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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF INDUSTRIES
ROMANIA

STUDY ON ENVIRONMENTAL POLLUTION CONTROL AND ENERGY SAVING IN THE INTEGRATED IRON AND STEEL WORKS "SIDEX" S. A. GALATI IN ROMANIA

(SUMMARY)

FEBRUARY 1995

Kobe Steel, Ltd.

Nippon Steel Corporation

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PREFACE

In response to a request from the Government of Romania, the Government of Japan decided to conduct a study on Environmental Pollution Control and Energy Saving in the Integrated Iron and Steel Works "SIDEX" S.A. Galati in Romania and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Romania a study team headed by Mr. Hiroshi Tsutsumi, Kobe Steel, Ltd., three times between November 1993 and December 1994.

The team held discussion with the officials concerned of the Government of Romania, and conducted field surveys in the study area. After the study team returned to Japan, further studies were conducted and the present report was prepared.

I hope that this report will contribute to the Environmental Pollution Control and Energy Saving in the Integrated Iron and Steel Works "SIDEX" S.A. Galati in Romania and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Romania for their close cooperation extended to the study team.

February 1995

Kimio Fujita
President
Japan International Cooperation Agency

INTRODUCTION

1 The Sidex SA Galati (Sidex) integrated iron and steel works on the river Danube in Romania, which is the subject of the brief paper, has a capacity to produce around 10 million tons of crude steel. It is the largest steelworks in Eastern Europe. Production has recently been decreasing mainly due to shortage of raw materials and energy.

2 An ongoing and fundamental task which it faces is the immediate necessity to improve the environmental impact which Sidex has on the Danube and the approximately 400 thousands residents in the Galati area.

3 The lack of environmental protection is a legacy of the heavy industrial policy of the former socialist "planned" economy. Romania suffered under this policy more than most as it was probably the most rapidly developing country in Eastern Europe.

4 During this forty years a low priority was given to environmental issues and virtually no consideration was given to adverse impact. Little investment was made in protection or preservation of the environment. The price is now being paid for this lack of foresight. Another consequence of this philosophy was that the price of energy resources such as petroleum and natural gas built into investment decisions was set extremely low so a great deal of precious resources were just wasted and the resultant waste products further added to environmental degradation. The resultant effect became a critical issue for the new regime and has resulted in new and urgent priorities for the management.

5 From the 26th of October 1992 until the 12th of November 1992 discussions were held between the Romanian and Japanese Governments on the problems which existed generally throughout this part of Eastern Europe (Romania, The Czech Republic and Slovakia). A program of technical assistance in the field of energy conservation, environmental protection and pollution control was agreed upon with Sidex chosen as a case study. This choice was based mainly on the probable impact any improvement would have on the three other major steelworks in Romania.

6 From the 20th of March to the 29th March 1993, a feasibility group visited the Sidex Plant to take an overview of energy utilization and environmental pollution. Their object was mainly to plan for the preparatory study and following this visit on the 21st of June 1993 an agreement was signed with Ministry of Industries and Sidex management on the scope of work of the Study.

7 The object of the Study is to analyze the present situation at Sidex in order to design a program to improve energy utilization efficiency, to reduce contaminant release and to improve the environment. The scope of work agreed to achieve this was as follows:-

Measures for energy saving (fuel, electric power and steam)

- i Coke oven batteries (including Coke Dry Quenching),
- ii Sintering plants,
- iii Blast furnaces (including hot stoves),
- iv Reheating furnaces.

Measures for environmental protection (dust, sulfur oxides, nitrogen oxides, wastewater and other waste)

- i Coke oven batteries and Coke chemical plants,
- ii Sintering plants,
- iii Blast furnaces.

8 The Study was carried out in accordance with the procedure described in the basic agreement as follows:-

"There are various facilities of the same type in Sidex. As some facilities do not need to be operated according to the production plan and some facilities are classified into the same category, a plant is chosen as a model from respective facilities. The conceptual design only for that model is studied and that design is applied to other facilities."

9 The following were selected as the models:-

- i No.5 Coke oven battery (including No.2 CDQ) and the corresponding Coke chemical plant,
- ii No. 6 and No. 7 Sintering plants,
- iii No. 6 Blast furnace (including a hot stove),
- iv Hot rolling mill No. 1 Reheating furnace.

On the 18th November, 1993, the inception report was submitted to the government of Romania, where the way of investigation, the organization of the field survey, its schedule, and questionnaires are involved. During the Study it was found that as a result of the Sidex production plan, parts of the plant were not available for use as a model because of shutdown for example. In such cases and based on the agreement with Sidex, a similar plant was selected as a model and investigated. In addition, Sidex requested that a few additional plants were added to the Study for various reasons and all these matters are described in the report.

10 The first field survey was carried out from the 22nd of November to the 18th of December 1993. At that moment, JICA explained the inception report at first, and SIDEX and JICA agreed the object as well as the way of investigation mutually, and the study began. The results and preliminary ideas on possible improvements were summarized in the Interim Report. This was submitted to the Romania Government on the 16th of June 1994.

11 The second field survey was carried out from the 6th of July to the 10th of August 1994. This Second Survey carried out supplementary investigations of the model plants to investigate the costs and effects of possible measures. It also discussed more deeply the contents of Interim Report, the financial arrangements and investigations of the effects on related plants.

12 After the second field survey, all available data and information such as the present problems, its causes, its possible solutions, the cost of investment, the implementation schedule, and so on was compiled in one book, a Draft of

Final Report, and it was submitted on the 16th November, 1994. The Summary of the Draft Final Report was, as well, submitted on the 22nd November, 1994.

13 The third field survey was carried out from the 26th of November to the 13th of December 1994. The purpose of the third field survey was to make an explanation about the Draft of Final Report to the Romanian counterparts, and then the contents of the Draft was agreed by the Romanian party and JICA. (On the 6th of December, 1994, the minutes of meeting was made and signed between the Romanian government and JICA.)

14 After discussions and approval by Sidex and Romania Government at the third field survey, the Final Report is submitted to the Government of Romanian in February 1995. The Study and the Final Report was facilitated by the wholehearted cooperation and support from our Romanian colleagues, especially those in the Ministries of Industry and Environment and in the Sidex management. The Japanese study team wishes to express its sincere appreciation.

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I. STUDY OF THE BACKGROUND

1. ECONOMIC CONDITIONS AND STEEL INDUSTRIES OF ROMANIA

1.1 Outline of the Present Economic Trends of Romania

After the revolution in December 1989, planned economy under former socialism economic structure was drastically transferred to the market economy. The new regime has conducted a rather gradual transfer of the economic system to the market economy. However, old economic constitution could not well timely cope with the new situation and abolition of government subvention to the producers based on price liberalization incurred an increase of consumer prices and unemployment.
The followings shows the changes of economy indices after the year of revolution (data from Anualrul Statistical Romaniei, etc.);

(1) Growth Rate of GDP (in percentage against previous year)

1990	1991	1992	1993*1
-5.6	-12.9	-13.5	1.0

(2) Consumer Price (in percentage against previous year)

1990	1991	1992	1993*1
105.1	274.5	310.9	355.1

Remarks)
According to the recent data from January, '94 to May, '94, average increase rate of consumer price is 6.0% which was approximately half the figure of the same period of the last year and seems to becoming stable in lower level.

(3) Unemployment percentage

1990	1991	1992	1993*1	1994*2
–	3.0	8.4	10.2	10.9

*1 : Tentative figure

*2 : Figure of June '94 and number of unemployment was registered 1,243,813.

1.2 Status of Privatization

According to the Council for Coordination of Strategy and Economic Reform, various policies are issued with priority given to the privatization of industries in the market economy, one of which is "the Law on Restructuring of State Enterprises into Government Corporations and Private Companies" established in August 1990. The "Enterprise Privatization Act" established in August 1991 stipulates the restructuring procedures. According to the Acts, the 70% of the stocks of an enterprise will be transferred to the state ownership fund and the remaining 30% to the private ownership fund. All the Romanian population older than 18 years will be given coupons free of charge, which can be changed with the stocks of this 30% whenever the stocks are opened to public in future.

Another important privatization policy is embodied in the establishment of "Management Contract Law." The management staff of the state enterprises were conventionally said to lack incentive mainly because of no reward for the achievement of given management targets. To improve the situation, this law stipulates that business objectives are auctioned to recruit managers and that the manager are assigned the owner of the enterprise when the objectives are achieved. Participation from abroad is possible.

This way, privatization is vigorously promoted. But few companies are showing profits presently yet and attractive for entrepreneurs to invest. Even if any profit could be expected, such profits are offset against the high inflation, thus discouraging the desire for investment.
However, owing to the money tightening policy targeted in the stand-by agreement made by IMF in December '93, inflation rate is somewhat calming down to lower level forming favorable circumstances to the investors.

