BERCEN Training Program on On-site Inspection

For the Environmental Enforcement Agencies and Inspectorates

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THE THERMAL POWER PLANT

REK BITOLA

(General information)
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1. INTRODUCTION

Mining and Energy Combine (REK) Bitola is a facility of strategic importance and primary installation for electricity generation in the Republic of Macedonia. It satisfies over 70% of the demand for electricity in the country, as well as major part of the needs for coal (lignite) of industrial boiler plants and general consumption.

REK Bitola is located in the southern part of Macedonia, in Pelagonia plain. It has been built on the basis of the finds of coal-lignite, at around 12 km eastwards from the City of Bitola.

The conception of development and exploitation of the thermal power plant Bitola was initiated in 1982. In parallel with the start up operation of block 1 in 1984, block 2 was put into operation, and block 3 in 1988, constructed in the manner that can be adapted for joint operation with another block - block 4 that remained undeveloped.

Today, REK Bitola with its three completed blocks of individual capacity of 225 MW or total installed capacity of 675 MW provides an average annual generation of 4.34 million MWh electricity.

The total remained usable reserves of coal in the Excavation Site Suvodol by September 2000 have been estimated at 76 h 10^9 tons, which, given the annual requirements to satisfy the consumption of the three blocks of the thermal power plant, amount 6h10^9 tons of coal, could facilitate operations by 2013.

REK Bitola operates as a Plant of the Public Enterprise Electric Company of Macedonia. It consists of the following infrastructural structures: the Mine Suvodol and Thermal Power Plant (TPP) Bitola, and three departments - for legal affairs, for economic affairs and for investments, research and development, with a total number of 2400 employees.
ЛЕГЕНДА:
1. ТЕ "БИТОЛА" 3 Х 225 [MW]
2. РУДНИК "СУВОДОЛ" 6.000.000 [t/god]
3. ТС - БИТОЛА 2 400/110 [kv]
4. ЛЕЖИЩЕ "СУВОДОЛ"
5. ТС - БИТОЛА 1 150/110/35 [kv]
6. ТС - БИТОЛА 3 110/10 [kv]
7. ТС - СУВОДОЛ 110/6,3 [kv]
8. АКУМУЛАЦИЈА "СТРЕЖЕВО"
9. АКУМУЛАЦИЈА "СУВОДОЛ"
2. DESCRIPTION OF FACILITIES

The Block of the Thermal Power Plant is an independent technological whole for electricity generation and operation of one block is not conditioned by the operation, i.e. nonoperation, termination of operation or stoppage in case of repairs of some of the other two blocks.

Each block of the TPP Bitola consists of the main installation building encompassing:
- boiler,
- turbine and generator and their accessory equipment, as well as
- starting boiler house,
- electric filter,
- stack, smoke ventilators,
- cooling tower,
- circulation pumping station,
- capacitor,
- water softening plant,
- crude oil station,
- oil station, etc.

TPP Bitola 3x225 MW generally consists of the following:
- three steam circulating steam generators with nominal production of superheated steam of 700t/hour, with pressure of 140 bar and temperature of 545 °C.
- three steam capacitation turbines with a nominal capacity of 225 MW
- transformers from 25 to 250 MVA
- long distance pipelines of 110 and 400 kV for connection with the electric power system
- three electric filters
- one joint stack for both blocks and one stack for the third one, and potentially fourth block
- two pumping stations for cooling water with pipelines
- three cooling towers with natural draft
- water softening 2h35 m³/hour and 2h80 m³/hour
- electrolysis station for production of carbon and distribution of CO₂
- pumping station for the raw water of Crna River
- crude oil station
- starting boiler house
- two coal supply systems with strips and roto dredgers
- three systems for internal pneumatic ashes removal with storage space for ashes and slag
- three systems for external transport of ashes and slag
- other auxiliary facilities, including: fire prevention, Diesel aggregates, cranes, elevators, etc.
In Thermal Power Plant:
1. Bus station
2. Doorman's booth
3. Administrative building of REK
4. Cooling towers
5. Restaurant
6. Administrative building
7. Workshop
8. Main installation building
9. Pumping station
10. Electrolysis station
11. Water softening
12. Starting boiler house
13. Crude oil station
14. Dressing rooms
15. Accommodation huts
16. Stack
17. Slanting bridge for coal
18. Mounting plateau with cranes
19. Storage houses
20. Power generation station 400/110 kV
21. Oil operations
22. Ashes and slag transportation system
23. Polyclinic
24. Investment
25. Neutralization hole
26. Fire prevention for power generation stations
3. DESCRIPTION OF APPLIED TECHNOLOGICAL PROCESS

