TSD # 11

ENVIRONMENTAL ACTION/MANAGEMENT PLAN FOR REDUCTION OF THE AIR POLLUTION FROM BOR COPPER SMELTER

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BOR
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CONTENTS

1. INTRODUCTION

Due to obsolete technology and dilapidated technical equipment, The Bor Smelter emitted increased volumes of waste gases during in the early 2006, leading to increased sulfur dioxide concentrations in the town and surrounding area. By implementing of temporary measures No. 480-501 – 91/06 from 05.05.2006., the work of the Smelter was temporarily banned. In order to create conditions for sustainable development of copper and precious metals production in Bor and Serbia, the "Action Plan for the air pollution from the Bor Copper Smelter reduction" was made, as well as taking emergency technical measures in cases of high concentrations of sulfur dioxide in the city and its surroundings. The Action Plan was approved with record since 10. 05. 2006. by the Working Group in the Ministry of Science and Environmental protection, after which the Smelter started working. Copper Smelter and Refinery strictly apply the Action Plan with a permanent control by Republic inspection for environmental protection.

2. INVESTMENT IN ENVIRONMENTAL PROTECTION FROM 2006 TO 2009

2.1. MINING-METALLURGICAL COMPLEX BOR INVESTMENTS

2.1.1. Investments In Smelter

Obsolete and dilapidated technical equipment in the smelter requires constant investments in the repair, replacement, reconstruction and modernization. The objectives of these investments are safe operation of employees, environmental protection and preservation of productive capacities.

In the period 2006-2009, in addition to daily regular maintenance, two detailed repairs were carried out in 2007 and 2009.

The most important works on the aggregates, equipment and installations, designed to protect the environment were:

1. **Preparation**:
    - Replacement of rubbles at 5 positions,
    - Replacement of cascading rubbles T-1126/1128,
    - Replacement of rail bars in bedding,
    - Replacement of six rubber bands,
    - Replacement of damaged rolls on conveyers,
    - Replacement of clutch that starts the conveyers

2. **Reactor**:
    - Replacement of pipes for transfering calcinated ore,
    - Replacement of reactor roof,
    - Replacement of casing segments,
    - Replacement of compensator Ø1000, Ø1500 and Ø2600,R
    - Replacement of parts of cyclone groups,
    - Repair of speed pipeline.

3. **Reverbatory furnace:**
    - Replacement of refractory bricks over 80%,
    - Replacement of water cooling jacket,
    - Replacement parts vagstaf (compensators, curves)
    - Repair of 20-tone bunkers
    - Replacement of conductive system
    - Replacement and repair of plumbing fittings.
4. **Boiler:**
    - Removal, repairl and installation of boiler equipment,
    - Replacement of pressure part of boiler (4. and 5. screen)
    - Replacement of ceiling pipes with collector,
    - Front plating screen,
    - Supply and connecting leads,
    - Replacement of thermal insulation.
5. **Firing**
    - Repair of mill no. 2 with accompanying equipment,
    - Repair of sealing air fan
    - Repair of the secondary air fan,
    - Replacement of pipes for air-mixture,
    - Replacement of burner elements at front of furnace
6. **Electro filters:**

    Filter SF3
    - Repair of levels by areas,
    - Override the output cone,
    - Repair of casing,
    - Removal of deformed deposit electrode
    - Repair of systems for dust shuddering
    - Replacement of dust transportation system.

Filter LC1 and LC2

- Replacement of front brile closing device
- Repair of deposit electrode
- Replacement and repair of pipelines at the entrance of the filters,
- Replacement of damaged joints on the middle chain,
- Repair of exit brile closing device,
- Repair of casing of both filters.

Converter Filter SF

- Repair of cabin for shuddering of emitting electrode
- Replacement of damaged gear of emitting electrode
- Design and replacement of isolator's parts,
- Repair of casing and systems for dust transport

7. **Gas pipeline**

- Repair and replacement of audit openings,
- Replacement of dilapidated segments of the pipeline,
- Replacement of damaged compensator,
- Replacement of lining within the pipeline,
- Thoroughly the pipeline cleaning.

8. **Converters:**

- Repair of refrigeration chamber of converters 3 and 4,
- Sanitation smoke catcher above converters,
- Sanitation of speed pipeline,
- Replacement of dilapidated compensator of gases,
- Repair of the audit opening,
- Repair of machines for drilling,
- Repair of water supply valves for jacket on chambers

9. **Refinery:**

- Replacement of entrance to the anode furnace 1,
- Return of the forehead of the furnace by replacing specific screws and springs,
- Removal and repair of the air fan,
- Repair of the gear assembly for the cast cup,
- Recovery of baths for cooling the anode,
- Repair of demolera for taking out the anode,
- Repair of the rotating table with gearbox of the cast machine

The value of the works listed, along with built-in equipment, is around 150 million RSD.

2.1.2. INVESTMENTS IN SULFURIC ACID PLANT

Sulfuric acid plant was built for acceptance and processing of Smelter gases. Its aim is to protect the air from air pollution. Any investment in this factory is investments in environmental protection.

In the period 2006-2009. RTB Bor through its own funds, undertook the following works:

- Repair of gas blowers G-203 in order to increase the capacity to collect gas from the Smelter to Sulfuric acid plant,
- Replacement of one wet electrostatic filter, replacement of the other is in the process,
- Installation of new heaters W-24 (old replaced) that is used during stopping and new start of Sulfuric acid plant,
- Reconstruction of the heat exchanger W -22,
  Replacement of the catalyst V_2O_5 in contact boiler,
  Replacement of the gas pipeline between 1. and 2. levels of the contact boiler
  Replacement of the air pipeline of the contact boiler,
  Replacement of the pressure installation of contact boiler,
  Built new production pumps,
  Completed the reconstruction of the tower D-1, D-2 and D-3, and belonging gas pipelines and equipment
- Replacement of the acid coolers on the towers D-5 and D-6,
- Replacement of the pipeline of dropper and dropper,
  Restore of the section for the absorption and gas drying
- Replacement of the tank C-1,
  Built new sedimentary tank C-4,
- Built new tank for acid production C-7,
  Built new production pumps,
  Renovated the acid installation in the production of acid and acid transport to the storage,
- Repair of pumps and fans,
- Replacement of the thermal isolation on aggregates and pipelines,
  Setting of new acid resistant tiles in the facility,
  Replacement of the part of the water installation,
  Repair and reconstruction of tanks in the storage of sulfuric acid, repair of pipelines and valves,
- Replacement of the hydrants for acid filling,
  Built gate valves in the collecting pit in warehouse that may prevent spillage of acid that could enter into the industrial sewage. Purchased and installed a pump that can return drop acid in the empty (spare) tank,
  All the damages on pipelines, piping and valves are regularly repaired.

