Chapter 8 Current Situation and Problems of the Five Bulgarian Steelworks

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The JICA study team visited and investigated the five Bulgarian steelworks. After hitting the bottom in 1991, production of finished products has recovered remarkably from 1,315,000 tons in 1992 and 1,636,000 tons in 1993 to 2,115,000 tons in 1994. This is led by exports. The export ratio soared to about 80% in 1994.
Their operations, productivity, quality, yield and energy consumption rate are not at a satisfactory level, because of the age of the equipment at the steelworks, with some exceptions at Promet and Stomana, and the low technical level of operations. Environmental pollution prevention measures should also be improved, especially at ironmaking plants.
The total number of employees of the five steelworks is 25,719. Although every steelworks has detailed internal by-laws and job descriptions, their actual management is not performed effectively. Their financial situation has deteriorated drastically due to the paralyzed markets after the collapse of the COMECON regime in 1989, with a huge loss accumulating. These situations are described in this chapter.

8.1 Production and Sales Records for the Past Five Years

As mentioned in Section 3.2, the steel production in Bulgaria, after the collapse of the COMECOM regime, fell by half to about 1,500,000 tons.
However, crude steel production hit the bottom in 1992 and thereafter has increased every year. In this chapter, the production of crude steel and final products and sales volume of each steelworks are described.

8.1.1 Production records of crude steel

The total crude steel production of each steelworks was 1,554,000 tons in 1992, 1,943,000 tons in 1993 and 2,488,0000 tons in 1994, showing a big increase from the previous year, 25.1% in 1993 and 28% in 1994 respectively. The break-down for each steelworks is shown in Table 8-1.
Kremikovtzi and Stomana Steelworks showed a remarkable increase in the production of crude steel.

Table 8-1 Production Records of Crude Steel

Steelworks	1992		1993		1994	
	$\times 10^3$ ton	Change in %	$\times 10^3$ ton	Change in %	$\times 10^3$ ton	Change in %
Kremikovtzi	1,190	N/A	1,476	24.0	1,892	28.2
Stomana	344	26.4	442	28.6	585	32.5
Kamet	12	Δ 60.0	8	Δ 31.1	N/A	N/A
Leko ko	8	6.7	17	25.8	11	Δ 35.5
Total	1,554	N/A	1,943	25.1	2,488	28.0

N/A Not available

(Note) Data before 1991 was not obtained by the reason of incompatibility of a new statistical standard introduced in 1991 with the method under the earlier COMECON regime.

8.1.2 Production records of final products

The records for the years 1993 and 1994 were obtained from the steelworks as shown in Table 8-2. The total production of the five steelworks was 1,636,000 tons in 1993 and 2,115,000 tons in 1994, approximately 30% increase from 1993.

As mentioned in Chapter 3, the total national production was 3,009,000 tons in 1989, 2,156,000 tons in 1990, 1,309,000 tons in 1991 and 1,315,000 tons in 1992. The production has been remarkably recovering after hitting the bottom in 1991. (See Table 3-1)

Table 8-2 Production Records of Final Products (× 10^3ton)

Steelworks	1993	1994	Change %
Kremikovtzi	1,178	1,491	26.6
Stomana	382	495	29.6
Promet	53	122	130.2
Kamet	9	N/A	–
Leko ko	14	7	Δ 50.0
Total	1,636	2,115	29.3

N/A: Not available

8.1.3 Sales records

The data before 1993 was not obtained because of confidentiality. The sales record of 1994 is shown in Table 8-3. Kremikovtzi achieved a 25% increase, Stomana an 18% increase; Promet a 138% increase and Leko ko a 78% increase in sales volume when compared with the respective results of the previous year. (The final product volume was used in 1993 in calculating a ratio of increase in sales volume in 1994.)

Table 8-3 Sales Records

Steelworks	1994 (Thousand tons)
Kremikovtzi	1,470
Stomana	451
Promet	126
Kamet	N/A
Leko ko	6

N/A: Not available

8.2 Export and Import Records for the Past Five Years

8.2.1 Export records of the five steelworks

Every steelworks maintains a high export ratio and especially after 1992, they shifted strongly to exports. The production increase mentioned in Section 8.1 solely depends on exports. The imports by the steelworks such as semi-finished materials are rather small.

8.2.1 Export records

Each steelworks explained to the team that production was being shifted to exports because of lack of domestic demand after the collapse of the COMECON regime. The export ratio calculated based upon the investigation results is shown in Table 8-4, showing a remarkable high export ratio.

Table 8-4 Export Ratio (%)

	1989	1990	1991	1992	1993	1994
Kremikovtzi	N/A	N/A	N/A	81.7	78.8	70.3
Stomana	14.9	27.4	36.5	61.1	77.4	82.6
Promet	7.3	23.0	22.6	74.3	89.3	N/A
Kamet	4.9	7.4	32.8	34.3	19.4	N/A
Leko ko	N/A	N/A	49.6	32.7	35.3	67.0

N/A: Not available

According to Kremikovtzi Steelworks, their export ratio should be 80 to 85% in 1994, although the table shows only 70.3%; the figure may include some indirect exports of products through exporting brokers or companies. The National Statistical Institute provisional report shows that national exports were1,614,000 tons in 1994, about a 79% export ratio.

8.2.2 Import records

Semi-finished products like ingots and billets were imported by some steelworks mainly from the Ukraine. The imported volume is rather small and it was 35,000 tons (all by Kremikovtzi) in 1992 and 56,000 tons (Kremikovtzi 33,000 tons, Stomana 12,000 tons, Promet 9,000 tons and Kamet 2,000 tons) in 1993.

8.3 Organization, Administration and Manpower

Each steelworks has detailed internal by-laws or regulations concerning the organization, operations, labor and wages, productions and so on. Each employee has a detailed job description to be followed. The entire power of authority is given to the executive director, and little delegation of power is done. These system of monopoly of power and strictly written job descriptions may rather hamper flexible activities of employees and tends to create an inactive organization and lower morale. These managerial situations will be described in this Chapter.

8.3.1 Internal rules and regulations of the steelworks

The team studied the internal rules and regulations, standards, and manuals of each steelworks, which are detailed and include many internal by-laws and regulations. All operational and personnel matters are regulated by written documents. The main ones are as follows:

(1) Organization and operation rules

Kremikovtzi, Stomana and Kamet steelworks are each defined as a joint-stock company owned by the state under the commercial code.

The Ministry of Industry owns all the shares of these companies, and appoints members of the board of directors for a tenure of three years. A business plan, and rights and obligations of members of the board of directors are signed between the minister of the Ministry of Industry and the board members. The board of directors elects a chairman and, if necessary, a deputy chairman, approves the internal by-laws of the steelworks, formulates and controls annual and quarterly business plans, and appoints an executive director and a deputy executive director for the steelworks.

The executive director concludes a management contract with the board of directors, and has the obligation to report the operational situation to the board of directors. The appointment is for three years, although the board of directors retains the right of dismissal by a majority vote.

In contrast, Promet and Leko ko are each defined as a limited company owned by the state, under the commercial code. (The Ministry of Industry refers to this status as "a single-person commercial limited company.") A president, with the title "manager," is appointed by the Ministry of Industry, and a controller is selected by the Ministry of Industry, and has the responsibility to report the operational situation on a quarterly basis.

The executive director of each steelworks has the responsibility to manage all aspects of business involving the legal, accounting/financial, labor, production, quality and technical departments, as well as development and investment. In one case, the deputy executive director controls production-related fields such as manufacturing, maintenance, safety, transportation and energy. The executive director concludes every employment contract, and has exclusive bargaining power with the employees' union. The executive director thus has quite broad and independent power, and not even the Ministry of Industry has the power to dismiss this person.

(2) Wages and labor rules

There are important external laws and regulations concerning wages and labor matters such as the Labor Code, collective agreement with the union, and tripartite agreement among the union, employer and government. These external laws and regulations bind the internal by-laws of a company, and prescribe details such as wages, fringe benefits, incentives, penalties and working hours. These by-laws retain the wide-ranging employee rights that existed under the former COMECOM regime, and the management of each steelworks feels shackled by the unfavorable effects that result.

(3) Job description

Each employee has a detailed job description which fully defines duties, working place, qualifications, line of responsibility, related work and safety rules.

(4) Other rules

The other major internal rules include production-related ones such as technical processes and quality standards, and rules for safety and fire prevention. It was explained that there are innumerable other regulations and rules in every field of the steelworks.

8.3.2 Management methods

The current situation of management at the steelworks and some problems are described in this section.

1) Profit planning and controlling

The executive director makes a detailed annual business plan, based upon the overall business plan agreed by the board of directors and the Ministry of Industry. Planning profit and controlling profit targets is done at Kremikovtzi by first planning the sales volume, taking into account the production capacity, outstanding orders and new orders forecast by the Domestic Sales and Export Departments.

Sales prices are planned by the Domestic Sales and Price Efficiency Departments for the domestic market, and by the Export and Management Analysis Departments for the export market.

As for production cost, the Technical Supervision Department sets the target unit consumption for each production unit, and the Management Analysis Department sums up the total cost of each production unit and sets the budget.

The Technical Supervision Department checks the monthly consumption of each unit and compares it with the target figure. The Accounting Department sums up the actual purchase amount, and checks the figures to make each payment. The budget is reviewed quarterly. Profit is controlled by raising the sales price, and if a customer will not accept this, then by trying to reduce production costs. The executive director reports the business results quarterly to the board of directors in accordance with the management contract. Labor cost is excluded from the basis of profit planning, and payment is made quarterly dependent on cash availability and adjusted for inflation. It was explained that there had been no lay-offs for the past several years.

2) Monthly operational management

All the daily and monthly operational management is done by reporting to the executive director or manager at each steelworks. Purchase and sales results, shipping and sales schedules, and bank account records are all reported to the executive director or manager.

3) Inventory control

Inventory control is done as follows at Leko ko. Upon approval from the Consumer Limits Bureau, commodities are warehoused after clearing a government inspection, and recorded as an entry by an accountant of the Purchase Department. Release of goods is done by a signed form issued by an authorized person of each production unit, and also recorded as a disbursement by an accountant of the department. The Accounting Department keeps and maintains an auxiliary ledger. Periodically and depending on needs, inventory inspection is done by an ad hoc committee, and their findings and the outstanding inventory are reported to the manager.

4) Management method

The management method is typically by the written word. Each steelworks has a daily telephone conference among production units, a weekly operational meeting among directorates, and a meeting as described in Section 8.3.3, in which major operational decisions are made among the top management. However, apart from these meetings, there are almost no inter-departmental meetings.

5) Delegation of power

All power is assigned to the executive director or manager. Although a deputy executive director or a deputy manager in charge of a production unit is sometimes appointed, all departments including such production units are under the control of the executive director or manager. Every contract, such as for purchases, sales and loans, are signed by this person. (A contract of more than 1 million Leva in value must be approved by the board of directors.) Bank account transactions can also be signed by the director of the Finance Department, in addition to the executive director. The situation is the same in the limited companies of Promet and Leko ko. The manager has a sole authority in every field and the sole right to sign outside contracts.

6) Problems

① As seen in above 1), although profit planning is done by some relevant departments, the target consumption of each production unit is set and checked by the Technical Supervision Department. The compilation of a budget and its control should instead be done by each production unit in relation to daily production. An inherent function of the Management Analysis Department should be cost analysis of the budget and its results, with explanation to each production unit. However, at Kremikovtzi only the total amount of each unit is summed up for the budget. This business practice is a result of strictly written job descriptions, and hampers the operation of an efficient and successful management and control system.

② As described in the above 4), there seem to be considerable restrictions on employees in general in communicating with others and deepening their knowledge, skills and talents in their daily work.

③ The management of each steelworks is solely assigned to the executive director or manager, and there appears to be little delegation of authority.

8.3.3 Decision-making method

How decision-making is done at the steelworks is described below. There does not seem to be any particular problem in this field.

1) Top decision-making system

Any investment of more than 1 million Leva, joint ventures and the disposal of fixed assets must be agreed by the board of directors in a joint-stock company. Any joint venture or disposal of fixed assets must also be agreed to by the Ministry of Industry for a limited company. At Kremikovtzi, the decision-making process for an investment in machinery and equipment involves every plan being discussed and studied at a technical council meeting involving the production department and other experts such as finance, this meeting being chaired by the chief engineer. A feasibility study involving such aspects as the return rate, amount of investment and efficiency is examined, and it is decided whether the plan should be proposed to the board of directors for approval.

2) Daily operational decision-making system

Other aspects of daily operational decision-making are made at a weekly council of directors meeting. Such a meeting is held every Friday at Kremikovtzi, topics, problems, analytical reports and other matters are discussed, and necessary assignments and decisions are made. Another council of directors meeting is held every monday for daily operations.

The other steelworks also have the similar meetings as at Kremikovtzi.

8.3.4 Organization and personnel

No steelworks had an official organizational chart, and the team could only obtain a make-shift or rough hand-written discription. None of the steelworks had any well-documented records with regard to the personnel structure, neither. It seems that they do not foreseen any neccessity of the organizational charts and personnel structure, because every documents such as job descriptions and internal by-laws well cover their neccessities. The number of employees as of the time of investigation (September 1994) was as follows;

Kremikovtzi Steelworks	16,070
Stomana Steelworks	5,619
Promet Steelworks	1,087
Kamet Steelworks	1,352
Leko ko Steelworks	1,591
(Total)	(25,719)

8.4 Condition of Operation and Equipment

The problems of operation and equipment are described below, and are summarized with countermeasures in Table 10-3.

8.4.1 Kremikovtzi Steelworks

1) Production Capacity

The production capacity of the existing equipment is shown in Table 8-5, together with actual production in 1993. The operating rate is high in the upstream process, approaching approximately 70% in steelmaking, but is 50% in slabbing, and is under 30% in many areas of the rolling division. It can therefore be said that the capacity of equipment in the downstream process is excessive. This is attributed to the fact that semifinished products (billets and coils) with little added value comprise half of all outside sales. One reason why productivity has not improved is the large amount of down time. The percentage of rolled product rejections for dimension and shape problems is relatively high.

2) Yield

Yield, defined as (product + stock) / (crude steel + imported slab), is approximately 76.5% (1993), which is rather low compared with advanced steelworks. In addition, the amount of scrap generated internally at Kremikovtzi reached approximately 30% of the plant's production, according to the data for 1993. Implementation of improvements would make it possible to reduce this amount to about 14% of production.

3) Labor Productivity

Labor productivity is very low compared with that the most modern steelworks. This is attributed to the age of equipment and the low level of rationalization.