1.3 Industrial Production

1.3.1 General

Due to the shortage of foreign currency actualized by collapse of COMECON where trades were made on the basis of account settled and the shift to the foreign currency settlement and due to disintegration of areal raw material/fuel supply network in the league, Romanian industries were encountered with the worst situation in procurement of raw materials. This has caused sharp drop in industrial production as shown in Table I.1-1

Table I.1-1. Transition of Industrial Production Index
(in percentage against previous year)

1990	1991	1992	1993*1
-19	-19.7	-21.8	0.8

*1 : Tentative figure

1.3.2 Capacity utilization of the metallurgical industry

The capacity utilization of the metallurgical industry including nonferrous metal is as low as half of the peak level as shown in Table I.1-2.

Table I.1-2. Transition of Capacity Utilization (100% as of 1989)

1990	1991	1992	1993
65	55	57	–

1.3.3 Transition in the production of the iron & steel industry

Compared with the crude steel production of 14 million tons before the Revolution, the production in 1992 is as low as 37% of the peak level as shown in Table I.1-3:

Table I.1-3. Main Steel Product Mix in Romania 1989-1992

(Unit: 1,000 t)

	1989	1990	1991	1992
1. Total production of crude steel	13,414	9,106	6,638	5,029
2. Total of products				
	10,263	6,787	5,163	3,816
3. High processing products				
• Seamless steel pipes				
• Cold rolled plates and sheets	823	590	288	251
• Cold drawn wire	1,108	755	659	441
• Special and coated plates and				
sheets	545	410	315	198
• Welding electrodes	76	64	35	40
• Calibrated steel				
• Steel ropes	63	65	35	40
• Tire strand	200	159	145	70
	39	27	22	19
	10	5.6	4	3.5

Data from the Department of Metallurgical Industry, Ministry of Industries

1.4 Iron and Steel Sector Policy, Projects, and Programs

1.4.1 General

Department of Metallurgical Industry, Ministry of Industries has conducted the study for the strategy of the whole Romanian iron & steel industry for 10 years from 1992 to 2002, with the PHARE fund.
The study was carried out by French consulting company SOFRES-CONSEIL
This results, together with the results of the modernization plans framed by the corresponding steel industries and institutes including IPROMET under the Romanian Ministry of Industries, are compiled by the Department of Metallurgical Industries as "Strategy for Restructuring of Romanian Iron and Steel Metallurgy".

The strategy, through its final approval by the Inter-Ministerial Committee, was finally approved by the Parliament in February, 1994 as the strategy of the whole Romanian iron & steel industries.
The Strategy quantitatively predicts future changes in the consumption and demand of iron and steel, proving more concrete than the restructuring plan ever disclosed.

1.4.2 Future projection of the iron & steel industry

The following analysis is based on "Strategy for Restructuring of Romanian Iron and Steel Metallurgy" issued by the Ministry of Industries.

According to this restructuring plan, restructuring and modernization are first required to make the Romanian iron & steel industry productive and competitive, for which the following basic policies need attention:

(1) To bring the capacity utilization of steel industries to about 80% by harmonizing the production capacity with the demand through reduction of unnecessary assets.

(2) To obtain competitiveness both in production cost and quality by gradually decreasing the technological difference from the world advanced iron and steel industries.

Then, as the main strategy for restructuring the Romanian iron & steel industry for the year 2002, the following measures need execution:

(1) To make SIDEX and the Calarasi works the strategic points for the supply of flat products, long products, and their semifinished products because these works, located along the Donau, are excellent in the transportation of raw materials and in the shipment of products.

(2) To make the Hunedoara works the main plant of long products because its location, in the central part of Romania, is excellent in its nearness to the production area of iron ores and coal.

(3) To restructure small iron- and steelworks scattered in the country as minimills consisting of electric arc furnace - continuous casters - rolling mills.

1.4.3 Production plan and demand

Estimation of the domestic market growth toward 2002 based on the World Bank's GDP growth rates is shown in Table I.1-4.

Table I.1-4. World Bank Estimations of Romanian Economic Growth 1989-2002

(Unit:%)

Indicator	Yearly increase percentage								
	1989	1990	1991	1992	1993	1994	1995	1996	1997-2002
1. Gross Domestic Product (GDP)	100	-6.2*	-13.0*	-5.2*	-1.8	1.0	2.9	3.5	4.7
2. Economic Branches									
• Agriculture	100	-12.5	-1.6	-5.0	-1.0	2.5	4.0	4.0	3.7
• Industry	100	-19.2	-20.0	-7.9	-3.0	-0.7	2.0	3.0	4.6
• Services (including public constructions and transports)	100	6.4	-8.2	-2.0	-2.0	2.0	3.4	3.7	5.4
• Exports	100	-46.8	-18.3	5.4	5.0	5.5	5.8	5.8	6.4
• Imports	100	-10.6	-25.1	-4.6	1.5	2.3	2.9	2.9	4.8
3. GDP Index	100	93.8	81.6	77.3	76.0	76.7	78.9	81.7	102.0
4. Industry Index	100	80.8	64.2	59.1	59.1	56.9	58.1	59.8	74.9

*Compared with the World Bank estimations, the growth rate of gross internal product was -7.4% in 1990, -13.7 % in 1991, and -15.0 % in 1992.

The corresponding structure of steel products demand in 1996 and 2002 is shown in Table I.1-5.

Table I.1-5. Forecast of Production and Demand

(Unit: 1,000 tons)

	1996	2002
<Domestic consumption>		
Domestic production		
• Semifinished products for forging	255	320
• Seamless pipe	320	351
• Long products	1,900	2,333
• Flat products	2,000	2,502
Subtotal	4,475	5,506
Imports		
• Long products	100	120
• Seamless pipe	25	30
• Special semifinished products	30	40
Subtotal	155	190
Total of domestic consumption	4,630	5,696
<Exports>		
• Long products	760	1,000
• Flat products	1,070	1,410
• Seamless pipe	220	315
Total of exports	2,050	2,735

As seen from the above table, the production in the year 2002 will be 8.241 million tons (9.5 million tons as crude steel). Then with the capacity utilization 80%, the present total production capacity of the major five iron- and steelworks, 17.7 million tons, will have to be reduced to about 12 million tons.

The production of SIDEX (production capacity 6.95 million tons) and Calarasi works, through full utilization of the geographical advantages as situated along the Donau and centering of production in these two works, will reach 72.2% of the whole Romanian production.

Outline of the production sharing and the capacity utilization of the main iron- and steelworks in 2002 after restructuring is shown in Table I.1-6.

Table I.1-6. Sharing of Production and Capacity Utilization in 2002

(Unit: 1,000 tons)

	Capacity	Production	Capacity utilization
• SIDEX, Galati	6,950	5,570	80.1%
• SIDERURGICA, Hunedoara	1,550	1,210	78%
• SIDERCA, Calarasi	1,700	1,400	82%
• Others	1,785	1,320	72%

1.4.4 Raw materials and fuels

The Romanian production of iron ores was about 1.46 million tons in 1991 and about 1.3 million tons in 1992 and the self-supply rate was about 16%. The production, however, is on the decrease from 3.2 million tons in 1970s and almost all the required 10.4 million tons of iron ore and pellets for the year 2002 is expected to be imported.

Dependency of Romanian demand of raw materials on the former USSR was high, which has caused confusion due to collapse of COMECON. Table I.1-7 shows the procurement plan of raw materials and fuels in 1996 and 2002.

Table I.1-7. Procurement of Raw Materials and Fuels in 1996 and 2002

		1996	2002
(1)	Requirement of iron ore and pellets (1,000 t/y)	7,200	10,400
	• Import from the former USSR and Brazil	6,900	10,100
	• Domestic production	300	300
(2)	Requirement of scrap iron (1,000 t/y)	3,550	4,195
(3)	Requirement of coking coal (1,000 t/y)	3,600	4,600
	• Import	2,450	2,980
	• Domestic production	1,150	1,620
(4)	Requirement of coal for PCI (1,000 t/y) (All to be imported)	300	800
(5)	Requirement of natural gas (MNm^3/y)	2,090	2,180
(6)	Requirement of electricity (million MWh/y)	5.23	5.46
(7)	Requirement of fuel oil (1,000 t/y)	49	47

Presently, each sector of the iron and steel industry tries to secure the raw materials needed for continuous production by bartering the products for raw materials and fuels or by triangular trade. In SIDEX, for example,around 95% of the export income is used for bartering for raw materials and fuels and the remaining 5% is received in foreign currency and used for purchase of spare parts, etc. If export products shown in Table I.1-5 are sold at US$330/t-product, 70% of the foreign currency needed for import of raw materials and fuels in Table I.1-7 will be secured. In other words, 70% of the money needed for import of raw materials and fuels will be secured by exporting 33% of the products manufactured.

1.5 Modernization Program and Investment Cost

Modernization toward the year 2002 requires not only introduction of advanced technologies but also revamping of the existing old production processes.

That is, the target of BOF steelmaking rate and continuous casting rate, based on the actual 55.4% and 42% in 1993, is 72.2% and 97% in 2002, respectively.