The cost of the above noted works involved an expenditure of 85 million RSD.

The effects of these works are reflected in the reduction of the sulfur dioxide concentration in the city and its surroundings, as well as in the number of days with exceeding of the emission limit values.

Fig 1 presents change of the sulfur dioxide concentration at the measuring stations "Gradski Park", "Jugopetrol", "Institut za bakar" and "Brezonik" for the period 2006-2009.

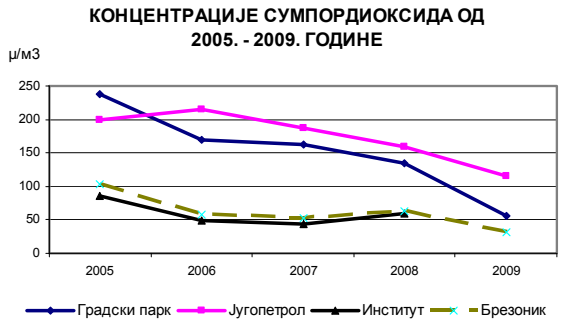

Fig 1: The concentration of sulfur dioxide in Bor and its surroundings in the period 2005. - 2009.

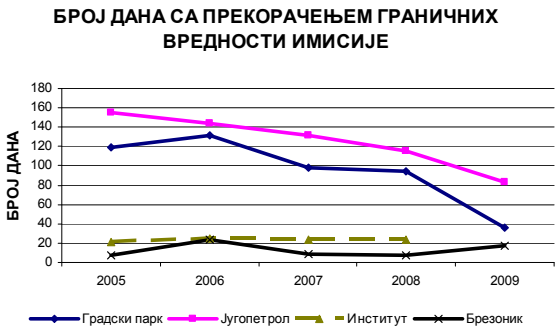

Fig 2: Number of days with exceeding of the emission limiting values in the period from 2005. to 2009.

The average annual concentration of sulfur dioxide in 2009. was less than in 2005. at all measuring stations. At the measurement point in ”Gradski Park”, downtown, where there are schools, kindergartens and public institution it is less than 25% of the 2005 values.

Number of days with exceeding of the emission limit values is in decline. The most important is the center of the city where in 2006. the concentration of sulfur dioxide was 132 days above the allowed values, and in 2009. was 36 days.

2.2. STATE INVESTMENTS IN THE PERIOD FROM 2006. TO 2009.

By National investment plan for 2007 approved is the amount of 75.629 million RSD, and from the Fund for Environmental Protection for 2008., 48.675 million RSD for the realization of the project “Regulation of the Krivelj river by repairing of the collector (80m in length) and documentation preparing for repairing of dams 1, 2 and 3 of flotation tailings Veliki Krivelj”.

With this project following activities have been executed: completed repair of the collector below the field 2 of the flotation tailings “Veliki Krivelj” in critical length of 80 m from station 0 +823 to 0 +903; completed repairing of the dam 1 by building two drainage systems for surpass dam up to K+385.00 and pumping stations for pumping drainage water; completed repairing of the dam 2 by building drainage system for surpass dam up to K +385,00; completed the geological and physical-mechanical research (research drilling) and established a dam monitoring by constructing of a piezometer; completed the dam 1, 2 and 3 breaking through project, informing

and alerting for the flood wave K +385, completed making of the technical and technological documentation.

The realization of all these activities and bringing dams into stable condition, thanks help and investment of state, the RTB Bor has been enabled to continue production and disposal of the flotation tailings in the valley of the Krivelj river, by raising up flotation dam 1 and 2 for another 35 m and by transferring from the field 2 to the field 1, further production and disposal of flotation tailings will be enabled until 2015.

The following has been done with the amount of 100 millions RSD from the Fund for Environmental Protection and the National Investment Plan during 2009:

- Completed the reconstruction of the dry electrostatic filter from Smelter,
- Reconstructed gas pipeline for the gasses from Smelter,
- The part of pipeline from the Smelter Plant to Sulfuric acid plant was built, Reconstructed two wet electro filters in Sulfuric acid plant.

The effects of these works are reflected in the following:

- Increased efficiency of sulfur dioxide, with a aggregate whole day work, which is above 60% (compared to 32% in November 2008),
- Production of acid on a daily basis is 350 tons, which is over 500 kg per tone of concentrate. Replacement of the casing on the LC-1 and LC-2, and the intervention on the pipelines, enable transport of high-quality gas from the Smelter Plant to Sulfuric acid plant with reduced pressure. Quality meter for the gas in Sulfuric acid plant marks the gas concentration above 8%, which is evidence of sealed system.
- Temperatures on the contact boiler levels in Sulfuric acid plant are within the design limits, that allows the maximum transformation of SO_2 to SO_3 and further to H_2SO_4.

3. DESCRIPTION OF TECHNOLOGICAL PROCESS

3.1.INTRODUCTION

The main activity of the Bor Copper Smelter is production of the anode copper from copper concentrate. Production is carried out by the so-called standard melting scheme. This method of production involves the preparation of a mixture of concentrate for further processing, roasting in fluo-solid reactor, melting in reverb furnaces, converting matte in standard PS converters (Pierce Smith) and anode refining where as the final product, we get anode copper purity 99.75 - 99.80%.

The production process of sulfuric acid in the Sulfuric acid plant is carried out by contact process. Raw materials for its obtaining, SO_2 gas, is an integral part of the gasses released from the Smelter, which is transported by the pipeline system to the plant. In addition to SO_2 gas, there is a certain amount of dust (up to 100 mgNm^3 of gas), as well as other chemical compounds. Maximum capacity of Sulfuric acid plant, which was in operation (K-2), amounts to 100,000 Nm^3/h of wet gas, i.e. around 88 000 Nm^3/h of dry gas. Minimum content of SO_2 in the gas at which the plant can auto-thermally work is 3.5 to 4.0%.