3.1. Operation cycle - water/steam/condensate

The water/steam/condensate tract in the closed cycle of TPP Bitola is the most important segment of the production cycle, the main goal of which is to provide steam in the steam generators. The boiler house aggregate of each block is provided with a system for technical control necessary for its management and operations monitoring, with a system of automatic regulation, with technological protection and blockades against industrial accidents.

3.2. Coal and crude oil preparation and supply

The main goal of this production section is to transport the coal obtained from the open pit Suvodol to TPP Bitola, and generation of coal dust used as combustion fuel in steam generators. In addition, the crude oil system provides sufficient quantity of crude oil required for turning on the steam generators of solid fuel from cold condition, so that the initial burning is carried out with liquid or gaseous fuel.

3.2.1. Coal supply system

The coal required for the TPP Bitola is supplied from the mine Suvodol. The coal from the mine is transported through a system of lines to the receiving disposal site which separates the coal flow to the landfill of blocks 1 and 2 or to the landfill of block 3 or to both landfills, and the coal is deposited on eight mining beams by means of four roto dredgers. The capacity of the landfill is 560,000 T, representing 25 days reserves for operation with a guaranteed quality of the coal.

3.2.2. System for preparation of coal dust

The coal once crushed in crushing plant in the mine, from the coal storage space, by means of dozer and supplier, is taken to the vertical section of the channel for recirculation of smoky gases and falls into the mill. The dust prepared in this manner, by means of the gases, is taken to the fireboxes for combustion.

The capacity of the coal storage spaces is 300 T or sufficient for 5 hours uninterrupted operation of one mill.

3.2.3. Crude oil system

The crude oil station is intended to supply the crude oil required for block starting and supporting the flame in the steam generators when it gets dark for various reasons.
3.3. **Preparation and supply of industrial water**

REK Bitola uses the accumulation Strezevo as a main source for supply of required quantities of industrial water, which provides 12 million m³ per year, through a pipeline. In addition to this, there are two more options, i.e. the river of Crna and the accumulation Suvodol, but their utilization is at minimum.

The demand for water by REK Bitola is up to 540 L/sec in summer, and less in winter, determined by the magnitude of the irreversible losses of water in the system for industrial water supply and the flows of water needed for the Combine itself. In order to meet the criteria required for use in the TPP, the raw water is subjected to processing by means of decarbonization and demineralization.

3.4. **Cooling water in TPP**

Due to the lack of running system, river or water body, lake or sea, and for the purpose of cooling, it was necessary to introduce a recirculation system for circulation cooling water, by use of cooling towers demonstrating sufficient technological and economic indicators.

Each block is provided with one cooling tower, condensation plant, pumping station and appropriate pipelines and socket parts.

3.5. **Drain and treatment of smoky gases**

The system of gas-air tract of each steam generator is basically composed of two regenerative air heaters, two ventilators for fresh air, two steam calorifier and two smoke ventilators. All these elements are mounted at the back part, outside the building of the steam generator.

After the regenerative air heater and before the ventilator for smoky gases, the electric filter is positioned, playing the role of electric condenser and keeping the particles of smoky gases due to the creation of dielectric power.

The stack of the steam generator is placed after the ventilators for smoky gases and its height is 250 m.

Blocks 1 and 2 have joint stack, and block 3 has a separate one, with a possibility and capacity to connect an additional block, i.e. Block 4 which could be developed in future.