On the other hand, the Council for Coordination of Strategy and Economic Reform recognizes that modernization should come before privatization. Its financial measures, however, should be studied for each strategy. The most expectable financial sources are:

- State ownership fund, which require approval of Parliament
- Bank credit
- Escrow account

Modernization of SIDEX should preferably be financed by the loan of the Institutional Finance of Japan, for example.

In terms of environmental protection measures, State ownership fund can be considered, but it should be applied within the framework of social protection. Therefore, application of the State ownership fund to SIDEX's energy saving and environmental protection will invite an considerable argument

According to the report of the Ministry of Industries (Strategy for Restructuring of Romanian Iron & Steel Metallurgy), the investment cost needed for the restructuring toward 2002 is estimated by the Institutes at about US$2,645 million, of which US$1,010 million is investment on foreign currency. These required amounts of money will consist of the own funds of each industry sector by 40.9%, bank credits by 34.3%, and capital increase by 18.6%. See Table I.1-8.

However, this is not easy for the industries because each sector of the iron

& steel industry is tight even in securing foreign currency for purchase of raw materials and fuels.

Table I.1-8. Investment Efforts Required for the Main Iron- and Steelworks as well as the Financing Sources

(Unit: Million US$)

Iron- and Steelworks	Investments total	Financing sources			
		Own sources	Government budget	Bank credits	Capital increase
SIDEX, Galati	1,378	700	10	598	70
COST + OTELINOX, Targoviste	130	70	5	35	20
SIDERURGICA, Hunedoara	300	150	5	95	50
SIDERCA, Calarasi	222	30	120	20	52
CSR, Resita	62	17	10	10	25
Others	553	115	15	149	274
Total	2,645	1,082	165	907	491

1.6 Background of SIDEX

The Romanian iron & steel industry can be said to have followed its own path even within the framework of job-division system under former COMECON, but this SIDEX is said to have been constructed apart from the framework of COMECON and so the technologies applied are rather Western. However, because the first priority was placed on the heavy industry in the socialist planned economy, SIDEX now suffers from the results of the following situation:

(1) Environmental pollution problems were not paid so much attention as paid in industries in then current western countries

(2) Energy saving was not considered serious because of the comparatively cheap energies within COMECON.

(3) Introduction of latest Western technologies was not sufficient.

For example, the production of crude steel in SIDEX was 2.9 million tons in 1992, and the capacity utilization was as low as 30%. Insufficient supply of raw materials from Krivoirog contributes to this low capacity utilization in spite of its nearness to Krivoirog, and the BF productivity is as low as 1.0 due to the market and the technological reasons.

Modernization plans, including environmental protection and energy saving, are on the way. In the ironmaking area, No.4 and No.5 blast furnaces, now equipped with the pulverized coal injection system (PCI system), are under modification.

For the No.1 steelmaking plant (directly connected to slab casters) which is supposed to play a major role in future, the following modernization plans are framed:

(1) Desulfurization of hot metal
(2) BOF bottom blowing
(3) Capacity increase of molten steel treatment facilities such as RH and VAD and modification of RH

Then, modification plans for the downstream processes are,
(1) Shape control of the final finishing stand by work roll shift in the hot strip mill and modification toward Level 2 control
(2) Integration of tandem mill and pickling line in the cold strip mill

1.7 Proposals from the Ministry of Industries

Presently, the Romanian iron & steel industry is a government-owned corporation and Romanian and foreign investors are not in a position to invest in the iron and steel industry in Romania. Correspondingly, the Ministry of Industries proposes that the Romanian Government should provide legal and systematic assistance to the achievement of the following policies of the Romanian iron & steel industry:

- To meet the domestic demand for high-quality steels at prices lower than those of the world
- To secure foreign currency needed for purchase of raw materials and fuels and for introduction of advanced technologies required for modernization by conducting export

Correspondingly, the Ministry of Industries proposes the following to the Government as urgent national needs within the framework of the Strategy for Restructuring of the Romanian Iron & Steel Metallurgy:

(1) To downsize the production facilities, having the capacity of 17.7 million tons, to the level that meets the domestic and foreign demand in 2002.

(2) To give assistance to investors at prime rate by using the governmental fund and to provide government guarantee needed for obtaining loans from international financial corporations. For the coming several years, investment of US$1,200 million is needed, of which US$400 million foreign currency is needed for introduction of advanced technologies and equipment.

(3) To prepare public investment programs for improvement of the infrastructure such as roads, railways, houses, and cultural activities. These programs should be able to activate the Romanian economy, to accelerate early participation of Romania in the economy of the Europe or the world, and also to motivate the people toward activation. Resultantly, these programs are expected to bring about yearly steel consumption of more than 1 million tons, equal to 20% of the domestic consumption in 2002.

(4) To provide tax exemption for import of the equipment and facilities needed for restructuring and modernization.

(5) To apply the social programs such as development of jobs and employment opportunities at both the national and local levels so that restructuring and modernization of the iron & steel industry can be promoted without social unrest.

(6) To collect scrap and to prepare strategies for reuse.

(7) To adjust the difference of prices among sectors of the iron & steel industry.

(8) To establish energy saving measures and guarantee systems for protection of resources.

(9) To protect domestic manufacturers during the restructuring process for expansion of the share of Romanian steel in the domestic and foreign markets.

(10) To revise the monetary policy during depression of the steel market.

(11) To approve of the Strategy for Restructuring as the Government.

2. REVIEW OF PRESENT STATUS AND FUTURE PLANS OF SIDEX

Investigations on the theme described herein are carried based on the information given by SIDEX and the interviews with the persons concerned.

2.1 Present Status of SIDEX

The Integrated Iron and Steel Works "SIDEX" S.A. Galați (called SIDEX), located along the Donau near the Black Sea, is the largest in Eastern Europe. Its location is advantageous in the procurement of raw materials and fuels from abroad such as the Ukraine and in the shipment of products to domestic and foreign customers.

Table I.2-1 and Fig.I.2-1. show the major production facilities and the layout of SIDEX, respectively. SIDEX is the only integrated iron- and steelworks of flat products in Romania and supplies long semifinished products to domestic rolling mills. The main steel products are plates (4 to 14 mm), hot-rolled products, cold-rolled products (0.2 to 3 mm), galvanized products, welded pipes and tubes (more than 500 mm in diameter), and semifinished products (blooms and billets).
The production of SIDEX reached its maximum 7.66 million tonne in 1989. Though it dropped down once to 2.9 million tonne in 1992 reflecting the depression, it is recovering since 1993. (Table I.2-6)

All the iron ores are imported mainly from the Ukraine, India, Brazil, and the South Africa. Coal is imported from Russia, Australia, and the North America. Domestic supply of coal, now small, will be replaced with imports in the near future. Due to shortage of foreign currency, more than 90% of the procurement of raw materials relies on the barter trade, which makes it difficult to secure long-term, stable supply of raw materials in quality and quantity, though this is quite important for stable operation of any large, integrated iron- and steelworks.

As a result of the transfer to the free economy from the planned economy by Government after 1990, negotiations with customers on sales contracts and prices have become the direct responsibility of SIDEX. SIDEX can now obtain the balance, that taxes, allotment, fund, etc. are deducted from the profits made by sales of products.

In the case of new installation or modification of the facilities, the iron- and steelworks in Romania including SIDEX can receive support and cooperation of the now privatized engineering Institutes at the various stages from planning to construction. As seen in Table I.2-2, though foreign equipment and technologies are introduced, the percentage of the equipment of Romanian make is considerably high, showing that SIDEX and these Institutes have a rich experience in the engineering of iron- and steelmaking facilities. In addition, SIDEX has a large-scale manufacturing factory for spare parts, and efficient operation of that factory is expected for modernizing the facilities further.

Table I.2-2. Outline of Main Engineering Institutes

Name	Employment	Functions
IPROMET	750	Overall planning of steel plant facilities, coordination, economic evaluation, engineering for iron- and steelmaking, refractories, coke
IPRORAM	670	Engineering for rolling, wire rods, environment
ICEM	550	Research in iron and steel (iron and steel, refractories, coke, chemicals, etc.)
ICPPAM	725	Designing of sheet and coil products, research, detailed designing
IACMSG	8000	Construction work