3.2.SMELTER

The primary raw materials are standard concentrates from own mines and imported ones, these concentrates are prepared for further processing in the department for preparation and distribution. Compositions of these concentrates are as follows:

1. Own: Cu 9 - 19%, H_2O 6,33 -16,48%, SiO_2 5,79 - 19,46%, Al_2O_3 1,67 - 5,51%, Fe 21,45 - 37,66, S 24,39 - 43,11%,
2. Imported - Buchim, Chile: Cu 21.47 to 30.14%, H_2O 8.17, - 11.25%, SiO_2 3.32 - 10.8%, Al_2O_3 1.42 - 2.76%, Fe 28, 23 - 30.94, S 28.65 - 33.35%.

The analysis is performed in an independent professional, certified institution Institute for Mining and Metallurgy in Bor, "Jugoinspekt" - Belgrade.

1. Charge preparation

After receipt of the concentrate and control (chemical and granulometric composition), concentrates of different origin are stored in separate boxes. Charge (starting materials) for the process in fluo-solid reactor is formed by a special system of conveyor belts. During the formation of charge the so-called fluxes (limestone and quartz) are added to concentrates, so that the final charge contains at least 27% of sulfur. Concentrates without the sulfur can not be processing by the existing technology.

2. Processing in fluo-solid reactor

Mixture of concentrate and fluxes is transported to the roasting process in fluo-solid reactor by the conveyor belt system. In this segment of the copper production, sulfur burn out is done primarily in boiling layer at the temperature of around 650°C. Desulphurizing degree is about 50%.

The process is exothermic (autogenous) and is based on the energy that is released during the reaction. Because of this, sulfur content in the mixture of concentrate and fluxes can not be less than 27%. Autogenousity of the process does not allow a longer interruption in process. The resulting gas from the reactor in the amount of ≈ 35000-40000 Nm^3/h, with the SO_2 content of 8-9%, after purification in the electrostatic precipitator, is further processed in Sulfuric acid plant. Calcinated ore, as the main product of this production phase, is further processed in smelting aggregate.

3. Melting in reverb furnace

Through the system of reception bunkers, located above the furnace, calcined ore is the gravimetric dosed in reverb furnace for melting. The function of calcined ore melting is the translation from solid to liquid state. For this procedure it is used high quality gas coal with high calorific power.

After melting in the reverb furnace it is formed two layers:

- The upper layer consisting of slag, and which is disposed at particular position (hald). Content of copper in it is up to 0.5%.
- Bottom layer, matte which contains 40-45% copper and with the temperature of about 1.180°C,
- Gasses from the melting process in the maximum amount of 60,000 to 70,000 Nm^3/h and the SO2 content of 0.5%, after treatment in the SF-type electrostatic precipitator gasses discharged into the atmosphere.

Matte is further processed in for these special aggregates – converters.

4. Converting process

Bor Copper Smelter has four horizontal type of converters Pears Smith (PS). One converter is in work.

Liquid matte is transported in the 6 m^3 volume pots by cranes to the PS converters. The converting process is, autogenous and is based on the reactions of oxidation of metal sulfides present in matte. Quantity of matte per converting operation is 220 tons.
The process takes place in two phases:

- The first phase or the work of the converter on slag. This is usually done in four levels of work, is extremely discontinuous and it is primarily performed to remove iron and to concentrate copper in the bath of converter to the final formation of the so-called white matte (pure copper sulfide). Its duration is from 8 to 9 hours in total. Then the second period begins.
- The second phase or the converter operation on "the copper". This part of the process is continuous and lasts for 3.5 to 4.5 hours. Stops only during the dosage of pure copper insert, which is required for the temperature control process.
- Quantity of wet air blowed in the converter is 35000-40000 Nm^3/h, depending on the phase of the operation.

In both of these phases, due to exceptional autogenousity of the process and development of high temperature in the bath of converter, it is necessary to carry out the process and temperature control in the first phase with copper bearing cold materials, and in the second phase with pure copper insert. Converting process can not be stopped, too, because the moments of interruption can cause significant cooling of melted materials, and therefore the crystallization of melted materials in the converter, which in itself means the damage of the process.

Products of converting process are:

- Gas from the first phase in the quantity of around 70,000 Nm^3/h after all dilution and SO_2 content of 5%. In the second phase after dilution gas is in quantities of 90,000 Nm^3/h, the content of SO_2 is 6 to 7%. Gasses from both periods are treated in electrostatic precipitator type SF and sent for further processing in the Sulfuric acid plant by gas pipeline system. The excess is discharged by the 150-meter stack.
- Converter slag with 3-5% of copper returns to the further processing in the aggregate for the primary smelting, reverb furnace.
- Blister copper which contains 99.3% of copper is sent to the department of anode refining.

5. Anodic Refinery

Blister copper in pots is transported using cranes and then poured into the anode furnace for copper refining capacity of 200 tons of copper per anodic operation. An anode operation consists of two converter operation.
Anode refining process involves several stages:

- Slag removal which involves removal of oxide from the anode furnace in the slag form and its return for further processing in the converters, due to the fact that it contains up to 50% copper. This phase is necessary and, above all, a consequence of the high-speed of converting process,

- Oxidation is not often performed, and when it is done usually lasts 30 to 50 minutes in order to separate a very small remaining amounts of impurities in copper,
- Reduction, has the task to reduce a small amount of copper oxide and transforme it in the anodic copper,
- Casting, final product from the Smelt, containing 99.8% of copper, is poured into special molds in the shape of the anode. The average weight of anode is 235 kg. The chemical composition of anode copper is adapted to further process treatment - electrolytic refining (in the electrolysis plant, where the final product is gain, the copper cathode with 99.99% copper purity). The physical shape of the anode is adapted to the requirements of electrolytic refining.

