Table 9-4 Distribution of Steel Production of Each Steelworks

(1,000t/y)

	Scenario	Kremi-kovtzi	Stomana	Promet	Kamet	Others	Total
1993		74%	24%	2%	-%	-%	1602
2004	A, A-2	70	25	0	0	5	1863
	B-1, D-1, 2	59	28	8	0	5	1863
	B-2, D-3	51	28	16	0	5	1863
	C, C-2	70	17	8	0	5	1863

Others show production by other steel makers including Leko ko and excluding Kremikovtzi, Stomana, Kamet and Promet.

9.4.2 Prospect for unit price of raw materials

Table 9-5 shows the unit prices of iron ore, coking coal, and steel scrap.
The prices of iron ore and coking coal are planned to be near to those prices in developed countries.

Table 9-5 Iron Ore and Coking Coal Price (Unit : $/t)

Powdery ore	30.00
Coking coal	60.00
Import scrap	145.00
Domestic scrap	95.00

Raw materials in detail are shown in Appendix 9-1.

9.5 Energy Source Plan

The results of study indicate no reason for concern about future supplies of energy in each scenario. The annual amount of purchased energy (natural gas and electric power) of the steelworks is estimated in order to confirm that the energy supply system will not restrict the selection of scenarios. The estimated amount of purchased energy shows that there should be no restriction on scenario selection because the present actual energy supply system at the steelworks has adequate capacity.

Forecast of energy unit consumption is shown as follows.

Natural gas	:	0.12 US$/$Nm^3$		
Electricity	:	Average	0.05	US$/$k_{wh}$
		Night time	0.024	US$/$k_{wh}$
		Day time	0.048	US$/$k_{wh}$
		Peak hours	0.088	US$/$k_{wh}$

Energy consumption and supply capacity are shown in Appendix 9-1.

Chapter 10 Modernization Plans for the Four Steelworks

Chapter 10 Modernization Plans for the Four Steelworks

10. Modernization Plans for the Four Steelworks

Because it is not appropriate to prepare one reconstructuring and modernization plan combining all the steelworks in Bulgaria as mentioned in Section 9.3.5, the plan will be divided into two (2) groups. One group will consists of Kremikovtzi, Stomana, Promet and Kamet Steelworks, and the other will consist of Leko ko Steelworks. In this chapter, the master plan concerning the four steelworks, Kremikovtzi, Stomana, Promet and Kamet Steelworks will be described.

The Bulgarian Government selected four (4) scenarios from the modernization scenarios prepared by the JICA study team. The JICA study team then added five (5) additional scenarios. In these nine (9) scenarios, it is proposed that two steelworks should remain, Kremikovtzi and Stomana. It will cost about US $ 270 million to realize the scenarios continuing the operation of the blast furnaces (Scenario A, B, C), and about US$ 150 million for the scenario discontinuing the operation of the blast furnaces (Scenario D). This cost difference mainly reflects investment for environmental pollution prevention.

10.1 Production Plan

10.1.1 Product mix and qualities

The high steel production costs at Promet and Kamet severely limit the cost competitiveness of these plants in world steel markets. Kamet and Promet should be closed as they cannot be restored to competitiveness in the future. As it would be a loss to Bulgaria to close down the new facilities at Promet, consolidation of Promet with another plant (Kremikovtzi or Stomana) will also be studied. In this case, Stomana is better to consolidate with Promet, because Stomana produces the same products as Promet. That means production control is easier and technique and technologies can be transferred. In the scenarios shown below, Promet is shut down or combined with Stomana, and Kamet is closed. (See Section 9.3.1)

Two steelworks (Kremikovtzi and Stomana) will continue operations. The product mix is shown in Figure 10-1. The product mix and quality in each scenario are summarized below.

1) Kremikovtzi Steelworks

① Scenario A, A-2, C, C-2

Coils, sheets, pipes and rods are produced. Appendix 10-1, 10-2, 10-3 shows detailed contents.

② Scenario B-1, B-2, D-2, D-3

Coils, sheets and welded pipes are produced. Appendix10-1 shows detailed contents.

③ Scenario D-1

The productions are the same with Scenario A, A-2, C, C-2 except billet.

Figure 10-1 Present Operational State and Nine Scenarios Planned

Steelworks	Products	Present Operation	Scenario A A-2	Scenario B-1	Scenario B-2 D-3	Scenario C C-2	Scenario D-1	Scenario D-2
Kremikovtzi	Sheets	○ (K)	○ (K)	○ (K)	○ (K)	○ (K)	○ (K)	○ (K)
	Rods	○ (K)	○ (K)	○ (S)	●	○ (K)	○ (K)	○ (S)
	Seamless Pipe	○ (K)	○ (K)	○ (S)	○ (S)	○ (K)	○ (K)	○ (S)
	Billet	○ (K)	○ (K)	○ (S)	○ (S)	○ (K)	○ (S)	○ (S)
Stomana	Plate	○ (S)	○ (S)	○ (S)	○ (S)	○ (S)	○ (S)	○ (S)
	Shapes, Bars, bell shape, supporting beams etc.	○ (S)	○ (S)	●	●	●	●	●
Promet	Shapes, Bars	○	●	○ (S)	○ (S)	○ (S)	○ (S)	○ (S)
	Rods				○ (S)			
Kamet		○	●	●	●	●	●	●
Production (million ton /year) Capacity / Plan after 10 years (Kremikovtzi,Stomana, Promet and Kamet)		3.50	1.76	1.76	1.76	1.76	1.76	1.76

Marginal Notes : ○ indicates to continue production.
● indicates to discontinue production.

(K) [dotted] indicates to be managed by Kremikovtzi.

(S) [grey] indicates to be managed by Stomana.

2) Stomana Steelworks

① Scenario A, A-2

Plates, balls, billets, bars and shapes are produced like now. Detailed contents are shown in Appendix 10-4.

② Scenario B-1, B-2, D-2, D-3

Plates, balls, billets, rods, bars, shapes and seamless pipes are produced. But by stopping of the shape and bar mill at Stomana, bell shape, supporting beams in the mining and rail connections etc. cannot be produced. Detailed contents are shown in Appendix 10-2, 10-3, 10-5.

③ Scenario C, C-2

Plates, balls, billets, bars and shapes are produced. But by stopping of the shape and bar mill at Stomana, bell shape, supporting beams in the mining and rail connections etc. cannot be produced. Detailed contents are shown in Appendix 10-5.

④ Scenario D-1

The productions are the same with Scenario C, C-2 with billet

10.1.2 Material Balance

The material balances at Kremikovtzi and Stomana are shown in Figure 10-2 (Appendix 10-6 shows in detail). Each scenario is briefly explained as follows.

① Scenario A

Operational improvements are main items in this scenario. Blooming, slabbing and billet mills are replaced with continuous casting machine. Promet is discontinued.

② Scenario A-2

The electric arc furnace at Kremikovtzi is discontinued, and all the crude steel is produced by blast furnaces and converters. Other items are the same as in Scenario A.

③ Scenario B-1

Kremikovtzi produces only coils and sheets. Stomana produces the shapes, bars, rods, pipes and plates. The shape and bar mill at Stomana is discontinued and produce shapes and bars at Promet as a part of Stomana. The rod mill and the seamless pipe mill at Kremikovtzi perform their duties as parts of Stomana and the materials are supplied from Stomana.

④ Scenario B-2

The rod mill at Kremikovtzi is closed, and install the finishing trains of rod mill after shape and bar mill at Promet . Another items are the same with Scenario B-1.

⑤ Scenario C

The shape and bar mill at Stomana is discontinued, and shapes and bars are produced at Promet as a part of Stomana. Another items are the same with Scenario A.

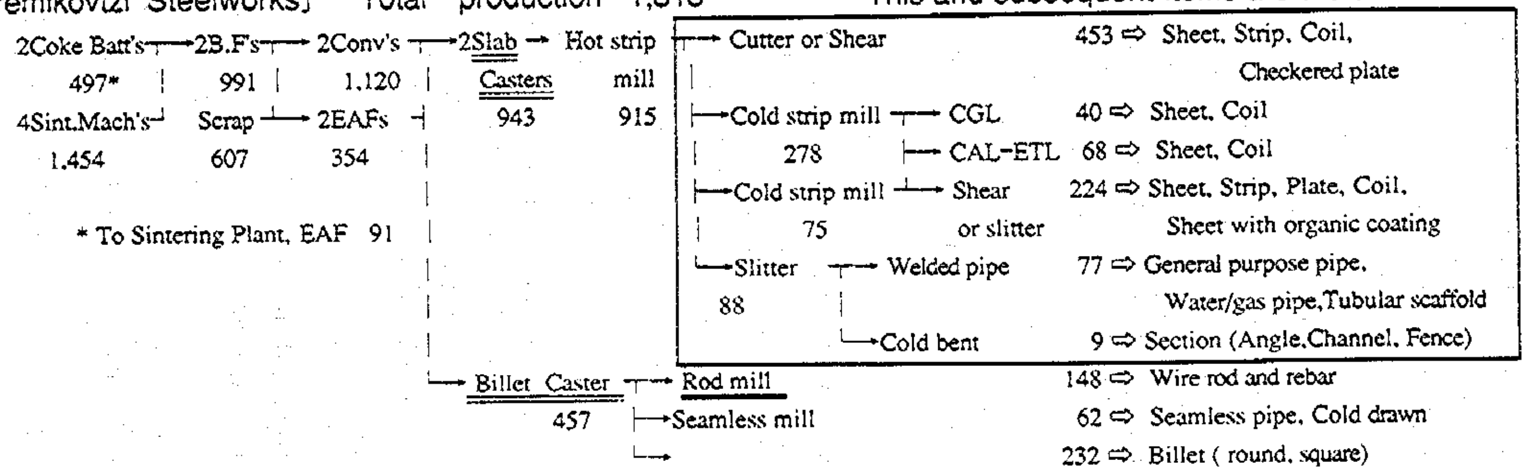
⑥ Scenario C-2

The electric arc furnace at Kremikovtzi is discontinued, and all the crude steel is produced by blast furnaces and converters. Another items are the same with Sce-

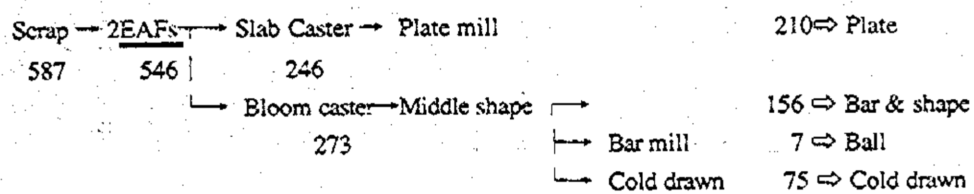
Figure 10-2 Material Balance

10-2-1 Scenario A

[Kremikovtzi Steelworks] Total production 1,313 — This and subsequent items are the same in all scenarios



[Stomana Steelworks] Total production 448



Unit : 1000 ton/year
All total production 1,761,000 tons in 2004
═══ : Newly installed
▬▬▬ : Modification

10-2-2 Scenario A-2

[Kremikovtzi Steelworks] Total production 1,313

```
2Coke batt's ┬→2B.F's ┬→ 3Conv's ┬→2Slab → Hot strip → [Same as Scenario A]
   659*     |   1,330 |   1,474    |  casters     mill
4Sint.Mach's┘  Scrap  ┘            |   943        915
  1,950          272               |
   * To sintering plant, EAF  114  └→ Billet ┬→ Rod mill        148 ⇨ Wire rod and rebar
                                      caster ├→Seamless mill  62 ⇨Seamless pipe
                                       457   |                              Cold drawn
                                             └→                 232 ⇨ Billet ( round, square)
```

[Stomana Steelworks] Total production 448

```
Scrap → 2EAFs ┬→ Slab caster  → Plate mill                    . 210⇨ Plate
 587     546  |      246
              └→ Bloom caster→Middle shape ┌→                  156 ⇨ Bar & shape
                      273      & bar mill  ├→ Ball mill          7 ⇨ Ball
                                    238    └→ Cold drawn        75 ⇨ Cold drawn
```

10-2-3 Scenario B-1

[Kremikovtzi Steelworks] Total production 871

```
2Coke batt's ┬→2B.F's ┬→2Converters→ 2Slab → Hot strip → [Same as Scenario A]
    443*     |  879   |     993       casters     mill
3Sint.mach's ┘ Scrap  ┘                 943        915
   1,289        200
   * To sintering plant, EAF  83
```

[Stomana Steelworks] Total production 890

```
Scrap  → 2EAFs ┬→ Slab Caster  → Plate mill                     210⇨ Plate
1,074   1,002  |      246
               ├→ Bloom caster→Bar & shape  ┌→                  156⇨ Bar & shape
               |      249       mill (P) 238 ├→ Ball mill          7 ⇨ Ball
               |                             └→ Cold drawn       75⇨ Cold drawn
               └→ Billet Caster ┬→ Rod mill (K)                  148 ⇨ Wire rod and rebar
                     457        ├→Seamless mill (K)          62 ⇨ Seamless pipe, Cold drawn
                                └→                             232 ⇨ Billet (round,square)
```

(P) ; Plant in Promet   (K) ; Plant in Kremikovtzi

10-2-4 Scenario B-2

[Kremikovtzi Steelworks] Total production 871

```
2Coke batt's ┬→2B.F's ┬→2Converters → 2Slab → Hot strip → [Same as Scenario A]
 443*        |  879   |   993           casters    mill
3Sint.mach's ┘ Scrap  ┘                  943        915
 1,289          200
   * To sintering plant, EAF 91
```

[Stomana Steelworks] Total production 890

```
Scrap  →2EAFs ┬→Slab caster  → Plate mill                210 ⇨ Plate
1,074   1,002 |   246
              ├→ Bloom →Bar & shape  ┌→                   156 ⇨ Bar & shape
              |  caster  mill (P) 391 ├→ Ball mill          7 ⇨ Ball
              |   249                 ├→ Cold drawn        75 ⇨ Cold drawn
              |                       └→Rod mill(P)       148 ⇨ Wire rod and rebar
              └→Billet caster ┬→Seamless mill (K)  62 ⇨ Seamless pipe, Cold drawn
                  457         └→                      232 ⇨ Billet (round,square)
```

10-2-5 Scenario C

[Kremikovtzi Steelworks] Total production 1313

```
2Coke batt's ┬→2B.F's ┬→2Conv's  ┌→ 2Slab → Hot strip → [Same as Scenario A]
 497*        |  991   |  1,120   |   casters   mill
4Sint.mach's ┘ Scrap  ┴→ 2EAF s  ┤    943      915
 1,454          607      354     |
   * To sintering plant, EAF 91   └→ Billet caster ┬→ Rod mill    148 ⇨ Wire rod
                                       457         |                     and rebar
                                                   ├→Seamless mill  62 ⇨ Seamless
                                                   |                  pipe,Cold drawn
                                                   └→ 232 ⇨ Billet ( round, square)
```