Table I. 2-1. Outline of SIDEX Plant Facilities

	Designed Capacity (Kt/Y)	Started from	Main Specifications	Supplier
No. 1 BF	1050	1968	1700m³	Romania
No. 2 BF	1050	1969	1700m³	Romania
No. 3 BF	1050	1972	1700m³	Romania
No. 4 BF	1200	1975	1700m³	Romania
No. 5 BF	1850	1978	2700m³	Romania
No. 6 BF	2500	1981	3500m³	Romania
Total	8700			
No. 1 BOF Plant	3200	1968	180T/heat, LD×3 RH + VAD	Romania
No. 2 BOF Plant	3500	1975	180T/heat, LD×3	Germany (GHH)
No. 3 BOF Plant	3000	1980	180T/heat, LD×3	
EAF	250		50T/heat×3 AOD + VAD	Russia 2 Romania
Total	9950			
No. 1 CC Plant	3000	1975	SL Caster(2 Strands) ×4	CONCAST 3 Romania 1
No. 3 CC Plant	2605	1981	BL Caster(5 Strands) ×5	CONCAST 1 Romania 4
Slabbing Mill	4300	1968		Russia
Blooming Mill	2500	1982		Romania
Total	12405			
Hot Rolling Mill	3500	1971	t 1.5-12 w 700-1550	Russia
No. 1 Plate Mill	1200	1966	t 4-100 w 800-3200	England+France
No. 2 Plate Mill	1500	1978	t 6-100 w 1000-4000 Low Alloy	U.S.A. + ABB
TOTAL	2700			
Cold Mill TDM No. 1	1020	1970		Germany (DEMAG)
TDM No. 2	540	1987		Russia
Reversing	84	1988		Romania
Galvanizing Plant	100	1971	t 0.3-2.5 w 600-1550	VAI+S.HEURTEY+Romania
Piping Plant		1987	d 610-1420 150000m/year	Romania

Coke Oven No. 1-4	1320	'73-75	3.8 ×12.85 ×0.46	Poland
No. 5-6	1200	'76-77	5.5 ×14.25 ×0.41	Russia
No. 7-8	1700	1982	7.0 ×15.16 ×0.41	Russia + Romania
Sintering Machine No. 1	1400	1968	156m²	Romania
No. 2	1400	1968	156m²	Romania
No. 3	1400	1978	156m²	Romania
No. 4	1400	1978	156m²	Romania
No. 5	1800	1978	200m²	Romania
No. 6	1800	1970	200m²	Romania
No. 7	5000	1981	500m²	Romania

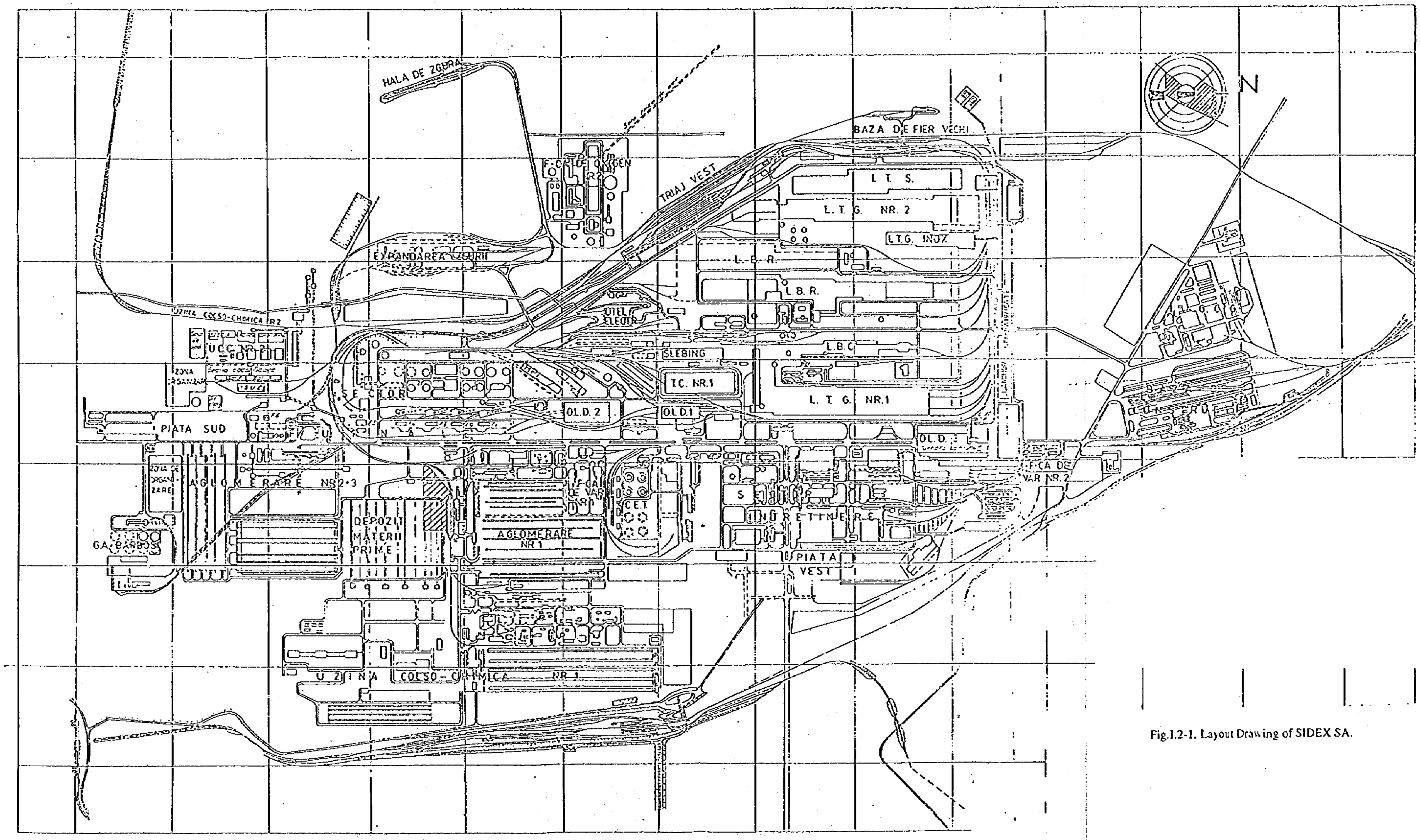

Fig.I.2-1. Layout Drawing of SIDEX SA.

2.2 Future Plans in SIDEX

2.2.1 Production plan for 2002

1) Outlook of future production

Outlook of future production in SIDEX is mentioned in the Restructuring plan of Romanian iron & steel production, that the Ministry of Industries has prepared based on the said PHARE REPORT. SIDEX has its own concrete plan based on the future prospect for the market, referring to the Restructuring plan. The production plan for the year 2002, shown in Table I.2-3 is the same. Accordingly, as premises to the Study by JICA, the production shown in this table is employed.

Table I.2-3 Production for 2002 (million tons)

- Crude steel : 5.57 (equipment capacity: 6.95)
- Products : 4.85
- Hot metal : 4.77

SIDEX's past and future production amounts till 2002 by production process are shown in Table I.2-4, while the material flow in the year 2002 is shown in Fig. I.2-2 (the amount of crude steel is regarded as equal to that of molten steel in this figure).

The production amount in 2002 will be about 73% of the peak recorded in 1989. The average of increase ratio in ten years from 1993 to 2002 is 4.7 %. Economic activities in Romania largely dropped in 1990 and was depressed since. However, the domestic steel demands is recovering at the present, and therefore further smooth recovery can be expected.

The sharp decreases in export to the former communist bloc have already been covered by exports to other countries. Future prospects for the cultivation of a new market are regarded as bright. In Romania, the export of products is regarded as a means of securing raw materials which are required to meet the domestic demand.

2) Product mix

The product mix at SIDEX and deliveries of steel products from SIDEX to the domestic and foreign markets are shown in Table I.2-5 The product mix in 2002 will consist of sheet and coil products by 36%, heavy plates by 25%, and semifinished products by 39%. The major end users are vehicles, industrial machinery, household electrical appliances, shipbuilding, pipes and tubes, and railway cars. SIDEX satisfies almost all the domestic demand for sheets and plates.

With regard to the heavy plates in the products, their qualities are approved by the Lloyd's and the API. SIDEX is particularly confident in the quality of those for shipbuilding and large-diameter pipes for oil transportation, that characteristically occupy about 70% of the export products. Besides, as to the semifinished products by 39 %, SIDEX is planning to develop product items and to produce billets for seamless pipes, and will play an important part as the base supplying long materials.