3.6. **Drain of ashes and slag**

The technological process of electricity generation in the TPP Bitola, during the combustion, produces ashes and slag, in operation conditions under nominal power of 225 MW and guaranteed quality of the coal of 7308 kJ/kg, as well as around 50 T/hour and around 8 T/hour of slag.
3.6.1. System of internal ashes removal of a block

The ashes as a product from the coal combustion in steam generators, together with the smoky gases, pass through smoke channels and enters into the electric filter at the exit from the steam generator. The task of the filter is to separate the ashes from smoky gases. According to project data, the electric filters in TPP Bitola have a purification degree of 0.9984.

3.6.2. System of external transport of ashes and slag

In the framework of the system of external transport of ashes and slag in TPP Bitola, two concrete storage structures are constructed for collection of ashes and slag, so that there is a joint storage structure for blocks 1 and 2 and separate one for block 3. They are developed as a single structure, internally divided into two parts, one of which is for ashes and the other for slag.

The transportation of ashes and slag is carried out by means of a system of dosers, lines, disposal and deposition sites.

The slag from the slag remover positioned under the steam generator is transported to the slag storage space, while the ashes from the electric filter, by means of pneumatic system, is transported to the ashes storage space.

There are three systems for external transportation of ashes and slag in TPP Bitola. Ashes and slag from the three blocks are transported through common lines, after which three separate transportation systems composed of the lines and disposal machines continue.

Ashes and transportation systems for blocks 1 and 2 have a capacity of 250 T/hour, while the capacity of the system for Block 3 is 500 T/hour.

All three systems, beginning with the line, are able to transport ashes and slag from any block.

At the bottom of ashes and slag storage spaces, there are concrete craters within which dosers are built in. From the dosers onto the lines, the slag falls first and then the ashes, moistured with water from the system of sparklers in order to prevent dispersion from the line under the influence of the wind.

The disposal of ashes and slag is carried out in the so called strongboxes to the slag disposal site. Then, it is covered with earth and the surface is recultivated.

3.7. Auxiliary plants and accessory equipment

As auxiliary plants supporting the TPP that have not been considered under one of the tracts, we should mention:

- block transformers
- starting boiler house
- electrolysis station, etc.
3.7.1. Block transformers

The provide higher voltage required for the electricity transmission at longer distances.

3.7.2. Starting boiler house

Its task is to provide steam required for the block starting and for certain accidental situations.

It contains two block boilers with a capacity of 50 T/hour and 10 T/hour, with reduced pressure of 13 Bar and temperature of 260 °C.

3.7.3. Electrolysis station

The task of the electrolysis station is to produce carbon required for cooling the windings of the generator's rotor. Technology of production is based on the principle of electrolysis of the water in plants called electrolysers, where the water is decomposed into carbon and oxygen.

3.8. Common technical plants and equipment

We can mention the following general technical plants and facilities for common use within the TPP:

- workshops
- depots and storehouses (open and closed)
- administrative and management premises
- restaurant
- huts for accommodation of workers
- boiler house for hot water based heating (reserve)
- other

Taking into account the purpose of the facilities, the following waste matters are found:

- solid waste
- sanitary wastewater
4. Globalized flows of raw materials, substances and waste matters

4.1. Tract of closed steam-lined cycle – supply water/steam/condensate

The main working process, during the work of the TPP blocks is being carried out in the tract of the closed steam-lined cycle (supply water/steam/condensate). During this process, a transmittion/transfer of the transformation of heat energy resulting from the fuel combustion in a mechanical energy of the turbine takes place, and even in an electrical energy, as a final product, being generated in the generator.

4.1.1. Raw materials and substances

As a power fluid used for transmittion/transfer of the transformation of energy from the fuel generation water is being used in a form of a supply water, steam and condensate.

4.1.2. Waste matters

The waste matters in the tract from the closed steam cycle include:

- temporary steam release from exhaust and safety armatures
- sludge removal from the boiler
- water release from the drain and in the engine room

4.1.3. Waste waters characteristics

The temporary steam release and the de-steaming from the condensation reservoirs does not pollute the environment, thus is not treated any further.

The waste waters characteristics resulting from the sludge removal of the boiler are given in section 5.2.