(Production 1,148,082t + stock 32,200t)/16,070 persons = 73.4t/man · y

4) Technical level by process

① Coke ovens and chemical plant

Two coke ovens, No. 3 and No. 4, are in operation. The equipment is new and operation is proceeding smoothly. However, energy consumption is high at 700 Mcal/t-coal, and combustion control and other countermeasures are urgently needed.

For cost reduction, it is necessary to standardize coal blending, operations, and equipment control, among others. Equipment control also requires strengthening at the chemical plant.

For environmental improvement, desirable measures include the introduction of dust collectors for use during coal charging and coke pushing, prevention of gas leaks from the coke oven doors, and installation of waste water treatment equipment for the chemical plant effluent.

② Sinter plant

Although the equipment is old, various operational improvements have been attempted recently with positive results. However, further improvement is still required from the viewpoint of productivity, unit fuel consumption, coke ratio, etc. Unit fuel consumption is high, at approximately 1.5 times the level in Japan, and there is still room for improvement. It is probably also necessary to standardize operations and equipment control, etc. and, for environmental improvement, to install predusters for the sintering main exhaust and auxiliary equipment dust collectors.

The clearance of the grate bars under the sintering layer is 3 ~ 12 mm, and the size of the materials for sintering is under 5 mm (usually 2 ~ 3 mm). Therefore, some materials fall through the grate, because at Kremikovtzi Steelworks the materials are directly loaded on the grate. The materials which falls through grate is carried as dust to the de-dusting system and partially to the chimney. This reduces the yield of sinter, increases the load on the de-dusting system, and lowers de-dusting effectiveness.

The upper several tens of mm of the sintering layer are easily powdered because of sudden heating and cooling. This powder is returned to the material hopper after screening. This process is inevitable, as the problem at Kremikovtzi is a thin sintering layer, but it means that the powder percentage is excessive.

The ignition burner is a "side burner" type, and its thermal efficiency is not good, because the temperature at all positions in the furnace must be raised to over the ignition point.

Table 8-5 Outline of Kremikovtzi Steelworks

1. Established ; 1961
2. Number of Employees ; 16, 070
3. Outline ; The largest integrated steelworks in Bulgaria. Old equipment and many environmental problems need restructuring and modernization.
4. Main Equipment ;

(Unit: $\times 10^3$ ton/year)

Equipment	Capacity	Production (in 1993)	Description
Coke Battery	937	857	No. 3 and 4 are in operation
Sinter Machine	3285	1768	75 t/h × 6
Blast Furnace	1898	1013	1033 m^3 × 6
Converter	1750	1132	127t/ch, 2/3 operation 40~41 heats/day
Electric Arc Furnace	430	344	100t/ch × 2, No. 3 is new one Tap-tap No.1, 3~4hr; No. 2, 2~2.5 hr
Slabbing & Blooming Mill	2500	1252	Soaking Pit × 40, Mill, Hot Scarfer, Shear,
Hot Strip Mill	2100	585	Reheating Furnace × 3, Rougher × 3, Finishing Stand × 6, Min. thickness 2mm, Max. weight 15t, Coil width 600 ~ 1550 mm
Billet Mill	1050	629	Stand × 10, φ 100 ~ 150, □80 ~ 120, Max. 12m length
Rod Mill	500	216	Stand × 21, φ 6.5 ~ 12mm, Weight 500 kg
Cold Strip Mill	300	41	Stand × 5, Thickness 0.18 ~ 0.6 mm, Width 746 ~ 1050 mm
	1000	87	Stand × 4, Thickness 0.25 ~ 2.0 mm, Width 700 ~ 1550 mm
E.T.L.	120	12	Thickness 0.22 ~ 0.36 mm, Max. weight 10t
C.G.L	170	28	Thickness 0.5 ~ 1.5 mm, Width 700 ~ 1250 mm
Color Coating Line	30	3.5	
Welding Pipe Line	97	35	φ 15 ~ 100mm
Zinc Coating Line	70	18	
Seamless Pipe Line	89	25	Outer Dia. 50 ~ 159 mm, Thickness 4 ~ 18mm
Slab Caster	1600		(Purchased but not installed yet)

③ Blast furnace

Generally, blast furnace operation is stable and smooth. In particular, No. 3 BF (blown in March 1993) has been improved and modernized, and good operational results are being achieved. However, the level of operation (productivity) cannot yet be called adequate, and further improvement is required in unit fuel consumption, coke ratio, ore ratio, etc. For cost reduction, it is necessary to standardize raw material blending, operation, and equipment control practices, and to improve the equipment.

Much hard coking coal is imported from the USA, Poland, and other countries, etc. Soft coaking coal is much cheaper, but the use of this material cannot be increased because this plant lacks a PCI (Pulverized Coal Injection System).

The combustion control of the blast furnace hot stoves depends on the skill of the individual operator. This causes low thermal efficiency and raises fuel consumption.

④ Steelmaking shop

Three (3) converters and two (2) electric furnaces are in operation. This plant is old in terms of hardware, and no major revamping has been carried out. At the converters, hot metal is charged by way of a hot metal mixer, but no hot metal pretreatment is performed. The hit rate is poor and S content is high, requiring an excessive number of reblows. Temperature measurements and sampling are performed manually by tilting the furnace. Ferroalloys are added to the metal in the ladle manually from the operation floor, placing a heavy load on the operators.

Kremikovtzi operates two (2) 100 ton AC electric furnaces. However, the capacity of the power source is inadequate, the treatment time for one heat is long at 2.5 to 4 hours, and the actual production capacity is therefore small. Energy consumption is high, being approximately 1.3 times that in Japan.

Construction of the continuous caster was discontinued, and at present, 100% of production is by the ingot route. ASEA-SKF ladle refining equipment is available, but is generally not used because it is not required for the steel grades being produced. It is used only for Ar gas bubbling treatment with electric furnace steels.

With both the converters and the electric furnaces, it appears that there is room for improvement such as saving energy, reducing tap-tap time etc. by introducing new technology, revamping the equipment and operational improvement. Converter and EAF off-gas is cleaned using a venturi type dust collector, but in both cases the efficiency of dust collection is extremely poor. No dust collection is applied to the buildings as a whole or at the furnace side, and countermeasures will therefore be necessary in the future.

⑤ Slabbing and blooming mill

A detailed analysis was not made because the plant is to be eliminated in the future. Early completion of the continuous caster is desirable.

⑥ Hot rolling mill

Yield is low, and loss is higher than in Japan. Although loss is not categorized as crop loss, misrolls, and sample loss, it appeared that loss due to misrolls is quite high. The unit fuel consumption of the heating furnaces is high, at about three (3) times the levels in Japan, indicating that there is room for improvement in operating practices.

Unit consumption of rolls was somewhat higher than in Japan. There is room for improvement in the selection of roll material properties, optimization of cooling, reduction of misrolls, etc.

⑦ Cold rolling mill

Productivity is low at approximately 30-50% of capacity. This appears to be due largely to the poor skill of operators.

⑧ Pickling line

In terms of productivity, the HCl line, is operating at only 15% of its capacity. There appears to be room for improvement at the line exit side. If the capacity of the HCl pickling line can be fully used, it will probably be possible to shut down the H_2SO_4 pickling line. Trimming loss attributable to the edger is excessive.

⑨ Bell annealing furnace

Unit consumption of fuel is high, at four (4) times the levels in Japan. Problems were found in the furnace structure and maintenance.

⑩ Continuous galvanizing line

This facility has an adequate capacity in terms of both productivity and quality.

⑪ Electrolytic tinning line

Production requirements are so low that we were not able to obtain adequate data for a comment.

⑫ Billet mill

Carbon steel comprises a large part of the current product mix. There are no problems in terms of quality. In terms of operation, the misroll ratio is high, at eight (8) times the levels in Japan. The amount of crops is also large.

Power consumption shows normal values and is not a problem. However, roll consumption is high at 400 g/t, and there appears to be room for improvement for both cost reduction and longer roll life.

⑬ Rod mill

The misroll ratio is high, at 1.5%. The percentage of crops is large because the unit weight of the rods is small. As a result, yield is low, at 92%. The rejection rate due to shape nonconformities is high, at 0.73%, suggesting that there are problems in roll shape and interstand tension. In terms of equipment, roll life is short, and consequently the operating rate is low. Unit fuel consumption is relatively high. Results in this area will depend on whether close, detailed operational control is being carried out or not.

⑭ Seamless pipe (hot product)

All the equipment was manufactured in the former Soviet Union (1968). Virtually no improvements have been made since the line was installed. It is not possible to meet international standards because nondestructive inspection (NDI) equipment has not been introduced. In terms of quality, the roundness of pipes and the inside surface quality are both poor. Unit fuel consumption is high because the furnace is inadequately insulated. Yield is poor, indicating much room for improvement.

⑮ Seamless pipe (cold product)

All the equipment was manufactured in the former Soviet Union (1968). Virtually no improvements have been made since the line was installed. It is not possible to meet international standards because nondestructive inspection (NDI) equipment has not been introduced. The low yield rate indicates significant room to improve technically.

⑯ Welded pipe

All the equipment was manufactured in the former Soviet Union (1971). Virtually no improvements have been made since the line was installed. An eddy current flaw detector is available as nondestructive inspection (NDI) equipment, but does not adequately check for weld defects. Welding bead is left untreated on the inside surface of welded pipes.

⑰ Galvanized pipe

All the equipment was manufactured in the former Soviet Union (1972). Virtually no improvements have been made since the line was installed. It is not possible to meet international standards with this equipment because short products cannot be processed and its is not possible to control the coating thickness on the inner and outer surfaces.

5) Equipment

Kremikovtzi is an integrated steelworks established in 1961, with a wide range of equipment and products. (See Table 8-5)

6) Current equipment plan by Bulgarian side

a) Ironmaking equipment

At the sinter plant, a new ignition furnace and burners are expected to be adopted. No. 1 blast furnace was relined in October 1995. At the hot stoves, construction of No. 4 hot stove is planned for No. 1 BF. Repairs of other hot stoves are proceeding in turn. A proposal for the introduction of PCI (pulverized coal injection) at the blast furnaces is under study.

b) In the field of steelmaking, purchases of the following have already been completed:

Continuous casting machine for slabs (two units), with auxiliary electric power supply equipment and water treatment facilities

Hot metal desulfurization equipment

Ladle refining equipment

Oxygen plant (No. 6)

However, the construction of the continuous caster shop was suspended with only part of the foundation and building completed. Work on the power supply and water treatment facilities is progressing, although gradually. A proposal has also been made to install a billet CCM in the electric furnace shop, but this project is still in the planning stage.

8.4.2 Stomana Steelworks

1) Production capacity

Production capacity is shown in Table 8-6. If Stomana had another ladle furnace, the quality of the molten steel could be stabilized. The steelmaking section and casting section have a larger production capacity than the rolling section.

In the rolling section, actual production is near capacity. However, in the steelmaking section, actual production is lower than the specification. The cold work section receives few product orders and is idle most of the time. At the EAF, the revamping of equipment and operational improvements are required to save energy and to shorten the tap-tap time, etc. Caster yield can also be improved by reducing the kinds of steel cast. To improve the yield at the plate mill, it is necessary to replace the side shear or similar equipment.

Table 8-6 Outline of Stomana Steelworks

1 Established ; 1953

2 Number of employee ; 5,619

3 Outline ; Steelmaking equipment is refreshed, and rolling mills are old.

4 Main equipment ;

(Unit: $\times 10^3$ton/ year)

Equipment	Capacity	Production	Description
Electric arc furnace	960	489	No. 1 & 2 furnace; 230,000 ton/year No. 3 furnace; Refreshed in 1993 500,000 ton/year
Ladle furnace	500	88	1 LF for No. 3 EAF
Continuous casting machine			Installed in 1982, made in USSR, 100% CC
Slab C.C.M.	400	263	1 strand. 220 × Max 1500 mm
Bloom C.C.M.	300	178	4 strand. 250 × 350, □ 200 mm
Small section & bar mill	} 216	174	Installed in 1953 250×300 mm ⇒ ϕ 12 ~ 20 mm, D10 ~ D20 Furnace ⇒ 2Hi 2std ⇒ Furnace ⇒ 2Hi 7std
Middle section & bar mill	}		Installed in 1996, ϕ 50 ~ 100 mm, 25 ~ 60 × 100 ~ 50 mm, ϕ 60 ~ 120mm Billet, Channel, Angle
Plate mill	250	208	Installed in 1996, Furnace (30t/H) × 2 Mill motor 4000 KW
Ball mill	83	5	Installed in 1967, Bar ⇒ Ball
Drawing machine	90		Installed in 1985 ~ 6, ϕ 8 ~ 100mm

2) Labor productivity

At 381,796 tons/year/5, 619 persons, labor productivity is 68 tons/man-year, which is lower than the level in Japan.

3) Technical level of processes

Technical problems are discussed below.

① The tap-to-tap time at the EAF is long, and operational improvement is required.

② Fuel consumption of the reheating furnace at the plate mill is more than twice as high as in Japan.

③ Because 5.9% of plate products are downgraded to 2nd grade due to surface defects, one additional ladle furnace should be constructed and the operating rate should be raised.

④ Bar mill misrolls are excessive. Misrolls have a negative effect on productivity, unit consumption values and quality. It is important to pursue and improve the real causes of this problem.

4) Equipment

Rolling section equipment is old, making it difficult to maintain good operation without major modernization. (See Table 8-6)

8.4.3 Promet Steelworks

1) Production capacity

Production capacity and actual production in 1993 are shown by equipment in Table 8-7. The specifications of this plant indicate a production capacity of 800,000 tons per year, but the maximum output in actual operation is only 107,000 tons. The real production capacity estimated from present conditions is only 215,000 tons.

One reason for the low production of this plant is excessive downtime.

Furthermore, the rejection rate for dimensional and material properties is not zero, and can be expected to increase if stricter inspections are made. Product quality must be considered a problem.

Table 8-7 Outline of Promet Steelworks

1 Established ; 1987
2 Number of Employees ; 1,087
3 Outline ; Only this works is near Black Sea (Burgus). Steel making equipment etc. were planned, but installed only bar & shape mill.
4 Main Equipment ;

(Unit: $\times 10^3$ton/ year)

Equipment	Capacity	Production	Description
Bar and Shape Mill	800	107	□80 ~ 200×6 ~ 12m F'ce×2, Rougher; HV 4std, Roller hearth F'ce, I.M. Mill; H12, F. Mill HV 8×2

2) Yield and labor productivity
Scale, crop, and misrolls are all excessive, totaling 6.27%. Calculating from production and considering only the manning which is directly related to production, labor productivity is 287/kg man-hour, which is no more than 1/10 to 1/20 of the levels in Japan.