Figure 1 shows the technological scheme of production in the Bor Copper Smelter

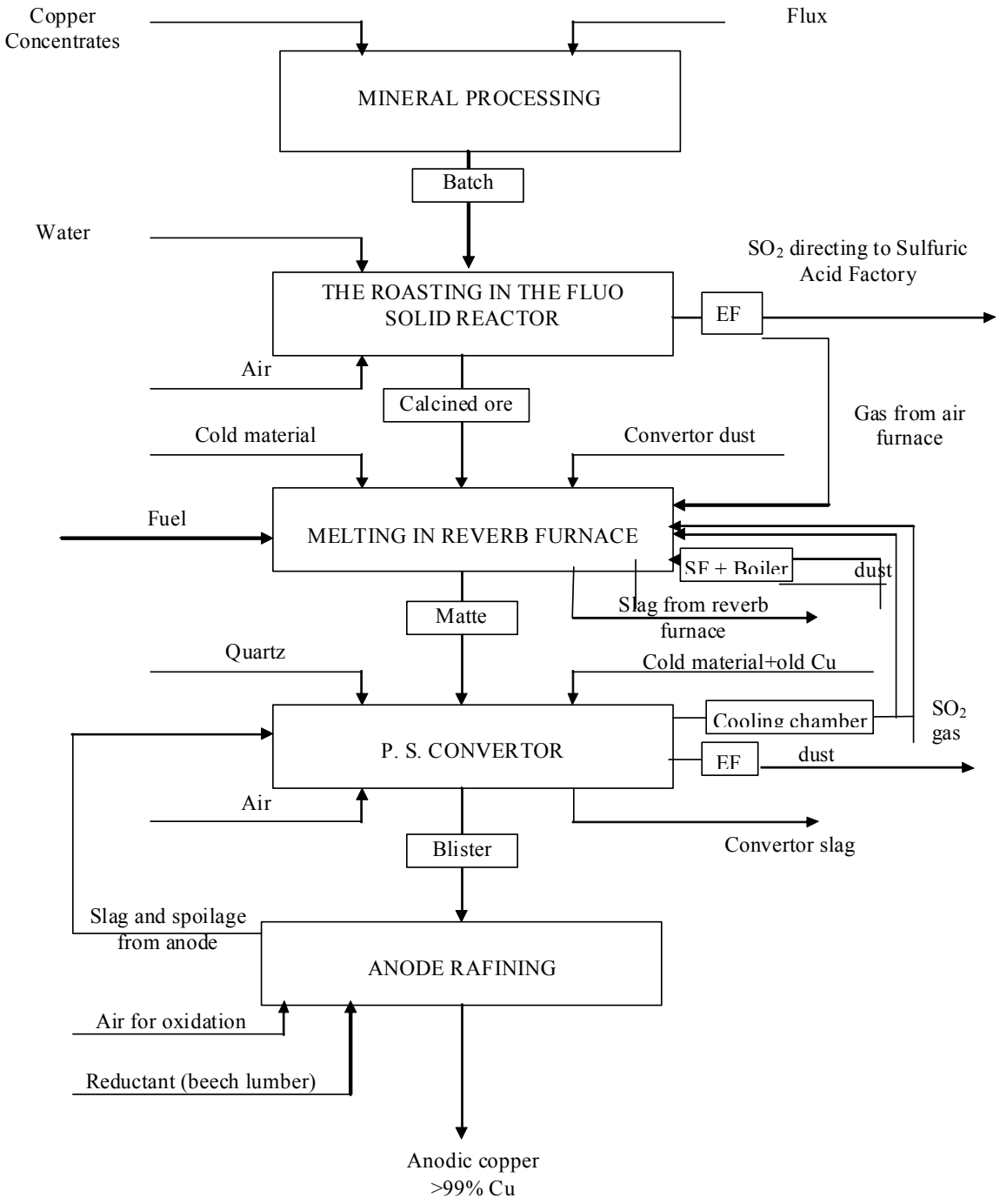

Figure 1 Technological Scheme of Production in the Bor Copper Smelter

3.3. SULFURIC ACID PLANT

The production process of Sulfuric acid plant consists of four phases:

1. Washing and cleaning of gas
2. Gas drying
3. Gas Conversion
4. Gas absorption.

1. **Washing and cleaning of gas** is conducted with water (weak acid) in two serial connected towers, D-1 and D-2, and the finest gas cleaning is in the four parallel connected wet electro filters. Gas is cooled in the cooling tower from 250 ° C to 55-60 ° C, where the most of the impurities from the gas (As_2O_3, SeO_2) and dust dissolve in dilute sulfuric acid. Washing process continues in the gas washing tower, where the temperature of output gas is in the range 30-40 ° C, which results in the appearance of a weak sulfuric acid mist, which is eliminated in the wet electro filter.

2. **Gas drying** is conducted in two serial connected towers, tower for pre-drying D-3 (with 76% acid) and tower for drying D-4 (with 96% acid). The essence of the process is to remove moisture from gas (water vapor) and to reduce the risk of formation of sulfuric acid in gas. Otherwise, the acid would condense at lower temperatures in aggregates, causing corrosion of equipment, reducing of the mechanical resistance of the catalyst and its catalytic activity. Therefore, during operating time, more frequent controls are taken; moisture in the gas is maintained at the level of 60-80 mg/Nm^3 of gas. Moisture from the gas is lowering the concentration of acid for drying, and therefore a constant concentration of acid is maintained by dosage of acid with high concentration (from the tower D-6).

3. **Converting SO_2 to SO_3 (gas conversion)** takes place in the reactor, contact boiler with four levels, by using a catalyst V_2O_5 at temperatures of 400-600 ° C, the reaction is:

$$2\ SO_2 + O_2 = 2\ SO_3$$

The conversion process depends on temperature, type of catalyst, the content of SO_2 and oxygen in gas. The degree of conversion is 97.5 to 98.3%.

Heat exchangers W-22, W-23, and W-24 are used in order to control the temperature of gas in contact group. Dried air is used for the gas temperature and the degree of conversion control; it is blown in at II and IV level.

4. **Absorption of SO_3** gas is conducted in the absorption tower D-6 by concentrated sulfuric acid (98.3%), the reaction is:

$$SO_3 + H_2O = H_2SO_4$$

The degree of absorption is 99.9%.

Gas is introduced into tower counter flow than acid, as is the case throughout the facility. The concentration of acid in the tower is maintained at constant level by dosage of low concentrated acid (from the tower D-3).

The whole process of production of sulfuric acid is exothermic, which results in the existence of coolers as part of each tower at the factory. Because of the need for large amounts of industrial water for acid cooling, it is taken up the cooling tower, where it is cooled and then returned in the production process

The picture in attachment shows the technological scheme of sulfuric acid production.

Sulfuric acid is storaged in tanks from which is transported to the factory for the production of artificial fertilizers. The operating factories are in Šabac and Prahovo.

3.4. QUANTITY OF SMELTER GASES, EMISSIONS AND IMMISIONS

Quantity smelter gas is:

1. Gas from reactor approximately 40 000 Nm^3 / h (with 7-9% SO_2)
2. Gas from reverb furnace 60000-70000 Nm^3 / h (with 0.5% SO_2)
3. Converter gas 70000-90000 Nm^3 / h (with 4-7% SO_2)

TOTAL: 170.000 ÷ 200 000 Nm^3 / h

The only remaining (correct) sulfuric acid plant may withdraw 100 000 Nm^3 / h of wet gas (approximately 88 000 Nm^3 / h of dry gas).