Table I.2-4. Production Amount at Each Process

Unit:1000t

	Production Result					Production Plan								
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hot Metal	6567	4736	3521	2508	3037	3336	3760	3896	3991	4120	4182	4287	4412	4770
Molten Steel BOF	7458	5267	3867	2826	3471	3813	4157	4478	4588	4763	4835	4986	5131	5400
EAF	204	109	68	80	94	120	164	160	160	160	170	170	170	170
Total	7662	5376	3935	2906	3565	3933	4321	4638	4748	4923	5005	5156	5301	5570
Slab by CC	2660	2028	1627	1425	1726	1950	2400	2400	2400	2400	2800	3000	3364	3368
by IC	2582	1697	1070	692	800	917	737	984	984	984	584	364	—	0
Total	5242	3725	2697	2117	2526	2867	3137	3384	3384	3384	3384	3364	3364	3368
Billet & Bloom	1434	806	684	392	598	600	720	720	820	1020	1220	1420	1620	1870
Heavy Plate	2162	1501	1120	976	1002	1065	1180	1200	1200	1200	1200	1200	1200	1200
Hot Rolled Coil	2385	1700	1205	854	1287	1540	1668	1880	1880	1880	1880	1880	1880	1884
Cold Rolled Coil	969	655	591	396	375	385	500	740	740	740	740	740	740	743
Galvanized Coil	64	52	27	30	28	35	50	60	65	70	75	75	80	80

Note: The figures of 1994 partly include actual amount

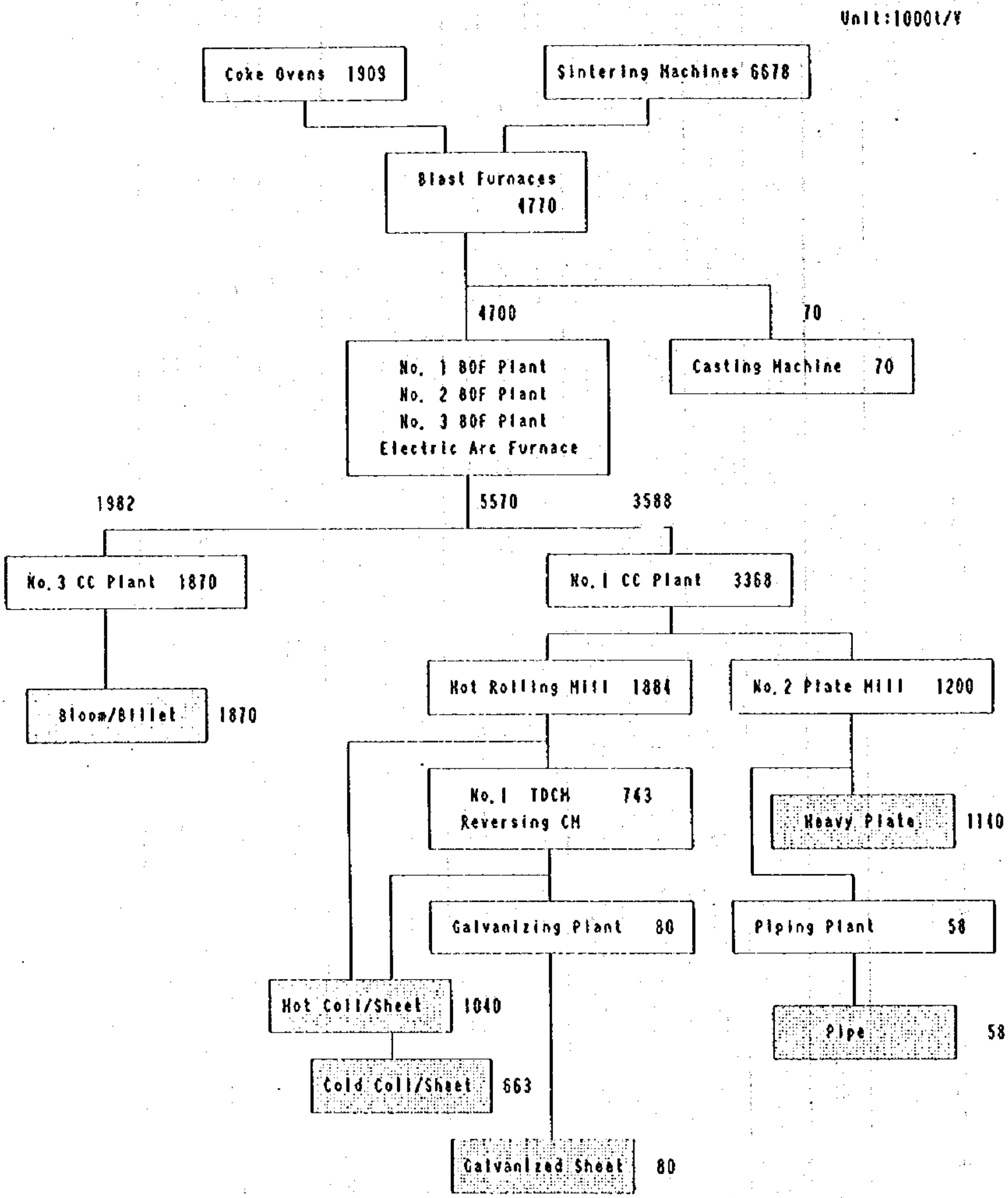

Fig. I. 2-2. Material Flow in the Year 2002

Table I.2-5. Delivery Amount of Steel Products

Total Delivery Amount of Steel Products Unit:1000t

	1989	1990	1991	1992	1993	1994	1995	2002
Heavy Plate	2123	1440	1075	954	992	1050	1150	1140
Hot Coil & Sheet	1360	988	580	433	859	1100	1100	1040
Cold Coil & Sheet	885	590	554	357	347	350	450	663
Galvanized Coil & Sheet	64	52	27	30	28	35	50	80
Pipe	27	46	30	11	10	15	30	58
Bloom & Billet	1300	745	640	365	598	600	720	1870
Total	5759	3861	2906	2150	2834	3150	3500	4851

Delivery Amount for Domestic Demand Unit:1000t

	1989	1990	1991	1992	1993	1994
Heavy Plate	1185	695	574	336	385	400
Hot Coil & Sheet	990	924	524	326	725	850
Cold Coil & Sheet	750	530	504	317	325	340
Galvanized Coil & Sheet	23	35	19	6	19	20
Pipe	24	45	27	4	10	10
Bloom & Billet	1300	745	640	330	568	600
Total	4272	2974	2288	1319	2032	2220

Delivery Amount for Export Unit:1000t

	1989	1990	1991	1992	1993	1994
Heavy Plate	938	745	501	618	607	650
Hot Coil & Sheet	370	64	56	107	134	250
Cold Coil & Sheet	135	60	50	40	22	10
Galvanized Coil & Sheet	41	17	8	24	9	15
Pipe	3	1	3	7	-	5
Bloom & Billet	-	-	-	35	30	-
Total	1487	887	618	831	802	930

(Note) 1989 -1993 Actual amount
1994 Planned amount and actual amount
1995 -2002 Planned amount

2.2.2 Facilities operation plan

As described previously, the equipment capacity of SIDEX in 2002 will be reduced from the past so called 10 million tons/year to 6.95 million tons/year for future restructuring. The facilities operation plan for all processes to meet the situation is shown in Table I.2-6.

1) Iron-making dept.

Three (3) blast furnaces (two (2) blast furnaces in operation), three (3) sintering machines, and two (2) groups of coke ovens will be operated, while the three (3) blast furnaces, three (3) sintering machines and one (1) group of coke ovens shutdown.
SIDEX plans to shutdown Nos. 1, 2, 4 ovens working at the present, and to operate again the repaired No.8 oven. However, No.8 oven is largely damaged, and then replacement of No.7 oven will be required before 2000.

2) Steel-making dept.

As to operation of three converter shops, according to the way of increasing the capacity of continuous casting machine for producing slabs, there are two ideas; one is to stop No.2 converter shop and the other is not to close the shop. A decision is not made yet now.

3) Rolling dept.

Before 2002, the slab rolling mill will stop its operation due to the capacity increase of slab continuous casting machine, and the bloom milling machine will also stop due to new installation of billet continuous casting machine.
One out of two mills for heavy plate will stop its operation, and as to the hot strip mill and the cold strip mill they will be operated as they are.

Table I.2-6. Facility Operation Plan in 2002

Facility	Designed Capacity (Kt/Y)	Main Specifications	Operation Plan in 2002
~~No. 1 BF~~	~~1050~~	~~1700m³~~	Not in operation
~~No. 2 BF~~	~~1050~~	~~1700m³~~	Not in operation
~~No. 3 BF~~	~~1050~~	~~1700m³~~	Not in operation
No. 4 BF	1200	1700m³	To be in operation
No. 5 BF	1850	2700m³	To be in operation
No. 6 BF	2500	3500m³	To be in operation
No. 1 BOF Plant	3200	180T/heat, LD×3 RH + VAD	To be in operation
No. 2 BOF Plant	3500	180T/heat, LD×3	Not decided at this moment
No. 3 BOF Plant	3000	180T/heat, LD×3	To be in operation
EAF	250	50T/heat×3 AOD + VAD	To be in operation
No. 1 CC Plant	3000	SL Caster(2 Strands) ×4	To be in operation
No. 3 CC Plant	2605	BL Caster(5 Strands) ×5	To be in operation
~~Slabbing Mill~~	~~4300~~		
~~Blooming Mill~~	~~2500~~		
Hot Rolling Mill	3500	t 1.5-12 w 700-1550	To be in operation
~~No. 1 Plate Mill~~	~~1200~~	~~t 4-100 w 800-3200~~	Not in operation
No. 2 Plate Mill	1500	t 6-100 w 1000-4000	To be in operation
Cold Tandem No. 1	1020		To be in operation
Mill ~~Tandem No. 2~~	~~540~~		Not in operation
Reversing	84		To be in operation
Galvanizing Plant	100	t 0.3-2.5 w600-1550	To be in operation
Piping Plant		d 610-1420	To be in operation

Coke Oven ~~No. 1-4~~	~~1320~~	~~3.8 ×12.85 ×0.46~~	Not in operation
No. 5-6	1200	5.5 ×14.25 ×0.41	To be in operation
No. 7-8	1700	7.0 ×15.16 ×0.41	Either No. 7 or No. 8 will be in operation
Sintering Machine ~~No. 1~~	~~1400~~	~~156m²~~	Not in operation
~~No. 2~~	~~1400~~	~~156m²~~	Not in operation
~~No. 3~~	~~1400~~	~~156m²~~	Not in operation
~~No. 4~~	~~1400~~	~~156m²~~	Not in operation
No. 5	1800	200m²	Either two machines of No. 5, 6, 7 will be in operation
No. 6	1800	200m²	
No. 7	5000	500m²	

2.2.3 Modernization plan

The modernization of SIDEX is aimed at the maintenance of competitiveness for quality and cost in the market, energy saving, and improvement of environment.

