

MEASURES TO ELIMINATE DAMAGING EFFECTS FROM THE KOSTOLAC B3 THERMAL POWER PLANT ON THE ENVIRONMENT

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Abstract: *This paper presents the measures that are provided by law and other regulations and standards, and which were implemented on unit B3 TPP Kostolac. To the greatest extent, they are covered by the technical solutions that were applied during the design of the unit. The application of environmental protection measures is set as an imperative during the design and construction of not only every thermal power facility, but any facility of any type and purpose. This requirement is, on the one hand, the result of compliance with the legislation related to environmental protection, and on the other hand, compliance with the specific conditions set by the characteristics of the area on which the operation of the considered unit B3 may have an impact. The characteristics of the location that need to be taken into account when defining protection measures from unit B3 relate to other pollutants that exist (TPP Kostolac A and B and open pit mine Drmno) or are planned in the vicinity of the location of unit B3, but also to the existing eco systems and material good.*

Key words: ENVIRONMENTAL PROTECTION, PROTECTION MEASURES, PRESCRIBED STANDARDS, REGULATIONS, THERMAL POWER FACILITIES, TPP KOSTOLAC B3, ECOLOGY

INTRODUCTION

The surroundings of the TPP Kostolac B location have an average population density (40-50 people/km², except for the town of Požarevac), and there are no large urban settlements in the vicinity. In the immediate vicinity of the site lies the archaeological site Viminacium. In the vicinity of the location there are also areas inhabited by rich wild life and vegetation (Deliblatska sandstone, Labudovo shaft). The quality of the environment in the area under the impact of unit B3 is affected by several different industrial complexes located in its vicinity, some of which are: TPP Kostolac A (two units with a capacity of 110 and 210 MW), TPP Kostolac B (two units with capacity of

348.5 MW each), lignite open pit mine Drmno, ash and slag dumps at Medium Kostolac Island and Ćirikovac, as well as local sources of pollution within the settlements of Old and New Kostolac, Petka, Bradarac, Klenovnik, Kličevac, Drmno.

The exploration area can be observed in more general or specific terms, depending on the type of impact that is analyzed. The area of interest for observing the natural characteristics (general geological, geomorphological, hydrogeological, climatic, hydrological), as well as the potential impacts of the respective project on environmental media, is the area of the so-called Kostolac mining and energy basin. The analyzed technological process, as well as the natural features of the terrain (geological features, hydrological regime that is affected by mining operations) indicate that potential environmental impacts can occur within this area, extending northwards from Požarevac to the Danube, and which in morphological terms represents a plain bounded by two ridges (Požarevac Bea in the west and Boževac Slope in the east).

The exploration area, (Energoprojekt Entel, 2017.) in specific terms is the area of TPP Kostolac B itself, i.e. a part of the respective enclosed area of the thermal power plant with an approximate size of 50 ha on which the plant was built. The exploration area in general terms includes the area under the impact of the plant. Considering the nature of possible impacts, the major impact is via flue gases. Impact assessments were made by modelling the process of diffusion of polluting substances in the atmosphere, for an area of 50 x 50 km.

METHODOLOGY

The methods of this research in further chapters include analyzes in all present maintenance processes in the thermal power plant. In most different industrial branches, such as nuclear power plants, petrochemical industry, companies are required to assess the risk probabilities, including all the significant risks on the systems as a whole by adopting and prescribing a set of measures defined by the project, guided by regulations both European and regulations of the Republic of Serbia. Some of the measures will be discussed in the following chapters.

RESULTS AND DISCUSSION

ENVIRONMENTAL PROTECTION MEASURES DURING OPERATION OF UNIT B3

According to the requirements of the relevant Rulebook, all protection measures can be classified into the following groups, and the first two are included in this work:

- Measures provided by law and other regulations and standards,
- Measures that include plans and technical solutions for environmental protection (waste treatment, reclamation, rehabilitation, etc.)
- Measures to be taken in the event of an accident,
- Other measures that contribute to reducing the environmental impact.