[Stomana Steelworks] Total production 448

```
Scrap  → 2EAFs ┬→ Slab caster  → Plate mill             210 ⇨ Plate
 560     521   |    246            210
               └→ Bloom caster→Bar & shape  ┌→          156 ⇨ Bar & shape
                     249        mill (P) 238 ├→ Ball mill   7 ⇨ Ball
                                             └→ Cold drawn 75 ⇨ Cold drawn
```

(P) ; Plant in Promet (K) ; Plant in Kremikovzi

10-2-6 Scenario C-2

[Kremikovtzi Steelworks] Total production 1313

2Coke batt's 658* ┬→ 2B.F's 1,328 ┬→ 3Converters 1,474 ┬→ 2Slab casters 943 → Hot strip mill 915 → Same as Scenario A

4Sint.mach's 1,974 ┘ Scrap 274 ┘

└→ Billet caster 457 ┬→ Rod mill 148 ⇨ Wire rod and rebar

├→ Seamless mill 62 ⇨ Seamless pipe, cold drawn

└→ 232 ⇨ Billet (round, square)

* To sintering plant, EAF 113

[Stomana Steelworks] Total production 448

Scrap 560 → 2EAFs 521 ┬→ Slab caster 246 → Plate mill 210 — 210 ⇨ Plate

└→ Bloom caster 249 → Bar & shape mill (P) 238 ┌→ 156 ⇨ Bar & shape

├→ Ball mill 7 ⇨ Ball

└→ Cold drawn 75 ⇨ Cold drawn

10-2-7 Scenario D-1

[Kremikovtzi Steelworks] Total production 1081

Scrap 1,053 → 2EAFs 979 ┬→ Slab caster 705 ┬→ Hot strip mill 915 → Same as Scenario A

[Stomana] 238 ┘

└→ Billet caster 225 ┬→ Rod mill 148 ⇨ Wire rod and rebar

└→ Seamless mill 62 ⇨ Seamless pipe, Cold drawn

[Stomana Steelworks] Total production 680

Scrap 1,104 → 2EAFs 1,027 ┬→ Slab caster 495 ┬→ Plate mill 210⇨ Plate

└→ [Kremikovtzi] (238)

├→ Bloom caster 249 → Bar & shape mill (P) 23 ┌→ 156⇨ Bar & shape

├→ Ball mill 7 ⇨ Ball

└→ Cold drawn 75 ⇨ Cold drawn

└→ Billet caster 232 ⇨ Billet (round,square)

(P) ; Plant in Promet (K) ; Plant in Kremikovtzi

10-2-8 Scenario D-2

[Kremikovtzi Steelworks]   Total production 871

Scrap → 2EAFs → 2Slab Casters → Hot strip mill → Same as Scenario A

1,067   993   943   915

[Stomana Steelworks]   Total production 890

Scrap → 2EAFs ┬→ Slab Caster → Plate mill   210 ⇨ Plate

1,074   1,002 | 246

├→ Bloom caster → Bar & shape mill (P) 238 ┌→   156 ⇨ Bar & shape

| 249   ├→ Ball mill   7 ⇨ Ball

| └→ Cold drawn   75 ⇨ Cold drawn

└→ Billet Caster 457 ┬→   232 ⇨ Billet (round,square)

├→ Rod mill (K)   148 ⇨ Wire rod and rebar

└→ Seamless mill (K)   62 ⇨ Seamless pipe, Cold drawn

10-2-9 Scenario D-3

[Kremikovtzi Steelworks]   Total production 871

Scrap → 2EAFs → 2Slab Casters → Hot strip mill → Same as Scenario A

1,067   993   943   915

[Stomana Steelworks]   Total production 890

Scrap → 2EAFs ┬→ Slab caster → Plate mill   210 ⇨ Plate

1,074   1,002 | 246

├→ Bloom caster 249 → Bar & shape mill (P) 391 ┌→   156 ⇨ Bar & shape

├→ Ball mill   7 ⇨ Ball

├→ Cold drawn   75 ⇨ Cold drawn

└→ Rod mill(P)   148 ⇨ Wire rod and rebar

└→ Billet Caster 457 ┬→ Seamless mill (K)   62 ⇨ Seamless pipe, Cold drawn

└→   232 ⇨ Billet (round,square)

(P) ; Plant in Promet   (K) ; Plant in Kremikovtzi

nario C.

⑦ Scenario D-1

The blast furnaces at Kremikovtzi are discontinued, liquid steel is produced from electric arc furnaces (EAF) and investment for environmental pollution prevention is reduced. The capacity of EAF at Stomana is large enough to supply the billet for export and slab to Kremikovtzi.

⑧ Scenario D-2

The blast furnaces at Kremikovtzi are discontinued. After the continuous casting machine, this scenario is the same with Scenario B-1.

⑨ scenario D-3

The blast furnaces at Kremikovtzi are discontinued. After the continuous casting machine, this scenario is the same with Scenario B-2.

10.1.3 Operating Conditions after improvement

Operating Conditions are shown in Appendix 10-7. The figures are markedly improved, and approach those of most modern steelworks.

10.1.4 Raw materials to be used

Main raw materials at Kremikovtzi and Stomana are shown in Tables 10-1 and 10-2 respectively.

Table 10-1 Coking Coal and Iron Ore to be Used at Kremikovtzi Steelworks

(Unit:1,000ton/year)

Scenario	Coking coal	Iron Ore			
		Sintered ore	Pellet	Lump ore	Total
A	658	1,454	80.5	80.5	1,615
A-2	873	1,951	108.5	108.5	2,168
B-1,B-2	587	1,289	72	72	1,433
C	658	1,454	80.5	80.5	1,615
C-2	871	1,949	108	108	2,165
D-1,D-2,D-3	0	0	0	0	0

Table 10-2 Scrap to be Used at Kremikovtzi and Stomana Steelworks

(Unit:1,000ton/year)

Scenario	Domestic	Imported	Returned	Cast iron	Total
A	600	335	259	0	1,194
A-2	600	0	259	0	859
B-1,B-2	600	443	231	0	1,274
C	600	334	234	0	1,167
C-2	600	0	234	0	834
D-1	600	1,296	245	15	2,157
D-2,D-3	600	1,295	231	15	2,141

10.2 Improvement Plan and Cost Estimate for Modernizing Each Steelworks

10.2.1 Improvement plan

The main problems and countermeasures at each steelworks are shown in Table 10-3 (for environmental countermeasures, air pollution is shown in Table 10-11, and water pollution is shown in Table 10-12).

Table 10-4 shows the detailed items to be improved. The necessary items are different from scenario to scenario. Ironmaking equipment and converters require many improvement items for environmental pollution prevention measures. For Senarios D-1, D-2 and D-3, improvement of these items is not necessary because the equipment will be shut down.

Considering the limited availability of human resources and high investment requirements, it would be difficult to investigate simultaneously the large number of items to be improved. We recommend that an investigation be divided into two periods of five years. Each items should be selected on the basis of urgency and the relationship between equipment.

The basic specifications for main equipment and machinery to be improved and the equipment layout are shown in Appendix 10-8.

10.2.2 Rough estimate of investment cost for main equipment and machinary

The total amount of items shown in Table 10-4 are shown in Tables 10-5, 10-6 and 10-7. These Lists show the total investment cost of each scenario and it will cost about US$ 270 million to perform the scenario for the case of continuing the operation of the blast furnaces (Scenarios A, B and C), and about US$ 150 million for the case of discontinuing the operating of the blast furnaces (Scenario D). This cost difference mainly comes from investment for environmental pollution prevention. In the scenarios continuing the operation of the blast furnaces (Scenarios A, B and C), the cost for pollution prevention and the other costs are about equal.

These costs contain the consulting fee (Note). Because it is necessary to have good consultants to construct the better equipment with more reasonable costs. Tables 10-8, 10-9 and 10-10 show the consulting fee only. And these costs consist of the fees of basic engineering, purchase engineering, construction engineering and assistance for starting up.

(Note) Estimated on the assumption that Bulgaria will invite engineers from Japan and have technical consulting.

Table 10-3 Problems and Countermeasures at Each Steelworks

Kremikovtzi Steelworks-1

Steelworks	Equipment	Problem	Countermeasure
Kremikovtzi	Coke plant	① Energy consumption is high.	Operational improvement, strengthening of equipment control
	Sintering plant	① Yield is low because iron ore falls through grate.	Hearth layer material charging equipment
		② Yield is low because the layer is thin.	Increase in layer thickness
		③ Ignition burner is poor for fuel consumption.	New type of ignition burner
		④ Energy consumption and coke ratio is high.	Operational improvement, strengthening of equipment control
	Blast furnace	① Productivity, fuel unit consumption, coke ratio and iron ratio are poor.	Operational improvement, strengthening of equipment control
		② Coking coal ratio is high.	Pulverized coal injection system (PCI)
		③ Heat efficiency of hot stove is poor.	Installation of oxygen (O_2) analyzer for hot stove waste gas
	Converter	① Energy unit consumption is poor, tap-tap time is long.	Ar-gas bottom blowing equipment, hot repair devices
		② Hit rate is poor. Number of reblows is excessive.	Sublance device for BOF
		③ Adding of ferroalloys puts heavy load on operators.	Alloy adding equipment

Kremikovtzi Steelworks-2

Steelworks	Equipment	Problem	Countermeasure
Kremikovtzi	Electric arc furnace	① Energy unit consumption is poor, tap-tap time is long.	Modification of No. 3 EAF, hot repair devices, oxygen/carbon manipulators, scrap treatment device, control system, operational improvement.
		② By scenario, production capacity is inadequate.	New EAF & auxiliary equipment
		③ Adding of ferroalloys puts heavy load on operators.	Alloy adding device
	Continuous casting machine	① Use of slabbing and blooming mill means poor yield and energy unit consumption.	Billet caster
	Hot strip mill, cold strip mill, etc.	① Yield and energy unit consumption are poor.	Operational improvement
	Rod mill	① Yield and energy unit consumption are poor.	Rod mill replace, operational improvement
		② Shape noncomformity rate is high.	
		③ There is no direct patenting line.	
	Pipe mill	① It is impossible to meet international standards because nondestructive inspection (NDI) equipment is not available.	NDI line (seamless pipe, welded pie)
		② Welded bead is poor.	Heat input control system (welded pipe)
		③ Galvanizing line does not meet international standard.	Pipe galvanizing line (welded pipe)
	Energy	① Energy system is poor for energy saving.	Introduction of energy control system

Stomana, Promet, Kamet

Steelworks	Equipment	Problem	Countermeasure
Stomana	Electric arc furnace	① Energy unit consumption is poor, tap-tap time is long.	Modification of EAF, hot repair devices, oxygen/carbon manipulators, scrap treatment device, operational improvement. Replacement of power supply for No. 1 EAF
		② By scenario, production capacity is not adequate.	Billet CCM
	Continuous casting machine	① Bar production from bloom is in efficient ② Productivity is poor	Modification of slab CC, operational improvement.
	Plate mill	① Energy unit consumption is poor. ② Yield is poor.	Operational improvement, side trimmer
	Bar & shape mill	① Yield is poor. ② Energy unit consumption is poor.	Closure (except scenario A)
Promet	Bar & shape mill	① Productivity is poor. ② Yield is poor.	Operational improvement, strengthening of equipment control
Kamet	EAF BAR mill	① Productivity is poor. ② Energy unit consumption is poor. ③ Yield is poor.	Closure

Table 10-4 Improvement Items

(Unit ; 1000 US$)

Item	Consulting fee	Equipment & construction	Pollution	Timing	Scenario A	A -2	B -1	B -2	C	C -2	D -1	D -2	D -3
1 Ironmaking													
1.1 Coke plant													
1.1.1 Dedusting system for coal charging	277	3,000	*	*	*	*	*	*	*	*			
1.1.2 Dedusting system for coke pushing	277	5,630	*	*	*	*	*	*	*	*			
1.1.3 New coke oven door	300	1,130	*	–	*	*	*	*	*	*			
1.1.4 Seal plates for coke oven doors	300	1,630	*	–	*	*	*	*	*	*			
1.1.5 De-S equipment for COG	593	24,240	*	*	*	*	*	*	*	*			
1.1.6 Treatment plant for gas liquor	593	14,920	*	*	*	*	*	*	*	*			
1.2 Sintering plant													
1.2.1 Hearth layer material charging equipment	100	3,260		*	*	*	*	*	*	*			
1.2.2 Increase in layer thickness													
1) Replacement of pallet side wall		1,000		*	*	*	*	*	*	*			
2) Replacement of main blower		4,590		*	*	*	*	*	*	*			
1.2.3 Installation of preduster in main gas treatment plant	407	7,000	*	–	*	*	*	*	*	*			
1.2.4 Installation of preduster in waste gas treatment at sinter coolers	460	11,380	*	–	*	*	*	*	*	*			
1.2.5 New ignition burner	238	2,400		*	*	*	*	*	*	*			
1.3 Blast furnace													
1.3.1 Pulverized coal	752	22,100		*	*		*	*	*				
injection system (PCI)	752	26,520		*		*				*			
1.3.2 Installation of oxygen (O_2)analyzer for hot stove waste gas	110	1,380		*	*	*	*	*	*	*			
1.3.3 Dedusting system from cast house	462	11,250	*	–	*	*	*	*	*	*			
1.3.4 Waste water pollution prevention	100	160	*	–	*	*	*	*	*	*			

Pollution : * shows item for environmental pollution prevention .

Timing : * shows item scheduled in first five years.

– shows item scheduled in second five years.

Scenario : * shows item of each scenario.

Kremikovtzi Steelworks - 2 (Steelmaking) (Unit ; 1000 US$)

Item	Consulting fee	Equipment & construction	Pollution	Timing	Scenario A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
2 Steelmaking													
2.1 LD converter					2	3	2	2	2	3	0	0	0
2.1.1 Ar-gas bottom blowing equipment	388	1,600		*	*		*	*	*				
	388	2,400		*		*				*			
2.1.2 Sublance device for BOF	813	3,200		—	*		*	*	*				
	813	4,800		—		*				*			
2.1.3 Hot repair devices	77	800		*	*	*	*	*	*	*			
2.1.4 Alloy adding equipment		600		*	*		*	*	*				
		900		*		*				*			
2.1.5 Dedusting system with local capture	517	4,130	*	—	*		*	*	*				
hoods	517	4,630	*	—						*			
2.1.6 Electrostatic precipitator for main waste gas treatment	460	16,500	*	—	*	*	*	*	*	*			
2.2 EAF					2	0	0	0	2	0	2	2	2
2.2.1 Modification of No.3 EAF	97	500		—	*				*		*	*	*
2.2.2 Hot repair devices (2sets)	205	1,100		*	*				*		*	*	*
(1set)	205	560		*		*	*	*		*			
2.2.3 Oxygen/carbon (2sets)	302	1,500		*	*				*		*	*	*
manipulators (1set)	302	830		*		*	*	*		*			
2.2.4 New EAF & auxiliary equipment	1,112	7,700		—							*	*	*
2.2.5 Scrap treatment device	310	2,600		*							*	*	*
2.2.6 Alloy adding device		500		*	*				*		*	*	*
2.2.7 Control system	108	0		*	*				*		*	*	*
2.2.8 Direct dedusting system and secondry dedusting system at building	517	12,630	*	—	*				*		*	*	*

Pollution : * shows item for environmental pollution prevention .
Timing : * shows item scheduled in first five years.
— shows item scheduled in second five years.
Scenario : * shows item of each scenario.