3) Technical level of processes
The nominal capacity of the equipment is 800,000 tons, but even 200,000 tons would be difficult to realize in actual operation. This indicates that Promet has not adequately mastered the use of this equipment. In addition, misrolls are excessive, indicating a low technical level.

4) Equipment
The specifications of the bar mill equipment are shown in Table 8-7. This fully continuous rolling mill for bars went onstream in 1988. The site was planned as an integrated steelworks, but the government changed when only the bar mill had been constructed and further plans were not materialized. Although this site has no steelmaking shop, it is the most advanced plant in Bulgaria and must therefore be used effectively.

8.4.4 Kamet Steelworks

1) Production capacity
Production capacity is shown by equipment in Table 8-8. These are not satisfactory levels in terms of quality, and downtime is excessive because of the aged equipment. Therefore, major improvements will be required if production is to be continued. Production has been particularly low in recent years, and the problems are large.

2) Yield and labor productivity

Yield is poor because the entire production of the steelmaking shop is by the ingot method, and the ingot size is small (120kg or 750kg). Stronger production control cannot be expected to produce major improvements.

Yield loss at the bar mill is about 18%. (Yield is only 82%.) Scale, crop, and mill loss are all excessive. Even allowing for the age of the equipment and the small size of the ingots, this figure is hopelessly large. Irrespective of the low production volume, these shops are heavily overstaffed.

Table 8-8 Outline of Kamet Steelworks

1	Established	;	1933
2	Number of Employee	;	1,352
3	Outline	;	The oldest steelworks in Bulgaria. The equipment is old except the forging machine.
4	Main Equipment	;	

(Unit: × 10^3ton/year)

Equipment	Capacity	Production	Description
Electric Arc Furnace	43.8	8.5	10 t/ch × 3 electric, tap-tap 3.5hr Ingot weight, 120kg(bar), 750kg (forging)
Bar Mill	48	7.1	Reheating Furnace, Rougher, Finishing mill
Forging Shop	25 t/h	2.1	Installed in 1986 Reheating Furnace, Heat treatment furnace, Forging machine
Hot Press Shop	3.9 t/h	1.4	Installed in 1969 Saw, Furnace, Descaler, Hot press
(Purchased but not installed yet)			
Electric Arc Furnace	200		40 t/ch × 1, Tap-tap 68 min.
Billet Caster			[ ] 120~ ϕ 230, 3 strands
Bar and Rod Mill	150		ϕ 10~ ϕ 90, Coil ϕ 5.5 ~ ϕ 26 Flat bar 100×10~ 130×40 Furnace 55t/h, V mill ×22, Block mill×8

3) Technical level of processes

The technology applied in steelmaking (small ingot casting) and rolling (by 3 Hi reversing mill) is thirty (30) years out of date. It is therefore not possible to offer any meaningful comment on the technical level. The electric power consumption of the electric furnace is nearly twice the normal level, at 800 kwh/t. At the heating furnaces, unit consumption is 10 times the normal level, partly due to the low level of production. No secondary refining equipment is available in the steelmaking shop, furnace life is short, and tap-to-tap time is long. These problems can only be solved by introducing new equipment. The dust collector has been left unrepaired and is not being used, and revamping work has been suspended. This is also a problem plant in terms of pollution, because building dust collection is not used. Only the forging and extrusion processes are relatively new, but they should be scrapped or sold from the view point of the profitability of their operation.

4) Equipment

The equipment is extremely old, as indicated by the fact that the bar mill dates back to 1934.

8.4.5 Leko ko casting and forging plant

1) Production capacity

In December 1979, Machino Export of Bulgaria placed an order with Kobe Steel for construction of a steel casting and forging plant as a part of the Radomir Heavy Machinery Complex. Kobe Steel performed the basic design, supply, and installation of equipment, load tests, complex tests and training services. After the final acceptance, the plant was turned over to Machino Export in August 1985.

The Radomir Heavy Machinery Complex is a steel casting and forging plant which consists of melting, ingot making, casting, heat treatment, and machining shops with a laboratory, a heavy machinery plant including welding and fabrication shop,utilities such as boilers, oxygen plants, an air compressor station, a water treatment station, a gas supply station,and a power sub station. These facilities are located in an area of 3 million square meters and were once the most modern and one of the largest heavy machinery complexes in eastern Europe. In 1991, the Radomir Heavy Machinery Complex was divided into the steel casting and forging plant, heavy machinery plant, and three (3) other small companies. The steel casting and forging plant is now called Leko ko. Leko ko's production capacity according to the basic design specifications of the facilities is shown in Table 8-9.

Table 8-9 Outline of Leko ko Steelworks

1 Established ; 1984

2 Number of Employees ; 1,591

3 Outline ; New large scale casting and forging steelworks. An increase in orders is the most important factor for reconstruction.

4 Main Equipment ;

(Unit: × 10^3ton/ year)

Equipment	Capacity	Production	Description
Electric Arc Furnace	150	17	15 t/ch, 25 t/ch, 60 t/ch 1 each
Refining Equipment		17	VOD (for stainless steel, 75t/ch, under repair) VAD (70t/ch)
Casting Shop	43	0.7	Molding mixer, Shot blast, Shakeout machine Annealing f'ce (50, 80, 150, 250 ton), etc.
Forging Shop	45	4.1	Press (3600, 1600t), Furnace
Heat Treatment Shop	28		Heat treatment furnace, Rapid heating f'ce, Induction heating machine, Oil quench tank
Machining Shop			Lathe, Drill, Milling machine, Grinder, etc.
Continuous Casting Machine	90		ϕ 170 ~ 360mm (Purchased but not installed yet)

Actual production capacity is considered less than 1/3 of the design production capacity due to lack of skilled workers and engineers as well as a low level of production control.

The machining shop was built by Bulgaria and its capacity is smaller than the material production capacity. While rolls are shipped in finished machined condition, most of the other products are shipped in rough machined, in forged, or in cast conditions. In a restructuring program, the installation of additional machinery should be studied to increase the machining capacity to allow shipment of more finished products, which are more profitable than forged or cast products.

As customers use steel casting and forging for vital plant parts, they have much concern about the supplier's quality assurance program as well as product quality. Two years ago, with the cooperation of consultants, Leko ko documented its quality assurance program as complying with ISO 9002, internal standard of quality assurance, and has been implementing a QA manual in their shops. This program was to be qualified by the end of 1996.

Production was considerably lower than production capacity. An increase in orders is the most important factor for restructuring and modernization.

Rolls for steel mills were the main product, and 10,000 tons/year of rolls were supplied to domestic mills and Russia until 1989. Although this amount has decreased since 1990, rolls for domestic mills are still the main product. Leko ko has tried to export steel castings and forgings for marine parts since 1991, and received orders from Finland, Sweden, Poland, and other countries for stern frames, rudder horns, propeller shafts, and intermediate shafts. These marine parts are inspected and qualified by Lloyd's register or other ship classification societies before shipment. Leko ko will be well prepared for marine business after qualification under ISO 9002 early next year.

Some of their biggest forgings include a 35 ton back up roll, a 30 ton marine shaft, and a 30 ton main crusher shaft. They can make a maximum 40 ton forging from an 80 ton ingot with their 3,600 ton press. A 93 ton stern frame ('94) and an 87 ton crusher casing (before 1989) are the largest steel castings they have made. In summary, Leko ko has the potential to establish itself as a supplier of heavy steel casting.

2) Yield, productivity and labor productivity

① Yield

The yields are standard levels for the steelmaking and ingot making process. Annual average yields of forgings and castings are 60% and 50% respectively. They also seem to be standard levels but cannot be discussed in detail because they change from product to product due to shape and specifications.

② Labor productivity

In a comparison of production per man year, Leko ko's productivity is about half that of eastern European suppliers and 1/10~1/20 that of western and Japanese ones. It is essential to receive more orders in order to improve productivity and competitiveness. Receiving more orders is the most important factor for the restructuring and modernization of Leko ko. Their shops have equipment equal in quality to that of other manufacturers and sufficient personnel, and they can easily increase their energy procurement, raw materials and submaterials for production.

There are a comparatively large number of personnel in service groups such as crane, maintenance and sub-operations compared to main operations. Service group operation should be studied to increase productivity, though labor costs are too low to justify rationalization by installing additional automated equipment.

3) Equipment

A list of equipment is shown in Table 8-9.

8.5 Energy

8.5.1 Energy plan

1) Kremikovtzi Steelworks

a) Electric power

① Amount of consumption

Actual consumption in 1993 was $1{,}283 \times 10^6$ kwh per year and 147 Mwh on average per hour. Electrical power to be purchased from the power company accounts for 67% of actual consumption. Kremikovtzi consumed approx. 869 Kwh of electric power per ton of crude steel.

② Characteristics of electric power system

- The electric power system at Kremikovtzi is a surplus system. The receiving voltage is high and the capacity of the transformers is large.

- The electric furnaces at Kremikovtzi Steelworks have an independent receiving system which is connected to the high voltage system. This system can prevent voltage fluctuations and voltage flicker due to the electric furnaces, not only inside the steelworks but also outside the steelworks.

- The substation of the electric power company supplying Kremikovtzi is connected with the 400Kv main system of Bulgaria, so that the power supply of this substation has adequate capacity for stable operation.

- The primary electric power distribution system supplying the 6 main substations in Kremikovtzi, which are a loop distribution system with two 110Kv lines, is a reliable system.

- The new 400Kv substation is maintained in good condition, but No. 1 substation needs improved methods of maintenance because some of the covers of the wiring pit are broken, many of the pits are open, and the condition of the inside wiring is bad.

③ Restrictions on factory modernization related to electric power system

The electric power system at Kremikovtzi has adequate capacity, so that there would be no restrictions on factory modernization relate to the electric power system in the future.

b) Natural gas

Natural gas was introduced as a substitute fuel for heavy oil and coal in 1975. Kremikovtzi consumes approximately 4,538 Mcal of fuel per ton of crude steel. Natural gas accounts for 44% of fuel consumption.

① Amount of consumption

Actual consumption in 1993 was 364.454 × 10^6Nm^3 per year, 41.6 × $10m^3$ on average per hour, and approximately 60.0 × 10^3Nm^3 at maximum per hour.

② Supply system

Natural gas is distributed to each factory with 1,000mm H_2O of pressure, which is reduced from 0.6 MPa at 4 reducing rooms after being received by pipeline from Bulgar Gas Company. Gas is distributed only to the power plant at 0.11 MPa. The maximum receiving capacity is approximately 85 × $10^3Nm^3/h$.

③ Restrictions on factory modernization related to natural gas

The natural gas supply system has adequate capacity, and therefore should not restrict factory modernization in the futures. However, abnormal low pressure, which the gas company should be requested to improve, occurs occassionally in the gas company supply system in the winter season.

2) Stomana Steelworks

a) Electric power

① Amount of consumption

Actual consumption in 1993 was 543 × 10^6 Kwh per year and 62 Mwh on average per hour. Stomana consumed 1,230 Kwh of electric power per ton of crude steel.

② Characteristics of electric power system

- The electric power system at Stomana is a surplus system. The receiving voltage is high and the capacity of the transformers is large.
- The electric furnaces at Stomana Steelworks have an independent receiving system which is connected to the high voltage system. This system can prevent voltage fluctuations and voltage flicker due to the electric furnaces, not only inside the steelworks but also outside the steelworks.
- The substation of the electric power company supplying Stomana Steelworks is connected with the 400Kv main system of Bulgaria, so that the power supply of this substation has adequate capacity and is stable.

③ Restrictions on factory modernization related to electric power system
The electric power system at Stomana has adequate capacity, and would not restrict factory modernization in the future.

b) Natural gas
Stomana consumes approximately 1,507 Mcal of fuel per ton of crude steel, all of which is natural gas.

① Consumption
Actual consumption in 1993 was $83.2 \times 10^6 Nm^3$ per year, $9.5 \times 10^3 Nm^3$ on average per hour, and approximately $14 \times 10^3 Nm^3$ at maximum per hour.

② Supply system
After being received from Bulgar Gas Company at 0.6 MPa of pressure by a 500mm ϕ pipeline, the pressure of the natural gas is reduced at the reducing room and distributed to each factory at 0.6 MPa, 0.06 MPa, or 0.02 MPa. The maximum receiving capacity is approximately $30 \times 10^3 Nm^3/h$.

③ Restriction on factory modernization by natural gas
The natural gas supply system has adequate capacity, and would not restrict factory modernization in the future.

3) Promet Steelworks

a) Electric power

① Amount of consumption
Actrual consumption in 1993 was 33×10^6 Kwh per year and 3.8 Mwh on average per hour. Promet consumed approximately 623 Kwh of electric power per ton of steel products.

② Characteristics of electric power system

- The electric power system is a surplus system in design in consideration of power consumption. The receiving voltage is high and the capacity of the transformer is large.
- Electric power is received via 3 lines from 2 power company substations. This is considered to be a highly reliable system.
- The power company substations supplying Promet are connected to the 400Kv main system of Bulgaria; therefore, the power supply has adequate capacity and is stable.

③ Restrictions on factory modernization related to electric power system
The electric power system at Promet has adequate capacity, and would not restrict factory modernization in the future.

b) Natural gas

Promet consumed approximately 665 Mcal of fuel per ton of steel produced. All fuel of the billet mill is natural gas, and the fuel for the boiler is heavy oil. Heavy oil was converted to natural gas in 1994.

① Amount of consumption

Actual consumption in 1993 was 3×10^6 Nm^3 per year, and 342 Nm^3 on average per hour. After conversion of the boiler from heavy oil, consumption will be increased by 1.4×10^6 Nm^3 per year.

② Supply system

Natural gas is received at a pressure of 0.6 MPa by pipeline and distributed to each plant. The maximum receiving capacity is approximately 15, 000 Nm^3/h.

③ Restrictions on factory modernization related to natural gas

The natural gas supply system has adequate capacity, and therefore would not restrict factory modernization in the future.

4) Kamet Steelworks

a) Electric Power

① Amount of consumption

Actual consumption in 1993 was 21×10^6 Kwh per year and 2.4 Mwh on average per hour. Kamet consumed 2,499 Kwh of electric power per ton of crude steel.