All gas from reverb furnace (60-70000 Nm^3 / h) and part of converter gas, during the time when the converter is working "on copper," are released through the stack as SO_2 emissions.

Permanently during the work of Smelter and during normal operation of Sulfuric acid plant, amount of discharged SO_2 is approximately 350 Nm^3 / h, and with the converter working "on copper" (30,000 Nm^3 / h), which occurs in cycles of approximately 1.6 times a day, there are "struck" of SO_2 emissions by an addition of approximately 2100 Nm^3 / h SO_2, that is, SO_2

emissions will increase by 6 ÷ 7 times and goes up to a value of 2450 Nm^3 / h. This can not be prevented, because the copper production process is continuous.

The distribution of emissions, i.e. SO_2 emission level depends on the current weather conditions (wind speed, atmospheric pressure, rose of winds, temperature inversions)and it could not be controlled. On the other hand, the process has its own inertia, limited capacity and the impact on the final effect - the amount of emission.

3.5. SCHEDULE FOR SULFURIC ACID PLANT

During the process of producing sulfuric acid, any problem in these stages requires stopping of the Sulfuric acid plant.

Aggregates work and management of technology is being done under the direct control of shift manager (responsible people in the shift). That work includes managing the technological process, maintenance and storage of sulfuric acid. Each shift has mechanists, electricians and workers on duty in the production and transport of sulfuric acid. Shifts masters are responsible for their operation and take their responsibility to production supervisor, production manager, technical supervisor and manager.

After a planned or unplanned stop it is necessary to heat the factory. Heating of the plant takes about 50 hours until the withdrawal of sulfur dioxide and 15-18 hours until the end of heating. During the period of sulfur dioxide withdrawal, gas flow ranges from min 20 000 Nm^3 / h up to max 75 000 Nm^3 / h.

After the end of heating (approximately 68 hours), sealing of heaters take place, after which the maximum flow of wet gas is approximately 100,000 Nm^3 / h, in normal conditions.

For normal operating of the factory minimal concentration of sulfur dioxide is 3.5 - 4%, and maximal 5.5 to 6%.

3.6. STORAGE CAPACITIES OF SULFURIC ACID PLANT

After a planned or unplanned stop it is necessary to heat the factory. The warehouse has 26 sulfuric acid tank capacities:

20 × 1000 t = 20,000 t
5 × 1400 t = 7000 t
1 × 1250 t = 1250 t

Total optimal storage capacity is 28,250 tons of sulfuric acid. Maximum capacity of existing reservoirs is 30 200 tons of sulfuric acid.

It should be noted that because of the potential danger of breaking-leaking of the tanks and taking into account the position of the tank, it is necessary to have two empty tank.

Protection measures in case of tank damage:

- The existence of two empty tank,
- Aggregate pit with a pump for pouring acid into the empty tanks,
- Valves in the aggregate pit that prevents the flow of acid into waterways,
- It is provided around 10,000 tons of neutralize means (lime and soda)
- Continuous control of storage and maintenance.

Wagon - tanks for the transport of sulfuric acid:

Sulfuric Acid Plant has 152 wagons - tanks for the transport of sulfuric acid. The capacity of a wagon - tank is 40 t.

4. MEASURES FOR AIR POLLUTION REDUCTION

4.1. PREVENTION MEASURES

Due to the fact that the gas phase is one of the products during the process of copper production at the Smelter in Bor, as it is noted in paragraph 2, it is necessary to purify the gasses in electrostatic filters and, only after that, only gasses directing from the reactor and the converter are forward for further processing in the Sulfuric acid plant.

Because of the low content of sulfur dioxide, gas products, from the process of solid fuel melting during the burning of reverb furnace, can not be used to produce sulfuric acid and are discharged directly into the atmosphere. Due to the obsolete technology, that is certainly an important reason of increased aero pollution. It should be noted that only one technological line is operating, so the amount of gas that is discharged into the atmosphere is 50% reduced compared to the designed capacity of the Bor Copper Smelter, which involves working with two lines with roasting and smelting and three PS converter at the same time.

Due to the facts mentioned above, the excess of the gas emissions must be strictly monitored. It is achieved in the Bor Copper Smelter by system for monitoring air pollution in the city and connecting with the Technical preparation of the Smelter.

The shift technician in the Technical preparation alerts technologists about pollution when measured concentration of SO_2 is above 500 μg/m3 at measuring station "Park" and "Brezonik". When the concentration values exceed 1000 μg/m3, measures to reduce the concentration of sulfur dioxide are taken. The perpetrators have obligations and responsibilities to take the following measures:

- The Shift technologist of Smelter contacts the shifts technologist of Sulfuric acid plant on the possibility of withdrawing the maximum amount of gas

- The shift manager of Sulfuric acid plant takes measures to withdraw the maximum amount of gas
- The shift technologist of Smelter reduces production by reducing the capacity of the reactor
- The shift technologist of the Smelter stops the converting process, which allows full use of high-concentrated reactor gases in Sulfuric acid plant
- The shifts technologist does not continue the converting process until sulfur dioxide concentration at any measure point drops below 500 μg/m^3
- He undertakes other measures to reduce air pollution (reduction of furnace firing)
- The shifts technologist of Smelter, in the case of the technology - technical needs, reports to the administrator or technical manager of Smelter and the shift manager of Sulfuric acid plant before the reactor and converter stopping
- The shift manager of Sulfuric acid plant notifies the administrator and technical manager of the Factory right after stopping the plant
- If an unplanned delay in Sulfuric acid plant is needed, the shift manager of this factory informs the shift technologist of Smelter for preventive production reduction
- Sulfuric acid plant pulls smelter gas after reactor stopping after turning on the zones in LC filters in Smelter
- In the case of Sulfuric acid plant work stopping, it is necessary to perform the following: stop the reactor operation, reduce the furnace heating by 50%, and strictly control the converter work process. If delay in the work of Sulfuric acid plant lasts more than 36 hours, it is necessary to access to the Smelter working stopping. In such cases, it is required to notify the national inspectors of environmental protection
- Responsible for the implementation of these points are managers and technical executives and Smelter and Sulfuric acid plant

If all the above measures do not provide the desired effect, it is accessed to the complete stopping of the total production process and the competent executives are notified at the same time.