Kremikovtzi Steelworks - 3 (Steelmaking & rolling) (Unit ; 1000$)

Item	Consulting fee	Equipment & construction	Pollution	Timing	Scenario A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
2.3 Continuous casting machine													
2.3.1 Billet caster (500,000ton /year)	1,675	30,900		*	*	*			*	*			
2.3.2 Billet caster (300,000ton /year)	1,675	22,900		*							*		
2.3.3 Increase of water supply volume	447	4,940	*	*	*	*			*	*			
	447	3,460	*	*							*		
2.4 Lime stone treatment													
2.4.1 New bag filter													
	517	4,250	*	*	*	*	*	*	*	*	*	*	*
3 Rolling													
3.1 Rod mill													
3.1.1 Rod mill replacement													
	1418	19,554		*	*	*			*	*	*		
3.2 Pipe production													
3.2.1 NDI line (seamless pipe)													
3.2.2 NDI line (welded pipe)	322	232		*	*	*			*	*	*		
3.2.3 Heat input control system(welded	322	175		*	*	*	*	*	*	*	*	*	*
pipe)	162	65		*	*	*	*	*	*	*	*	*	*
3.2.4 Pipe galvanizing line (welded pipe)													
	535	2030		—	*	*	*	*	*	*	*	*	*
4 Others													
4.1 Energy													
4.1.1 Introduction of energy control system	487	4,500		*	*	*	*	*	*	*	*	*	*
4.2 Waste water treatment													
4.2.1 Treatment plant for waste water with oil	238	2,320	*	—	*	*	*	*	*	*	*	*	*
4.2.2 Strengthening of waste water treatment system	292	4,570	*	*	*	*	*	*	*	*	*	*	*

Pollution : * shows item for environmental pollution prevention .

Timing : * shows item scheduled in first five years.

— shows item scheduled in second five years.

Scenario : * shows item of each scenario.

2. Stomana Steelworks (Unit ; 1000$)

Item	Consulting fee	Equipment & construction	Pollution	Timing	Scenario A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
1 Steelmaking													
1.1 EAF													
1.1.1 Modification of No.1 EAF	397	1,000		—	*	*			*	*			
	397	2,500		—			*	*			*	*	*
1.1.2 Modification of No.3 EAF	97	1,100		*	*	*	*	*	*	*	*	*	*
1.1.3 Hot repair devices	97	1,100		*	*	*	*	*	*	*	*	*	*
1.1.4 Oxygen/carbon manipulators	97	1,500		*	*	*	*	*	*	*	*	*	*
1.1.5 Replacement of power spply for No.1 EAF		3,000		—			*	*			*	*	*
1.1.6 Scrap treatment device	310	2,600		*			*	*			*	*	*
1.2 Continuous casting machine													
1.2.1 Modification of slab CC	708	4,000		—	*	*	*	*	*	*	*	*	*
1.2.2 Billet caster (500,000 ton /year)	1772	28,900		*			*	*				*	*
1.2.3 Billet caster (300,000 ton /year)	1772	20,900		*							*		
1.2.4 Water supply for slab & billet caster	323	6,344	*	*			*	*				*	*
1.2.5 Water supply for slab & billet caster	323	6,540	*	*							*		
1.3 Limestone treatment													
1.3.1 New bag filter	473	4,250	*	*	*	*	*	*	*	*	*	*	*
2.Rolling													
2.1 Plate mill													
2.1.1 Side trimmer	468	8,300		—	*	*	*	*	*	*	*	*	*
2.2 Rod mill													
2.2.1 Rod mill replacement (Kremi.)	1,418	19,554		*			*					*	
2.2.2 Rod mill replacement (Promet)	1,418	18,713		*				*					*
2.3 Seamless mill													
2.3.1 NDI line (Seamless) (Kremi.)	322	232		*			*	*				*	*
2.4 Bar and shape mill													
2.4.1 Improve of operation (wear resistant rolls, etc.)	600	1,780		*			*	*	*	*	*	*	*
3 Waste water treatment													
3.1.1 Treatment plant for waste water with oil	265	4,190	*	—	*	*	*	*	*	*	*	*	*

Table 10-5 Total Cost for Improvement (include consulting fee)

Kremikovtzi Steelworks (Unit; 1000$)

		Scenario								
		A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
Environmental pollution prevention	First five years	64,546	64,546	59,159	59,159	64,546	64,546	13,536	9,629	9,629
	Second five years	71,891	59,244	58,744	58,744	71,891	59,244	15,705	15,705	15,705
	Total	136,437	123,790	117,903	117,903	136,437	123,790	29,241	25,334	25,334
Other improvement	First five years	102,922	106,624	47,003	47,003	102,922	106,624	58,437	12,336	12,336
	Second five years	7,175	8,178	6,578	6,578	7,175	8,178	11,974	11,974	11,974
	Total	110,097	114,802	53,581	53,581	110,097	114,802	70,411	24,310	24,310
Total	First five years	167,468	171,170	106,162	106,162	167,468	171,170	71,973	21,965	21,965
	Second five years	79,066	67,422	65,322	65,322	79,066	67,422	27,679	27,679	27,679
	Total	246,534	238,592	171,484	171,484	246,534	238,592	99,652	49,644	49,644

Table 10-6 Total Cost for Improvement (include consulting fee)

Stomana Steelworks

(Unit; 1000$)

		Scenario								
		A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
Environmental pollution prevention	First five years	4,723	4,723	11,390	11,390	4,723	4,723	11,586	11,390	11,390
	Second five years	4,455	4,455	4,455	4,455	4,455	4,455	4,455	4,455	4,455
	Total	9,178	9,178	15,845	15,845	9,178	9,178	16,041	15,845	15,845
Other improvement	First five years	3,991	3,991	61,479	60,638	6,371	6,371	31,953	61,479	60,638
	Second five years	14,873	14,873	19,373	19,373	14,873	14,873	19,373	19,373	19,373
	Total	18,864	18,864	80,852	80,011	21,244	21,244	51,326	80,852	80,011
Total	First five years	8,714	8,714	72,869	72,028	11,094	11,094	43,539	72,869	72,028
	Second five years	19,328	19,328	23,828	23,828	19,328	19,328	23,828	23,828	23,828
	Total	28,042	28,042	96,697	95,856	30,422	30,422	67,367	96,697	95,856

Table 10-7 Total Cost for Improvement (include consulting fee)

Kremikovtzi and Stomana Steelworks (Unit; 1000$)

		Scenario								
		A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
Environmental pollution prevention	First five years	69,269	69,246	70,549	70,549	69,269	69,246	25,122	21,019	21,019
	Second five years	76,346	63,699	63,199	63,199	76,346	63,699	20,160	20,160	20,160
	Total	145,615	132,968	133,748	133,748	145,615	132,968	45,282	41,179	41,179
Other improvement	First five years	106,913	110,615	108,482	107,641	109,293	112,995	90,390	73,815	72,974
	Second five years	22,048	23,051	25,951	25,951	22,048	23,051	31,347	31,347	31,347
	Total	128,961	133,666	134,433	133,592	131,341	136,046	121,737	105,162	104,321
Total	First five years	176,182	179,884	179,031	178,190	178,562	182,264	115,512	94,834	93,993
	Second five years	98,394	86,750	89,150	89,150	98,394	86,750	51,507	51,507	51,507
	Total	274,576	266,634	268,181	267,340	276,956	269,014	167,019	146,341	145,500

Table 10-8 Consulting fee for Improvement Kremikovtzi Steelworks

(Unit; 1000$)

	Scenario								
	A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
First five years	9,662	9,554	5,692	5,692	9,662	9,554	7,679	3,817	3,817
Second five years	5,206	4,592	4,592	4,592	5,206	4,592	2,499	2,499	2,499
Total	14,868	14,146	10,284	10,284	14,868	14,146	10,178	6,316	6,316

Table 10-9 Consulting fee for Improvement Stomana Steelworks

(Unit; 1000$)

	Scenario								
	A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
First five years	764	764	5,509	5,509	1,364	1,364	3,769	5,509	5,509
Second five years	1,838	1,838	1,838	1,838	1,838	1,838	1,838	1,838	1,838
Total	2,602	2,602	7,347	7,347	3,202	3,202	5,607	7,347	7,347

Table 10-10 Consulting fee for Improvement Kremikovtzi and Stomana Steelworks

(Unit; 1000$)

	Scenario								
	A	A-2	B-1	B-2	C	C-2	D-1	D-2	D-3
First five years	10,426	10,318	11,201	11,201	11,026	10,918	11,448	9,326	9,326
Second five years	7,044	6,430	6,430	6,430	7,044	6,430	4,337	4,337	4,337
Total	17,470	16,748	17,631	17,631	18,070	17,348	15,785	13,663	13,663

10.2.3 Plan of enhancement of corporate culture

In Bulgaria, the enhancement of corporate culture is as important as the improvement of equipment. The restructuring and modernization of the steel industry in the Republic of Bulgaria must start with a breakthrough, from the top to the first line of workers. For that purpose, the Bulgarian steel industry needs management and operation consultants, such as those described below.

1) Seminar for modernization of the steel industry
This is the seminar of management held in Bulgaria by the consultant from abroad. The detailed program is shown in Section 10.3.3 2) b).

2) Consultation for restructuring the steel industry (as a whole)
This is the one-year on the-job-training by the consultant from a western country who has a good experience of management in a market economy.

3) Training in Japan
This is the training in Japan for the key persons in the steel industry in Bulgaria, and includes factory tours and lectures on the most modern steelworks. Every trainee should have a four (4) week lecture course, including a general course such as management, quality control, production control, etc. and an expert course. The detailed program is shown in Appendix 10-9-1.

4) Assistance of operational improvement
In this program, experts including technicians, if necessary, assist in each shop in the improvement of operations. The total man-months of the trainer are 157 (102 in Bulgaria, 55 in Japan). The detailed program is shown in Appendix 10-9-2.

10.2.4 Rough estimation of cost for enhancement of corporate culture

A rough estimation of the cost for the enhancement of the corporate culture for management and operation are shown below. Assistance of operational improvement, as shown in the above 10.2.3 4), will be performed with respect to the main equipment. Some scenarios require the closure of some equipment, however, the assistance of operational improvement will be necessary in all the scenarios because the cost for this assistance can be recovered in a short period before the equipment is closed.

1) Seminar for modernization of the steel industry

2 week × 2 times	Number of lecture 7
In Bulgaria	7 Man•months
In Japan for preparation	7 Man•months
Total	Japanese Yen 61,427,000-

2) Consultation for restructuring of the steel industry (as a whole)

In Bulgaria	9 Man•months	
In Japan for preparation	3 Man•months	
No of transfers	3 times	
Total		Japanese Yen 43,138,000-

3) Training in Japan

2 week × 2 times	Number of lectures 19	
	37 Man•months	
		Japanese Yen 81,400,000-

(Not included travel, hotel, meal, and translation expenses)

4) Assistance of operational improvement

Kremikovtzi	Japanese Yen	350,000,000-
Stomana	Japanese Yen	220,000,000-
Total	Japanese Yen	570,000,000-

10.2.5 Environmental Pollution Prevention Measures

1) Air pollution prevention measures

The outline of the countermeasures for air pollution prevention is shown in Table 10-11, and can be summarized as follows. Appendix 10-8-25 shows the main specifications for improvement and Table 10-4 shows the cost of these measures.

a) Kremikovtzi Steelworks

① Coke oven coal-charging car and guide car dust collecting system

Dust is not collected during charging and pushing at either of the two coke batteries. Because this is a source of much dust, collection is required for both operations.

For charging, a dust collection system having an intake volume of about 1,000 m^3/min would be sufficient. For pushing, it is desirable that dust collection be performed on both the coke-side and machine-side and indispensable that it be performed on the guide car side. For this, a guide car dust collecting system should be installed. Some special features will be required with regard to the dust collection hood and the joints with fixed ducts. The intake volume should be about 2,000 m^3/min. A bag filter which prevents addhesion of tar should be installed.

Partially because of the composition of the gas such as benzene, much effort should be directed at the suppression of coke oven emissions. To prevent leaks through doors, it is important to adopt doors of a seal-plate type and install a door cleaner.

Table 10-11 Environmental Pollution Prevention -Air-

1. Kremikovtzi Steelworks

Items	Outline of specifications
Dedusting system for coal charging	Bag filter 1,000 Nm^3/min (60°C) × 1 set
Dedusting system for coke pushing	Bag filter 2,000 Nm^3/min (60°C) × 1 set
Seal plates for coke oven doors	65 doors
Door cleaner and jambo cleaner	Door cleaner 1 set, Jambo cleaner 1 set
Dedusting system for lime kiln	Air-cooling system, bag filter 2,700 Nm^3/min (300°C) × 1 set
Preduster for sinter main gas	Preduster with louver (5,300 Nm^3/min) × 4 sets
Preduster for sinter cooler gas	Preduster with louver (10,000 Nm^3/min) × 4 sets
Dedusting system for blast furnace casting house	Bag filter 7,000 Nm^3/min (100°C) × 2 sets
Dedusting system for EAF--- direct and secondary	Bag filter Max in scenarios 8,200 Nm^3/min (60°C) × 2 sets
Dedusting system for LD converter main gas	Wet-EP [corresponding to 2 converters] 8,000 Nm^3/min (100°C) × 1 set
Dedusting system wit local capture hood for LD converters	Bag filter [corresponding to 2 converters] 4,800 Nm^3/min (60°C) × 1 set

2. Stomana Steelworks

Items	Outline of specifications
Dedusting system for lime kiln	Air-cooling system, bag filter 2,700 Nm^3/min (300°C) × 1 set

② Sinter plant main waste gas and cooler dust collection

Although there are six (6) sinter plants, we studied environmental prevention measures based on four (4) machines of No.1 to No.4.