The waste waters characteristics resulting from the drain and in the engine room, are given in section 5.2.

4.1.4. Waste matters treatment

The waste waters treatment shall be reviewed in the section 5.2.

4.2. Tract of coal supply

The tract for coal supply for the TPP blocks includes:

- crushing plant
- coal disposal site
- roto dredging machines
- transport systems (located as external, in oblique bridges and over-bunker storage space)
- storage space
- dozers, suppliers and transporters

4.2.1. Raw materials and substances

Basic raw material used for production of electrical energy in TPP Bitola is the coal, generated in the own mine of a surface excavation site.

**Coal characteristics**

<table>
<thead>
<tr>
<th>Lignite characteristics:</th>
<th>parameter</th>
<th>measuring unit</th>
<th>lowest</th>
<th>mean</th>
<th>highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂</td>
<td>kJ/kg</td>
<td>6200</td>
<td>7280</td>
<td>7830</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>%</td>
<td>49</td>
<td>50,5</td>
<td>52,25</td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>%</td>
<td>12,7</td>
<td>13,5</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Sulphure</td>
<td>%</td>
<td>0,4</td>
<td>0,52</td>
<td>0,7</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>%</td>
<td>19,7</td>
<td>22,55</td>
<td>24,3</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>%</td>
<td>1,9</td>
<td>1,93</td>
<td>2,2</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>%</td>
<td>0,3</td>
<td>0,3</td>
<td>0,3</td>
<td></td>
</tr>
<tr>
<td>O₂</td>
<td>%</td>
<td>8,25</td>
<td>8,4</td>
<td>11,1</td>
<td></td>
</tr>
</tbody>
</table>

**Coal consumption at an average power (Nₚ₉=209, 9 MW)**

<table>
<thead>
<tr>
<th></th>
<th>measuring unit</th>
<th>per block</th>
<th>TPP in total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal consumption per hour</td>
<td>t/h</td>
<td>304,4</td>
<td>913</td>
</tr>
<tr>
<td>Coal consumption per day</td>
<td>t/day</td>
<td>6,732</td>
<td>21,914</td>
</tr>
<tr>
<td>Coal consumption per month</td>
<td>t/month</td>
<td>174,964</td>
<td>524,893</td>
</tr>
<tr>
<td>Coal consumption per year</td>
<td>t/year</td>
<td>2,099,573</td>
<td>6,298,722</td>
</tr>
</tbody>
</table>

4.2.2. Waste matters

In the coal supply tract, waste matters are generated as a result of self-founded processes:
- evaporation of moisture and volatiles as a result of the coal drying on the open disposal site
- Dust dispersion from an open disposal site
- Dust generation from the coal transfer and transport with the transport systems
- Surface water pollution by coal rinsing at the open disposal site, during atmospheric rainfalls

This pollution is of a relatively small size and basically the TPP micro location is being polluted.
4.2.3. Waste matters characteristics

The qualitative structure, as well as the waste matters quantifying were not discussed.

4.2.4. Waste matters treatment

- **Dust dispersion from an open disposal site**

No measures are anticipated for waste matters treatment, except the maximizing of the levee coal layer, from an aspect of preventing its spontaneous combustion.

- **Dust from the transport systems**

For the external transport systems, no special measures are anticipated for preventing the dust dispersion, having in mind they are short routes. The inclined bridges where the transport lines for fuel supply to the over-bunker area are placed, are enclosed with tinplate, thus the dust dispersion is taking place in the inside. This area is regularly cleaned. For the over-bunker area, in which there is significant coal dust dispersion generated during the coal transport and transfer, an aspiration system and manual cleaning of the area are anticipated.

4.3. Tract of crude oil supply

The crude oil in TPP Bitola is used as an additional fuel, when starting the TPP blocks, as well as supporting the process of coal combustion. Especially in conditions of coal supply with low caloric value to the fireboxes/burners, or coal with increased percentage of fireproof matters (most often with increased percentage of soil in the coal).