4.2. REACTION TO INCREASED SULFUR-DIOXIDE CONCENTRATIONS

By a standard procedure that is described in Section 4.1, the shifts technologist of Smelter stops parts of the process which at the moment are a source of increased air pollution.

Stopping the parts of the process, and if necessary, the total production, can cause adverse effects in terms of stability of aggregates. The shift technologist of Smelter and the shift manager of Sulfuric acid plant notify the relevant managers about taken measures.
After normalization of the air pollution indicators, shifts technologist gives permission for the reactivation of the stopped manufacturing process.

Those ordes for the possible stopping and restarting of the production process are directly forwarded to shift managers in individual technological units and to shift manager of Sulfuric acid plant by the shift technologist.

Shifts technologist uses the monitoring system for the conduction of technological processes. In the case that data transfer in monitoring system itself is late, measures for data transfer normalization are taken.

In addition to the results obtained by monitoring system reading, shifts technologist is required to respond to the citizens alerting by the following procedure:

- Alerts from citizens are registered by the shift technician who actively followes the monitoring system, to the phone number 427-485,
- The shift technician informs the shift technologist of that dialer
- Shifts technologist, after this notification, conducts testing of the air pollution state and takes measures for reducing the air pollution, which are the same measures as in the case of occurrence of increased air pollution values on the monitoring system. In addition, he is obliged to organize the visit to the threatened area or district by the official vehicle.

4.3. COORDINATION OF SMELTER AND SULFURIC ACID PLANT WORKS

The shift technologist informs the shift manager in Sulfuric acid plant about all unplanned (unexpected) delays of the Smelter plant which are not a consequence of increased air pollution in the case of stopping the parts of the plant. The shift manager in Sulfuric acid plant then stops the Sulfuric acid plant works and informs managers and technical managers at the same time.

After eliminating the causes of delays, the shift technologist of Smelter informs the shift manager in Sulfuric acid plant that Smelter plant is ready to work and after consent that Sulfuric acid plant is also ready to work, he issues an order for the start of Smelter plant.

After the start of Smelter plant, Sulfuric acid plant also starts and this way the technological relationship between plants of Smelter and Sulfuric acid plant is achieved and there is no risk of increased emissions from the production process into the atmosphere. On the pulling pipeline system between Smelter and Sulfuric acid plant plants, the shift technologist is required to provide the parameters of gases pulling which are required by the Sulfuric acid plant.

When it comes to delays in Smelter plant works (which can take several days), it is necessary to provide Sulfuric acid plant with the exact term-plan of the start of Smelter plant. Sulfuric acid plant is required to coordinate their term-plan of delay with a term-plan of Smelter and to provide Smelter with it. Sulfuric acid plant needs about 48 hours of technological preparations in order to be absolutely ready to accept the gas from the Smelter plant. After the initial start of Smelter plant, Sulfuric acid plant can be started with minimal gas pulling, which in the next 18 hours could lead to the level of maximum pulling.

4.4. COMUNICATIONS

4.4.1. Monitoring of Work from the Aspect of Environmental Protection

In order to provide efficient synchronization of technological processes with the aim of reducing the air pollution in working and living environment and increased productivity of copper production, a complex LAN was established. Efficiency in the use of monitoring systems can be achieved by using the technical and organizational capabilities. Technical possibilities are reflected in the availability of resources and data from each of the computers in a network with other users. The organizational structure is defined so that certain information were made available to all authorized users. This system provides instant access to all the important parameters of technological processes and functionality of equipment in the Smelter and Sulfuric acid plant and enables decision-making in which part of the process it is possible to act in accordance with the Action Plan.

4.4.2. Communications with the Public

In order to establish cooperation with stakeholders (local communities, civic associations, trade and non-governmental organizations and individuals) a permanent telephone line was opened, where people can report increased air pollution, provide comments and suggestions. On this line is always a professional person on duty, who can give precise answers at any time (Telephone: 427-485 and 064 / 81-78 - 578).

4.4.3. Communication with Local Government and State Bodies

Copper Smelter and Refinery has provided technical, personnel and technical assistance in the formation of the Department of Environmental Protection in Municipal Administration. The cooperation with the Department and the monitoring team is established and also the direct permanent connection via electronic networks. Member of monitoring team from the TIR participates in the preparation of weekly and monthly reports.

Permanent contacts with the heads of local offices and secretaries of local communities were established and those persons are informed of increased concentrations of sulfur dioxide in areas without spots for measurements by shift technologists or technicians.

TIR designated a qualified person which is constantly available to the Republic Inspector of Environmental Protection, from which this person can get all the necessary data and information. The same person is responsible for ongoing communication with the inspectors of environmental protection.

Republican inspectors for environmental protection visit Smelter and Sulfuric acid plant on a daily level. For their undisturbed work, all the information on concentrates, work units, emissions and immision in the environment are available to them all the time. They are provided by office space and computer information system with installed informational system of aggregate working, from which from which the monitoring system can be traced in the city and its

surroundings. Inspectors are provided mobile phones which are connected with phones of persons responsible for implementation of this Action Plan.

5. MONITORING

Copper Smelter and Refinery performs regular control of gas flows and emissions from the Smelter and Sulfuric acid plant. Control is performed by an authorized, independent, professional institution - the Institute of Mining and Metallurgy.

Monitoring of immision is performed by Department of Public Health 'Timok' Zajecar. The concentration of sulfur dioxide emissions are controlled at three measuring stations, which are selected in accordance with national and international recommendations and criteria, as follows:

1) In a city park - in the old city center - measuring position is selected to be located near the emitter and at the direction of the eastern wind,
2) Near the Jugopetrol storage - at the direction of the dominant, northern wind
3) In Brezonik – the nearest suburban area

At these measuring stations the average daily concentrations of sulfur dioxide are measured by the "British method". These measurements are submitted to the municipal administration and the TIR and they are available only after the monitoring team meeting (the earliest after the fifteenth day of the month for the previous month).