MEASURES PROVIDED BY THE LAW AND OTHER REGULATIONS AND STANDARDS

Bearing in mind that unit B3 (Figure 1 and Figure 2) is part of the existing TPP Kostolac B, some of the environmental protection measures provided by law and other regulations and standards, which will also apply to unit B3, will be implemented through activities that are carried out for the needs of all units. These measures include all activities within the jurisdiction of the Environmental Protection Management Service of TPP-Open pit mine Kostolac, which relate to:

- Carrying out monitoring according to annual plans and submitting reports on the results of the state of environmental quality and compliance of the operation of TPP Kostolac with the regulatory requirements
- Conducting control measurements of the functioning of the waste treatment system
- Control of the implementation of prescribed procedures for waste management as well as other procedures related to environmental impacts (handling of hazardous materials, etc.),
- Creation of plans, programmes and reports, according to the requirements of the relevant Ministry, in accordance with the Law on Environmental Protection,
- Carrying out periodical training of personnel on performing tasks related to environmental protection (internal), including conduct in emergency situations,
- Adopting plans and providing funds for external staff training in accordance with current changes in relevant regulations.

The measures provided by law and other regulations and standards include:

- systems for purification and discharge of flue gases,
- systems and devices for preventing the emission of all other types of powdery substances into the air from the system of unit B3,
- waste water treatment facilities,
- a system for the recirculation of leachate from landfills, which prevents its direct release into the surrounding waterways,
- technical solution for preventing particles from being blown away from the landfill
- a technical solution for preventing groundwater pollution
- systems for monitoring the operation of the unit, including monitoring of air and water emissions.



Figure 1, Thermal power plants B1, B2 and B3



Figure 2, Thermal power plant B3

Technical protection measures, which are foreseen in the Unit B3 Construction Project, are defined by the Regulation on criteria for determining the best available techniques, for the application of quality standards, as well as for determining emission limit values in the integrated permit (Official Gazette of RS, No. 84/2005).

The bases for defining certain techniques applied as protection measures are summarized in the BREF document for large combustion plants (LCP BREF - IPPC Reference Document on Best Available Techniques for Large Combustion Plants, European

Commission, July 2006), which was a reference document at the design time of unit B, (Energoprojekt Entel, 2017).

AIR PROTECTION MEASURES

Air protection measures are defined and classified by groups for the purposes of environmental protection for reducing the impact of unit B3, as follows:

SYSTEMS FOR REDUCING AIR EMISSIONS THROUGH FLUE GASES

In order to comply with the limits of emissions of polluting substances into the air through flue gases in accordance with GVE¹ according to Directive 2010/75/EC, as well as according to national regulations, the following measures are foreseen:

- Primary measures for reducing nitrogen oxide emissions, which are part of the technical solution of the boiler plant, and include the installation of burners with low NO_x emissions and multi-level combustion, with the injection of secondary and tertiary air into the combustion chamber, guarantee concentrations of nitrogen oxides <200 mg/Nm³ (dry gas, 6% O₂)
- Dry electric filter for the first-stage reduction of emissions of powdery substances guarantee concentrations of powdery substances <30 mg/Nm³ (dry gas, 6% O₂)
- ODG plant for reducing sulfur dioxide emissions guarantee sulfur dioxide concentrations <150 mg/Nm³ (dry gas, 6% O₂)
- Wet electric filter for the third-level reduction of emissions of powdery substances guarantee concentrations <10 mg/Nm₃ (dry gas, 6% O₂)

FLUE GAS DISCHARGE SYSTEM – STACK

The emission of purified flue gas will be carried out through a new, wet stack, which, in addition to the measures shown for reducing emissions, regulates the level of air pollution in the vicinity of boiler plants, in accordance with the requirements of the regulations on ambient air quality. The dimensions of the stack (Energoprojekt Entel, 2017) are determined so that the air quality in the vicinity of the TPP Kostolac is in accordance with the current legislation, with provision of reserve for the effects of pollutants that form the phon of pollution.

MEASURES FOR REDUCING THE EMISSION OF POWDERY MATTER FROM THE SYSTEM FOR DELIVERY OF LIMESTONE AND PREPARATION OF SUSPENSION

The following air protection measures are provided within the limestone system:

- The limestone warehouse is covered and partially closed from all sides, which reduces the possibility of small fractions of limestone being blown away by the wind.
- In the unloading station, which is covered, there are underground bunkers into which the wagon is unloaded.