In 1996, the standard for dust concentration in the sinter waste gas becomes 80 mg/Nm^3. Currently, this level is occasionally exceeded. Although we did not see this level of dust concentration, one probable cause is a high inlet concentration. Here, it is necessary to control the operation of the EP, including factors such as charge voltage and dust shake-out, so that the EPs run properly, and to install predusters to reduce the concentration at the EP inlets. This situation is the same for cooler waste gas.

③ Blast furnace casting house dust collection

No blast furnace has a casting house dust collection system, and the MOE has made an issue of this.

The requirements are a system for taphole/chute dust collection and dust suppression measures, such as runner covers. The standard for emission dust concentration is 30 mg/Nm^3, so the dust collectors must be bag filters. A dust collection intake of 7,000 m^3/min, including 4,000 m^3/min at the taphole and 3,000 m^3/min at the chute, should be sufficient. If dust collection is performed effectively at the taphole, there should be no need for a secondary dust collecting system.

④ Lime kiln off-gas dust collection

The off-gas volume of the new lime kiln (No.4) is 160,000 m^3/h. An electrostatic precipitator is installed, but the gas temperature is too high (300°C) for it to function effectively. As a result, the outlet dust concentration is 10 g/Nm^3, greatly exceeding the standard (which is to be 80 mg/Nm^3 from 1996 onwards).

As a measure against this, the gas should be cooled by fresh air intake. In order to consistently meet the standard, the EP should be retrofitted or replaced by a bag filter after confirmation of the efficiency of dust removal with gas cooling. However, it is recommended to install a cooler and bag filter to meet the standard.

⑤ Converter dust collection

The converters have boiler-type gas systems and are provided with venturis and water sprayers. The dust removal efficiency is over 99 percent, but the concentration at the outlet is still 100 mg/Nm^3. This exceeds the local emission standard (30mg/Nm^3), and even exceeds the standard of 50 mg/Nm^3 for Germany and other countries. Here, it is necessary to install a wet EP after the venturi and keep it in optimum operational condition.

A gas volume of 8,000 m^3/min for the EP is necessary to treat the off-gas of the converters.

In the future, it may be necessary to replace the boiler type gas system with the recovery type when boiler replacement becomes necessary. Dust collection is not carried out at the furnace nose, and, as a result, much dust is emitted during blowing and tapping. Dust collection must also be done at the furnace nose. Bag filters should be provided for the two (2) converters, and the intake volume should be 4,800 m^3/min. Also, a hood should be placed on the back side of the converter.

⑥ Electric arc furnace dust collection
A wet scrubber has been installed for EAF direct off-gas. At times, the dust emission standard is met; at times, it is greatly exceeded. This is because of the capacity and/or performance of the dust collector is insufficient to meet the standard. Since the off-gas is cooled to 100 °C at the cooler, a bag filter (the capacity of one bag is 1,000 Nm^3/min) that can meet the 30 mg/Nm^3 standard could be installed.

As for secondary dust collecting, the current production situation makes it desirable to install equipment mainly to handle dust from scrap charging and from tapping. However, if the number of taps increases or if an additional EAF is added to boost production, then a secondary dust collection system will become a necessity.

In such case, the dust collection system should be able to handle a maximum of 7,200 Nm^3/min × 2 (the capacity of one bag is 8,200 Nm^3/min for both direct off-gas and secondary dust collecting), although this will vary somewhat depending on the scenario.

b) Stomana Steelworks

① Lime kiln dust collection
Off-gas from the lime kiln is currently led directly to a dust collector (EP) without cooling. The dust concentration standard of 130 mg/Nm^3 (to be applied from 1996 onwards) will often be exceeded. As a measure against this, a cooling plant is installed, and the EP should be retrofitted or replaced by a bag filter after confirmation of the efficiency of dust removal with gas cooling. However, it is recommendable to install a cooler and bag filter to meet the standard.

c) Promet Steelworks

Promet Steelworks does not need additional countermeasures, especially plant installation, for air quality. However, environmental control, including the maintenance of dust collectors, should be done more effectively.

d) Dust collector management/control

The countermeasures mentioned above are to a large extent dust collector installation. Management/control of dust collection is vital to assure consistent compliance with dust emission standards.

Beginning with charging (for EP) and pressure differential (for bag filters), there are a number of items that should be closely checked on a daily basis. These checkpoints are listed below.

(1) Checkpoints for EP (dry)

a. Clogging of baffle walls
b. Electrode spacing
c. Dust adherence on collector electrode
d. Position of dust collector hammering bars
e. Problems with dust collector electrode hammering device
f. Dust adherence on discharge electrode
g. Problems with discharge electrode hammering device
h. Problems with electrical instruments
i. Problems with baffle device
j. Problems with insulation system

(2) Checkpoints for bag filter (pulse jet backwashing)

a. Filter attachment, expansion joint problems
b. Pulse jet compressed air pressure
c. Pulse jet valve system operation problems
d. Pulse jet nozzle attachment problems
e. Shake-out cycle
f. Intake gas volume

e) Environmental control system

The ISO environmental control system (ISO 14000 series) is currently being studied and ISO 14001 will begin in July 1996. An EC directive on the environmental system has been in effect since April 1995.

While it is not mandatory to enroll in this system, some European countries and the USA are positive about it. Some type of environmental control system is necessary, and the ISO should at least be considered as a reference.

2) Water pollution preventive measures

The outline of the countermeasures for water pollution prevention is shown in Table 10-12. The following two (2) common points summarize the water quality pollution control measures taken at the Bulgarian steelworks.

Table 10-12 Environmental Pollution Prevention - Water -

1. Kremikovtzi Steelworks

Items	Outline of specifications
Installation of coke oven-gas liquor treatment plant	Pre-treatment system ┐ 60m³/h Ammonium stripping system ┘ Biological treatment system 75m³/h
Strengthening of Wastewater Treatment Plant (final treatment plant at Kremikovtzi)	Improvement of Wastewater Treatment Plant 1set Filter ┐ Active carbon adsorption ┘ 500m³/h
Installation of oil-containing wastewater treatment (for Hot rolling mill)	Dissolved air flotation method 100m³/h
Installation of cyanide removal facility for BF wastewater	Chemical-feed system 3 sets
Water treatment facility for CC	Direct cooling water system 1 set Indirect cooling water system 1 set
Water treatment facility for EF (Increase of water volume to be treated)	Strengthening of water treatment 1 set

2. Stomana Steelworks

Items	Outline of specifications
Installation of oil-containing wastewater treatmetn	Dissolved air flotation method ┐ Filter ├ 120 m³/h Active carbon adsorption ┘
Water treatment facility for CC	Direct cooling water system 1set Indirect cooling water system 1 set

① At all of the steelworks, there is too much oil in the wastewater. The following action should be taken to deal with this problem.

[Step 1]

(1) Oil must not be allowed to flow into the wastewater treatment facilities.

(2) If there is an oil leak, operations at that plant should be suspended and the leaked oil should be recovered by the operators. These ideas must be strongly impressed upon the minds of personnel to prevent oil contamination.

A fundamental change in attitude should be strongly promoted from the top down as part of steelworks' environmental protection policy. At the same time, an administrative organization dealing with environmental protection should be established.

[Step 2]

The amount of oil used (amount of leaked oil) should be assessed, and measures should be taken to reduce leaks. This should be followed by the improvement of equipment to prevent oil leakage, especially when replacing or installing new machines/devices.

In Japan, an oil thrower is set at every drainage outlet to prevent the oil discharge. Since no such preventive measures are currently being taken in Bulgaria, this measure should be implemented.

[Step 3]

If oil is mixed with wastewater and cannot be removed even after implementing Steps 1 and 2, such wastewater should be isolated from other wastewater, and collected at a single location, where there is an oil-containing wastewater treatment facility. Oil-free water should be separated from the oil-containing wastewater, and the volume of oil-containing wastewater should be reduced to minimize the expenses of the treatment facility.

② All the steelworks are located in inland areas, upstream of rivers. As a result, they have difficulty in obtaining industrial water. For this reason, the steelworks must work hard to raise their industrial water recovery rate. Some already return a portion of their treated water to the steelworks. However, because of this, the concentration of total hardness, chlorine ions, and sulfates ions has steadily increased. While this in itself does not constitute pollution, it can cause problems with machinery through corrosion and scale deposition.

With the exception of the Kremikovtzi Steelworks, there are currently no problems with present levels. However, to prepare for future increases in production, we recommend that the rate of corrosion in the main circulating water systems be measured in order to determine the relation between the chloride-ion concentration and the corrosion rate. As a countermeasure, the volume of treated recycled water should be adjusted so that the total hardness of the make-up water is less than 300 ppm and the chloride-ion concentration is less than 50 ppm. (Chloride-ion concentration of the circulating water should be no more than 150 ppm.)

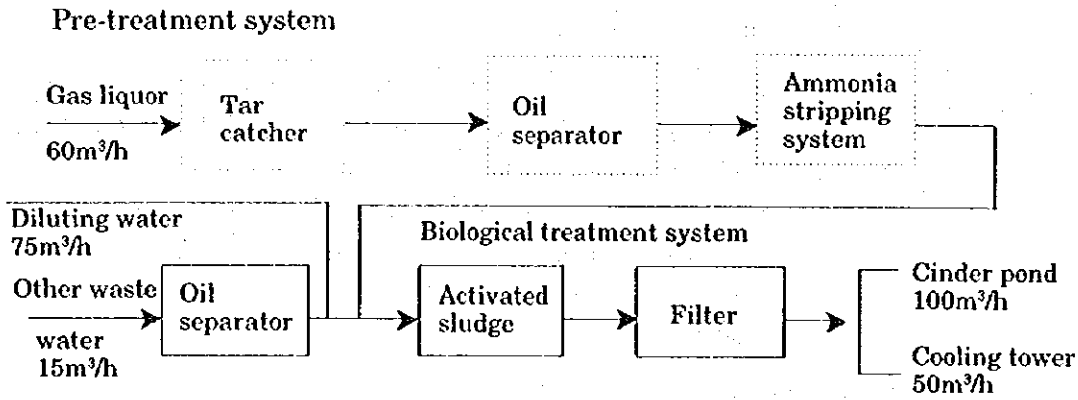
a) Kremikovtzi Steelworks

① Installation of coke oven gas liquor-treatment facilities

Since the coke oven gas liquor contains high levels of harmful substances such as cyanide and phenols, treatment facilities for this waste liquor must be installed. Specifically facilities incorporating general ammonia stripping and activated sludge should be installed. This method is economical and effective in its decomposition and removal efficiency.

Figure 10-3 shows the equipment used in this treatment system. The sludge resulting from this wastewater treatment facility is then dewatered, mixed with coal, and incinerated in the coke oven.

Figure 10-3 Coke Oven-gas Liquor Treatment System



Assuming the production output of the existing chemical formation line to be 980 ktons/y-coal, the ammonia stripping treatment capacity would be 60 m^3/h, and the activated sludge treatment capacity would be 60 + 15 = 75 m^3/h. The treated water, as presently designed, contains a cyanide concentration of 1 ppm, phenols of 0.05 ppm, NH_3 of 100 ppm, and COD of 70 ppm. The treated water is designed to flow through a closed system, and 100 m^3/h is sent into Cinder Pond.

Therefore, cyanide and phenol have almost no effect on cinder pond and wastewater treatment plant, and the ammonia concentration is estimated to be 10 ppm at cinder pond inlet and 5 ppm at the reservoir inlet. Moreover, since the water is diluted more than five (5) times by the make-up water supplied to each plant, the level is about 1 ppm, which satisfies the effluent standards applied to the wastewater treatment plant.

② Installation of cyanide-removal equipment

The blast furnace dust-collection water contains 4 ppm of cyanide, which is a harmful substance that must be removed by a treatment facility. The cyanide compounds present in small amounts in the blast furnace dust-collection water are either metallic cyanides (expressed in the general form M(CN)n and produced by the combination of hydrogen cyanide with a metal base) or cyano complexes (formed by the combination of complex cyanide ions and a metal base). The first type can be removed by decomposition into an oxyacid and ammonium. The second type is usually removed by precipitation. The treatment method involves injecting chemicals which causes both of these removal reactions. In the future, slurry recycling facilities should be built within the steelworks.

③ Measures against oil

As shown in the outline, Steps 1 and 2 should be implemented first. For Step 3, all preparations should be complete once the oil-containing wastewater treatment facilities have been installed in all the plants (especially the hot-rolling and bar mills). However, oil-containing-wastewater treatment facility are already established in the wastewater treatment plant. Because it would be cheaper to modify this facility than to construct new facilities, we recommend that this facility be modified. The countermeasures are as follows. ① The coagulation is not adequate, so optimal chemicals should be injected and the chemical injection point should be changed to assure sufficient mixing time. ② Bubbling only occures at the center of the dissolued air flotation tanks, so the control of the water level in the pressurized tanks should be modified.

If these measures are implemented, the oil content in the treated water should drop from the current average of 3 ppm(max.9 ppm) to the current average of 1 ppm(max.3 ppm). At the same time, the SS level should drop below 5 ppm. However, to meet the effluent standard of an oil content of 0.3 ppm or less, filters and an activated carbon filter must be installed.

Furthermore, some of the rolling oil, used in hot and cold mills emulsify, and is therefore difficult to treat. It is thus necessary to pretreat this wastewater by installing an oil-containing wastewater-treatment facility within the steelworks.

Beaker tests should be conducted prior to the installation of this facility. If it is found that the wastewater cannot be effectively treated with chemicals (emulsion breakers), then it will be necessary to change the types of oil used in the mills.

When the facility is designed, a buffer tank should be added to keep the requirements for the oil-containing-wastewater treatment facility to an absolute minimum.

To avoid the need for enlarging wastewater treatment plant in the future, the amount of wastewater accepted should be kept below the capacity of the dissolved air flotation tank of 3,380 m^3/h. The industrial water recovery rate in the water treatment plants at each factory within the steelworks should therefore be increased. Some locations currently discharge blow water from the indirect cooling water system into the wastewater treatment plant. Such blow water should be supplied to the direct cooling water system to decrease the amount discharged into the wastewater treatment plant.

b) Stomana Steelworks

The oil content at all the outlets is 2 to 5 ppm, which does not satisfy the effluent standard of < 0.3 ppm. Compared with levels in Japan, there is a very large influx of oil into the water-treatment facilities. Therefore, countermeasures, Steps 1 to 3, should be implemented in order.

It will eventually be necessary to install an oil-containing-wastewater treatment facility to treat oil-containing wastewater after it has been isolated from other wastewater. While a detailed study will be necessary to determine suitable treatment capacity (oil-containing wastewater intake volume) for this facility, a maximum capacity of 120 m^3/h will be sufficient. The facility would comprise dissolved air flotation tanks (oil content <2 ppm), a filter (oil content <1 ppm), and activated carbon filters (oil content < 0.3 ppm).

c) Promet Steelworks

Existing facilities are sufficient, and no additional pollution preventive measures are needed.

d) Kamet Steelworks

This steelworks is planned to be shut down, and hence no measures are required.