② Characteristics of electric power system

Kamet Steelworks does not have a receiving substation as the other steelworks do, and receives electric power directly from Republic Power Station (power and heat co-generation plant) neighboring Kamet via required number of lines.

③ Restrictions on factory modernization related to electric power system

Depending on the restructuring plan, if a new EAF and new mill are installed, a new power supply system will be required. The existing power supply system is not adequate.

b) Natural gas

Kamet Steelworks consumed approximately 2,136 Mcal of fuel per ton of crude steel, using as fuel natural gas and heavy oil in a 1 to 3 ratio.

① Consumption

Actual consumption in 1993 was 560×10^3 Nm^3 per year, with one hour average of 64 Nm^3.

② Supply system

Received from Bulgar Gas Company with a pressure of 0.6 MPa by a 200mmϕ

pipeline. Maximum distribution capacity is estimated at approximately 5,000 Nm^3/h.

③ Restrictions on factory modernization related to natural gas

Study based on the assumptions of factory modernization is required.

5) Leko ko Steelworks

a) Electric Power

① Amount of consumption

Actual consumption in 1993 was 52 × 10^6 Kwh per year and 6 Mwh on average per hour. Leko ko consumed 3,055 Kwh of electric power per ton of crude steel.

② Characteristics of electric power system

- The electric power system at Leko ko is a surplus system. The receiving voltage is high and the capacity of the transformers is large.
- Leko ko has an independent receiving system for the electric furnace, which is connected to a high voltage line. This system prevents voltage fluctuations and voltage flicker due to the electric furnace, not only inside the works but also outside the works.
- The substation of the electric power company supplying electricity to Leko ko Steelworks is connected to the 400 Kv main network of Bulgaria, so that the power supply has adequate capacity and is stable.

③ Restrictions on factory modernization related to electric power system

The electric power system at Leko ko Steelworks has adequate capacity, and would not restrict factory modernization in the future.

b) Natural gas

Leko ko Steelworks consumed approximately 6,110 Mcal of fuel per ton of crude steel. All this fuel is natural gas.

① Amount of consumption

Actual consumption in 1993 was 13 × 10^6 Nm^3 per year, and 1.5 × 10^3 Nm^3 on average per hour.

② Supply system

Natural gas is received at a pressure of 0.6 MPa by a 420 mm ϕ pipeline. The maximum receiving capacity is approximately 20 × 10^3 Nm^3.

③ Restrictions on factory modernization related to natural gas

The natural gas supply system has an adequate capacity, so there would be no restriction on factory modernization in the future in this regard.

8.5.2 Energy balance

1) Kremikovtzi Steelworks

a) Total energy unit consumption per unit of crude steel

Kremikovtzi consumed approximately 1.5 times to 2 times as much energy as the most modern steelworks. Almost all fuel and electric power consumed in Japanese integrated steelworks is normally by product gas and electric power generated from by product gas as self-supplied energy. However, Kremikovtzi purchases a large amount of natural gas and electric power because of the high energy unit consumption at each plant. Kremikovtzi produces only 55% of its total fuel consumption and 33% of its total electric power consumption. Kremikovtzi has to implement overall energy saving activities intensively.

b) Energy unit consumption per ton of crude steel

The actual energy unit consumption of fuel, electric power, low pressure steam and compressed air at Kremikovtzi Steelworks in 1993 was approximately 1.5 times as much as those of the most modern steelworks. Oxygen and nitrogen were exceptions to this heavy consumption.

c) Energy unit generation of BFG and COG per ton of pig iron

The energy unit generation of BFG and COG is high due to the high coke ratio, however, a large amount of coking coal is consumed. The optimum coke ratio should be studied from the viewpoint of total cost reduction.

d) Energy consumption rate of main plants

Almost all values of energy consumption such as fuel and electric power of the main plants at Kremikovtzi are more than those of the most modern steel plants, sometimes being more than 2 times higher.

e) Energy plant unit consumption and generation

① Power plant

The power plant at Kremikovtzi generates not only electric power but also blast air, the supply steam for the COG exhaust blower and low pressure process steam. The fuel consumption of the power plant is large and reaches 43 % of total fuel consumption and 46% of purchased natural gas volume.

The following are the causes of high fuel consumption:

- The high consumption of blast air, as a result of the high coke ratio.
- The generated power efficiency is low, and the own-use power rate is high; moreover, the technical level of plant control equipment is low.
- The consumption rate of low pressure steam is high.

It is important for energy saving at the steelworks to improve power efficiency and to reduce fuel consumption in the power plant and the power plant must be operated in such a way that power generated using natural gas is cheaper than purchased power.

② Oxygen plant

Both consumed electric power per unit of generated oxygen and the oxygen supply volume per ton of pig iron are high.

③ Power consumption at night

The contracted night time power consumption rate at Kremikovtzi in 1993 is 33.3%, whereas that at Mizushima in Japan is 46%. Shifting power consumption to night time should be considered in order to reduce power costs.

④ Energy management

The energy control system in a large scale integrated steelworks should be effectively used in order to minimize purchased energy costs. The technical level of this system at Kremikovtzi is low.

2) Stomana Steelworks

a) Energy unit consumption per ton of crude steel

Stomana consumed more than two (2) times as much energy as Japanese arc furnace steelworks. Moreover, 66% of the total energy is electric power, and 33% is fuel.

b) Energy saving

- The fuel and power consumption rates are very high, and immediate improvement is required.
- 30% of fuel natural gas was consumed at the plate mill, whose unit consumption should be improved immediately, and as 12.7% of fuel natural gas was consumed for low pressure steam, which is used mainly for heating, more effective use is desirable.
- 72% of electric power was consumed at the EAF and CC. It is therefore important to improve the unit consumption at the EAF and CC. 11% of electric power was consumed at plants other than the oxygen plant and main plant, indicating that energy saving is required at these other plants.
- Compressed air was consumed in an amount of 411 Nm^3/t-steel, which was far larger than the Japanese average unit consumption of 130 Nm^3/t-steel. Pressure and consumption should be reduced for energy saving.

3) Promet Steelworks

a) Energy unit consumption per ton of crude steel

Promet consumed more than three (3) times as much energy as Japanese steel mills.

b) Energy saving

- The fuel and electric power consumption rates are very high, and immediate improvement is required.
- 212 Mcal/t-s (30% of the total fuel consumption rate of 665Mcal/t-s) of fuel (heavy oil) was consumed by the boiler for hot water, which is used to mainly for machine heating and room heating. Therefore, it is necessary to take prompt measures for energy saving.
- 189 Mwh/t-s (30% of the total electricity consumption rate of 623 kwh/t-s) of electric power was consumed for oxygen and compressed air generation. The pressure and consumption of oxygen and compressed air should be reduced for energy saving.
- As described above, a large volume of fuel and electric power is consumed by non-production sections. This situation should be improved as quickly as possible.

4) Kamet Steelworks

a) Energy unit consumption per ton of crude steel

Kamet consumed a large amount of energy, almost five (5) times as much as Japanese steelworks, of which 66% was electric power, 23% was fuel, and 11% was low pressure steam.

b) Energy saving

- The fuel and power consumption rates are very high, and immediate improvement is required.
- The fuel used is natural gas and heavy oil, in a 1 to 3 ratio. Natural gas is used only at the press plant. 72% of fuel (heavy oil) is consumed at the billet mill, which must improve its unit consumption for energy saving.
- 52% of electric power is consumed at the EAF. It is important to save electric power at the EAF.
- A large amount of low pressure steam is consumed, and this should be reduced by more reasonable use.

5) Leko ko Steelworks

a) Energy unit consumption per ton of crude steel

Leko ko consumed almost four (4) times as much energy as Japanese EAF steel mills.

b) Energy saving

- The fuel and power consumption rate are very high, and immediate improvement is required.
- 88% of fuel is natural gas consumed at the EAFs and Shop 2, which must improve their operation and take other countermeasures.
- 45% of the electric power is consumed at the EAFs. Improvement of the unit consumption of the EAFs would be effective in reducing purchased power. Since 15% of electric power is consumed at the oxygen plant and compressed air plant, measures are required. Especially, compressed air consumption is 2,820 Nm^3/t-steel, which is far larger than the 300 Nm^3/t-steel maximum level at Japanese works. Therefore, consumption should be reduced by more appropriate use. Electric power unit consumption at the oxygen plant is also high.

8.6 Environmental Pollution Prevention Measures and Facilities

8.6.1 Air

The air pollution prevention measures are described below, and are summarized in Table 8-10.

1) Kremikovtzi Steelworks

a) Raw material yard

Water spray and coating are not performed at the raw material yard. The grab cranes have no water spray capability. Some conveyors are provided with covers and some are not. Conjunctions are enclosed, but dust is not collected there. The crusher and screens are provided with dust collectors which, however, are not operating now. There are six (6) water spray trucks which spray water onto roads in the yard and elsewhere. There is no mandatory requirement in the regulations, but from the environmental point of view, dust prevention measures such as yard water spraying and dust collection at the conveyor conjunctions are desirable, if not indispensable.

b) Coke ovens

Of the coke oven gas, 11,000 m^3/h (H_2S: 20 mg/m^3) is desulfurized and 56,000 to 58,000 m^3/h (H_2S: 2 ~ 5 g/m^3) is not desulfurized. Considering the situation of western Europe and clean energy in general, 100% de-S should be executed.

Coal-charging-cars and guide-cars for the two (2) coke oven batteries are not provided with dust collectors.

Puffs are sometimes seen from the standing pipes. A water type quenching system is used at these coke ovens. Environmental protection measures against dust are necessary. Especially, coal-charging-car dust collection at the time of coal charging, guide-car dust collection at the time of pushing, and door cleaning for door leak prevention are important and would be effective.

Table 8-10 Environmental Countermeasures for Plant and/or Situation

① Kremikovtzi

Plant and/or situation	Existing situation	Criteria for measurement	Measure	Notes
(1) Ore storage yard/dust	No large dust scattering. Water spray around the yard.	--------------------	No	Water spray in west-Europe
(2) Conveyor/ dust	Housed, partly underground. Some scatter at the junction.	Using conveyor to trans-port powdered material.	No	Not necessary to dedust the conjunctions. Some West-E do
(3) Charging car and guide car of coke oven/dust	No dedusting system. Large dust emissions were seen	MOE orders to improve Common in west-Europe. Requirement in Germany.	Yes	
(4) Coke oven doors/emission	Regular type. Some emissions were seen.	Seal type in some w-E. Requirement in Germany.	Yes	CAA requirement is stricter.
(5) COG de-sulfurization	11 km3/H after de- s :20 mg/m3 before :2--5 g/m3	De-s in west Europe. S-content in Germany.	Yes	Gas volume: 55 km3/H Re-investigation in 2000.
(6) Sinter main/dust	Installation EPs. mg/Nm3 Dust concentration #1: 297 #2: 149 #3: 252 #4: 132	80 mg/Nm3	Yes	EPs were in good condition ('93.10) Maintenance is important.
(7) Sinter main/SOx	Concentration : 200-260 ppm Details were not obtained.	No SOx standard for the sinter main.	No	The conc. is not so high. Scarce de-S in west Europe.
(8) Sinter main/NOx	No data	ditto	No	No de-NOx in west Europe.
(9) Sinter cooler/dust	Installation EPs. Dust concentration mg/Nm3 #1:96 #2:64 #3:453 #4:--	80 mg/Nm3	Yes	#2: 276 mg/Nm3 (1993)
(10) BF material bin/dust	#1BF: No dedusting system. #3BF: 5.000 m3/min EP	Dedusting in west Europe 80 mg/Nm3	be in the plan. 1996	
(11) BF casting house/dust	No dedusting system. Large dust emissions were seen	MOE orders to improve. Common in west-Europe. Requirement in Germany.	Yes	
(12) BF house/secondary dust	No dedusting system	- - - - -	No	If local system is good.
(13) Lime kiln main/dust	160 km3/H EP Dust concentration : 10 g/Nm3	MOE orders to improve. 130 mg/Nm3	Yes	
(14) Converter main/dust	Venturi and water spray system Dust concentration : 100 mg/Nm3	30 mg/Nm3 German : 50 mg/Nm3	Yes	Target is 50 mg/Nm3.

Plant and/or situation	Existing situation	Criteria for the measure	Measure	Notes
(15) CV vessel mouth/dust	No dedusting system. Large dust emissions were seen	MOE orders to improve. Common in west-Europe.	Yes	
(16) CV house/secondary dust	No dedusting system.	- - - - - - - - - - - - -	No	If local system is good.
(17) Electric Arc Furnace main/dust	1.000 Nm3/min wet-scrubber. Dust concentration : #1 18-107 #3 66-353 mg/Nm3	30 mg/Nm3	Yes	Bag filter
(18) EAF house/secondary dust	No dedusting system.	Some can be seen in west Europe and Japan.	Yes	
(19) Reheating furnace Boiler/ dust SOx NOx	Fuel: natural gas	Example of the standard (heat power 500Kw--5Mw) fuel:solid oil gas dust 150 80 --- SOX 2000 1000 --- NOX 500 450 200	No	dust: mg/Nm3 SOx : ppm NOx : ppm

② Stomana, Promet and Leko-ko Steelworks

Plant and/or situation	Existing situation	Criteria for the measure	Measure	Notes
(1) Stomana EAF / dust	Main and secondary dedusting. Dust concentration sometimes exceeds the standard.	30 mg/Nm3	in the plan	
(2) Stomana Lime kiln main/dust	EP(42-45 KNm3/H) Dust concentration : 25--130 mg/Nm3 Sometimes exceeds standard.	gas : 21 km3/H volume -20 -60 61- mg/Nm3 150 130 80 130 mg/Nm3 MOE orders to improve.	Yes	
(3) Stomana, Promet, Lekoko Reheating furnace Boiler / dust SOx NOx	Fuel: natural gas	Example of standard (heat power 5Mw--50Mw) fuel:solid oil gas dust 120 50 10 SOX 2000 1000 --- NOX 500 450 200	No	dust: mg/Nm3 SOx : ppm NOx : ppm

c) Sintering machines

There are six (6) sintering machines, and each is provided with an electric precipitator for main waste gas. No. 1 through No. 4 sintering machines were formerly equipped with multi-cyclones for main waste gas, however, at the present time all are stopped. (Resumption of operation is impossible due to corrosion.) One smokestack is provided for main waste gas from No. 1 to No. 4 sintering machines and another for main waste gas from No. 5 and No. 6 sintering machines, for a total of two (2) stacks serving six (6) sintering machines.

Dust collection is performed on coolers, each of which is equipped with a stack.