The main items of equipment modernization at the respective processes and their implementation time are shown in Table I.2-7. This plan is still in the stage of study, including fund raising which is the greatest problem in realizing the modernization plan.

Table I.2-7 Outline of SIDEX Modernization Plan

Facilities	Contents	Purposes
1) 1993 to 1995		
• Nos. 5 and 6 coke ovens	COG desulfurization, dust collection at the time of pushing, CDQ	Environmental protection
• No.7 sintering machine	Recovery of heat from cooler, De-dusting of main exhaust gas	Energy saving, environmental protection
• Nos. 4 and 5 blast furnaces (BF)	Pulverized coal injection	Energy saving
• No.3 BOF plant	Hot metal desulfurization, secondary refining	Quality improvement
• No.1 BOF plant	Hot metal desulfurization, combined blowing	Quality improvement
• No.1 CC plant	Prevention of gas and slag mixing, electromagnetic stirring, HCR	Improvement of quality and yield, energy saving (HCR)
• Hot strip mill	Modernization of reheating furnace, control of strip thickness and profile, RF modification (3 sets)	Energy saving (HCR), improvement of quality and yield

Facilities	Contents	Purposes
2) 1995 to 1997		
• No.6 BF	Relining, PCI	Energy saving and environmental protection
• No.1 TDCM	Revamping of electrical system, control of sheet thickness and profile	Improvement of quality and yield
• No.2 plate mill	RF modification, automization, control of plate thickness and profile	Improvement of quality and yield
• Coating line	Installation of new painting line	Expansion of product mix
• Galvanizing line	Control of coating weight	Quality improvement and environmental protection
3) 1998 to 2002		
• No.7 coke oven	Construction of new coke oven	Energy saving and environmental protection
• Semifinished product plant	Installation of new billet continuous casters for rails and pipes	Expansion of product mix
	Shutdown of billet and bloom mills	Energy saving

2.3 Summary

With regard to the representative indices for operation of facilities and for performances on production, Table I. 2-10 shows the comparison between SIDEX and a Japanese steelworks. Great differences are found in the indices between SIDEX and the Japanese steelworks, and the same phenomenon appears in the energy consumption of whole SIDEX and in the operation level in each factory, respectively, as mentioned in Chapter II. The followings are the main items that SIDEX needs to improve in the future.

1) Stable security of raw materials

Continuous stable supply of raw materials in long term could be one condition of stable operation in an integrated iron and steelworks. However, SIDEX encounters continual problems in securing the quantity and quality of its raw materials, which is preventing stability of operation in each step of production.

2) Engineering capabilities

Because performance, efficiency, and durability at SIDEX are not superior to those in Japan, it is necessary to analyze the conditions of the facilities by examining operational results as feedback, pointing out failure of designs, and realizing more economical designs for the future.

3) Level-up of operation control

In operating the process stably and maintaining the competitive quality and cost of product, the high technology of operation and maintenance and the capability of control greatly influence. Activities connecting all workers to be made tight, i.e. motivating all employees, solution of problems, standardization of works, observation of the standards, are important.

4) Introduction of new management concept

The management organization of SIDEX has a function of controlling the integrated steelworks, and in fact it seems to efficiently work. The production activities directly connect to the management as SIDEX is established with one steelworks, and communication in the management team is smoothly done. Hence, further improvement can be expected by observing the independency of the Line and by adopting a new management concept, e.g. setting a target, a new management system in which employees can participate with, etc.

Table I.2-10. Comparison of Major Operational Indices

1. Operational availability*

Process	SIDEX in 1989		NIPPON STEEL OITA WORKS 1992
Hot Strip Mill	Hot Strip Mill	80.2%	92.5 %
Plate Mill	No.2 Plate Mill	78.5%	93.1 %

*Operational availability(%)

$$= \frac{\text{Operating time (h)}}{\text{Calendar time (h) - Scheduled shutdown time (h)}} \times 100$$

2. Yield of each process

	Unit	SIDEX 1989	NIPPON STEEL OITA WORKS 1992
Molten Steel	%	91.5	95.8
CC Slab	%	91.3	97.1
Plate Mill	%	86.6	94.7
Hot Strip Mill	%	94.5	99.3

3. Relining interval of ovens and furnaces

	Unit	SIDEX	JAPAN
Coke Oven	Years	10-12	25-30
Blast Furnace	Years	4-5	10-15
Hot Stove	Years	4-5	15-20

II. ENERGY SAVING

1. REVIEW OF ENERGY IN ROMANIA AND SIDEX

1.1 Present Demand & Supply

The energy consumption rate of the whole manufacturing industry in Romania occupies as much as 71% under the negative growth economy (about 45% in Japan) because of the preferential policies for the heavy industry.
The energy consumption of the Romanian iron & steel industry occupies about 12% of the whole consumption in Romania manufacturing industry and SIDEX's consumption amounts to about 73% of the whole consumption of the iron & steel industry, showing the importance of SIDEX in the promotion of energy-saving measures in Romania.

As to the primary energy for SIDEX, coal (including purchased coke) occupies 67% and petroleum (including natural gas and purchased electric power) occupies 33%, showing that the ratio of coal is quite low compared with 93% in Japan. That is, the high unit consumption of energy can not be supplemented by byproduct gas, requiring supplementary energy (natural gas and electric power) from the outside. On the other hand, the supply of natural gas, the main source of supplementary energy, fluctuates seasonally, thus placing a limit to the operation of the works due to shortage of natural gas. Decrease of natural gas consumption is therefore most required.

In the production of the secondary energy, the energy generated in the works such as byproduct gas and recovered energy occupies about 50%, quite low compared with the Japanese 85-90% which supplies almost all the secondary energy required in the works.
Especially in fuels, many plants use natural gas because COG or BFG cannot be utilized effectively due to insufficient functioning of gas mixers and also because recovery and use of LDG is not conducted. Conclusively, dependence of secondary energy on outside energy sources such as natural gas of unstable supply and purchased electric power is high in SIDEX.

The unit consumption of energy in SIDEX in 1992 was 8.45 Gcal/t-s (per tonnage of crude steel), and is fairly higher by 2.45 Gcal/t-s than the Japanese 5.0-6.5 Gcal/t-s (average 6.0 Gcal/t-s) in 1992. The difference can be analyzed for each division. Approximately 75 % of the difference is caused by the difference of energy unit consumption in the iron-making division and the rolling division, and hence improvement in these divisions is first demanded. While, where the difference is analyzed for energy types, fuel holds about the half of it and electric power does not much. That is, consumption of fuel should be reduced with a top priority.

1.2 Future Estimation

1.2.1 Before taking energy saving measures

The energy unit consumption, 8.45 Gcal/t-s in 1992, is expected to lower to 7.0 Gcal/t-s based on the production of 5.57 million tons/steel in 2002 as judged from the actual results so far due to the effect of production increase. However, a large volume of natural gas (940 x 10^6 Nm^3/y) is necessary and the dependency to petroleum energy shows 35 % which is still high in level.

1.2.2 After taking energy saving measures

The SIDEX energy-saving measures, purposing to reduce the purchased natural gas as much as possible, should be taken to realize the followings:

(1) Decrease in the energy unit consumption of the plants which greatly consume energy compared with those in Japan, especially BF and reheating furnaces

(2) Higher control of energy supply

(3) Recovery of unutilized waste energy

For the model plants, the measures for energy saving are studied in the following views;

(1) Decrease of heat loss and of energy loss

(2) Improvement of thermal efficiency and of heat transmission

(3) Recovery of waste energy and its efficient use

If the measures for the model plants can be applied to all the related plants, the effects of energy saving measures taken by each plant for the whole steelworks will be summarized as 990 Mcal per tonnage of crude steel.

In relation to the effects by the enhanced control of energy supply including improvement in the energy demand-supply adjustment function in the energy center, 610 Mcal/t-s (including 180 Mcal/t-s by LDG recovery) in total seems to be saved.