Agency for the Environment of the Ministry of Environmental Protection and Spatial Planning has been very active in expanding and improving the monitoring of air quality in Bor in recent years. Previous activities of the Agency (chronologically) are:

1) Designing a measurement point of BOR-Institute in the public network for automatic monitoring of air quality (funds - donations EU),
2) Supply, installation and activation of automatic measuring stations for monitoring of air quality at the site BOR-Brezonik, Measurement results - hour value to every 10 minutes available on the website of the Agency, www.sepa.gov.rs (funds - Fund for Environmental Protection RS)
3) Help for the Department of Environmental Protection of the Bor Municipality in the performance of automatic measurement of SO_2,
4) Design, implementation of tender procedures, procurement, establishment and activation of a new automated stations AMSKV BOR-Gradski Park. Equipment of newly formed AMSKV is one of the most reliable in the world. Measurement results - hour value to every 10 minutes available on the website of the Agency, www.sepa.gov.rs (funds - Ministry of Environment and Spatial Planning, Fund for Environmental Protection RS)

5) To promote knowledge about the possible impact on the environment and creating better conditions for the management of technological processes in the Smelter, the Agency has designed and implemented a special web site (access is possible only with a password) with the most detailed results of the automatic monitoring for the needs of TIR, time of averaging – from 3 minutes to 1 hour.

6) The experts of the Agency, by invitation, participate in the work of the monitoring team

7) The Agency has set up and activated AMSKV BOR-Institut (EU donation). The testing of installed equipment is in progress. Measurement results of AMSKV will be shown on the site of the Agency when all equipment of the state network AMSKV is delivered and activated (current estimation – middle of the March 2010.)

Further increase in the number of automatic devices for air quality monitoring is necessary. With the proper maintenance of existing equipment, improvement of monitoring should be directed to the application of meteorological numerical models to generate the distribution of pollutants and air pollution forecasts.
Meteorological parameters are monitored by automatic measuring devices at places 'Brezonik', 'Gradski Park' and 'Institut'. On Site Institute, Institute of Mining and Metallurgy performs a classic meteorological measurements and observations, (a continuation of activities initiated 1986). There is expressed need for support from the Republic Hydrometeorological Institute. That support would consist of: meteorological forecast for the planning of activities and delays during adverse weather conditions and support to the continuation of classical meteorological station work.

6. PROPOSAL FOR FURTHER ACTIONS

In the following period, considering that the expected start of the new smelter construction, in which the existing converter line is going to be kept, investments should be directed to the converter department. As an emergency, this department should restore the system for pulling out of gases from converters, so as fugitive gases were included. The velocity pipelines of the converter 3 and 4 also need to be replaced, in the volume above 80%. Along with these pipelines compensators and curves should be replaced, and corrected their supporting construction. Considering cooling chambers, armature replacement for water supply needs to be completed. On the mentioned converters, should be replaced machines for drilling blowers should be replaced and the modernization of their usage needs to be performed. In this department, as well as in department of fire rafination which remains a part of the new smelter, detailed reconstruction of the crane track way and 3 cranes needs to be conducted. On the pipeline system for gases pulling, repair needs to be done and it is required to again put into operation another fan B3-28 and repair the complete coating of filter SF3 with accompanying equipment for dedusting (vibrating pipes). Casing and impeller of fan of blowers with suction and discharge collectors are in such condition that their thorough overhaul needs to be done in the next year.

In recent years, the extensive reconstruction is carried out in Sulfuric acid plant. In order to ensure its continuous and safe operation, the reconstruction of the cooling tower contact the factory K-3 that does not work is required and connection to the factory K-2 is needed, for the cooling tower of this factory is dilapidated and can cause destruction. It is necessary to modernize the system to neutralize the waste water, so that their treatment was in accordance with the regulations.

7. SUMMARY

1. Bor copper smelter was built in 1961st (the first line) and in 1971st (the second line), with total concentrate smelting capacity of 500.000 tonns/year of dry concentrate, that is 100.000 tonns/year cathode copper. By intensification of the process with technical oxygen during 80-es, that capacity is increased to 600.000 tonns/year, that is 123.000 tonns/tear of cathode copper. Since 2000, the production began to decline, and only in the last two years has it started to grow again. In 2010 the production plan calls for the processing of 200.000 t of dry concentrate, which is less than half the installed capacity.

2. Only the Sulfuric acid plant (K2) in order, with a pulling capacity of 100.000 Nm^3/h of wet gas, i.e. about 88 000 Nm^3/h of dry gas, can not 'pick up' all metallurgical gases. Gas from fire furnace is continuously discharged into the 100-meter stack (70 000 Nm^3/h, i.e. about 350 Nm^3 SO_2/h). In addition, 1.6 times a day, or cycle to 15 hours in duration from 3.5 to 4 hours, about 30,000 Nm^3/h (2100 Nm^3SO_2/h) is emitted and it makes so called shock emissions, 6-7 times higher than fire furnace gas emissions. This phenomenon is related to the operation of converter on 'copper'. Increase in emissions of SO_2 increases immision that are causing problems on the measuring station 'Park' i.e. in the direction of the town part (County, Municipality, Hospital). Statistically, those increased immision and excessive pollution last for 3-5 days per month and, despite all the influences of technology, can not be avoided. Short-term excess imission reach a value of 3000-5000 $\mu g/m^3$, but do not last longer than 15 to 30 minutes. Despite all the interventions in Metallurgy process, it can not be avoided due to inertia of the system.
3. Storage capacity of sulfuric acid in the Bor is about 30,000 tons (26 tanks). We have a total of 146 wagon-tanks, of which one part remained to be repair. Other (140) are circulating to Sabac and Prahovo (capacity about 5500 tons). Measures for protecting the storage of sulfuric acid are as follows: there are two empty tanks, aggregate pit with a pump for filling, and 10,000 tons of resources for neutralization (lime and soda) are provided.
4. After a temporary stop Smelter early May 2006. The Action Plan was prepared to respond in the production process in cases of high concentrations of sulfur dioxide in the town and its surroundings. A permanent connection between the measuring station and Smelter was established. There is a opened telephone line to which citizens can report increased pollution and in that cases parts of the town are visited in shifts and measures in accordance with the Action Plan are conducted.

5. Air pollution monitoring system is set to measuring stations 'Park' and 'Jugopetrol' in the town, and 'Brezonik' outside populated part of town. Measurements are recorded at 3 minutes on the measuring station 'Park' and at 10 minutes on the measuring stations 'Jugopetrol' and 'Brezonik' and they are monitored in the Smelter by the shift technologists continuously for 24 hours. There are precise instructions for the administration and management of technology in the Smelter and coordination with operations in Sulfuric acid plant.
6. Measures for reducing of air pollution in Bor include:
    a. Prevention measures,
    b. Reactions and treatments in case of increased concentrations of sulfur dioxide (Procedures for the exclusion of parts of the process with assignments of shift technologists, duties on the telephone lines: 064/ 81-78-635 and 427-485 for citizens diallers, tours to vulnerable areas of the town and surrounding area),
    c. Permanent and efficient coordination of works between Smelter and Sulfuric acid plant.

