survey

Once PMF components and structures are dismantled and removed from the PMF area, the remaining structures and auxiliary equipment will be included in a final radiological survey.

1.2.5 Other activities related to the investment proposal

Safety analysis made in [2] shows that there is no DBA or BDBA that could lead to significant radioactive contamination outside the site of PMF. Guidelines for accident management will be developed describing the required actions of the personnel in case of design and beyond-design basis accidents, to prevent these accidents and to mitigate their consequences if they do occur. They will be developed on the basis of accident analysis results from the Final Safety Analysis Report, safety functions, the operating limits and conditions and the additionally held analysis for the installation's behaviour in emergency conditions.

For the purposes of occupational safety and health a "Safety and Health Plan" [10] has been developed. The structure of the Safety and Health Plan is in compliance with Art. 10 of the Ordinance No 2/22.03.2004 on the minimum requirements for healthy and safe work conditions during execution of construction and installation works. All measures, rules, programs and instructions for nuclear, radiation, fire, emergency and technical safety, which are in force on the territory of KNPP, have been considered in the "Safety and Health Plan".