The tract of crude oil supply for the TPP blocks includes:

- reservoirs for crude oil storage
- pump plant
- heat-exchanging equipment for thermic preparation of the crude oil
- pipelines and armature
- crude oil burners

4.3.1. Raw materials and substances

The only raw material treated in this tract is the crude oil.

**Crude oil characteristics**

The crude oil characteristics depend on the characteristics of specific procurements. Most often they are:

### Exploitation experience

The average yearly crude oil consumption for the three blocks is **3680 t/year**.

#### 4.3.2. Waste matters

There are no waste matters in the tract of crude oil supply. The volatile evaporation from the crude oil reservoirs in the atmosphere has no significant impact to the environment.

#### 4.3.3. Waste matters characteristics and treatment

Since no waste matters are identified, neither their characteristics nor the treatment were discussed.

#### 4.4. Gas-air tract

In the process of combustion, a mixture of gasses is generated, in accordance with the fuel type and its chemical characteristics, and the regime of combustion.

##### 4.4.1. Raw materials and substances

The raw materials and materials which are part of the process of combustion are:

- coal
- crude oil
- air

##### 4.4.2. Waste matters

With regard to the amounts of ejecting, their structure/content, physical-chemical characteristics of their integral elements, the smoky gases are one of the main pollutants of the TPP operating. The smoky gases, as aerosol, may be discussed as a composition of:

- gas mixture: O₂, CO₂, CO, SO₂, CO₃, NOₓ, H₂O . . .
4.4.3. Waste matters characteristics

The waste matters characteristics shall depend on the products of combustion and the measures applied for their cleansing.

4.5. Tract of ashes and slag

The ashes and the slag are products of the combustion. The tract of ashes and slag includes plants and elements where the separated ashes and slag are collected from the basic gas flow of the smoky gasses, as well as the ashes and slag transport to the open ashes disposal site.

4.5.1. Raw materials and substances

Regarding the fact that this is a tract for collection, transport and disposal (storage) of hazardous substances, the materials used are in a function of the equipment functioning:

- oils and lubricants
- water for slug cooling
- air for the air-lift, and for moisturizing of the pneumatic ash transport.

4.5.2. Waste matters

The waste substances from this tract (ashes and slag) are the main solid waste matters, characteristic for the electrical energy production using coal as a fuel.
5. ANALYSIS OF THE SOURCES OF POLLUTION IN THE PRODUCTION PROCESS

5.1. AIR POLLUTION

5.1.1. Emission of harmful matters from REK Bitola

Measured values:

<table>
<thead>
<tr>
<th></th>
<th>Volume gas flow (m³/h)</th>
<th>Dust</th>
<th>SO₂</th>
<th>NOₓ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>mg/m³</td>
<td>kg/h</td>
<td>mg/m³</td>
</tr>
<tr>
<td>Block 1</td>
<td>1.435.582</td>
<td>72, 3</td>
<td>103,79</td>
<td>1.760</td>
</tr>
<tr>
<td>Block 2</td>
<td>1.374.404</td>
<td>66, 9</td>
<td>91, 94</td>
<td>1.610</td>
</tr>
<tr>
<td>Block 3</td>
<td>1.091.001</td>
<td>39, 4</td>
<td>42, 98</td>
<td>2.311</td>
</tr>
<tr>
<td>Total</td>
<td>3.900.987</td>
<td>61, 2</td>
<td>238, 7</td>
<td>1.861</td>
</tr>
</tbody>
</table>

5.1.2. Immission of harmful matters from REK-Bitola

Background concentrations in the vicinity of REK Bitola are measured at three measuring points: Gneotino, Dedebalci and Ribarci. Concentrations of SO₂, smoke (flying particles) and aero sediment are measured. The existing equipment enables measuring only of 24 hour concentrations, while for the brief/transient ones there are no measured data so far.

According to the measured data, the average daily concentrations measured at the three points in the vicinity of REK Bitola are lower than the ones defined by Law.

5.2. WATER POLLUTION

5.2.1. Waters in the processes of the Thermal Power Plant

5.2.1.1. Needs of water

In the process of electrical energy production in the thermal power plants, besides the coal as a power fuel, technical water is needed as well, used for:

- replenish the losses by the demineralized water in the closed steam lined system
- replenish the losses in the recirculation cooling system
- cooling of single plants
- slag extinguish and ashes moistening
- firefighting
- maintenance of the hygiene of infrastructure
- for the horticulture.