    The operative in Technical preparation (shift technician) warns the technologist of the air pollution when measured value of SO_2 in the park exceeds 500 μg/m3. When the measured value exceeds 1000 μg/m3, measures to reduce the concentration of sulfur dioxide are taken. Before mentioned executors have obligations and responsibilities to take the following measures:

    a. The shift technologist of Smelter contacts the shift manager of Sulfuric acid plant about possibility for maximum amount of gas withdrawing
    b. The shifts technologist of Smelter reduces production by reducing the capacity of the reactor
    c. The shifts technologist of Smelter stops the converting process, which allows full use of high-concentrated gases of reactor in Sulfuric acid plant
    d. The shift technologist of Smelter does not continue the converting process until concentrations of sulfur dioxide in any of the measuring stations drop below 1000 $\mu g/m^3$
    e. He undertakes additional measures in order to reduce air pollution (by reducing the heating of the fire furnace)
    f. The shift technologist of Smelter, in the case of technology - technical needs, report manager or technical manager of Smelter and the shift manager of Sulfuric acid plant before stopping the reactor and converter
    g. The shift manager of Sulfuric acid plant informs manager and technical manager of Factory after stopping the plant

h. If an unplanned delay in Sulfuric acid plant is required, the shift manager of Factory informs the shift technologist of Smelter about delay for preventive reduction of production.

i. Sulfuric acid plant takes smelter gas after stopping the reactor, after turning on the zones in LC filters in Smelter

j. In the case of stopping the work of Sulfuric acid plant due to planned or non planned delay, it is necessary to perform the following: stop the reactor operation, reduce heating furnace for 50%, and the process of the converter must be strictly controlled. If sulfuric acid plant slowdown persists for longer than 36 hours, be sure to access stopping of the Smelter. In such cases, it is required to notify the national inspectors of environmental protection. Responsible for the implementation of these points are managers and technical executives of Smelter and Sulfuric acid plant.

Staff Responsible for Site Operations

Persons responsible for the implementation of preventive measures and responses to increased concentrations of sulfur dioxide from points 1-6 are:

Shifts technologists in the Smelter**:**

a. Sasa Marković, Bor, a village Metovnica, 19210 Bor, personal identification number 0701972751047,

b. Dejan Mitić, Bor, St. Dr. Milovanović no. 19/34, personal identification number 1107970751028

c. Slaviša Gajić, Bor, St. 3. October br.292 / 3, personal identification number 2809959751014

d. Dejan Krstić, Bor, St. M. Pijade 74/605, personal identification number 2412969751015,

e. Elver Murina, Bor, St. I.L. Ribara 15 / 3, personal identification number 0206958760032,

f. Dejan Stanojević, Bor, a village Metovnica, personal identification number 0505971751031
Phone of shifts technologists is: 064 / 81-78 – 635

Persons responsible for the implementation of points 7-9 are:

a. Budimir Ilić. Bor, St. I.L. Ribara 19 / 5, personal identification number 1007960973028,

b. Ljubisa Zlatanović. Bor, St. Bosko Buha no. 5 / 2, personal identification number 2811961710400,

c. Dean Pavlović. Bor, St. A. spomenice 10 / 35, personal identification number 2106959751013,

d. Jovanka Božilović. Bor, St. D. Tucovića no. 6 / 1, personal identification number 0609955751013,

e. Nasser Maksuti. Bor, St. Omladinskih brigada no. 33 / 2, personal identification number 0106964751032,

f. Goran Lazić. Bor, St. 7. jula, no. 41 / 5, personal identification number 1,707,967,753,315th
Phone shifts masters is: 064 / 81-78-578.

Persons responsible for the implementation of point 10 are:

a. Smelter Manager, Slaviša Stefanović, phone: 030 / 421-595 and 064 / 81-78 - 528, Bor, St. Radnička 17/18, personal identification number 2503956731010,

b. Technical Manager of Smelter, Boban Todorović: 030 / 421-595 and 064 / 81-78 - 527, Bor, St. Cara Lazara br. 6 / 9, personal identification number1401970751031,

c. Sulfuric acid plant manager, Zoran Aleksov: 030 / 421-547 and 064 / 81-78-517, Bor, St.Bobijeva 3 / 5, personal identification number 2208956751036,

d. Technical manager of Sulfuric acid plant, Nedeljko Vučićević: 030 / 421-547 and 064 / 81-78-518, Bor, St. 3. oktobar no. 30/13, personal identification number 2305955850036

When it comes to delays in Smelter plant (which can take several days), it is necessary that Sulfuric acid plant provides the correct term-plan for delays and start of Smelter plant. Sulfuric Acid Plant is required to coordinate its term-plan for delays to the term-plan of Smelter and submit it to Smelter. Responsible for compliance of term-plans are managers and technical executives in Smelter and Sulfuric acid plant.

7. In order to provide better communication the following is done:

   a. monitoring the process in terms of environmental protection. So far, necessary infrastructure (computers, modems, software required) is provided. The installation of software and training of users to use the resources (programs and information) are completed.

   b. communication with the public is established by a permanent telephone line for citizens to report excessive pollution, also for comments and suggestions. Has been or will be established (where hasn't) cooperation with stakeholders (local communities, civil associations, trade and non-governmental organizations and individuals),
   c. communication with the local and state governments is established: it is given the technical, personnel and technical assistance in the formation of the Department of Environmental Protection in Municipal Administration. Cooperation with the monitoring - team (the member of the team from TIR participates in weekly and monthly reports on air pollution). TIR set a qualified person who is constantly available to the Republican Inspector of Environmental Protection. Cooperation with the Agency for Environmental Protection in repairing of measurement spots, working on reliability of measurement, analysis of the measurement results and definition of recommendations for a successful response in the case of high concentrations of sulfur dioxide.

In Bor

16. 02. 2010.

Chairman of the working group for the environment monitoring and the implementation of action plans and projects related to solving environmental problems in Bor

Assistant of Minister for Environment and Spatial Planning

Aleksandar Vesić