The emission standards for pollutants in sinter waste gas are as follows:

SO_2 : Not specified
NOx : Not specified
Dust : 150 mg/Nm^3 until 1995 and 80 mg/Nm^3 from 1996 onward

The conditions of the emissions from the stack for main waste gas, as visually observed at time of the site investigation in October 1994, were very good. The dust concentration of the main waste gas from No. 1 sintering machine was 954 mg/Nm^3 on average in 1993 (measured 4 times) and 297 mg/Nm^3 on average up to Sept. 1994 (measured 3 times), both of which exceed the current as well as future standard.

The dust removal efficiency of each dust collector is high. On the other hand, there are only two (2) units, namely No. 6 sintering machine and No. 10 AEP for general dust removal, whose main waste gas or exhaust gas average dust concentration is lower than the future standard of 80 mg/Nm^3. In order to stably keep the values (including maximum values) within the standard, aggressive implementation of appropriate operational controls for dust collectors such as electric charging, dust shake-off and installation of a preduster to reduce the dust concentration at the EP inlet is necessary.

d) Blast furnace

Each BF is provided with an EP for B-gas. No casting house dust collection system has been installed. Taphole and pouring hole dust collection systems and other dust protection measures (such as runner covers) are necessary, and such dust collectors should be of the bag filter type because the dust emission standard is 30 mg/Nm^3.

It is unnecessary to provide secondary dust collection (building dust collection) facilities as long as appropriate primary dust collection such as taphole collection is properly performed.

e) Lime kiln

There are two (2) rotary kilns for lime calcining, of which only the older is currently operating. Waste gas from the new kiln is 160,000 Nm^3/h. It is provided with an EP which, however, is not working efficiently as the gas temperature is high (300°C). (The electric charge turns on when the gas temperature drops below 200°C and off when it exceeds 200 °C.) The dust concentration at the outlet is 10 g/ Nm^3, which drastically exceeds the future standard (80 mg/Nm^3 from 1996 onward). Dolomite is also baked in this kiln, and its dust emission standard is also 80 mg/Nm^3.

Gas cooling is necessary as a corrective measure, and a change from the EP to the bag filter method is desirable for stable attainment of the standard.

f) Ferroalloy furnace

There are two (2) Fe-Si furnaces, both provided with efficient dust-gas treatment systems. Data on the specification of their dust collectors is not available, but from visual inspection, they seem to require no improvement.

There is an Fe-Mn furnace, but it is not operating. We were told that it was stopped because its waste gas dust concentration drastically exceeded the standard value. Kremikovtzi Steelworks is planning to operate this furnace again after the installation of a suitable dust collecting system.

g) Converters

The gas treatment systems of the three (3) converters are of the boiler-type and are provided with a venturi scrubber and a water spray facility. The venturi scrubber is supplied with 200 m^3/h of water before 120 m^3/h of water is sprayed. Dust having a concentration of 30 g/Nm^3 is introduced into the venturi to be treated to a dust concentration of 100 mg/Nm^3, meaning that the dust removal efficiency is more than 99%.

Although the dust emission standard is 30 mg/Nm^3, the present technical level does not enable easy attainment of this standard with the boiler type even though the best Available Technology (BAT) is employed. Revision of the standard, accompanied by a scientific restudy of the environmental effects, is required.

Since no consideration has been made for converter side dust collection, severe dust generation and emissions are seen at blowing and tapping. For this reason, converter side dust collection should at least be considered.

h) Electric arc furnace

The EAF main waste gas is 1,000 Nm^3/min, which is treated by a wet scrubber. The dust concentration of emissions changes according to the scrubber condition, for example, ranging from 18 mg/Nm^3 to 107 mg/Nm^3 at No. 1 collector, and from

66 mg/Nm³ to 353 mg/Nm³ at No. 3 scrubber. These data exceed the emission standard (30 mg/Nm³), requiring improvement at the collector.

Gas of 1,500 °C is cooled by the cooler to 100 °C. This temperature is suitable for a bag filter, the adoption of which would satisfy the dust requirement.
The adoption of a bag filter is necessary in order to attain the dust emission standard.

i) Heating furnaces and boilers
Heating furnaces are installed at the soaking pit, rod mill, billet mill, hot strip mill, CAL, batch annealer and tube mill. A number of boilers are also installed. These furnaces and boilers operate on natural gas fuel and therefore raise no environmental problems.

2) Stomana Steelworks

a) Electric arc furnace
The waste gas flow is 1,045,000 Nm³/h in No. 1 EP and No. 2 EP and 295,000 Nm³/h in No. 3 EAF. The dust concentration is 52 mg/Nm³ and 38 mg/Nm³ respectively, which is slightly higher than the emission standard of 30 mg/Nm³.

The EP for No. 1 EAF is currently being changed to a bag filter. After this change and with stricter control of the bag filters, the furnace should meet the dust standard.

b) Gas cutter
Slab machine: Not provided with a dust collector.
Bloom machine: Provided with two (2) bag filters.
Total 50,000 m³/h bag filter
Dust concentration:
Inlet 30 mg/Nm³
Outlet ND (not detectable). Denotation of the dust concentration as ND is not scientific but will probably not raise any problem as the concentration at the inlet is low at 30 mg/Nm³.

c) Continuous casting
A dust collector is installed for the torch.
300,000 m³/h Electric Precipitator
Dust concentration: 8 mg/Nm³ at outlet
This dust collector, however, is not operating now due to corrosion of parts.

d) Lime kiln

Gas from the kiln is directly led to the dust collector without being cooled. Dedusted gas is discharged from a smokestack 42 meters high.

The waste gas conditions are as follows, and require countermeasures for the dust collector.

The waste gas flow is 42,000 - 45,000 Nm^3/h, and the temperature is high at 300°C (design temperature is 340 - 360°C). The dust concentration is 25 - 370 mg/Nm^3, which sometimes exceeds the emission standard (200mg/Nm^3, but 130 mg/Nm^3 from 1996 onward). The cause of the excessive dust concentration seems to be the high gas temperature and high electrical resistance of the dust.

e) Dolomite kiln

Gas from the kiln is led to the EP after being cooled by water spray. Dedusted gas is then discharged from a smokestack 60 meters high.

Waste gas conditions are as follows, and show no problem:

The waste gas flow is 80, 543 Nm^2/h, and the temperature is 220°C. The dust concentration is 61 mg/Nm^3, which meets the emission standard (200mg/Nm^3, but 130 mg/Nm^3, 1996 on ward).

f) Heating furnaces and boilers

Heating furnaces are installed at the bar mill, plate mill, and annealer, and the plant also has two (2) boilers. These furnaces and boilers operate on natural gas fuel and therefore raise no environmental problems.

3) Promet steelworks

a) Heating furnaces and boilers

There are two (2) heating furnaces and five (5) boilers. These operate on natural gas fuel and therefore raise no environmental problem.

4) Kamet Steelworks

a) Electric arc furnace

The EAFs are located in the steelworks 5 km from the roll mill. There are three (3) electric furnaces of 10 ton capacity each. One is now operating while the remaining two (2) are stopped. The construction of a site local waste gas treatment system and building of a dust collecting system are unfinished and have been suspended. There is no data available on waste gas conditions. As the dust collection method, direct gas treatment is preferable to a side local dust collection system. The construction of an additional 35 ton EAF was started but discontinued. In this case also, direct gas treatment would be preferable.

b) Bar mill

The reheating furnace at the bar mill operates on heavy oil fuel. At present, this furnace is stopped. There is no data available on the waste gas, but the concentrations of SOx, dust, and soot may be high when the furnace is in operation. Accordingly, it is preferable to change the fuel (for instance, to natural gas).

c) Hot press mill

There are three (3) electric high-frequency induction heating furnaces at the hot press mill, which raise no environmental problems.

d) Forging mill

One (1) rotary furnace and two (2) batch furnaces are installed at the forging mill. They all operate on natural gas fuel.

There is no data available on the waste gas, but no environmental problems are anticipated.

e) Boiler

There is no boiler. The necessary hot water is obtained from the nearby power station.

5) Leko ko Steelworks

a) Electric arc furnace

No data on the exhaust gas is available. (Administrative authorities have no such data.) Visual inspection of the bag filter suggests that the emission standard of 30 mg/Nm^3 is not being met.

Replacement with a better quality bag filter may be necessary in order to meet with the standard. The side local system should be of the direct gas dust collection type.

b) Heating furnace

The steelworks has more than twenty (20) heating, reheating or pre-heating furnaces, all of which are operated on natural gas fuel, seemingly without any environmental problems.

The summary of this section is shown in Table 8-10.

8.6.2 Water quality

1) Kremikovtzi Steelworks

a) Water balance and flow

The water flow is shown in Figure 8-1, the water quality in Table 8-11, and water balance in Appendix 8-1.

This steelworks owns Lake Botunetze which is used to store industrial water.

There are two (2) sources of industrial water. Lake Pancharevo, which contains water having a low concentration of water-hardening components (total hardness of 90 ppm as $CaCO_3$), supplies about 900m³/h of water to the water demineralizer, etc. The other source of water is Lake Botunetze (total hardness of 300 ppm), which receives water from Lake Pancharevo and also receives treated water from tailing pond and cinder pond. Every plant in the steelworks (except the sintering plant and the ore preparation plant) receives water from Lake Botunetze. Part of the water thus supplied is pumped back to Lake Botunetze after being used as indirect cooling water.

Since the treated water from tailing pond and cinder pond is recycled, the quantity of water taken in for industrial use (fresh water) is about 4,050 (900 +3,150) m^3/h.

Each plant in the steelworks is provided with a water treatment facility to allow the recirculation of water. There are four (4) wastewater treatment plants in the general vicinity of the steelworks, which treat wastewater and slurry from the plants and plant water treatment facilities.

Tailing Pond:

This receives and treats wastewater and slurry from the sintering plant and the ore preparation plant.

Cinder Pond:

This receives and treats neutralized wastewater, waste slurry, demineralizer regeneration waste, coke oven-gas liquor, and dust-collection slurry from the blast furnace, converter and electric furnace.

Wastewater Treatment Plant (final water treatment plant):

This receives and treats wastewater (except slurry) from plants and plant water treatment facilities.

Treatment plant for domestic wastewater:

This receives and treats sewage and wastewater from the food-preparation facilities and toilets, and also receives and treats sewage from nearby villages.

The effluent from wastewater treatment plant (about 3,590 m^3/h) and the domestic water treatment plant (about 290 m^3/h) are discharged into the Lesnovska River which then leads to the Iskar River, the Danube, and finally the Black Sea. Therefore, these effluents are subject to the effluent standards in Section 7.1.3 (At present, Environment standards are regarded as effluent standards.)

In January 1995, the recycling system for returning the treated water from waste-water treatment plant (terminal facility) back to Lake Botunetze and reusing it as

industrial water was completed, and it has already begun operation.
As a result, of the 3,590 m^3/h of water, the amount discharged into the Lesnovska River has been decreased to about 440 m^3/h, with the remaining approximately 3,150 m^3/h being returned to Lake Botunetze. Accordingly, the industrial water (fresh water) taken from the two (2) lakes has decreased from about 4,050 to 900 m^3/h.

b) Quality of industrial water and restrictions on industrial water for plant expansion

Most of the treated water from wastewater treatment plant has been sent to Lake Botunetze since January 1995. As a result, the volume of fresh water has decreased. At present, the drainage volume of the steelworks is about 440 m^3/h, and the discharge volume per ton of crude steel is about 3 to 4 m^3/t-steel. The average discharge volume for an integrated steelworks in Japan is about 4 m^3/t-steel, so that the discharge volume at Kremikovtzi Steelworks has reached to the same level compared with Japan.

However, a concentration of salts has been building up in Lake Botunetze. The total hardness (as $CaCO_3$) in this case is now about 300 ppm and the chlorine ion content is 70 ppm, however, usually it is preferable to have a lower total hardness (as $CaCO_3$), and a chlorine ion content of below 50 ppm. Algae and scales have formed, corrosion has occurred, and precautions must now be taken.

Restrictions on industrial water do not need to be considered, as the increase in the volume of industrial water due to reasons such as the enlargement of CC plant is only several hundred m^3/h, which is quite a small amount. It is more important to continue to monitor the present problems of corrosion and scale deposits.

c) Drainage concentration

The water quality at the outlet of wastewater treatment plant in the terminal facility is shown in Table 8-11. Oil content, cyanide, phenol and ammonia do not presently conform to the effluent standards.

Concerning oil content:

① A large amount of oil is discharged from the plants (especially from the hot-rolling mill), and the concentration of raw wastewater at wastewater treatment plant is 23 ppm (max. 36ppm).

② The treatment capacity of the plant (design value) is 3,380 m^3/h in terms of flow rate (this being the capacity of the pressurized flotation tank in the later stages). SS is reduced from 150 to 50 ppm, and oil content from 110 to 15 ppm, but the oil content does not satisfy the effluent standard of less than 0.3 ppm.

③ Because of a defect in the design of the dissolved-air flotation tank, it is not operating effectively.

④ Injection of coagulant was started and treatment has improved, with the oil content of the treated water now being 3 ppm (max. 9 ppm). However, the injection spot was not suitable.

Concerning cyanide, phenol, and ammonia

① The coke-oven gas liquor is sent directly to cinder pond and treated there, but this treatment is not sufficient. And the treated water (water quality is ⑥ in Table 8-11) is sent to Lake Botunetze, then sent to the wastewater treatment facilities of the plants as part of the make-up water. It finally flows into wastewater treatment plant, where it becomes a factor for exceeding the effluent standards (Fig.8-1;②→④→⑤→⑥→⑦→⑧→⑨→①). Therefore, treatment equipment for the coke-oven gas liquor is needed. In addition, the cyanide concentration, which is 4 ppm, is high in the blast-furnace dust-collection wastewater, and therefore measures for treatment must be taken.

2) Stomana Steelworks

a) Water balance and flow (See Figure 8-2)

This steelworks is located upstream (in the city of Pernik) of the Struma River. The industrial water source is the Lobosh Dam on the Struma River. From here, the water is sent through a storage pond(Stomana Pond) to each plant of the steelworks. The average amount of water used in the steelworks is 1,579 m^3/h.