The needs for water of REK Bitola are up to 540 l/s in the summer period, and less in the winter period.

Besides the technical water, REK Bitola also needs drinking water for the needs of the staff, food, sanitary needs etc.
5.2.1.2. Water supply

Main, auxiliary and reserve sources for raw water supply for TPP Bitola:
- the system Strezevo
- the accumulation Suvodol
- the river Dragor

The water supply in TPP Bitola is carried out with pipelines and complete additional equipment.

5.2.1.3. Waste waters

The waste waters in TPP Bitola may be divided to:
- industrial waste waters
- communal waste waters
- atmospheric/storm waste waters

Waste waters are let in a separate sewerage.

5.2.1.4. Expected harmful matters in the waste waters

According to the origin:
- industrial waste waters
- communal waste waters
- atmospheric/storm waste waters

According to the regime of releasing:
- eventual
- periodical
- continuous with constant release
- continuous with changeable release
- occasional

According to the quality and characteristics, the waste waters may be divided to:
- chemically polluted
- mechanically polluted
- thermically polluted
- greasy
- cooling waters

According to the type of pollution, the industrial water treatment is carried out separately.
### 5.2.1.5. Table of the balance of waters

<table>
<thead>
<tr>
<th>Place of occurrence</th>
<th>Technological process</th>
<th>Raw material and other materials</th>
<th>Waste water</th>
<th>type of pollution</th>
<th>Quantity</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decarbonization</strong></td>
<td>It is carried out by sedimentation with settling agents</td>
<td>- raw water and chemicals (lime slaked, ferri-chloride and poly-electrolyte)</td>
<td>From sludge removal from the reactor</td>
<td>Not very much polluted, rich in flocules, pH=6,5-8,5</td>
<td>-12,5 m³/h, -18.000 m³/year</td>
<td>-continuous removal of sludge from the reactor for deka-water -in Channel 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>From sand filters rinsing</td>
<td></td>
<td></td>
<td>75, 6 m³/month, 900 m³/year</td>
<td>-during PF washing -in Channel 10</td>
</tr>
<tr>
<td><strong>Demineralization</strong></td>
<td>With kation and anion exchangers</td>
<td>Decarbonized water and chemicals</td>
<td>From regeneration of ion exchangers</td>
<td>CaSO₄, MgSO₄, Na₂SO₄ and Fe salts, NaCl, Na₂CO₃ and Na₂SiO₃</td>
<td>8.683 m³/year</td>
<td>-during regeneration -in the pit for neutralization in HPV (capacity of the pit=210 m³)</td>
</tr>
<tr>
<td><strong>Block station for desalting</strong></td>
<td>Condensate purification from Fe, ammonia, and easily dispersed matters</td>
<td></td>
<td>From regeneration of ion masses with H₂SO₄ and NaOH</td>
<td>Acids and bases from rinsing</td>
<td>1100 m³/month, 12500 m³/year</td>
<td>-during regeneration -in a retention tank of 10000 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>From straining through filters</td>
<td>Pure water with corroded substances from the tract of the boiler</td>
<td>6000 m³/year</td>
<td>-discharge during straining -in the retention tank of 10000 m³</td>
</tr>
<tr>
<td><strong>Transfer of the conversion of</strong></td>
<td></td>
<td></td>
<td>From acid washing and rinsing of the boiler</td>
<td>Water with diluted acid</td>
<td>6500 m³ every 5 years</td>
<td>-discharge during washing -in the retention tank</td>
</tr>
<tr>
<td><strong>Steam generating aggregate</strong></td>
<td>Thermal energy into mechanical and ultimately in electric energy</td>
<td>Water, steam and condensate</td>
<td>From conservation of the boiler</td>
<td>Hydrazine ((N_2H_4))</td>
<td>3-5 conservations/annually, 800 m(^3)/year</td>
<td>-During conservation - in the retention tank of 1000 m(^3)</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Loss of water for cooling and moistening of slag</td>
<td>-pH=8</td>
<td>-temp. 22-39°C</td>
<td>60000 m(^3)/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thickness of the mixture from 1020 to 1090 g/l</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cooling towers</strong></td>
<td>Water is treated with evaporative cooling up to 28°C</td>
<td>Pure water, to prevent settling dispersant, biocide and algaeicide is added</td>
<td>From sludge removing in cooling towers</td>
<td>-pH do 9,0</td>
<td>- do 29°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
### Other