10.2.6 Energy to be used

The energy unit consumption per ton of crude steel, electric power unit consumption, and fuel unit consumption are predicted after the annual amount of electric power and natural gas produced, purchased, and generated in each scenario are estimated. All unit consumption values improve markedly and reach nearly the same level as that of most advanced steelworks. The energy balance is shown in Appendix 10-10.

1) Kremikovtzi Steelworks

Table 10-13 shows the estimated annual amount of electric power and natural gas purchased, generated and produced in each scenario. By-product gas is not produced and only natural gas is used as fuel in Scenario D-1, -2, -3.

Table 10-13 Estimated Annual Amount of Electric Power and Natural Gas Produced, Purchased and Generated in Each Scenario

	Unit	Scenario A, C	Scenario A-2, C-2	Scenario B-1, -2	Scenario D-1, -2, -3
Electric power purchased	10^6 Kwh	730.2	646.1	478.2	731.5
Electric power generated	10^6 Kwh	347.1	342.8	317	359.8
Natural gas purchased	10^6 Nm^3	233.8	169	223.6	373.2
BFG produced	10^6 Nm^3	2231.4	2994.7	1979.2	-
COG produced	10^6 Nm^3	235	311.8	209.7	-

Table 10-14 shows the estimated electric power and fuel unit consumption and energy unit consumption per ton of crude steel in each scenario. The energy unit consumption per ton of crude steel, which means the total efficiency of energy consumption in the steelworks, is reduced to the same level as that of the most advanced mills (5,000~8,000 Mcal/t). Therefore, operational conditions after improvement in the selected scenarios can be evaluated as good terms of energy use.

Table 10-14 Estimated Unit Consumption in Each Scenario

	Unit	Scenario A, C	Scenario A-2,C-2	Scenario B-1, -2	Scenario D-1, -2, -3
Electric power unit consumption	Kwh/t	785	725	881	1,180
Fuel unit consumption	Mcal/t	3,291	3,602	4,390	3,069
Energy unit consumption per ton of crude steel	Mcal/t	7,513 (6,438)	8,185 (7,233)	9,270 (8,225)	6,461 (4,862)

Note : Figures in ( ) are adjusted by changing the conversion constants (kcal/kwh) from the value of Kremikovtzi's in-plant power plant to the Japanese standard (2,450 kcal/kwh).

2) Stomana Steelworks

Table 10-15 shows the estimated annual amount of electric power and natural gas purchased, generated and produced in each scenario. Electric power and by-product gas are not generated in this steelworks because it is an electric furnace plant. All energy unit consumption values improve markedly.

Table 10-15 Estimated Annual Consumption and Unit Consumption of Electric Power and Natural Gas in Each Scenario

	Unit	Scenario A, C	Scenario A-2,C-2	Scenario B-1, -2	Scenario D-1, -2, -3
Electric power consumption	10^6 kwh	510.7	510.7	835.1	854.6
Natural gas consumption	10^6 Nm^3	91.1	91.1	95.8	97.2
Electric power unit consumption	Kwh/t	935	935	833	832
Fuel unit consumption	Mcal/t	1,335	1,335	765	757
Energy unit consumption per ton of crude steel	Mcal/t	3,683	3,683	2,838	2,827

The energy balance in each group is attached in Appendix 10-10.

10.2.7 Disposal of unused equipment bought by the former government and not yet installed.

There is much equipment which was bought by former communist government and has not yet been installed at each steelworks. The proposed disposition is as follows.

1) Stomana Steelworks

a) Reheating furnaces for plate mill

The plate mill has two (2) reheating furnaces which have not been installed, but they are so old that there would be no point in installing these units. This equipment should be used only for parts (e. g. pushers).

2) Kamet Steelworks

a) Danieli Project (Electric arc furnace-Continuous casting machine-Bar and rod mill)

Equipment manufactured by the Italian company Danieli was purchased, but has been left uninstalled. The steelmaking equipment comprises an electric arc furnace, LF (ladle furnace), degausser, and round billet caster. The capacity is 35t/charge. The rolling mill equipment is capable of producing bar and wire rod, but has a small capacity of only 150,000 tons per year. It is also possible to produce specialty steels such as tool steel and stainless. However, this equipment cannot be recommended for use in Bulgaria for the following reasons.

① Because demand for specialty steels is low in Bulgaria, the equipment cannot be used for specialty steels as originally planned.

② Electric arc furnace capacity is sufficient in Bulgaria as a whole. If more capacity is needed, it would be better to increase the capacity of the already installed EAF than to put a new EAF into operation.

③ New billet continuous casting machines are necessary, but the capacity of this continuous casting machine is too small to be practical.

④ For the bar and rod mill, there are two options: One is to replace the rod mill at Kremikovtzi, and the other is to add the finishing mill and finishing equipment only to the bar mill at Promet. For both options, this mill's rolling speed of 60 m /s is too low to be used.

3) Promet Steelworks

a) Universal stands

There was a plan to roll shapes with some universal stands instead of two-high stands in the bar mill. For this reason, there are six (6) universal stands at Promet, but these have not been not installed. There is not a large market in Bulgaria for shapes rolled by the universal stand (which means large sizes). Therefore, it is not necessary to consider installing these stands now, as it will not be possible to recover this investment.

b) Plate mill

The housing and rotor of the motor are in the warehouse at Promet, but it might be possible to use this mill as a plate mill at Stomana Steelworks, if the existing facility needs to be replaced. However, because of uncertainty of the specifications of this mill, it was unclear whether this mill can actually be used at Stomana. In any case, this is not an urgent item.

c) Argon plant

This equipment produces hydrogen and argon by separating air. The plant is necessary for steelmaking, but without a steelmaking plant, this plant is not necessary.

4) Disposal of unused equipment

As described above, none of the unused equipment is suitable for use in Bulgaria. This hardware should be sold, but it will be necessary to have equipment lists, general drawings, etc. and to check the equipment against the lists before it can be sold. The Ministry of Industry should prepare these documents.

10.3 Organization, Management, and Human Resources

The steel industry, as mentioned in Section 3.1.4 and Section 8.3.1, comprises two types of companies, joint-stock companies and limited companies. The following will discuss the nationally-owned joint-stock company because Bulgaria's largest steelworks, Kremikovtzi and Stomana, are of this type.

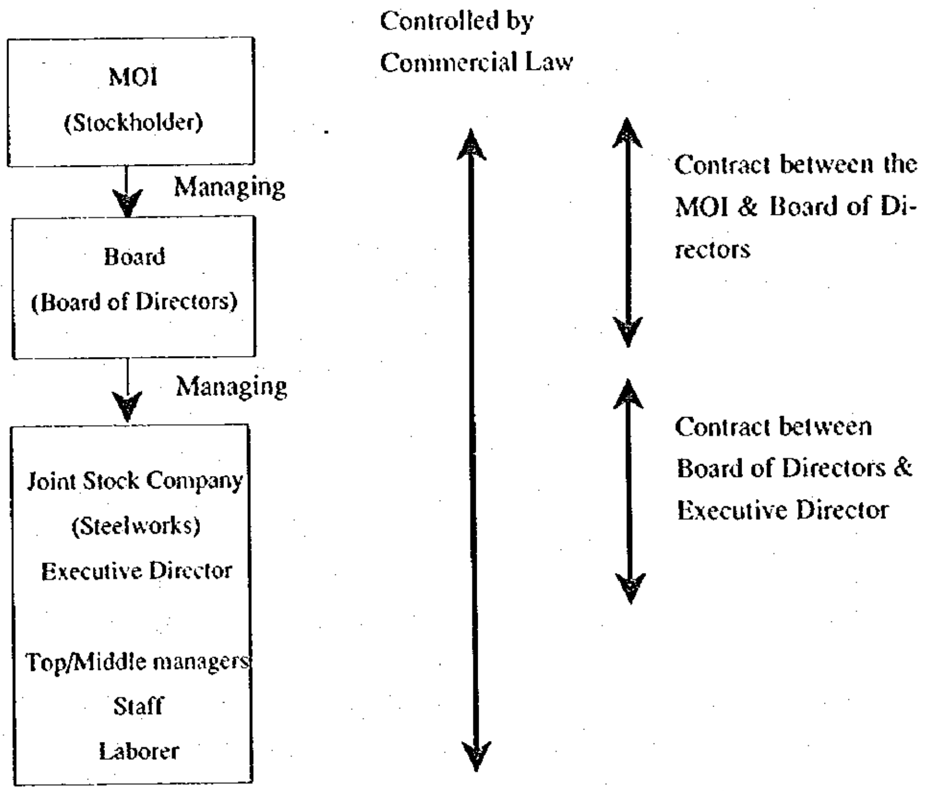
Although concrete methods of restructuring the steel industry and modernizing the steelworks have already been discussed, various management systems must be constructed and promoted by outstanding human resources when these programs are implemented. Study of the organization should be carried out at the stage when human resources are secured and the plan for constructing the management systems is implemented.

As mentioned in Section 8.3.1, the management of a nationally-owned company involves a relationship among three parties, the Ministry of Industry (MOI) as shareholder, the board of directors, and the steelworks.

10.3.1 Management system

Figure 10-4 shows the relationship of the MOI, board of directors, and steelworks.

Figure 10-4 Relation between MOI, Board of Directors and Steelworks



10.3.2 Management problems

Management problems were studied based on the idea that the reasons for the existence of a company are pursuit of profit, welfare of employees and social responsibility.

On the basis of the information obtained by the JICA study team from the MOI and the five steelworks during the study, the following problems related to the management of the steelworks can be mentioned.

1) MOI, board of directors, and executive director

Contracts between the MOI and members of the board of directors, and contracts between the board and executive director determine the respective roles of these persons and their conditions of service. The following problems can be cited from the contracts, and the current condition of the steelworks.

a) Although the obligations and rights of the shareholder, board of directors and executive director are prescribed in the management contracts, the responsibility of each person with regard to business results is obscure. In spite of being the shareholder, the Ministry of Industry disregards its right to receive dividends as the sole representative of the people, and on the contrary, the Government has continued to give financial support.

b) The most important purpose of a company is the pursuit of profit. The Ministry of Industry does not have the power of dismissal of any executive director even if he cannot earn a profit.

c) The board of directors and its members are not participating sufficiently in the management of any of the steelworks. It was found during the discussions with the counterparts at the steelworks that the business plan prepared the executive director and approved by the board of directors, was not followed up by any employee.

d) Management contracts should avoid detailed descriptions of the rights and obligations of the top management such as the board of directors, the executive director, etc., because it will hamper a flexible and timely response to changes in business and political circumstances in a rapidly changing world.

e) Not a few people, not only in the steelworks but also outside the steelworks, raised the problem of the low morals of certain executive directors.

2) Steelworks

a) Top management (executive and deputy executive directors) does not make employees understand the management policies in its business plan.

b) Because items to be managed are not clearly defined in management policies, much data which is unnecessary for operational control is collected without employees understanding what should actually be controlled in production processes. The level of importance for operations, and the number and treatment of data collected are different in each production process.

Control of raw materials such as coal and scrap and intermediate products is careless. The material balance between production processes is not coordinated.

c) The job description prescribes in such great detail the job contents of each employee that it hampers flexible personal relationships within the steelworks and voluntary activities. It also makes jobs rotation difficult.

d) Middle managers (directors, deputy directors), engineers, and workers lack the desire to improve the operation and facilities in production processes.

e) Owing to a shortage of number of sales personnel and lack of sales skills among personnel in the sales and marketing department, the steelworks have little information about clients in the steel market. The current balance in 1994 showed a deficit resulting from the sale of steel products at extraordinarily low prices.

f) The present technical level of labor and improvement measures are shown in Section 11.4.1.

10.3.3 Measures for improvement of business management

The measures to solve the problems mentioned in Section 10.3.2 are as follows.

1) MOI and the board of directors

a) Amendment of laws and regulations

Laws and regulations should be amended to make the relative responsibilities of the MOI, the board of directors and the executive director clear in order to seek a profit, promote employee welfare, and contribute to the public welfare as a joint-stock company. It should be indicated in contracts that persons in charge of ensuring the rights of shareholders and seeking a profit by managing a company are assigned clearly, and if the person assigned to manage the company fails to realize a profit for some period of time, he should be dismissed by the MOI.

The company should be controlled by the minimum laws and regulations to prevent hardening of the system and management of the company. It is easy to amend company regulations.

In times of rapid change in political and economic conditions worldwide, company regulations should be revised adequately so that the company can maintain competitiveness in world markets.

2) Steelworks

a) Modernization of management of steelworks

The business plan should be achieved in ordinary production activities, and the executive director and top and middle managers should participate in achieving the business plan. The activities should be continued permanently.

For the early stages of modernization of the steelworks, an expert should be posted to the works to assist top and middle managers in preparing and implementing business plans and evaluating the results of implementation, and to give the managers training in the administrative skills necessary for implementing business plans.

(Responsibility of executive director)

The executive director should clearly indicate the management precepts and policies not only inside but also outside of the steelworks. This will enhance the reputation of the steelworks and give a sense of pride to employees. The policies should harmonize seeking of profit, promotion of employee welfare, and contribution to public welfare. The executive director should clearly indicate concrete targets and the implementation plan to be achieved.

(Top and middle management)

Top and middle managers should establish concrete targets in the area of their own responsibility to meet the targets of the business plan and prepare concrete implementation plans.

(Promotion of business plan)

The executive director and top and middle managers should periodically check targets and performance to see if the targets are being achieved. If the targets are not achieved, they should make efforts to achieve the targets by revising the implementation plan. Top and middle managers should be evaluated by their degree of success in achieving targets.

(Parties concerned with business plan)

The relationship between the MOI, board of directors, and steelworks in preparing and implementing a business plan is shown in Figure 10-5. A flow sheet of the preparation and implementation of the business plan and reference schedules are shown in Figures 10-6 and 10-7 respectively.

b) Seminar on modernization of the steelworks

In order to implement business plans, the executive director, top and middle managers, and operators must use skills to solve many kinds of problems. However, because Bulgaria had a socialism government until recently, the concerned parties have not had a chance to acquire the requisite skills. The parties should therefore acquire at least the minimum basic skills needed to modernize the steelworks. This basic training should be given to the parties by experts in many fields at a Bulgarian university separately from their jobs. Foreign experts should be invited temporarily as teachers. At present, a possible curriculum for basic training is shown in Table 10-16.

c) Expansion of sales and marketing department (urgent matter)

- Employment of sales staff
- Training of sales staff

10.4 Overall Schedule for Modernization

In a modernization program, it is important to progress systematically. The enhancement of corporate culture, personnel adjustments, operational improvements and equipment countermeasures should be carried out in a well-coordinated manner. The overall schedules of each scenario are shown in Figure 10-8, 10-9, 10-10. We recommend that investment should be divided into two periods, considering the urgency of the investment item and the relationship between equipment because it would be difficult to investigate simultaneously the aspects of personnel and funding, considering the large number of items to be improved. The two investment periods would each be five years.