On the other hand, providing that the measures for energy saving and for environment are practically implemented, electric power, energy for utilities, and so on will be additionally consumed and it seems as 70 Mcal/t-s in total

The energy-saving measures recommended so far will decrease the SIDEX's energy unit consumption for crude steel by 21% from 7.0 Gcal/t-s to 5.5 Gcal/t-s. The average crude steel energy unit consumption in the Japanese BF mills in 1992 was 6.0 Gcal/t-s, and this corresponds to 5.35 Gcal/t-s when adjusted according to the production balance in SIDEX, showing a fairly high level in 2002. And, in spite of large increase of production, the purchased volume of natural gas is expected to decrease by 81% from 940 MNm^3/y (before execution of energy-saving measures) to 171 MNm^3/y, which will bring about stable operation not affected by the supply condition of natural gas. Purchased electric power, on the other hand, is expected to decrease from 2,300 GWh/y to 2,170 GWh/y. Together with future further strengthening of electric power saving measures such as prevention of idling at operational shutdown, rotating speed control according to operational conditions, and improved efficiency of rotary machines, further energy saving is expected.
The above is summarized in Table II.1-1.

Table II.1-1 Resources of Primary Energy of SIDEX in 2002

			Unit	Energy Saving Before	After
Purchased Energy	Coal	Coking Pit Coal	kt/y	3,045	2,845
		Purchased Coke	kt/y	800	31(*)
		PC Coal	kt/y	0	715
		Sub Total	Tcal/y	26,355	24,615
	Petroleum	Natural Gas	Mm3/y	940	171
		Purchased Power	GWh/y	2,300	2,170
		Others	Tcal/y	1,125	675
		Sub Total	Tcal/y	14,328	7,369
Total			Tcal/y	40,683	31,984
Sold Energy			Tcal/y	1,490	1,290
Net Consumption of Energy			Tcal/y	39,193	30,694
Crude Steel Production			kt-s/y	5,570	5,570
Energy Unit Rate per Crude Steel			Gcal/t-s	7.03	5.51

(*) This value = Purchased coke - Sold coke

2. STUDY FOR MODEL PLANTS

2.1 Coke Plant (No.5 Coke Oven Batteries and No.2 CDQ)

The themes for energy saving for the model plant are as follows:

(1) Presently, the coke oven temperature has to be set high.
(2) Many facility-related troubles, which disturbs efficient, are caused unstable operation.
(3) The combustion air ratio is high.
(4) The recovery of CDQ steam is as low as 202-258 kg/t-coal, compared with the 376-411 kg/t-coal in Japan,
(5) Presently, COG is the only fuel. If mixed gas (3,800-4,000 kcal/Nm^3) can be used instead, the remaining COG can be used in the reheating furnaces, etc., leading to a decrease of natural gas consumption.

The energy saving measures to improve these problems and their estimated effects are summarized in Table II.2-1.

Table II.2-1 Energy-saving measures and estimated effects for coke oven battery

Purposes		Measures	Estimated Effects in 2002
To improve the operation	To decrease oven set temperature by improving the combustion control	To identify abnormal combustion oven and to adjust it	•Decrease of heat consumption: 30 Mcal/t-coal •Decrease of COG consumption: 5,900 x 10^3 Nm^3/y
	To decrease fuel gas consumption by improving operation and maintenance practices	•To decrease damage to oven bricks and failure of coke oven machinery •To optimize operating conditions	•Decrease of heat consumption: 5 Mcal/t-coal •Decrease of COG consumption: 1,000 x 10^3 Nm^3/y
To modify or improve the equipment	To increase BTX recovery rate	To install continuous gas chromatography for measuring BTX	Increase of BTX yield: 3,500 t/y
	To change fuel gas from COG to mixed gas of BFG and COG	To install BFG piping and gas mixer	•Decrease of heat consumption: 3.5 Mcal/t-coal •Decrease of COG consumption: 3,800 x 10^3 Nm^3/y
To add new functions or to renew the equipment	•To decrease COG consumption by semi-automatic combustion control •To decrease heat loss by fortified combustion control of COB	•To install combustion control system with continuous instrumentation •To process data using personal computer •To conduct improved combustion control and trend control by installation of operation control monitor	•Decrease of heat consumption: 31.5 Mcal/t-coal •Decrease of COG consumption: 6,200 x 10^3 Nm^3/y
	To increase recovery of steam by overall revamping of CDQ	To replace by high performance CDQ 145 t/h x 1	•Increase of steam recovery: 363 kt/y •Replaced amount by cheap coal* 58 kt/y

* : As a result of overall revamping of CDQ, coke quality will be improved. A part of coking pit coal is replaced to cheaper and weak coking coal.

2.2 Sintering Plant(No. 7 Sintering Plant)

The themes for energy saving for the model plant are as follows:

(1) To decrease consumption of coke breeze
(2) To decrease consumption of COG
(3) To lower sensible heat of sintered ore
(4) To decrease consumption of electric power
(5) To recover waste heat

The energy-saving measures for the model plant and their estimated effects are summarized in Table II.2-2. Operational measures will save energy by 5Mcal/t, improvement of facilities by 16 Mcal/t, and facilities expansion by 90 Mcal/t, amounting to 111 Mcal/t of energy saved in total. And the energy unit consumption in 2002 is estimated to be about 485 Mcal/t. Though this effect is based on the production quantity of 1992, the similar effect can be expected for 2002.

Table II.2-2 Energy-saving measures and estimated effects for sintering plant

Purposes		Measures	Estimated Effects in 2002
To improve the operation	Improvement of burning	•Avoidance of excessive air at the pallet sides •Avoidance of large coke breeze sizes	Yield 0.2% (△Coke 0.1 kg/t) (△E 0.1 kWh/t)
	Prevention of air leakage	• Prevention of the air leakage around the pallets •Prevention of the air leakage around the EP	Air leakage 3% decrease (△E 0.6 kWh/t) Yield 0.5% (△Coke 0.2 kg/t) (△E 0.3 kWh/t) Air leakage 2% decrease (△E 0.4 kWh/t)
To modify or improve the equipment	Improvement of burning	Avoidance of excessive air at the pallet sides	Yield 0.5% (△Coke 0.2 kg/t) (△E 0.3 kWh/t) Air leakage 1% decrease (△E 0.2 kWh/t)
	Improvement of the ignition furnace	Prevention of the penetration of cold air into the ignition furnace	Decrease of COG (△COG 2.0 Nm^3/t)
	Prevention of air leakage	•Modification of the pallet seal mechanism •Modification of various kinds of valves	Air leakage 5% decrease (△E 1.0 kWh/t) Air leakage 5% decrease (△E 1.0 kWh/t)
To add new functions or to renew the equipment	Enhancement of the operation control system	•Measurement of the cold strength of sinter product •Partial renewal of each weighing machine	Yield 2.0% (△Coke 1.0 kg/t) (△E 1.2 kWh/t) Coke breeze (△Coke 2.0 kg/t)
	Improvement of burning	•New-type charging device •Installation of a recrushing system for large coke breeze	Yield 3% (△Coke 1.5 kg/t) (△E 1.8 kWh/t) Coke breeze (△Coke 3.5 kg/t)
	Ignition furnace	Replacement with a small-size ignition furnace	Decrease of COG (△COG 4.0 Nm^3/t)
	Recovery of cooler waste heat	•Preheating of the raw material mix and the combustion air for the ignition furnace •Installation of new equipment for recovering the sensible heat of waste gas at about 300 ^oC in the No.6 sintering plant	Yield 0.5% (△Coke 0.2 kg/t) (△E 0.3 kWh/t) Decrease of COG (△COG 0.5 Nm^3/t) (Steam 15 kg/t)
	Production increase	•Yard stock system for sinter product •Quick lime adding system	Production increase (△E 1.4 kWh/t) (△Coke 0.6 kg/t) Yield 1% increase (△Coke 1.0 kg/t) Production increase (△E 2.0 kWh/t)

2.3 Blast Furnace(No. 6 Blast Furnace)

The themes for energy saving for the model plant are as follows:

(1) To decrease fuel rate
(2) To install PCI system
(3) To establish techniques for massive PC injection
(4) To renew the blower for BF
(5) To reduce energy consumption in the hot blast stoves

The energy-saving measures for the model plant and their estimated effects are summarized in Table II.2-3.
The most important in energy saving is to lower the fuel rate and to raise the productivity, which require facility improvements and operational optimization. Accordingly, it is inevitable to establish the optimum operation by introduction of proper operating techniques and training for high PCI, high pellet-ratio operation, etc.

Execution of the energy-saving measures will manifest the effects shown in following table.