- Rinsing of oily surfaces in garages, workshops, during equipment repairs and maintenance;
- Waste water resulting from weak sealing of some tanks, pouring out etc;
- Waste water from washing of construction surfaces, plateaus etc;

<table>
<thead>
<tr>
<th>Source</th>
<th>Type of Water</th>
<th>Oil Quantity</th>
<th>Volume per Year</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oily water</td>
<td>With average quantity of oil 100 mg/l</td>
<td>300,000 m³/year</td>
<td>-in the tank for oily water with laminar separator, and after purification the water is discharged in the retention tank and the separated oils in a tank for oil separation.</td>
<td></td>
</tr>
<tr>
<td>From keeping hygiene in the infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Kitchen and sanitary facilities

- Sanitary waste water

<table>
<thead>
<tr>
<th>Source</th>
<th>Type of Water</th>
<th>Volume per Year</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary waste water</td>
<td>about 270,000 m³/year</td>
<td>In PSEMO device for purification and then in Channel 10</td>
<td></td>
</tr>
</tbody>
</table>

**Total:** 600,000 m³/year

- In Channel 10
5.3. Solid Waste

Solid waste is generated from:

– Repairs and maintenance of the equipment of the blocks
– Solid wrapping material of various origin
– Waste from the kitchen and the restaurant
– Waste from the administrative offices, workers accommodation, first-aid department etc.

5.3.1. Solid waste treatment

Metal elements, generated from repairs and maintenance are disposed on the temporary plateau and sold from time to time.
The other solid waste is transported to the city landfill near REK Bitola.
5.4. Noise and vibration

Chart No.1. Disposition of the objects in REK Bitola with measured places of noise
5.4.1. Strength of noise as criteria for the assessment

Measurements of the level of noise have been made in the surroundings of REK Bitola. The results show that the noise is within the limits of the allowed.

5.4.2 Family of N-curves, defined with ISO 1996 as criteria for the assessment

According to this criteria the measured timely record of the noise is analyzed by using frequency analysis and the N-curves as criteria for the assessment. The results are of the one within the limits of the allowed.

5.4.3. Assessment of the existing level of vibrations

At all spots where the measurement of noise and vibrations has been made, vibrations have not been registered.

6. MONITORING SYSTEM

Environment quality monitoring activities for the mine and the thermal power plant are carried out by the Technical Safety Service. This Service also monitors the technological process, including:
- the process of coal combustion
- the content of sulfur in coal
- the work process and electrostatic filter maintenance
- harmful substances emission
- air quality at selected measuring points
- establishment of the efficiency of the technological equipment for delivering coal, transport and deposition of ash.

The Service is expected to keep regular documentation and to have complete and regular database, and to regularly report on the monitoring carried out.

6.1. Emission Monitoring

There is optical equipment from SICK Company installed for measuring of the emission of harmful substances as SO₂, NOₓ, and particles from all three blocks. Two exit channels of Block 1 and 2 have 4 GM30 instruments mounted for measuring SO₂, NOₓ, and dust, while exit channels of Block 3 have two instruments each, type PM41 for continuous measuring of dust.

6.2. Immission Monitoring

Concentrations of harmful substances (SO₂ particles in the air and air sediment) are measured at three measuring points:
- v. Ribarci
- v. Gneotino
- v. Dedebalci
For this purpose a standard eight channels) equipment for measuring 24 hour concentrations of harmful substances is used. The equipment is of old date and not suitable for measuring shorter (half-hour, one-hour) concentrations.