Table 10-16 Curriculum of Training for Management

Classification	Trainee	Content of Training
Management for Directors	Director	1. Modernization of Steelworks 2. Accounting and Financial Situation 3. Labor Control
Management skills	Manager Staff	1. Steel Production Technologies 2. Steel Production System 3. Quality Control 4. Operation Research 5. Industrial Engineering 6. Basic English
	Manager Staff	1. Improvement of Group Activities
Production Skills	Labor at Leko ko	1. Production Skills for Casting and Forging

Figure 10-5 Relation between MOI, Board of Directors, and Steelworks in Implementing Management Policy

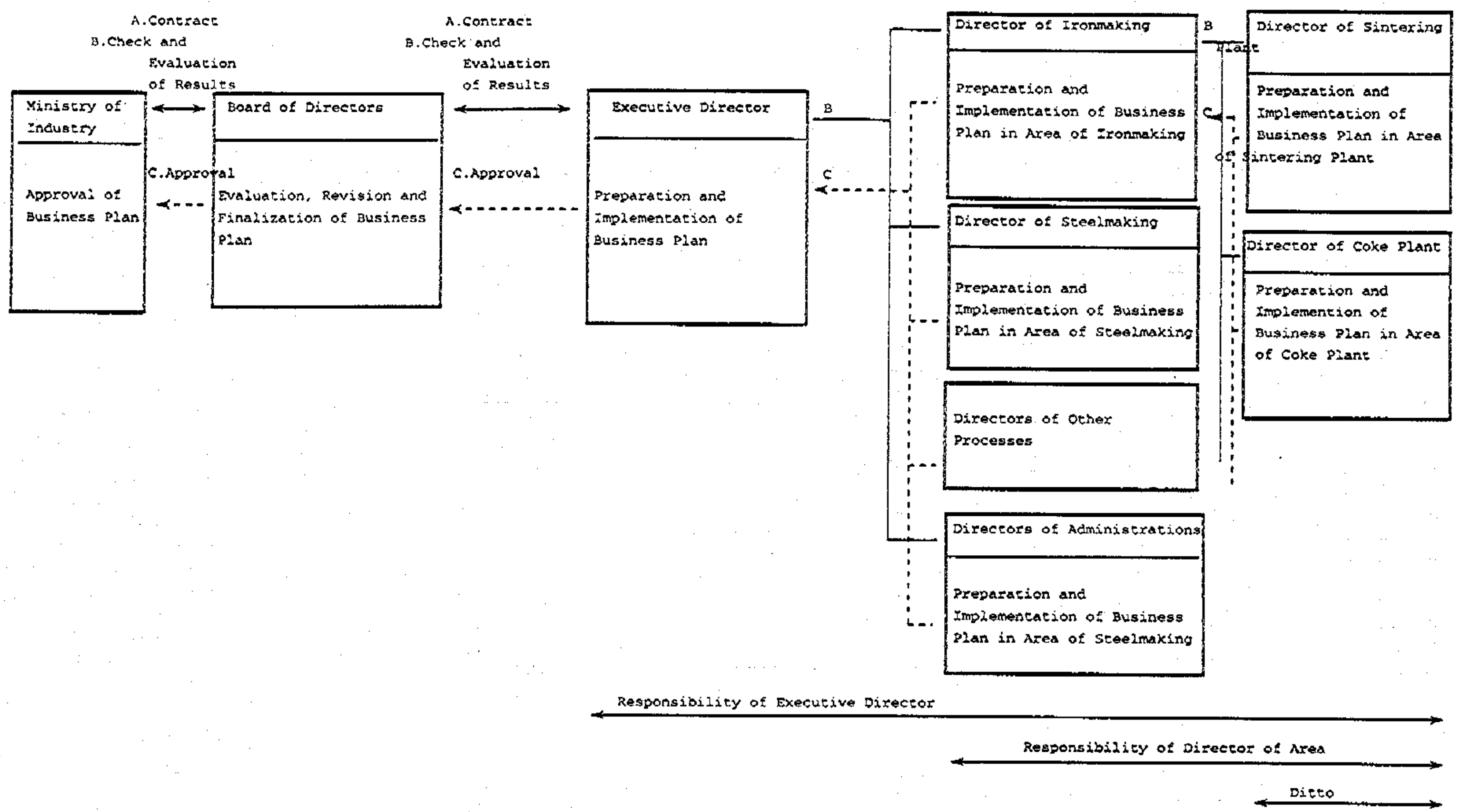


Figure 10-6 Flow Sheet for Preparation and Implementation of Business Plan

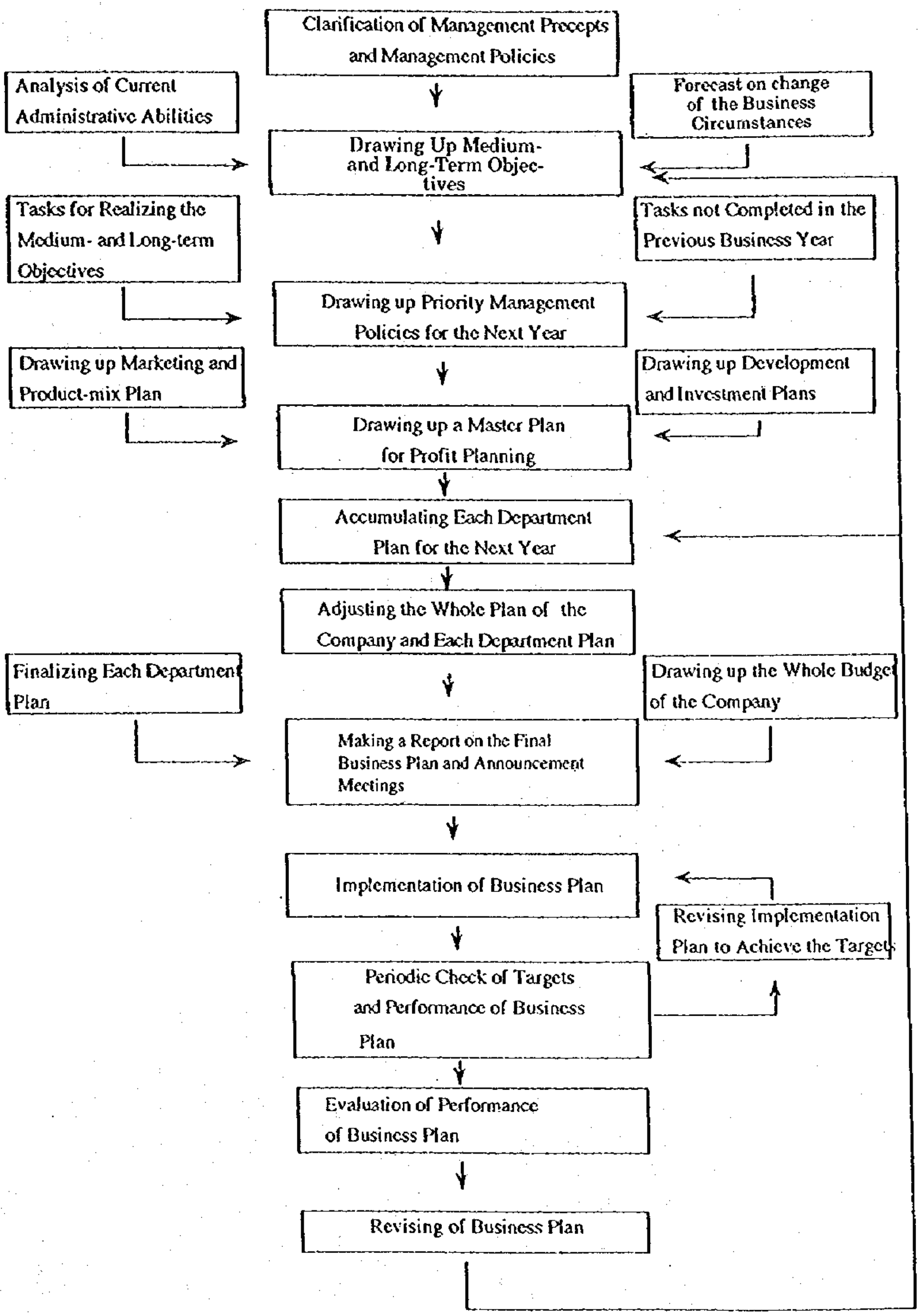


Figure 10-7   Schedule of Preparation of Business Plan

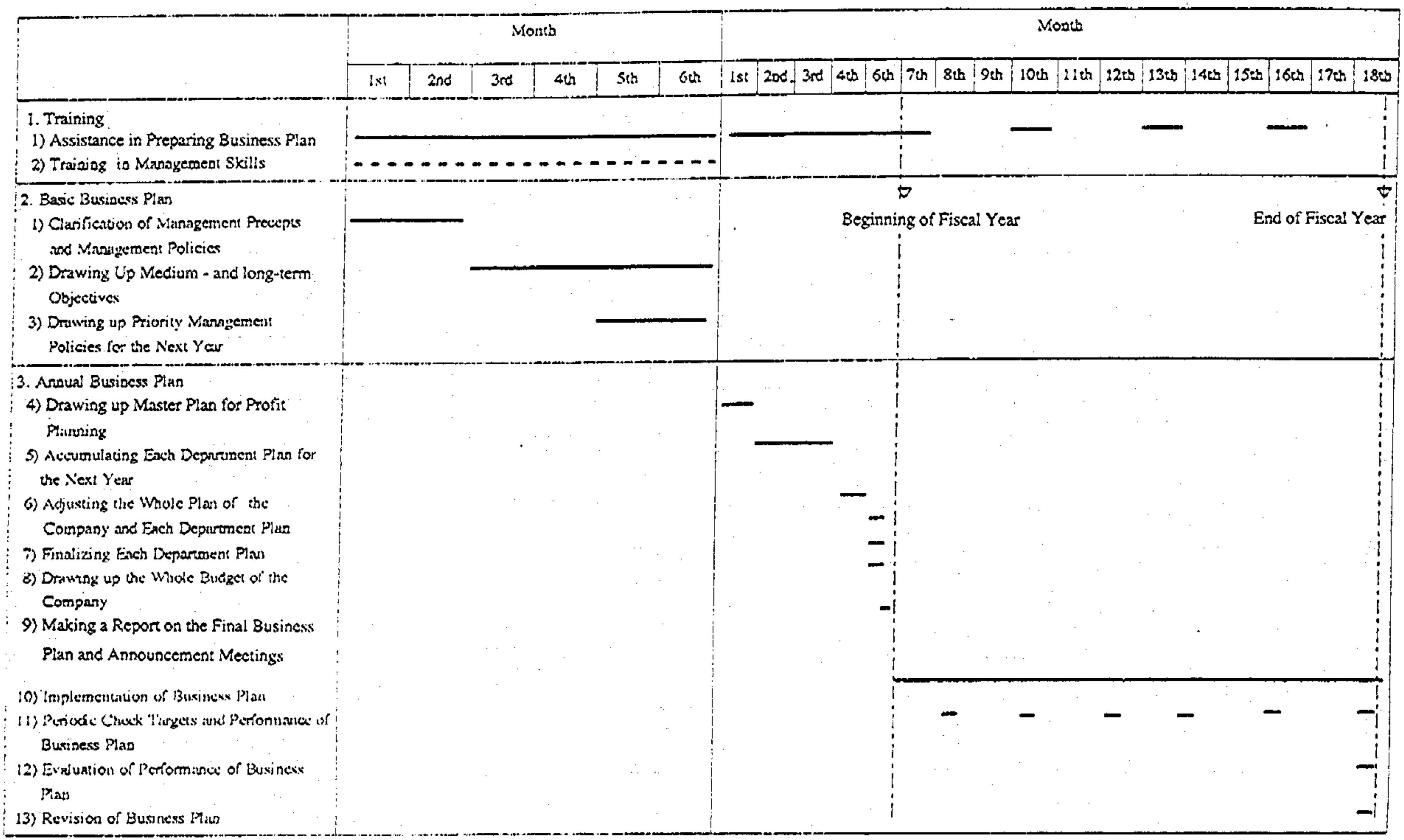


Figure 10-8 Overall Schedule for Modernization of Steelworks

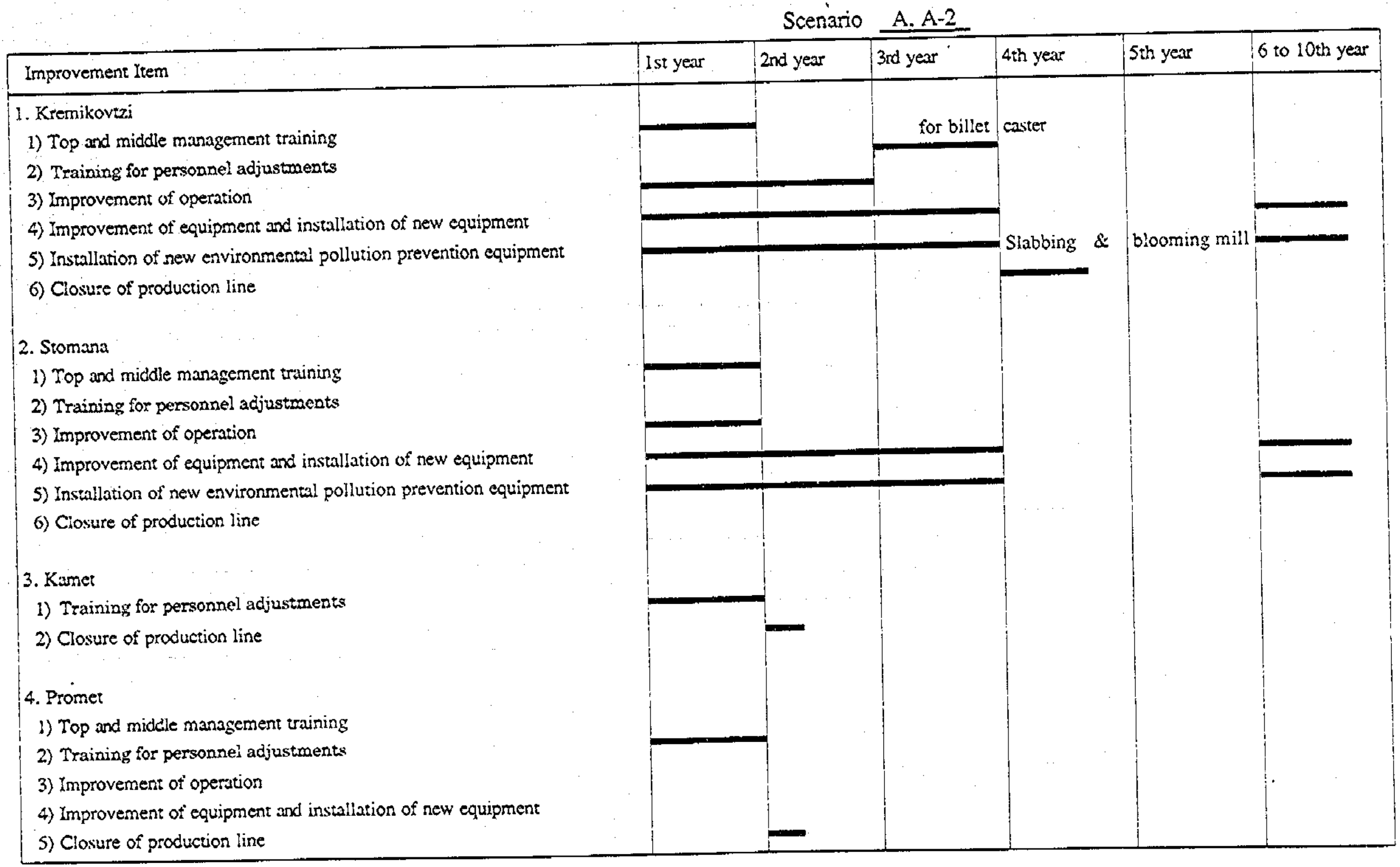


Figure 10-9 Overall Schedule for Modernization of Steelworks

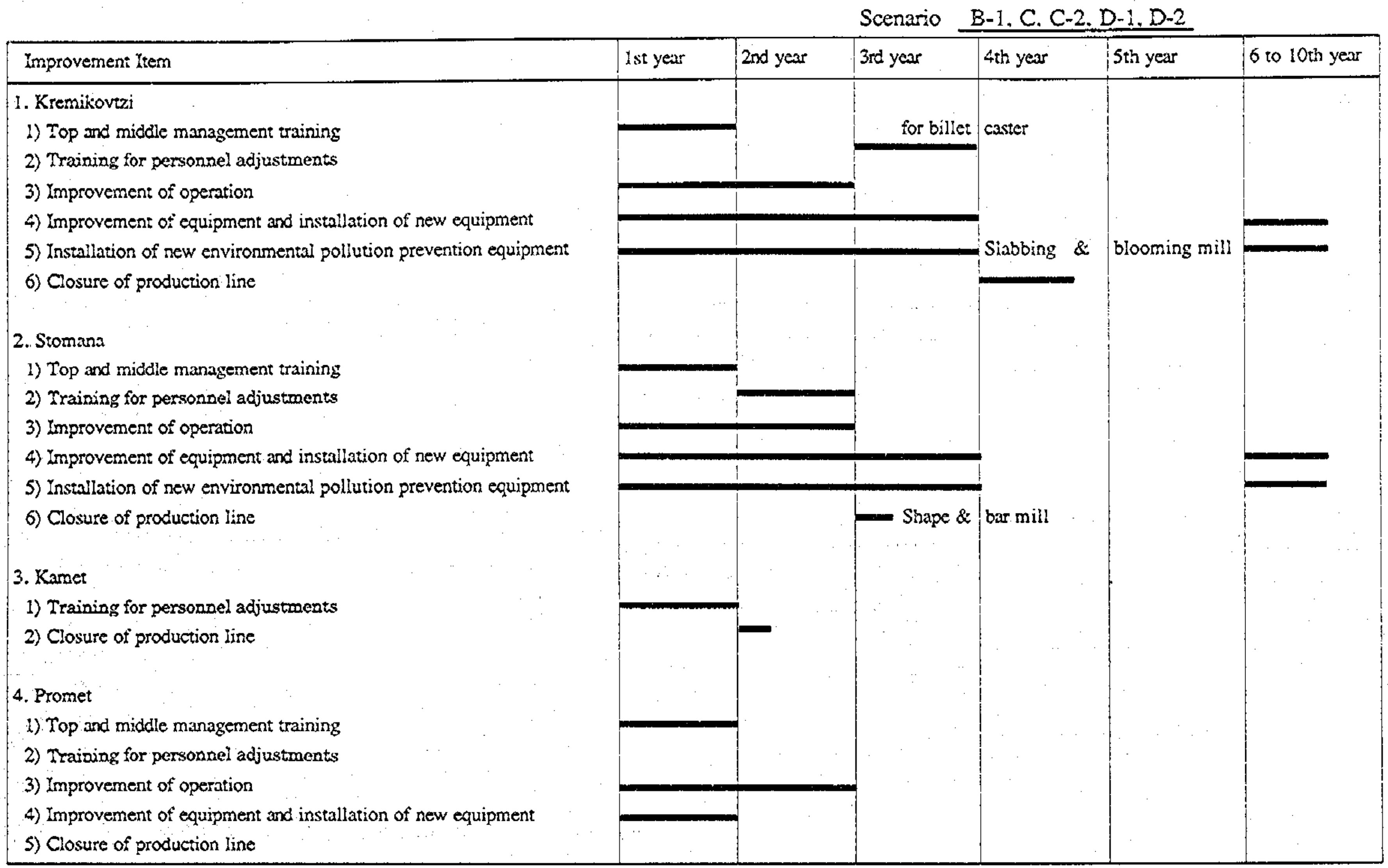
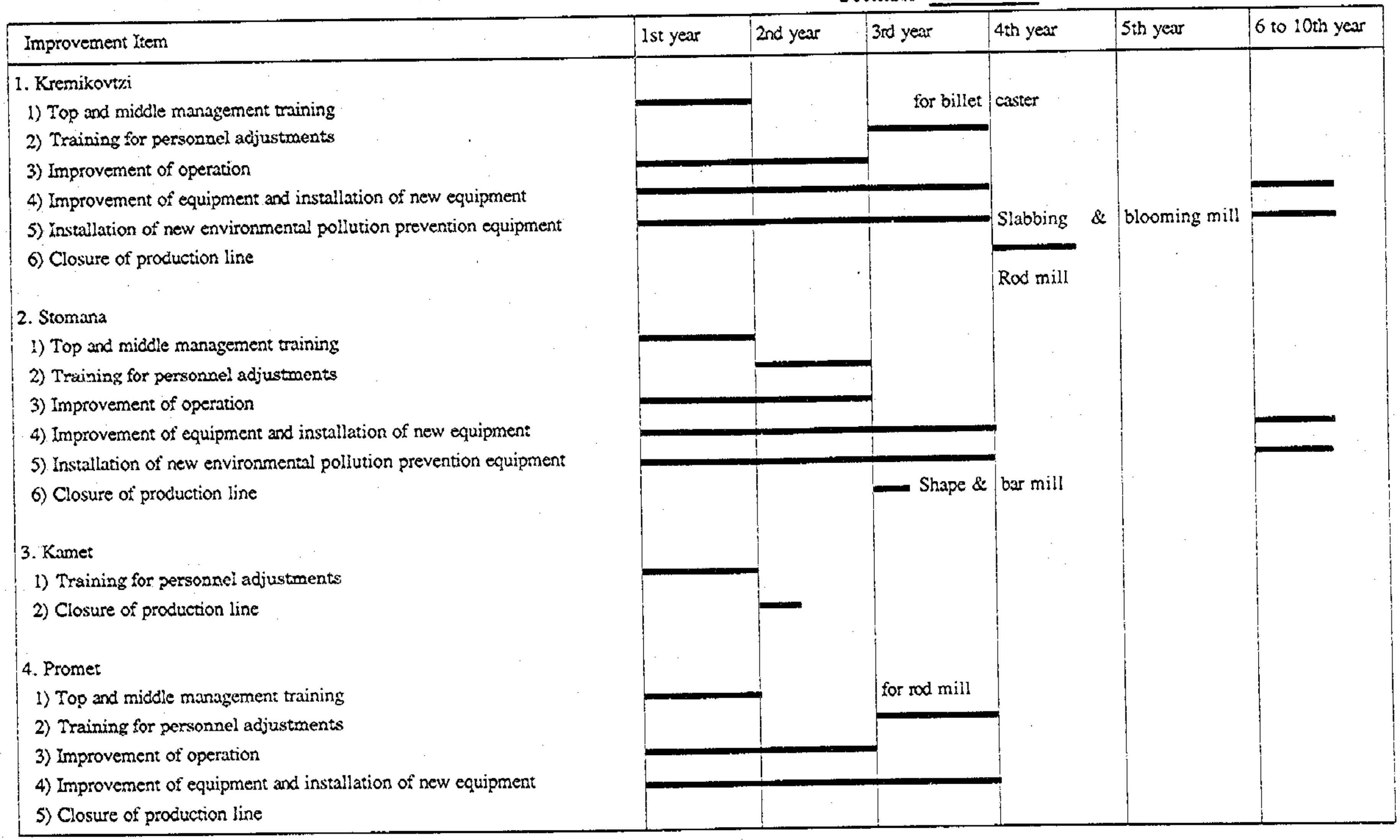


Figure 10-10 Overall Schedule for Modernization of Steelworks

Scenario B-2. D-3



Chapter 11 Modernization Plan for Leko ko Steelworks

11. Modernization Plan for Leko ko Steelworks

The major markets for heavy steel castings and forgings are the shipbuilding, energy, steel-making and industrial machinery sectors. Demand is projected to increase gradually, not drastically. No steel casting and forging manufacturer can survive without international competitiveness in the market, considering the overcapacity/oversupply situation of steel castings and forgings. Tangible fixed assets are generally large for heavy steel casting and forging manufacturers, who can therefore only make a profit by increased capacity utilization. Leko ko's main problems for restructuring are sales promotion and cost reduction. Leko ko should transform itself from a low cost supplier to western customers into a manufacturer of competitive products by improving its technology, skills, and products.

Leko Ko' competitiveness is now strong in terms of its labor costs, material costs, and energy costs, but weak in sales capacity, productivity, technology, and skill.

The competitiveness of steel casting and forging manufacturers depends not only on their facilities and capacity but also on the abilities, technology, and skill of their managers, staff, and workers. Leko ko should improve the abilities, technology, and skill of managers, staff, and workers and achieve better productivity in management and production in order to produce products which will be competitive in quality, delivery, and cost in the international market. The main problems for the modernization plan are education and training, sales promotion to support increased production improvement of productivity and cost reduction, improvement of production systems and increased machining capacity.

11.1 Forecast of Supply and Demand for Heavy Steel Castings and Forgings

Heavy steel castings and forgings are vital parts of machinery and equipment which are installed in ships, steel plants, power plants, mining plants, industrial equipment, etc. Users of castings and forgings put first priority on quality and second on price and delivery.

Future demand for shipbuilding, steel making and electric power sectors are predicted in Figures 11-1, 11-2 and 11-3. It is predicted that the gross tonnage of shipbuilding and steel product consumption will increase gradually all over the world. Electricity consumption also will increase gradually in developed countries with a significant increase in Asia. It is hard to predict the future demand for mining plants and industrial equipment because of a lack of statistical data, however, such demand is expected to increase gradually as with shipbuilding and steel making.

Each developed country has one or more heavy steel casting and forging supplier. Table 11-1 lists major heavy steel casting and forging suppliers in the world. Each supplier has the same kind of production facilities, consisting of electric arc furnaces, ladle refining furnaces, presses, heat-treatment facilities and casting facilities, but they have developed their own technology and made their skills competent to strengthen the competitiveness of