¹ GVE- Threshold emission value

- The system for dedusting limestone silos, for which a dry dusting system with bag filters is intended will be placed on the silos: the efficiency of the bag filter is such that the output concentration of powdery substances of max. 20 mg/nm³ in the air is ensured. Air flow is 5,000 m³/h.
- For grinding limestone, the so-called wet grinding process in ball mills, which prevents the emission of suspended particles during the grinding process is foreseen.

MEASURES FOR REDUCING THE EMISSION OF POWDER MATTER FROM COAL DELIVERY AND DISPOSAL SYSTEMS

Within the coal delivery and disposal system, the following air protection measures are foreseen:

- Coal is transported in closed conveyor belts,
- At all transshipment points, dedusting is provided through autonomous bag filters with a "pulse-jet" system for shaking the bags,
- In the above-bunker tract, dedusting is provided during the transfer of coal from inclined belt conveyors to the transfer funnel, which consists of filter devices with a system of round steel channels for vacuuming the air with dust from the upper zone of the bunker,
- For occasional cleaning of these surfaces of the floors of the above-bunker tract, the inclined bridge and the boiler room, a central cleaning system with dust extraction is planned,
- In order to prevent the blowing of coal particles from the landfill, regular spraying of the landfill is suggested during the period without precipitation and when the wind speed is higher than 6 m/s.

MEASURES FOR REDUCING THE EMISSION OF POWDER MATTER FROM THE ASH, SLAG AND GYPSUM TRANSPORT AND DISPOSAL SYSTEM

Within the system for transport and disposal of ash, slag and gypsum, the following air protection measures are provided:

- The transport of ash, slag and gypsum within the TPP Kostolac B complex to the surface mine and within the surface mine is carried out in closed conveyor belts,
- The technology of joint disposal of ash, slag and gypsum, in the form of a mixture that represents stabilized matter, reduces the probability of scattering of particles from the surface of the landfill. The possibility of dosing additives for hardening the deposited mass (for the formation of stabilizers) is also foreseen.
- A sprinkling system is provided for wetting the dry areas of the landfill during the dry period,
- All transfer towers in the mixture transport system, T1, T2, T3 and T4 are closed.

OTHER AIR PROTECTION MEASURES

Between the power plant buildings, the surface mine and populated areas, barriers should be erected or windbreaks built to prevent the scattering of suspended particles.

WATER PROTECTION MEASURES

Water protection measures are defined and classified by groups for the purposes of environmental protection from the reduction of the impact of block B3 into the following

SURFACE WATER PROTECTION MEASURES

The planned construction of a common waste water treatment plant (for all units at the TPP Kostolac B site). After treatment (table 1), the purified water will be discharged into the recipient or will be used within the thermal power plant (re-use).

Table 1, Surface water protection measures

<i>Waste water from the ODG process</i>	-pretreatment with a base solution in order to achieve the ph value up to the required water quality to be released into recipients or circularly used in hydromixtures
<i>Oily and greasy waste water</i>	-by fuel oil treatment or GPO ² plant (oily waste water) to the common treatment plant
<i>Atmospheric wastewater from the area of the coal dump</i>	- the limestone storage is on a concrete surface with a slope, from which the generated stormwater is collected in a controlled manner, which is drained and treated with other stormwater (in separators).
<i>Atmospheric wastewater from the area of the coal dump</i>	-collection and purification of wastewater around the third landfill line in the facilities; treated water will be used for wetting the landfill
<i>Other atmospheric waste water from the plateau in the vicinity of unit B3</i>	- is collected and adequately channeled to the common plant
<i>Sanitary waste water from the buildings of unit B3</i>	-is channeled into a common plant for the entire thermal power plant
<i>Waste water from the transformer oil pits</i>	-is regularly cleaned and emptied of collected atmospheric precipitation
<i>Waste water from the ash, slag and gypsum landfill</i>	- is collected in a water reservoir designed to receive rainwater; treated water will be used for wetting the landfill

MEASURES OF LAND AND GROUNDWATER PROTECTION WASTEWATER TREATMENT PLANTS

Sludge and other solids from the waste water treatment system and waste water from the ash and slag system, as well as the settling tank in the waste water treatment plant from the ODG plant, depending on the composition, will be disposed of at the ash landfill of

² GPO - the main operating facility within unit B3

the power plant, the coal landfill or to the place designated by the competent utility service.