At each plant, the industrial water is either circulated or passed through once. Wastewater is discharged into the Struma River from outlets at eight (8) locations, and then flows down to the Lobosh Dam into the Aegean Sea. In addition, some of them in this dam is supplied to steelworks once more. The Lobosh Dam also serves as the water source for Leko ko Steelworks. (See Appendix 8-3)

There is no final wastewater treatment plant at Stomana Steelworks, as there are at Kremikovtzi Steelworks and Promet Steelworks.

b) Quality of industrial water and restrictions on industrial water for plant expansion

The hardness components in the industrial water are high (total hardness is 235 ppm as $CaCO_3$), and care must be taken when dealing with areas receiving high heat load, such as in mold-cooling areas. Because calcium scales are formed and impede heat exchange.

At present, a facility for recovering and circulating the wastewater at outlet No. 3 (wastewater flow rate at 470m³/h) is under construction, but attention should be paid to the concentration of salts during actual operation.

There are no particular restrictions on industrial water for plant expansion.

c) Drainage concentration (See Figure 8-2)
The oil content at all outlets is 2 to 5 ppm, which exceeds the effluent standards (oil content < 0.3 ppm). Compared with levels in Japan, the oil content in the wastewater coming from the direct cooling water system for the rolling mill is high. Oil-containing wastewater flows to the dam through the outlet. As this water is taken from the dam as industrial water, oil is sometimes detected in the make-up water.

There are two main reasons for the high oil content in the wastewater.

① One is that oil-containing wastewater is not separated from general wastewater, and the existing water-treatment facilities are not designed to separate and remove oil. These can be assumed to be an equipment problem.

② The other is the plant workers' attitude of indifference toward oil at the wastewater treatment facilities. Little effort is made to keep oil out of the wastewater. Therefore, this can be assumed to be a management problem.

3) Promet Steelworks

a) Water balance and flow (See Appendix 8-4)
The water source is the Yasna Polyna Dam. Water is taken from this dam, and is used as direct cooling water system for the works. Since this water has a high hardness (about 200 ppm as $CaCO_3$), its hardness is lowered by a desalination system. Desalted water is then supplied to the indirect cooling water system and demineralizer. The total amount of such water is approximately 170 m³/h.

Wastewater from the steelworks is treated at the wastewater treatment facilities (oil-containing wastewater treatment, sewage treatment and rainwater treatment) located outside the steelworks. Then treated water is sent back to the dam and reused, with some being discharged into the Black Sea.

b) Quality of industrial water and restrictions on industrial water for plant expansion
The total hardness of industrial water is 125 to 200 ppm (as $CaCO_3$), with chlorine ions being 20 to 30 ppm. Therefore, the total hardness is relatively high, although this is not a serious problem, because there are desalination systems.
There are no particular restrictions on industrial water for plant expansion.

Figure 8-1 Kremikovtzi Steelworks Water Flow (July 1994)

Remark: F:Flow rate (m3/h)
→ : (1995. 7)

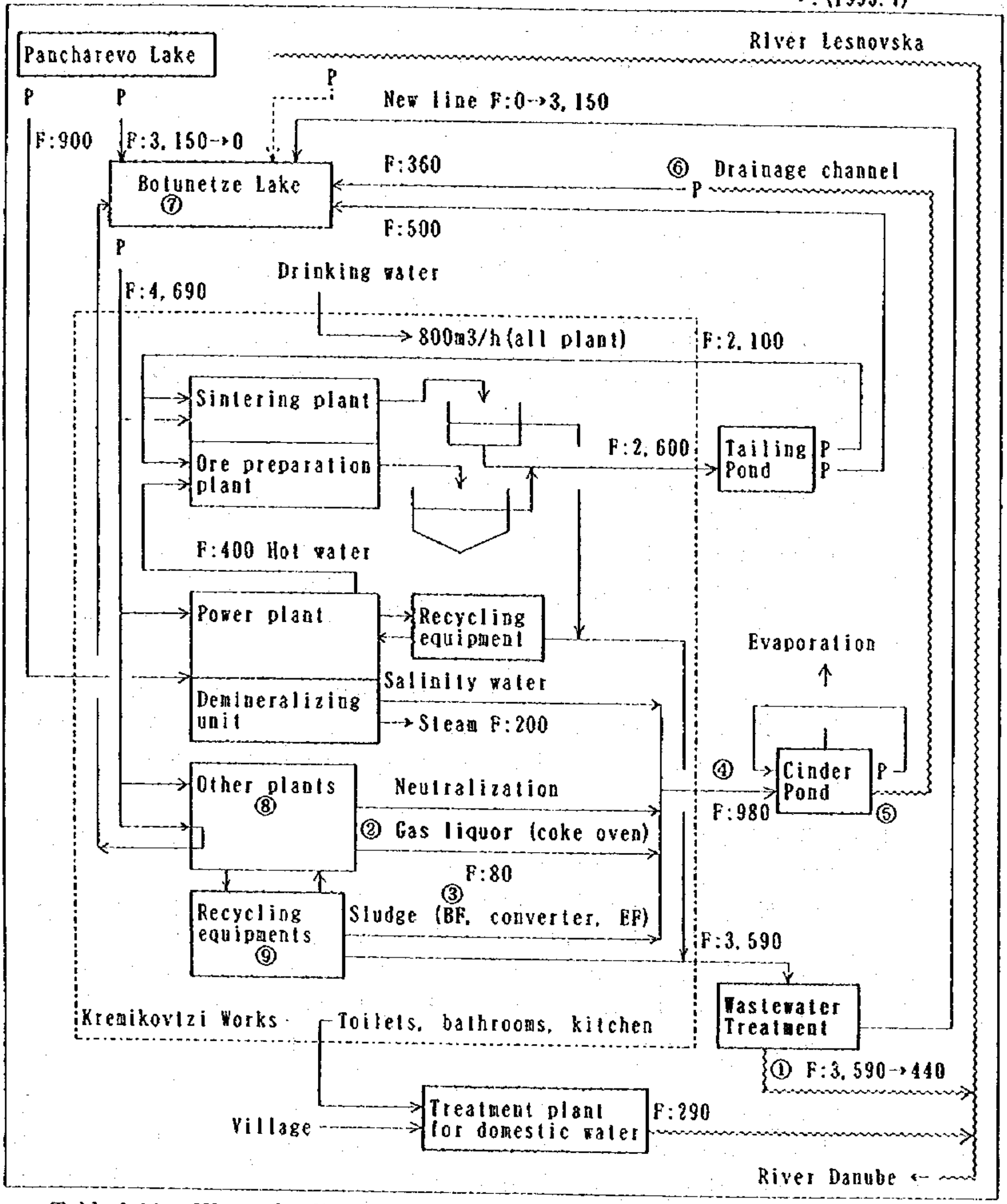


Table 8-11 Water Quality (ppm)

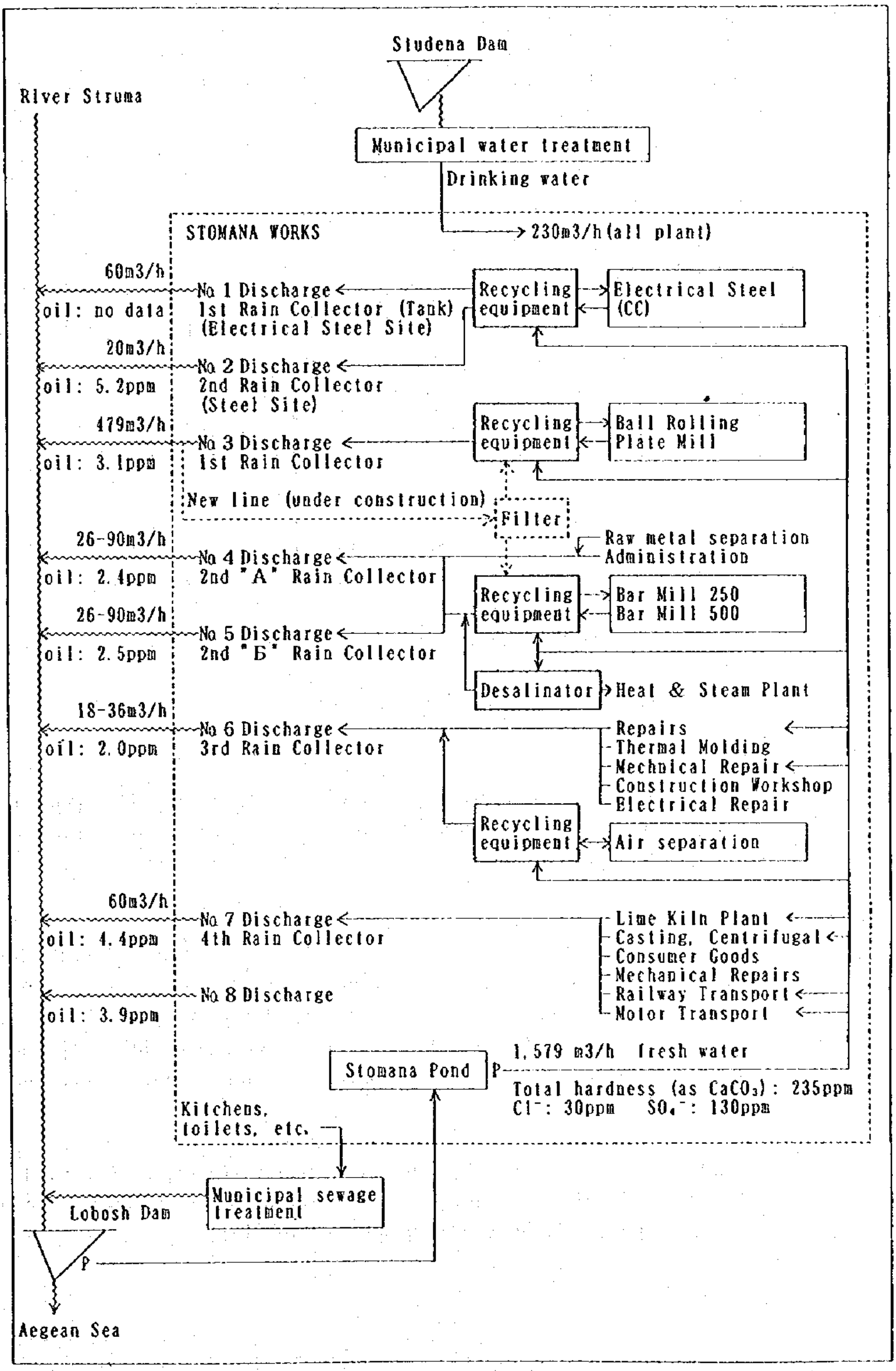
(Jan. -Aug. 1994)

Items	①WT effluent	Effluent standard	Judgement ※	②Coke oven-gas liquor	Cinder pond ④Inlet	Cinder pond ⑤Outlet	⑥
Flow rate	3590m3/h			80 m3/h	980 m3/h		360 m3/h
oil	11	< 0.3	×	1000	5	2	0
phenols	0.12	< 0.05	×	900	70	38	0.6
CN^-	0.15	< 0.05	×	40	9	2.5	0.14
NH_3	2.0	< 2.0	×	1200	82	41	12.7
T-Fe	1.7	< 1.5	×		75	10	0.6
COD	12.6	<30	○	1744	400	110	3.8
SS	21	<50	○		5600	25	10

WT, Wastewater Treatment

※○: good
×: bad

Figure 8-2 Stomana Steelworks Water Balance



c) Drainage concentration

Although the oil level is high in the wastewater (direct cooling water) from the bar and shape mill, the oil content is kept low by the wastewater treatment facility outside the steelworks. This facility has an up-to-date system comprising dissolved air flotation tanks, filters, and activated carbon adsorption.

Therefore, the overall quality of the final treated water, including oil content, conforms to the effluent standards.

4) Kamet Steelworks

a) Water balance and flow (See Appendix 8-5)

The industrial water source is the Studena Dam, from which about 400 m^3/h of industrial water is taken. This steelworks is divided into two parts, the Mir area and the Blogoi Porov area. In the Mir area, the make-up water is used once-through at an electric arc furnace and bar mill. Through individual outlets, water is discharged into the Struma River, eventually reaching the Aegean Sea through the Lobosh Dam.

In the Blogoi Porov area, industrial water is mainly circulated in the indirect cooling water system. Wastewater is sent into the municipal sewage treatment plant, together with other sewage. The treated water is discharged into the Struma River, runs through Lobosh Dam, and eventually flows out into the Aegean Sea.

b) Quality of industrial water and restrictions on industrial water for plant expansion

Data is not available because the water quality was not measured. Management of water quality is necessary. There are no particular restrictions on industrial water for plant expansion.

c) Drainage concentration

While no water quality analysis data is available for the effluent from the Mir area, the effluent from the electric arc furnace (point B in Appendix 8-5) is only used for cooling, and should therefore present no problems in terms of the effluent standards. The bar mill effluent from the sedimentation pond (point C in Appendix 8-5) may have a high oil content. Caution is required, and the water quality should be measured.

In the Blogoi Porov area (point A in Appendix 8-5), the oil content is 32 ppm and SS is 86 ppm, and both very high levels. The reason for this is the presence of oil discharged from the machine tool shop and the press shop.

There is a general-precipitation type clarification treatment facility to handle this wastewater, but it is not effective in dealing with oil. Hence, another facility for treating oil-containing wastewater is needed.

5) Leko ko Steelworks

a) Water balance and flow (See Appendix 8-6)

This is an inland steelworks (in the city of Radomir). As with the Stomana Steelworks, the industrial water source is the Lobosh Dam. From there, water is sent to storage tanks (3,000 + 6,000 m^3), passes through filters, and is then sent to the steelworks at the average rate of 285 m^3/h. Most of the water is used in the indirect cooling system of the works.

The effluent is discharged through three (3) outlets to the Struma River, and the effluent water is pooled into the Lobosh Dam, and then out to the Aegean Sea. Part of this pooled water is recycled to the steelworks.

b) Quality of industrial water and restrictions on industrial water for plant expansion.

Since the quality of industrial water is quite similar to the industrial water in Stomana Steelworks, and the hardness of this industrial water is high (total hardness of 285 ppm as $CaCO_3$), attention should be paid to scale deposits at sites where the heat load is high such as at heating furnaces.

There are no particular restrictions on industrial water for plant expansion.

c) Drainage concentration

Water quality analysis data is not available for each effluent outlet (points A-C, Appendix 8-6), but the effluent standards can be satisfied as long as oil contamination is limited by the proper daily management of oil leakage. Therefore, the quality control of wastewater should be implemented.

6) Other points

Although there is no pollution (legal) problem, the items requiring improvement at the water treatment facility are listed in Appendix 8-7.

8.7 Production Cost

The production cost of the Bulgarian steelworks has some remarkable characteristics. The results of the study on production cost, its characteristics and major problems will be described in this section.