their products in their main market.
Figures 11-4 and 11-5 show the annual production levels of steel castings and forgings of major countries. Italy, Germany and Japan are the three largest forging suppliers, and the four largest steel casting suppliers are Japan, Germany, France and Korea. Annual production decreased from 1992 to 1993 due to the worldwide economic recession but began increasing gradually in 1994.

Since 1984, some heavy steel casting and forging manufacturers have been restructured, closed or merged on an international scale because demand for steel castings and forgings from the shipbuilding, steel making and power (energy) industries decreased significantly. However, the price level is still low in the steel casting and forging market due to excess production facilities and oversupply of steel castings and forgings. The market price level seems to have become worse after eastern European forgemasters and foundaries entered the market in 1989, when the socialist countries collapsed.

Some western forgemasters, foundaries and fabricators are now buying semi-finished products and low and middle grade products at cheap prices from CIS and eastern Europe. In Europe, sharing of the product mix seems to be developing between eastern producers (semi-finished products and low and middle grade products) and western producers (high grade products and high technology products).

11.2 Steel Casting and Forging Production Plan (Product Mix and Quantities)

The main problems are sales promotion and cost reduction of products, which will make Leko ko profitable by the increased capacity utilization brought about by growth in production. In 1994, Leko ko produced 13,793 tons of molten steel, which was larger than the figure planned the previous year. Table 11-3 shows production plans in 1998, in which Leko ko will produce 54,278 tons of molten steel per year.

Leko ko should strengthen its sales department by increasing the number of sales people, and educating and training them. In the meantime, without a major sales effort, Leko ko can receive orders for rough finished rolls, marine shafts, die plates for plastic molds, round bars and steel castings for ships from western customer who are looking for cheap suppliers, as explained in the previous section. In order to achieve the production plans after 1996, it is necessary for Leko ko to reinforce its sales activities and develop new products for new markets. Possible new products are finished machined rolls and marine shafts, hydraulic runners, turbine casings, axles and turbine rotors. Leko ko can expect demand for replacements of mining equipment parts from mines in the CIS to whom they had supplied original parts.

Leko ko was able to provide necessary raw materials and energy to produce the products in quantities listed in Table 11-2, as explained in the Chapter 6 and 8, and they once produced 60,000 tons of molten steel in 1987. However, it is a source of concern that imported

raw materials will cost more in the future owing to depreciation of leva in foreign exchange markets. Leko ko imports all its materials such as electrodes, ferro-alloys, refractories and isothermic powder, except scrap and limestone. A further concern is that scrap will cost more due to the shortage of supply caused by the increase of iron and steel production and opening of the domestic scrap market to free competition in 1998.
As reported in Chapter 7, there are no environmental pollution problems which might hinder production in the production plan.

11.3 Production Plan

11.3.1 Product mix and sales plan

Leko ko planned the sales and production plan shown in Table 11-3. As shown in Table 11-2, the production quantities for 2000 and 2005 are estimated at 70,000 tons and 80,000 tons of molten steel respectively after considering the plant design capacity, the maximum production record, other advanced shops and the market condition.

Table 11-4 shows extension ratios from 1995 to 1998 for each of the product mix and sales plans in Table 11-3, with the present and future products and markets. By 1998 Leko ko will expand roll and shaft production by 4 times compared to 1995, ingot and casting by 4 times and other forging by 9 times.