FUEL PLANT

- The transfer of fuel oil must be carried out according to the procedure EHSU 08/01 - Instructions for manipulation and storage of fuel oil in TEKOB.
- In the event of leaking occurring on the fuel oil pipelines, it is necessary to proceed with collecting of the spilled liquid according to the procedure that also applies in case of fuel oil spillage during extraction
- The resulting waste should be temporarily stored in accordance with the procedure IMSP 200 – Waste Management.

LANDFILL OF ASH, SLAG AND GYPSUM

The technological solution of the system of transport and disposal of ash, slag and gypsum suspension is designed in such a way as to enable the protection of soil and groundwater by applying the following measures (Table 2).

Table 2, Technological solutions for soil and groundwater protection

<i>Transport of a mixture of ash, slag and gypsum suspension with max. 30% moisture</i>	- a small amount of water; without a settling pond - compact mass - full use of binders in the mixture - transport via closed conveyor belts
<i>Existing location Open pit mine Drmno</i>	- without degradation of new areas - formed on clay, adsorption of pollutants and water
<i>Technical establishment of the landfill</i>	- double waterproofing - drainage system for collecting water

MEASURES FOR REDUCING EMISSIONS OF HEAVY METALS INTO THE ENVIRONMENT

Project solutions (Energoprojekt Entel, 2017) that were applied to unit B3 also achieve a reduction in heavy metal emissions in the following ways:

- By ensuring high unit efficiency
- Applying measures to reduce the emission of dusty substances: dedusting in an electric filter, desulfurization of flue gases using a wet process and dedusting in a wet electric filter
- By ensuring the impermeability of the ash, slag and gypsum landfill, which prevents the migration of heavy metals into the soil and groundwater
- Recirculation of free water from the landfill of ash, slag and gypsum for the needs of wetting the landfill itself
- The technology of depositing a moistened mixture and wetting the landfill, which prevents particles from spreading to the surrounding soil

- By recirculating waste water from the ash and slag system within the system, without discharge into the waterway (Danube)
- By using treated waste water from the HPV, ODG plant and a wet electric filter for the preparation of a thick hydromix of ash and slag (for the needs of units B1 and B2).

MEASURES THAT INCLUDE PLANS AND TECHNICAL SOLUTIONS FOR ENVIRONMENTAL PROTECTION (WASTE TREATMENT, RECULTIVATION, REHABILITATION, ETC.)

In this grouping of measures for the construction plan of block B3, they are divided into the following groups:

- Protection measures in the process of storing and handling dangerous substances
- Measures taken during the construction of block B3
- Measures to protect the archaeological site of Viminacium
- Measures to monitor the impact on human health
- Environmental protection measures when closing the facility

PROTECTION MEASURES IN THE PROCESS OF STORAGE AND HANDLING OF HAZARDOUS MATERIALS

Hazardous materials (Energoprojekt Entel, 2017) that will be used for the needs of the operation of unit B3 will be delivered and stored in the same way as for the needs of the existing units B1 and B2. Therefore, the same procedures and protection measures will be applied to these activities that are prescribed within the existing internal documents of the power plant, procedures related to ISO 14000 standards and occupational safety. This implies the application of the following measures:

Loading and unloading of hazardous materials (loading, transshipment, racking, unloading, flowing out, storage and other manipulations related to loading or unloading) should be carried out only at specially designated locations within the TPP (and/or unit B3), according to prescribed procedures.