8.7.1 Production cost of the Bulgarian steel industry in general

The average production cost per ton of final products is as follows.

Major materials cost			
Coking coal	52	US$/ton	
Iron ore/sinter/pellets	47		
Scrap	31		
Sub-total	130		
All other materials cost *	100		* Energy, sub-materials,auxiliary materials, outside services, expenses etc
Labor cost	49		
Operating cost before depreciation and interest	279		
Depreciation	9		
Interest	46		
Production cost after depreciation and interest	334	US$/ton	

(Note) The cost is the average value excluding Promet, which specialized mostly in processing outside orders, and Leko Ko, which specializes in castings and forgings. The monthly exchange rate published by the National Statistical Institute was used to calculate the US$ figure. The average rate in 1993 was US$1=27.854 Leva.

8.7.2 Results of production cost analysis

The Bulgarian production cost described in Section 8.7.1 has the following characteristics, when compared with that of other countries, as shown in Table 8-12.

① The production cost for products such as ingots, slabs and hot-rolled coils is the lowest in the world.

② No other country enjoys a labor cost per steel of ton produced as low as that in Bulgaria. While the labor productivity in Bulgaria is 1/6 that of Japan and Germany, the low hourly cost, which is 1/20 that of Japan and Germany and about 1/5 that of Mexico and Brazil, well offsets the low labor productivity.

③ While the production cost is the lowest, the Bulgarian selling price per ton is also low. The average selling price in 1993 nearly covered operating costs before depreciation and interest, but could not pay the whole cost including depreciation and interest, resulting in a loss of about $50/t. The product mix sold in 1993 was mostly of low added-value, including many semi-finished products such as billets and slabs, and hot-rolled coils.

Table 8-12 International Cost Comparison

(per metric ton shipped)

	Bulgaria	Australia	India	South Korea	Taiwan	Brazil	Mexico	USA	Japan	Germany	U.K.	France	Nucor (thin Slab
Currency conversion to/US$	27.854	1.41	31.34	808	26.4	431	3.1	1	109	1.74	0.67	5.89	1
Major materials cost/ton shipped:													
Coking coal	52	17	76	37	39	56	36	34	34	43	40	38	-
Iron ore/sinter/pellets	47	42	33	49	50	37	52	61	47	57	54	51	-
Scrap	31	48	67	48	48	51	59	46	44	46	47	46	164
Total raw material costs	130	107	177	134	137	144	147	141	125	146	141	135	164
All other materials cost	100	144	174	161	165	160	172	141	186	170	152	160	140
Labor cost:													
Employment cost/hour	1.66	22.00	0.90	12.00	18.50	8.00	9.00	33.00	34.00	34.00	19.40	27.50	29.00
MH/ton	29.5	5.3	58.4	6.7	6.8	8.6	9.5	4.7	5.0	5.2	5.2	5.2	1.5
Total labor cost	49	117	53	80	125	69	86	156	170	177	101	142	42
Total operating cost	279	368	404	375	427	373	405	438	481	493	394	437	346
Financial expenses:													
Depreciation expense	9	35	25	90	70	40	30	26	82	35	20	36	39
Interest expense	46	20	23	20	11	30	25	15	24	11	1	13	0
Total financial expense	55	55	48	110	81	70	55	41	106	46	21	49	39
Pretax cost	334	423	452	485	508	443	460	479	587	539	415	486	385
Cost through process:													
Coke ovens	101	59	96	100	111	118	71	118	107	128	109	116	-
Blast furnace	156	93	114	112	121	115	97	141	125	145	124	127	-
Liquid steel	160	157	175	172	185	177	164	198	195	209	182	192	224
Slab	185	184	218	200	216	205	202	231	229	247	211	223	245
Hot-rolled coil	232	247	282	249	285	259	274	302	303	329	272	292	288
Cold-rolled coil	494	328	365	323	377	337	368	391	399	429	350	382	326
S.G&A. & Local state tax	279	368	404	375	427	373	405	438	481	493	394	437	346

* Sources: Bulgaria, in 1993 per metric ton produced Other countries, Paine Webber "World steel dynamics" as of Feb. 1994

④ The percentage share of the major-material cost in the operating cost before depreciation and interest is extremely high, at 47% (Japan, 26%; South Korea, 36%; and Mexico, 36%). This high material cost had its origin in a high coke ratio of 765kg/ton, a high ore ratio of 1,850kg/ton and low yield ratios through to the final products. The foregoing production cost is based on an abnormally low scrap cost of only $40/t, this being favorably regulated by the Government. If the scrap was purchased in the international market, it would have increased the average material cost per ton produced to $190, with the proportion of the material cost surpassing 50%.

⑤ The depreciation burden is rather slight, because the depreciation period adopted is long. This fact also implies that the Bulgarian steel industry has not made positive investment in the industry.

⑥ The interest expense is heavy because the interest rate increased to about 40% p.a. on average during 1993. Although the interest burden was reduced in 1994 through interest relief treatment by the government (please refer to Section 8.7.4), the burden is still heavy. In the Bulgarian financial market, the interest rate for borrowings in leva rose to 70% p.a. in 1994 and borrowings in US dollars cost as much as 20% p.a. currently.

8.7.3 Production cost and major problems at each steelworks

① Kremikovtzi Steelworks

The average selling price covered the production cost before depreciation and interest, but was not enough to pay the whole cost after depreciation and interest with a $34/t loss. The high coke ratio, the high ore ratio and the low yield ratio through to final products resulted in extremely high materials cost. The machines and equipment are quite old with low depreciation expenses of about $3/t. The interest expense of $40/t is quite heavy.

The production cost after interest and depreciation in 1994 was reduced by $64/t compared with that of the previous year. The components of this reduction were $25/t from increased production, $19/t from interest relief, $11/t from a reduced coke ratio (765kg/ →660kg/t) and $8/t from a reduced ore ratio (1,850kg/t →1,650kg/t)

② Stomana Steelworks

In 1993, the average selling price nearly covered the production cost before depreciation and interest. The whole cost after depreciation and interest exceeded the average selling price by about $100/t. Stomana seems not to have well-managed inventories such as raw-materials, semi-finished products and return scrap, preventing it from precisely grasping the yield ratio and unitary volume of variable expenses.

Stomana has a lot of low operation process such as ball mills and round calibrated mills, and seems to have unnecessary and excess equipment and inventories, still cherishing the original image of being an integrated steel mill, which makes the average production cost high.

The production cost after interest and depreciation in 1994 showed a marked reduction of $96/t from the previous year. The major components were $29/t from increased production, $15/t from reduced real wages, $12/t from interest relief, $16/t from reduced depreciation (due to a change in the calculation method), and $16/t from a reduced interest burden by shifting to US$ loans.

③ Promet Steelworks

Although the average processing cost before depreciation and interest was about $95/t, the processing revenue was only $59/t resulting in a big loss in 1993. Depreciation and interest have to be further added by about $200/t processed. This means that the more Promet produces, the more it loses. An immediate solution to this problem should be implemented.

The production cost after interest and depreciation in 1994 was reduced by $216/t from the previous year. The major components were $66/t from increased production and $141/t from interest relief by the Government.

④ Kamet Steelworks

The average production cost before depreciation and interest surpassed the average selling price by more than $300/t in 1993. On top of that, the loss increases to as much as 570 $/t after depreciation and interest. As at Promet, the more Kamet produces, the more loss it makes. An immediate solution to the problem should be implemented.

⑤ Leko ko Steelworks

The production cost after interest and depreciation in 1994 was reduced by $2,292/t, being halved from that of 1993. The major components were $1,183/t from increased production and $1,003/t from interest relief by the Government. However, Leko ko still suffers from a loss of about $600/t.

Leko ko's depreciation rate was only 1.1% of the outstanding tangible long-term assets, which will cause a significant cash flow shortage in the future.

(Note) To calculate average selling prices for the year of 1993, the total final product volume obtained from the material fow analysis was used, instead of sales volume which was not properly answered. The monthly exchange rate published by the National Statistical Institute was used to calculate the US$ figure. The average rate in 1994 was US$1=56.036 Leva.

8.7.4 Interest relief treatment by the government

The interest relief treatment by the Government is described in this section. A special law concerning interest relief for the period of six years from 1994 was put into effect in December 1993. The amounts of relief for the Bulgarian steel companies are shown in Table 8-13 below. Borrowings subject to this treatment amounts to about US$ 200 million, and are those which were negotiated before December 1990 and had not been performing for more than six months as of June 1993.

Table 8-13 Interest Relief Treatment

Steelworks	Principal amount to be relieved		Contents of special treatment
	Million US$	Million Leva	1. Repayment; 20 years after a 5 year grace period 2. Interest rate; 10 % p.a. 3. Relief ratio; 2/3 for the first 2 years, 1/2 for the succeeding 2 years and 1/3 for the next succeeding 2 years
Kremikovtzi	80	415	
Stomana	18	663	
Leko ko	0.5	208	
Kamet	86	17	

The Ministry of Industry explained that the Government had assumed the said debts of Promet Steelworks ($12.7 million). They also explained that kamet Steelworks has been placed under the control of a trustee.

8.8 Financial Situation

The financial situation of the Bulgarian steel companies has deteriorated drastically since democratization in 1989, reflecting slackened production activities due to the paralyzed markets. Every steelworks has been suffering from income loss in spite of the interest relief treatment by the Government and favorable factors such as production increases. A general view of the financial situation of the Bulgarian steel industry, and financial results and major problems of each steelworks are described in this section.

8.8.1 A general view of the financial situation

① Every steelworks has been suffering from net losses for all the years of our investigation. Therefore, the equity ratio has markedly deteriorated.
Although the steelworks execute re-evaluations of assets periodically when accumulated net losses pile up, their financial structure soon worsens due to their permanent deficit operations. No steelworks had a current equity ratio of more than 100%. (Kamet achieved a current ratio of 262% in 1993 due solely to the accounting of "expenses for future period" of 823 million Leva.) Their cash flow worsened further and outstanding borrowing increased.

② With regard to operating profit or loss, all the steelworks except Kremikovtzi and Stomana incurred a loss in 1992. Except Kremikovtzi, all the steelworks incurred an operating loss in 1993. In 1994, all the steelworks except Leko ko reported an operating profit thanks to increased production. The operating loss ratio for Kamet and Promet in 1993 was especially large, at minus 92.7% and minus 67.4% respectively, amounting to as much as 90% and 70% of individual sales, respectively.

③ As for the net income ratio after interest and other extraordinary items, all the steelworks incurred a large loss; in 1994, Kremikovtzi, minus 0.3%; Stomana, minus 6.8%; Promet, minus 168%; Leko ko, minus 51.7%.

④ Sales per employee in 1994 were $24,000 at Kremikovtzi and $18,000 at Stomana, but were extremely small at $6,300 at Promet and $5,300 at Leko ko. At Kamet, sales per employee were only $2,300 in 1993, which did not cover even the labor cost of the employee.

⑤ Total sales revenues at Kamet and Leko ko were extremely small, the sales/total assets ratio being only 2% (in 1993) and 14% (in 1994) respectively. The sales/total assets ratio improved to 54% in 1994 from 17% in the previous year. This ratio was 111% at Kremikovtzi and 86% at Stomana in 1994.
As for the sales/inventory ratio, Kremikovtzi and Stomana attained 528% and 506% in 1994; on the other hand, Leko ko and Kamet only achieved 201% and 91% (in 1993) respectively, which means the latter two sold products equivalent to less than one to two times the year-end inventory value, which is extremely low.

8.8.2 Financial situation of each steelworks

Financial situation and major problems of each steelworks are described in this section. (See Table 8-14)

① Kremikovtzi Steelworks
This fell into negative net assets in 1993, with accumulated losses surpassing equity value.

A re-evaluation of fixed assets was made in 1994, improving the equity and liability ratios. The production cost was reduced by increased production and real wages, and the material cost was also reduced. The interest burden was eased by $27/t through special governmental treatment. On the other hand, although the sales volume increased by 25% from the previou year, the sales value showed only a 10% increase in US$ value. This was caused by a $30/t fall in sales prices on average, which implies a major problem in the marketing policy at Kremikovtzi, when compared with the world trend. Although the operational profit ratio improved to 9.1% in 1994 from 3.6% in the previous year as a result of the increased sales value and reduced costs, net income still suffered a loss. (The net income ratio in 1993 was minus 11.5% and minus 0.3% in 1994.)

② Stomana Steelworks

Although the sales value per employee increased from $13,000 to $16,000, the operating profit ratio drastically deteriorated to minus 12.4% due to cost increases. As a result, the outstanding borrowings increased by $15 Million, resulting in a high interest burden.

Production cost was markedly reduced in 1994 compared with that of 1993 through increased capacity utilization, real wage reduction, interest relief and other factors. On the other hand, even though sales volume increased by 18% from the previous year, sales value showed only an 8.7% increase in US$ value, as the average sales price dropped by $20/t. This fact suggests major problems in their marketing policy, as with Kremikovtzi. Operating income became profitable, changing from minus 12.4% in 1993 to plus 5.5% in 1994; however, the net profit ratio was still minus 6.8% (the net income ratio in 1993 was minus 49.2%). Financial indicators deteriorated, as the equity ratio worsened from 40.4% to 19.5% in 1994, and the liability ratio worsened from 1.5 to 4.1 times in 1994.

③ Promet Steelworks

The sales value was extremely small, being only 17% of total assets and 128% of year-end inventory value, while the operational profit ratio was minus 67.4%, which means that the operating loss was as much as 70% of annual sales. As a result, Promet fell into a minus net equity situation in 1993. Outstanding borrowings ($19.3 Million) are quite heavy, an interest burden of as much as $200 per ton processed. An immediate solution, including considering factory closure, should be studied.

Production cost was significantly reduced in 1994 compared with that of 1993 through increased capacity utilization, interest relief and other factors. Average process revenue per ton almost covered the cost before interest and depreciation. Although the interest burden was reduced from 191/t to $50/t, this was not sufficient due to another large interest payment on borrowing negotiated after 1991, which is not subject to government relief. In addition to this, Promet had $40/t non-operating financial costs. As a result, although the operating profit ratio turned profitable from minus 67.4% to plus 4.6% in 1994, the net profit ratio still showed an enormous loss of 168% (the net profit ratio for 1993 was minus 312%).

④ Kamet Steelworks

As at Promet, the sales revenue was extremely small, being only 2% of its total assets, 6% of its fixed assets and $2,300 per employee. As a result, it suffered a huge operating loss ratio of minus 92.7%, which is almost equal to its annual sales revenue. Labor cost per ton was quite high at $258 and interest expense per ton was as much as $235. An immediate solution, including the possibility of factory closure, should be implemented.