7. TECHNICAL SOLUTIONS FOR ENVIRONMENT PROTECTION AGAINST POLLUTION

REK Bitola, by its nature, represents a major polluter of the environment. Through the stacks approximately 64.000 T SO\(_2\), 6.200 T NO\(_x\), 2.400 T particles and 5.700.000 T CO\(_2\) is discharged and large quantities of coal dust, slag and ash from the process of production, transport and disposal.

7.1. POLLUTION AND PROTECTION OF THE ATMOSPHERE

In the case of REK, emission values of waste substances discharged in the atmosphere are as follows:
- SO\(_2\) several times exceeds legal norms
- NO\(_x\) is within the limited values
- CO\(_2\) is within the limited values
- Solid particles exceed the values proscribed in legal normatives

7.1.1. Existing solutions for protection of the atmosphere against air pollution

In the case of REK Bitola, the treatment needed for individual pollutants is:
- SO\(_2\) - equipment for treatment is not planned
- NO\(_x\) - equipment for treatment is not planned
- Solid particles - electric filters are planned and built with a coefficient of treatment of 99.7%.

7.1.2. Measures needed for treatment of waste substances

- SO\(_2\) - a device for treatment of exhaust gases is needed
- NO\(_x\) and CO\(_2\) - additional measures for enhancing the treatment efficiency are not needed.

7.2. RECICLING OF THE SLAG

The pollution of the environment caused by the disposal of the slag can be considerably reduced if the slag is recycled and processed in a high quality fuel.
7.3. POLLUTION AND PROTECTION OF WATER

From the aspect of environment protection, the waste water derived from technological processes and the sanitary waste water are treated. Depending on the type of pollution, the treatment of industrial waters is done separately by:

- neutralization
- oil removal

The water from the cooling towers is not subject to treatment because the analyses show that, except for minimal increase in pH values, other types of pollution range within the allowed concentrations.

Chemically polluted water is characterized with big range of pH values. Therefore, this water is treated with neutralization.

**Fig. 1 Technological scheme of waste water treatment and use**
neutralization

Waste water resulting from regeneration of ion exchangers

Waste water resulting from regeneration in the devices for condensate treatment

Sprinkling of ash on the transport line

Retention tank

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**Fig. 2. Technological scheme for water subjected to neutralization**

Neutralization is executed in a neutralization pit which is located in the facility for chemical preparation of water.

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**Treatment of oily water**

The treatment of oily water in general includes collecting of the water in channels placed in pits aimed for that purpose and then pumping or gravitational discharge into the main gravitational pipeline for oily water taking it to the treatment device – laminar separator (oil remover).

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**Fig. 3. Scheme of the treatment of oily water**
The treatment of the received oily and greasy water is executed in a laminar separator, where the floating oils are extracted with a moving pipe and collected in oil tank, while the dust and the other impurities slow down when going through the laminas and settle. Pure water is pumped in the retention pool.

**Cooling towers**

The water treated by cooling reaches the temperature of 20° in the cooling towers and is returned in the process. During this occurs water loss, which is replenished.

**Retention tank**

The waste water from the three blocks is collected in a tank with 10,000 m³ volume. The tank is placed under ground and coated with acid-resistant and waterproof clay.

The role of the retention tank is multiple. Beside the role of a reception tank, it serves as a place where pH value of the chemically polluted water is definitely regulated and the most delicate particles are deposited, and where water for sprinkling of ashes is taken from.

**Treatment of sanitary waste water**

Sanitary waste water is taken with special pipes to the fecal water treatment device PSEMO. The principle of work is based on a biological process of reduction of organic substances with active mire.

### 7.4. SOIL POLLUTION AND TREATMENT

Waste water, ashes and slag are the main solid substances derived from the production of electric power using coal as fuel.

The storage places for ashes and slag have concrete craters on the bottom with built-in dosers. From the dozers first the slag falls on the transport line and then the ashes which are moistened with water by a system of sprinklers in order to prevent its blowing off the transport line by the wind.

The ashes and the slag are placed in boxes in the slag disposal site and covered with soil, and later the surface is recultivated.