Although Leko ko should be able to increase its orders without increasing its sales activities in this and the next year, as long as western customers are expected to buy cheaper ingots and semi-finished products from eastern European manufactures, it should strengthen its sales capabilities to achieve the higher sales targets in the sales plan, which includes extending the present products of rolls, die plates for plastic molds, round bars and steel castings for shipbuilding and developing new products for new markets. The following should also be executed, as well as the reinforcement of sales capabilities in order to achieve the sales plan.

1) Receiving all roll orders from domestic mills
Leko ko should attempt to secure the entire Bulgarian roll market for itself by establishing close, customer oriented relationships with the other Brugarian mills. Roll engineers should be dispatched to the roll shops of domestic mills, as their technical service will encourage the mills to place roll orders with Leko ko. If it has no roll engineers, Leko ko should ask the other mills to train its sales engineers in their roll shops. Leko ko can also recruit roll engineers from domestic mills or foreign firms. Data packages for roll services as well as roll engineers should be provided to encourage roll purchases.

2) Expanding exports of rolls
Although Leko ko is now exporting semi-finished rolls to Germany, UK and other western customers, it should make an effort to sell finished rolls directly to the end custom-

ers and make these finished rolls one of its main products with competitiveness in the world market. In order to sell finished rolls to western mills, who now hesitate to use these rolls due to a lack of actual roll operation records in western mills, Leko ko can introduce manufacturing technologies from western firms or produce rolls under OEM agreements with a western roll manufacturer.

Leko ko should also enter the roll replacement market in the CIS and other eastern countries, who formerly were their main customers for rolls.

3) Sales promotion of castings and forgings for shipbuilding
Leko ko seems to be sufficiently competitive to produce castings and forgings for ships, having well equipped facilities including a shop certificate from the Lloyds and DNV classification societies and a quality assurance certificate as for ISO 9002 until the end of 1995. Some western European foundaries are not as competitive as before owing to shop closures and a lack of workers. The present is therefore a good time for Leko ko to sell more stern castings to shipbuilders around the world including Korea, Japan, Taiwan and China. Leko ko should promote active sales operations by dispatching salesmen with sales engineers to customers.

Overseas sales offices could become a very strong tool for foreign trade, not only in stern castings and shafts but also rolls for Asian mills.

4) Re-entering the CIS market
Leko ko once exported a large amount of rolls, metal processing machinery parts and mining machinery parts to the CIS, and is now contacting these customers in an effort to resume business with them. When the CIS market revives, Leko ko should be able to receive large orders for replacement parts and new projects.

5) Development of a new product mix for the future
In the future, Leko ko will develop a new product mix using excellent skills and technology, starting from competitive finished rolls and stern castings. The new product mix should be developed in two steps.

① 1st step (1995 ~ 2000)
Sales promotion of the present product mix, such as rolls and stern castings.
Increase sales of finished rolls and shafts for ships.
Receive trial orders for hydraulic runners and turbine casings.

② 2nd step (2000 ~ 2005)
Sales promotion of hydraulic runners and turbine casings.
Receive trial orders for turbine shafts.

6) Cooperation between sales people and shop engineers
An user of heavy castings and forgings puts the first priority in quality, although also

considering price and delivery, since these components are assembled as vital parts of the user's machinery and equipment installed in ships, steel mills, power plants, mining plants and industrial facilities. The specifications of the castings and forgings change for each product, and orders are placed with suppliers for each product item. The number of products in one lot is small, even with repeat orders and lot production.

The product specification is usually finalized through discussions between customer and supplier. Therefore, it is very important for suppliers to keep close contact with customers, both in commercial and technical matters.

It is also important to earn customer confidence by trouble-tree products shipping and by trouble free operation of the product in the user's facilities. A quick reply to the customer's inquiry on cost, delivery and quality and quick and appropriate disposition of nonconformities and claims are the supplier's responsibility if he expects to keep the customer's confidence.
Shop engineers should take part in sales activities, understand customers' needs and give customers technical service upon request.

11.3.2 Production quantities and material balance

Table 11-2 shows the annual production quantity up to 1998. The sales amount was first decided, and the annual production quantity was calculated by dividing the sales amount by the per ton price of the product, which was assumed not to change. The annual production quantity may change if the price of product rises or the number of finished products increase. Leko ko should achieve the goals explained in Section 11.4.1 Improvement plan, to achieve the production quantities in Table 11-2.

Figure 11-6 shows the material balance in 1994 and 1995. The yields of ingots and castings relative to molten steel are 82% (1994) and 80% (1995 1~6), which are considerably lower than the 98% yield ratio of 1993. No clear explanation was given for the lower yield ratio, but it seems to be a statistical mistake. The forging yield ratio and casting yield ratio are normal.
As reported in Section 6 and 8, the necessary energy and raw materials can be provided for the production quantities of production plan, but it should be noted that energy and raw material costs will be higher in the future.

11.3.3 Productivity and yield

Table 11-5 compares the productivity and yield of Leko ko and the most advanced manufacturers. Some of data in the Leko ko column is not applicable now, and fresh data should be collected to help improve future productivity.
The most serious problem is low labor productivity owing to small production quantities and a large number of workers. Table 11-2 shows the labor productivities of steel making, forging and casting. Labor productivities were calculated using the number of

workers directly in charge of each process. In 2005, Leko ko's labor productivity is predicted to be less than half of that of advanced shops in 1994, even if Leko ko is able to hold the number of workers the same level as in 1994.
Leko ko's labor productivity in steel making is forecast to be 271 tons/man-year in 1998, or about one third that of advanced shops.
It is most important for Leko ko to improve labor productivity by executing production plans without increasing the number of employees. Improvement of labor productivity will bring an improvement of process productivity and yield as well as cost reduction due to an increase in capacity utilization.

The number of workers in service groups such as crane, maintenance and sub-operations is larger relative to the main operation. Service groups should be studied to determine the necessary service items and the minimum number of necessary workers to improve productivity.

Leko ko should also study the possibility of separating the energy department as an independent company of 300 personnel.
Process productivity and yield will be improved after labor productivity is improved and the staff becomes more competent through education and training.

11.4 Improvement Plan and Cost Estimate for Modernization

11.4.1 Improvement plan

Heavy casting and forging facilities are generally behind other facilities in automation and mechanization. Therefore, the technology and skill of personnel greatly affects product quality, cost and delivery. Heavy casting and forging facilities are equipped with electric furnaces, ladle refining furnaces, presses, casting equipment, heat treatment equipment and machining equipment. This equipment is all conventional, and the competitiveness of the facilities depends on ability of the personnel to produce products with better quality, lower cost and shorter delivery times than those of their competitors. Table 11-6 shows Leko ko's competitiveness in term of sales force, cost, etc.

1) A lack of engineers and skilled workers
Leko ko started production of castings and forgings in 1984 using technical and work standards transferred from Kobe Steel. Kobe Steel also educated and trained about 60 engineers and workers who were expected to play major roles in manufacturing. Around 1984, Leko ko mainly made rolls for Russian mills under a Russian supervisor who controlled the procedures and operations in shops. There was some confusion between their standards and the Russian system of control.

At present only 5~6 remain at Leko ko out of the 60 educated and trained in Kobe Steel. Leko ko is technically capable of making carbon steel for marine products, low alloy steels and roll steel but unable to improve its technology or to develop new products. Leko ko has 1,670 employees, consisting of 1,310 workers, 300 staff and 60 others.

There are only 30 expert staff who are qualified to manage the necessary functions. These 30 staff members must handle all the functions of sales, technical matters, production, quality assurance and maintenance. Leko ko has the problem of a lack of expert engineers and young engineers with future potential.

At the shop, the number of capable foremen is so small that Leko ko can not schedule the shifts necessary to increase production. Leko ko needs more time to develop capable foreman, which takes more than ten years from hiring. Many workers retired after the collapse in 1989, and there are few potential young engineers.

The lack of excellent engineers and capable foreman not only prevents the execution of production plans, but also causes major problems in sales promotion, productivity improvement, development of technology and products, and education and training.

Education and training is one of the major functions and responsibilities of top management in the shop. Top management should understand the importance of education and training, make a basic policy for education and training and implement that policy.

Leko ko should study the present condition of the staff and workers and make a personnel chart which shows the necessary number of staff and workers in the future, together with their specialties and level. The education and training plan should be provided with specific education and training programs for the necessary staff and workers. The education and training program should contain the following items.

① Leko ko should recruit personnel from western countries to meet its urgent need for salesmen, engineers and foremen of casting and roll engineers.

② JICA's overseas service of dispatching specialists should be used for the education and training of staff and foremen to improve their technology and skill in steelmaking, casting, forging, production control and technical service.

③ Leko ko can also send its staff and workers to JICA's education and training course to improve their abilities.

④ It will be highly effective for Leko ko to dispatch its personnel to on-site education and training at advanced steel casting and forging shops. However, most advanced steel casting and forging shops will not easily accept trainees from Leko ko because they are now under reconstructuring and cannot spare manpower for education and training of personnel from the outside.

2) Investment in machining equipment and steam ejector

① Machining equipment

Leko ko should install new machining equipment and, retro-fit, move and install old machining equipment in order to machine the product mix for 1998. Table 11-7 shows the new and old equipment as well as a rough estimation of the investment costs for installation of new and old equipment.

To cover the lack of machining capacity, Leko ko needs to ask Bulgarian machining shops for machining services. It should be noted that the cost of machining services might be more expensive due to their lower capacity utilization than at Leko ko. The total investment cost of $ 17.9 million should be submitted to the MOI for approval.

② Steam ejector
Only one ejector is available for the 75ton VAD, 70ton VOD and 75ton vacuum casting tank. The capacity of the ejector is too small for parallel operation of this equipment. One more ejector is necessary for increased production, especially of stainless steel. Leko ko is now constructing an ejector with the budget of 12.4 million Leva.

3) Production control system

At Leko ko, 690 personnel are assigned to steelmaking, casting, forging, heat treatment and machining, 300 to the energy department, and 680 to control departments such as production control and plant management which do not work directly in production. The number of control department personnel seems large compared to that at other steel casting and forging shops. A total production control system would be effective for rationalizing control and managing departments by automatic preparation and control of documents, information control, planning and decision making. However, it is not feasible for Leko ko to introduce such a total production system at once because the cost cannot be justified at the present level of income.

Increased production to achieve the sales plan is now the most important problem for Leko ko. The total production control system should be introduced in steps, as explained below, starting from the steps which are directly useful for increasing production.

① Define and standardize the functions and responsibilities of each department and section.
② Make a preliminary basic design of the total production system and adjust the system balance among sections.
③ Each department separately makes computer programs which cover its own functions.
④ The following systems are introduced to increase production, if it is found profitable by a detailed study.
  Steelmaking support system
  Press schedule support system
  Machining schedule support system
⑤ Computer programming of the total production system and installation of a host computer, workstations and network cable lines
⑥ Education and training in operation, system start.

Figure 11-7, 11-8 and 11-9 illustrate a steel making support system, press operation control system (the press schedule support system is a part of this system) and machining schedule support system. The total production and operation control system shown in Figure 11-9 has been developed by Japanese steelmakers over a long period of 20 years and required enormous investment. It is not feasible for Leko ko to introduce a production and operation control system at once which covers all activities from order receiving to production, shipment, and accounting. Leko ko should introduce in steps the systems shown in Figures 11-7 and 11-8, which are considered the most cost-effective investments.

4) Improvement of productivity

Leko ko's productivity and yield are far behind those of other advanced steel casting and forging shops, and there is much room for improvement, as explained in Section 11.3.3 Productivity and yield. Most managers, staff and workers have not been trained in how to improve productivity and are not motivated to improve it. No section is responsible for improvement, and there are no capable staff who can promote improvement activities. It is necessary to implement education and training before promoting improvement.

Leko ko has a quality assurance manual and will be certified under ISO 9002 by Lloyd's register of shipping. TQC education will also be useful for improving productivity and yield in the future. Education of TQC could be performed while using the manual in the education and training program.

5) Environmental pollution prevention measures

a) Air pollution prevention measures

Leko ko steelworks do not need additional countermeasures, especially plant installation, for air quality. However, environmental control, including the maintenance of dust collectors, should be done more effectively.

b) Water pollution prevention measures

Additional pollution preventive measures are not necessary, although the daily operation control of oil leakage must be enforced more strictly.

The installation of oil detectors at the drainage outlets to permit the early detection of oil leakage is desirable.

6) Disposal of unused equipment

a) Horizontal continuous casting machine

There is a two strand continuous casting machine made by Mannesmann-Demaag in packing. The product sizes are ϕ 170 ~ 360, and the capacity is 90,000 tons per year. This machine is also not necessary for the reasons described below.

① Usually a horizontal continuous casting machine is used for stainless billet. The market in Bulgaria is small.

② The market for stainless steel scrap is also small in Bulgaria, so it would be hard to obtain material for stainless steel.

③ The billets made by the horizontal continuous casting machine are not competitive, because an expensive break ring made from boron nitride is required. (The break ring must be changed with each charge.)

11.4.2 Rough estimate of investment cost for improvement

The main subjects of improvement are sales promotion and education and training, which requires much time and many personnel. The manpower cost is not estimated here but the costs are estimated in Table 11-7 for installation of machining equipment and the introduction of a production control system.

It should be noted that the cost seems very high when compared with typical European costs because all costs except the steam ejector are estimated as costs in Japan. The ejector is now under construction with the budget estimated by Leko ko. Leko ko can reduce the software cost when it introduces the systems if it does its own programming or use Bulgarian programmers under the consultation of system engineers.
Leko ko should have a potential to develop software by itself and construct its own total production system with minimum support from a computer system company, because it is not profitable for Leko ko to buy all its software and hardware outside even after 2000.

Numerical controllers are incorporated in all the machining equipment listed in Table 11-7 to reduce operator requirements and improve productivity. The detailed specification of machining equipment should be decided to maximize profit and minimize investment. Leko ko should choose the most appropriate machine considering the dimensions of the work, rough or finished machining, and the use of new, used or retro-fitted machines.

11.5 Organization, Management and Human Resources

It seems that the organization and management are inflexible not only in Leko ko but also in other Eastern European firms. Management policy is not clarified at the top of the organization. Even if a top management policy exists, middle management and staff are not given actual action programs showing what should be done and when the targets of the policy should be achieved. It will take much time to modernize the organization and management, because a change is mentality in needed to perform modernization. Without modernizing the organization and management, it will be impossible to restruct and modernize Leko ko. The following items should be considered in modernizing the organization and management.

① Top policy should be clearly announced with regard to modernization of the organization and management

② It is necessary for all managers to change their management policy from that of a state-owned company to that of a private company. They should have a business mentality.