⑤ Leko ko Steelworks

Leko ko re-evaluated its assets and enjoyed a high equity ratio of 81% in 1993. The current ratio was as low as 38%, causing cash flow shortages.

Production cost after interest and depreciation was almost halved in 1994 compared with that of the previous year thanks to higher capacity usage and interest relief by the Government. On the other hand, the average sales price dropped or levelled off in 1994. As a result, although profitability was markedly improved, the loss was still large. (The operating profit ratio was minus 19% in 1993 and minus 13.3% in 1994.)

The net profit ratio was minus 193% in 1993 and minus 51.7% in 1994. Therefore, Leko ko disposed of reserves of $15 million, deteriorating its equity ratio from 81% in 1993 to 71.9% in 1994, and its liability ratio from 0.23 times in 1993 to 0.39 times in 1994.

The problems at Leko ko are the depreciation shortage described in section 9.7.3 ⑤ and the low sales revenue compared with total assets (sales/total assets ratio of 0.14 times and sales per employee of $5.300). Unless Leko ko reduces its operational size or reinforces its marketing capacity, its continuing operation will be endangered.

Table 8-14 Financial Analysis

Δ= Minus

Financial indexes	Kremikovtzi			Stomana			Promet			Kamet			Leko ko		
	1992	1993	1994	1992	1993	1994	1992	1993	1994	1992	1993	1994	1992	1993	1994
1. Current ratio (%)	117	87	84	53	47	58	32	30	25	75	262	N/A	31	38	47
2. Equity ratio (%)	14.6	Δ 5.2	59.3	49.5	40.4	19.5	1.6	Δ51.4	Δ24.9	Δ0.05	11.1	N/A	Δ24.7	81.0	71.9
3. Liability ratio (%)	574.5	-	68.7	101.9	147.5	411.6	6.177	-	-	-	798.0	N/A	-	23.4	39.1
4. Interest coverage ratio (fold)	0.24	0.28	1.80	0.03	Δ0.52	0.74	Δ0.41	Δ0.29	0.07	Δ1.40	Δ1.30	N/A	N/A	Δ0.10	Δ0.40
5. Operating profit ratio (%)	3.1	3.6	9.1	1.6	Δ12.4	5.5	Δ31.1	Δ67.4	4.6	Δ37.4	Δ92.7	N/A	N/A	Δ19.0	Δ13.3
6. Net income ratio (%)	Δ9.3	Δ11.5	Δ0.3	Δ52.5	Δ49.2	Δ 6.8	Δ96.4	Δ312	Δ168	Δ63.6	Δ169	N/A	N/A	Δ193	Δ51.7
7. Sales amount per employee(1000US$)	17	21	24	13	16	18	4.8	4.0	6.3	4.4	2.3	N/A	N/A	3.2	5.3
8. Labor cost (US$/ton)	42	46	30	52	53	30	48	46	15	171	258	N/A	N/A	531	434
9. Sales/total assets ratio (fold)	1.29	1.59	1.11	N/A	0.52	0.86	0.16	0.17	0.54	0.05	0.02	N/A	N/A	0.07	0.14
10. Sales/fixed assets ratio (fold)	2.69	3.46	1.75	N/A	0.62	1.17	0.19	0.21	0.75	0.06	0.03	N/A	N/A	0.08	0.15
11. Sales/inventory ratio (fold)	3.40	3.76	5.28	N/A	5.16	5.06	1.48	1.28	4.28	1.63	0.91	N/A	N/A	0.74	2.01

N/A: Not available

[Definitions]

Current ratio : Current assets/Current liabil. x 100
Equity ratio : Equity/Total assets x 100
Liability ratio : Total liabil./Equity x 100
Interest coverage ratio: (Oper. profit + Interest income)/Interest expense
Operating profit ratio : Operating profit/Sales
Net income ratio : Net income/Sales
Sales/total assets ratio : Sales/Total assets
Sales/fixed assets ratio : Sales/Long-term assets
Sales/inventory ratio : Sales/Inventory

Chapter 9 Basic Framework for Restructuring and Modernizing the Steel Industry

Chapter 9 Basic Framework for Restructuring and Modernizing the Steel Industry

9. Basic Framework for Restructuring and Modernizing the Steel Industry

Steel products and quantity produced by the steel industry in Bulgaria, as mentioned in Chapter 5, were forecast. There are many combinations (that is, scenarios) of production processes of the five steelworks to execute a production plan. Modernization plans are elaborated for every steelworks according to nine (9) realizable scenarios.

9.1 Basic Strategies for Steel Production

1) Structure of scenarios studied

a) The present Bulgarian steel industry has a steel production capacity of about 3.5 million metric tons per year. The necessary production capacity after ten (10) years is estimated at 1.86 million metric tons per year as mentioned in Section 5.6, which is much smaller than 3.5 million metric tons. Since not all steelworks can continue to produce steel, some steelworks with the highest competitiveness in production cost will survive and others will be closed or merged into other steelworks.

b) Scenarios will be established not to secure the world competitiveness of any specific steelworks, but to gain benefit for the entire Bulgarian steel industry.

2) Strategies for improving the steelworks

a) Based on our investigation of the present steelworks, because the equipment for air and waste water pollution prevention is not completed, environmental pollution prevention equipment should be installed over the next ten (10) years. Especially, Kremikovtzi Steelworks is in the capital city of Bulgaria, Sofia which has been seriously affected by environmental pollution from Kremikovtzi. Therefore, environmental pollution prevention for Kremikovtzi Steelworks should be completed.

b) Reduction of steel production capacity and production cost together with an improvement of the quality of steel products will be implemented to win competitiveness in world markets over the next ten (10) years.

c) The present production capacity and process were adequate for the steel production system under the former COMECON regime. It is necessary for the Bulgarian steel industry to improve its present steel production capacity to meet the future production plan and win in world markets through competitive production costs. The improvement should be implemented at the expense of laborers, steelworks and the Government.

d) The prices of raw materials and energy will rise to the foreign market price levels.

3) Production plan

a) Production of the present steel products should be continued for the next ten (10) years. Therefore, production of new steel products should be studied in consideration of domestic steel demand and trends in world steel markets after ten (10) years.

b) Steel production to be consumed in Bulgaria should be supplied by the Bulgarian steel industry.

9.2 Future Prediction of Supply and Demand of Steel Products, and Steel Product Production Plan

As mentioned in Section 5.6, the optimistic case of GDP growth is more probable, when the actual production amount in the past, the current production capacities and the willingness of the Bulgarian people are taken into the consideration. The GDP growth rate turned to plus in 1994, as mentioned in Section 5.1. (The GDP rate in the pessimistic case in 1994 is minus 1.0%) Therefore, the production volume in the optimistic case will be more properly adopted with regard to steel product production planning in this section and the succeeding sections of this report.

Domestic consumption of finished steel will increase gradually from 0.86 million tons in 1993 to 1.23 million tons in 2004 following the economic recovery (See Section 5.5.3). On the other hand, exports will decrease from 1.46 million tons in 1993 to 1.03 million tons in 2004 because of severe competition in foreign steel markets (See Section 5.5.7). Steel production will increase very slightly from 1.60 million tons in 1993 to 1.86 million tons in 2004 (See Seciton 5.6). The ratio of exports to production will gradually approach 55% or more, which is an average level in the European countries. A prediction of supply and demand of steel products is shown in Table 9-1.

Table 9-1 Forecast of Steel Supply and Demand

(Million Tons)

	1993	1999	2004
Production	1.60	1.65	1.86
Domestic Consumtion	0.86	1.00	1.23
Exports	1.46	1.04	1.03
Imports	0.72	0.40	0.40
Exports Ratio vs. Production	91%	63%	55%

Sources: National Statistical Institute & Ministry of Industry of Bulgaria
(Forecast: JICA Consultant)

9.3 Scenarios Studied in Master Plan for Modernization of Each Steelworks

9.3.1 Establishing scenarios

The steel production costs at Kamet and Promet are so high that cost competitiveness in world steel markets is weak, as shown in Section 8.7.3 . Under any normal business situation, they would be in bankruptcy. It is supposed that Kamet and Promet should be closed as they cannot be recovered in the future. As it is a loss to Bulgaria to discard production facilities of Promet by closing its still new facilities possible to produce products to meet production plan until 2004, it will be studied that Promet should perform its role as a part of other steelworks.

Kremikovtzi and Stomana should be continued to exist.
Kamet should be closed.
Promet should be closed or perform its duties as a part of Kremikovtzi or Stomana.
Leko ko should be continued to exist.

9.3.2 Methods of evaluating scenarios

The purpose of restructuring the steel industry is to make the steel products produced in Bulgaria competitive in the world markets. Therefore, the criteria for evaluation of the scenarios are production costs, investment, grant of Bulgarian Government, and the number of reduction of the regular workers.

9.3.3 Procedure of study on scenarios

1) Evaluation of production records in 1993

Factors composing production costs such as production volume, energy and raw material consumption, production yield, number of workers, etc. in 1993 are evaluated.

2) Estimate of production costs

The production costs of the steel production plan for 2004 including the following items will be calculated based on the operating conditions shown in the production records of 1993.

a) Increases in energy and scrap prices
Increases to an international price level are included.

b) Completion of environmental pollution prevention measures
The prevention measures to meet the Bulgarian environmental pollution prevention regulations and the western European technical levels of environmental pollution prevention are to be completed.

c) Improvement of operational conditions and facilities to reduce production costs and to improve quality of steel products is evaluated.

3) Reduction of overhead expense
The expense should be reduced by 30%.

4) Grant of Bulgarian Government relief
It is assumed that the grant of Government relief such as bearing of interest, take-over of the debts, and conversion of debts into the authorized capital by the Government, etc. can be expected for scenarios in which the total production costs estimated from the above mentioned items 1) to 3) including interest, exceeds the total sales amount.

9.3.4 Establishment of target average sale prices

Steel product price competition is the most intensive at Bangkok and accordingly, the prices are the lowest. Based on prices of hot coil and bloom (and billet) at Bangkok, target average prices for domestic and export sales are established and production cost is evaluated scenario by comparing with target average prices. (See Section 5.5.6)

Target average sale prices of hot coil, billet, bloom and slab are shown in Table 9-2.

Table 9-2 Target Sale Prices at Bulgarian Steelworks

Steel Products from Kremikovtzi

	Domestic Sale		Export Sale		Target Sale
	Price (US$/t)	Quantity (10^3t/y)	Price (US$/t)	Quantity (10^3t/y)	Price (US$/t)
Hot Coil	295	329	243	606	261
Bloom	235	269	193	191	218

Steel Products from Stomana

	Domestic Sale		Export Sale		Target Sale
	Price (US$/t)	Quantity (10^3t/y)	Price (US$/t)	Quantity (10^3t/y)	Price (US$/t)
Slab	235	90	193	167	208
Bloom	235	164	193	117	218

9.3.5 Establishment of scenarios studied

Steel products forecast in Chapter 5 will be produced by production process existing at each steelworks. There are many combinations of the process (that is, scenarios). Realizable nine (9) scenarios selected from many scenarios are evaluated by the criteria.

Production plan in accordance with the nine (9) scenarios is shown in Table 9-3 and 9-4. The products and production process of Leko ko, which specializes in forgings and castings, are quite different from those of other steelworks, where ordinary steel products are produced, and it is not appropriate to make one restructuring plan combining all these plants. Therefore, the restructuring and modernization plan should be studied in two groups, one for Kremikovtzi, Stomana, Kamet and Promet and the other, Leko ko steelworks.

9.4 Raw Material Source Plan (Iron Ore, Coal and Steel Scrap)

The results of the study indicate no reason for concern about future supplies of iron ore and raw coal in each scenario.

9.4.1 Forecast of future supply

1) Iron ore and coal

Most of the iron ores consumed at Kremikovtzi Steelworks are powdery ores. As mentioned in 6.2.1, there is adequate supply capacity in the powdery ores in the world, and no problem is seen to the supply of iron ores. With regard to coal, as mentioned in Section 6.4.1, demand will continue to be stable, and no supply problem is seen in the mid and long terms.

2) Scrap

If Bulgaria is obliged to import scrap, sufficient supply sources can be found in world market, as mentioned in Section 6.2.2.

Table 9-3 Steel Production at Each Steelworks

(1000MT)

Scenario	Kinds of Products	1993						Forecast 1999						2004					
		Kremi-kovtzi	Stomana	Promet	Kamet	Others	Total	Kremi-kovtzi	Stomana	Promet	Kamet	Others	Total	Kremi-kovtzi	Stomana	Promet	Kamet	Others	Total
A	Long	560	169	32	9	0	770	324	153	0	0	82	559	380	156	0	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	1138	427	0	0	82	1647	1313	448	0	0	102	1863
A-2	Long	560	169	32	9	0	770	324	153	0	0	82	559	380	156	0	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	1138	427	0	0	82	1647	1313	448	0	0	102	1863
B-1	Long	560	169	32	9	0	770	120	204	153	0	82	559	148	232	156	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	934	478	153	0	82	1647	1081	524	156	0	102	1863
B-2	Long	560	169	32	9	0	770	0	204	273	0	82	559	0	232	304	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	814	478	273	0	82	1647	933	524	304	0	102	1863
C	Long	560	169	32	9	0	770	324	0	153	0	82	559	380	0	156	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	1138	274	153	0	82	1647	1313	292	156	0	102	1863
C-2	Long	560	169	32	9	0	770	324	0	153	0	82	559	380	0	156	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	1138	274	153	0	82	1647	1313	292	156	0	102	1863
D-1	Long	560	169	32	9	0	770	120	204	153	0	82	559	148	232	156	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	934	478	153	0	82	1647	1081	524	156	0	102	1863
D-2	Long	560	169	32	9	0	770	120	204	153	0	82	559	148	232	156	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	934	478	153	0	82	1647	1081	524	156	0	102	1863
D-3	Long	560	169	32	9	0	770	0	204	273	0	82	559	0	232	304	0	102	638
	Flat	440	208	0	0	0	648	582	204	0	0	0	786	662	210	0	0	0	872
	Final	179	5	0	0	0	184	232	70	0	0	0	302	271	82	0	0	0	353
	Total	1179	382	32	9	0	1602	814	478	273	0	82	1647	933	524	304	0	102	1863

Long : Long Products, Flat : Flat Products, Final : Final Products

Sources : National Statistical Institute & Ministry of Industry of Bulgaria
(Forecast : JICA Consultant)