- Provide that the place where hazardous materials are loaded or unloaded be supplied with the prescribed devices and equipment and marked in a visible place with the appropriate danger sign.
- Hazardous materials must be stored in accordance with the manufacturer's instructions, in areas specially designed for this purpose, equipped with a concrete base and a system for collecting and transporting waste water to the treatment plant.
- Areas for the storage of hazardous materials must be equipped with a suitable system of controlled local / general ventilation.
- Store dangerous substances (chemicals, grease, diesel) in containers (reservoirs) located in protective tubs for receiving spilled liquids taking care to separate incompatible chemicals (special tubs for acids and bases, etc.). Ensure the connection of the protective tub and the appropriate technological sewage system.

- Instructions for handling hazardous materials must be displayed in visible place everywhere where hazardous materials are handled.
- In places of storage and use of dangerous substances, provide sorbents (e.g. sand barrels) to collect the chemical in case of spillage.

MEASURES TAKEN DURING CONSTRUCTION OF UNIT B3

In accordance with the Law on Confirmation of the Protocol on Heavy Metals, the design solutions applied to block B3 also include measures to reduce heavy metal emissions, waste management measures, reclamation measures, noise protection measures.

PROTECTION MEASURES OF THE VIMINACIUM ARCHAEOLOGICAL SITE

The archaeological site of Viminacium has been declared an immovable cultural asset of exceptional importance. Accordingly, pursuant to the Law on the Protection of Cultural Property, as well as the conditions set by the Institute for the Protection of Cultural Monuments, the Investor is obliged to comply with the following requirements related to the protection of immovable cultural property:

- stop work immediately after finding an archaeological site or object, contact the Republic Institute for the Protection of Cultural Monuments in Belgrade and secure the place of discovery,
- In case of discovery of significant remains of immovable property, the Investor is obliged to foresee the modification of the project and the dislocation of the facilities,
- The investor is obliged to provide funds for geophysical measurements and archaeological excavations, relocation and presentation of endangered objects on the area of the archaeological site.
- The investor is obliged to provide funds for the preparation of studies and projects, protective archaeological exploration of endangered sites and the performance of work on dislocation, conservation, presentation and publication of the discovered property.
- The investor is obliged to provide permanent archaeological Supervision

MEASURES FOR MONITORING IMPACTS ON HUMAN HEALTH

Bearing in mind that in the past period of operation of thermal units at the locations of TPP Kostolac A and B, there have been public complaints regarding the negative impact of the operation of thermal power plants, as well as pit mine Drmno on the quality of life and health of people, it is necessary, in cooperation with the Institute for Public Health in Požarevac to envisage the following activities in order to monitor changes in the health status of the population:

- Carry out periodic, regular, health systematic checkups of the population in the settlements located in the vicinity of TPP Kostolac B

- Record and monitor the number and types of diseases that occur in the population living in the settlements in the vicinity of TPP Kostolac B, especially in vulnerable categories of the population
- Carry out statistical analyses of the frequency of occurrence of certain diseases with the proposed activities aimed at mitigating the consequences (if necessary). Particular attention should be paid to the analysis of the effects of measures applied to reduce emissions from existing thermal capacities on the health of the population in the coming period
- Establish permanent measuring points for air quality control in settlements
- Analyze the chemical composition of suspended and settling substances (combustible, non-combustible, content of heavy metals, etc.).

ENVIRONMENTAL PROTECTION MEASURES WHEN CLOSING THE FACILITY

The closing of the facility is a special activity defined in the Law on Planning and Construction, which is carried out on the basis of prepared technical documentation. Approval for the execution of works is obtained on the basis of accepted technical documentation, as well as the Plan of protection measures for the closure of the facility.

CONCLUSION

If we start from the basis that environmental protection is a process of preventing pollution and degradation of all environmental media, this paper shows only some of the mechanisms and preventive activities of environmental protection that are being considered at Thermal power units in Kostolac. Numerous and binding documents and legislation regulating environmental protection issues may seem as unnecessary or such that they additionally complicate sectoral cooperation. However, from the example mentioned in the paper, it can be concluded that a systemic approach is extremely important and that it covers all aspects and areas of related measures and activities that include a clear policy, strategy, planning, monitoring, management and control of implementation at all levels. In this way, ecological issues can be solved and preservation of the environment can be achieved, especially on a long-term basis, in order to enable an optimal development of the society and the state for the future.

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