Estimated Operation of BF after Execution of Energy-Saving Measures

	Present	After measures in 2002
BF input heat	4.6 Gcal/t	4.2 Gcal/t
Productivity	1.0	1.8
Fuel rate	580 kg/t	520 kg/t
Coke rate	580 kg/t	370 kg/t
BFG generation	2,000 Nm^3/t	1,570 Nm^3/t
HS input heat	630 Mcal/t	460 Mcal/t
HS efficiency	78%	85%
TRT recovered electric power	-	29 kWh/t

Table II.2-3 Energy-saving measures and estimated effects for blast furnace

Purposes		Measures	Estimated Effects in 2002
To improve the operation	To decrease fuel rate of blast furnace	•To optimize furnace gas distribution by improving the burden distribution •To optimize furnace gas distribution by optimizing the blast condition •To increase the reducibility of raw materials •To increase furnace permeability •To supply high-temperature blast to BF •To decrease Si content in hot metal •To increase operational availability of equipment •To decrease the blast humidity •To decrease the slag rate	△41.4 kg/t (high-pressure operation base) - 17 kg/t (compared with Japan) △29 kg/t △10 kg/t
	To decrease the supply volume of blast to BF	To decrease the supply volume of blast per ton of hot metal by decreasing the fuel rate	1,500 → 1,200 Nm^3/t
To modify or improve the equipment	To decrease the fuel consumption of hot stove	To improve HS control system	O2 content in the exhaust gas 4-5% → 1-2%
	To increase the operational availability of blast furnace	To increase the life of tuyere To increase cooling ability fot tuyere	△7.6 kg/t
To add new functions or to renew the equipment	To lower BF energy cost	To install PCI system	• Shutdown of one COB • Decrease of purchased coke • Decreased emission of pollutants from COB
	To recover top gas pressure	To install TRT	8,600kW(2.0 bar), 8,000t/d 29 kWh/t
	To increase productivity of blast furnace	To adopt the higher pressure operation	
	To increase HS efficiency	To install fuel preheater and combustion air preheater	HS efficiency from 78% to 83% 25 Mcal/t

2.4 Reheating Furnace (No. 3 Reheating Furnace for Hot Strip Mill)

The themes for energy saving for the model plant are as follows:

(1) Large amount of heat loss, especially by cooling water
and by excessive combustion air
(2) Low waste heat recovery
(3) Improper heat pattern for slab

The energy-saving measures can broadly be either of the following two:

- To modify the existing two reheating furnaces
- To install a new reheating furnace

Each has advantages and disadvantages. Conclusively, it is recommended to install a new reheating furnace. The energy-saving measures and their estimated effects in this case are summarized in Table II.2-4.

Table II.2-4 Energy-saving measures and estimated effects for reheating furnace

Purposes		Measures	Estimated Effects in 2002
To add new functions or to renew the equipment	To improve performance such as heat unit consumption by replacing with high performance reheating furnace	•To improve heat transfer function by optimizing the profile including extension of furnace length •To improve the heating performance by optimizing the heating method and type & specifications of burners •To use walking beam and also to optimize location and specifications of walking beam, and thus to obtain uniform heating and to decrease the loss of cooling water •To decrease radiation of heat from furnace wall by reinforcing insulation on the furnace body •To install high efficient air recuperator •To install fuel gas recuperator (stop of waste heat boiler) •To renew the instrumentation control system: • Combustion temperature control • Furnace pressure control	New reheating furnace: • Capacity: 250 t/h • Heat unit consumption: 282 Mcal/t

2.5 Energy Supplying Facilities

Stable and efficient supply of energy is essential as the most fundamental measures, besides the promotion of energy saving in each process, in actually taking the measures for energy saving in SIDEX. Stable supply of fuel gas to the model plants and renewal of the blower for No.6 Blast Furnace are especially the important items.

The measures for this purpose and their estimated effects are shown in Table II.2-5.

Table II.2-5 Energy-saving measures and estimated effects for energy supplying facilities

Purposes		Measures	Estimated efects
To add new functions or to renew the equipment	Stabilization of gas supply facilities and use of by-product gas	•Install the gas holder in BFG and COG lines, and reduce the pressure variation of byproduct gas. •Build the concentrated gas mixing device, and supply the stabilized gas to every plant.	Decrease of gas diffusion (5 % → 0.5 %) $\triangle NG = 56 \times 10^6$ Nm^3/y
	Increse of discharging pressure of blower for No.6 BF and of heat efficiency	•Install the steam turbine and boiler which drive the blower, at the same time when relining No.6 BF. •Renew the power station by steps.	1. Improvement of unit consumption of blowing steam 635 → 290kg/t 2. Improvement of fuel efficiency in power station 4,060 → 2,650-2,950 kcal/kWh (unit consumption of blowing electric power 0.12 → 0.07 kWh/Nm^3)

III. ENVIRONMENTAL POLLUTION CONTROL

1. PRESENT STATUS OF ENVIRONMENTAL POLLUTION CONTROL IN ROMANIA

After the liberalization in 1989, aimed at improvement of the environmental pollution in Romania in line with the EU countries, survey and study were conducted and compiled into the Romanian Environmental Strategy Paper in July 1992. Following this paper, new policies are issued mainly by the Ministry of Water, Forestry, and Environmental Protection and are under discussion and establishment.

1.1 Environmental Protection Law and Environmental Standards

As the basis of the national environmental protection, there exists the Law of the Environmental Protection established in 1973 and a new Romanian Environmental Protection Law, has been under discuusion in parliament. Atmosphere and river water quality standards are already issued as shown in Tables III.1-1 and III.1-2.

Concerning the emission of SOx, NOx, and soot in chimney waste gas that were not restricted, standards were issued in September 1993. The limit values for SOx, NOx, and soot are shown in Table III.1-3 and the comparison between these values and the EU Directives are shown in Table III.1-4. The standards are quite satisfactory compared with the EU Directives as seen from Table III.1-4, and satisfaction of these standards will eventually secure the environment similar to that of the EU countries.

Regarding waste water, different from waste gas, there are no nationwide standards, but restriction is placed through agreement with the Water Resources and Protection of MOE and the Local Environmental Control Agency.

As for standards for landfill using solid wastes, there exists only the Basel Treaty that restricts cross-border transportation of harmful industrial wastes, and there are no detail restrictions on the storage, transportation, and disposal of wastes according to properties. Establishment of corresponding standards are desired in future.

Environmental assessment system to obtain approval of the Local Agency for constrution and operation, which requires forecast and preliminary assessment of environmental impact due to expansion or new facilities, was issued in 1992.

1.2 Tax Reduction for Investment in Environmental Protection Facilities

The Order No.12 enacted in 1991 stipulates the tax reduction in the case of investment in production facilities and to promote the installation of environmental protection facilities as follows:

In the case of investment for the purpose of expansion or modernization of production facilities, similarly in the case of the investment for the purpose of environmental protection facilities, 50% of tax for the investment cost shall be reduced.

That is, for the environmental protection facilities, 50% of the tax on the investment cost will be cut.

1.3 Monitoring System for Waste Gas and Waste Water

The Ministry of Water, Forestry, and Environmental Protection is promoting a plan for monitoring the general environmental conditions throughout the nation. For the discharges, the company owner will have to measure by himself and report to the Local Agency according to the execution of the New Romanian Environmental Protection Law.

1.4 Execution System of Environmental Pollution Control

The Ministry of Water, Forestry, and Environmental Protection controls overall environmental activities in Romania. All the country is divided into 40 areas and one special area (Bucharest), and its Local Environmental Control Agency in each area takes charge of execution, supervision, and monitoring of the regal activities. Each of these Agencies is authorized to conclude agreements of particular restrictions with the individual enterprises in addition to the national standards.

Table III. 1-1. Ambient Air Quality Standard (Main Indicators)

Pollutants	Admitted Concentration (mg/m^3) short term medium 30min.	long term medium 24hours	Yearly
Sulfur dioxide: SO_2	0. 75	0. 25	0. 06
Nitrogen dioxide: NO_2	0. 3	0. 1	0. 04
Suspended powders	0. 5	0. 15	0. 075
CO	6. 0	2. 0	—
Ammonia	0. 3	0. 1	—
Phenol	0. 1	0. 03	—
Oxidants (O_3)	0. 1	0. 03	—
Lead	—	0. 0007	—
Sedimented dust	17 g/m^2/month		

Table III. 1-2. Water Quality Standard (Main Indicators)

Indicator	Admitted Values in Quality Categories (mg/l) I	II	III
Biochemical Oxygen Consumption: CBO_5	5	7	12
Chemical Oxygen Consumption: CCO	10	15	25
Dissolved Oxygen	6	5	4
Ammonium ion (NH^{4+})	1	3	10
Nitrates (NO_3^-)	10	30	—
Phenols	0. 001	0. 02	0. 05
Total iron	0. 3	1	1
pH	6. 5 ~ 8. 5		
Oil	0. 1		
Free residual chlorine (Cl_2)	0. 005		
Cyanides (CN^-)	0. 01		
Cadmium (Cd^{2+})	0. 003		
Lead (Pb^{2+})	0. 05		
Hexavalent Chromium (Cr^{6+})	0. 05		

Table III.1-3. Limit Values of Waste Gas in Romania(Main Indicators)

ANNEX I

Pollutants	Limit Values (mg/Nm³)
SOx (as SO_2)	500
NOx (as NO_2)	500
Soot	50

ANNEX II

Liquid Fuel	Unit	Thermal Capacity(MW/t) <100	100 - 300	300 - 500	>500
Soot	mg/Nm³	50	50	50	50
CO	mg/Nm³	170	170	170	170
SOx (as SO_2)	mg/Nm³	1700	1700	400	400
NOx (as NO_2)	mg/Nm³	450	450	450	450
Oxygen conc.	%, vol	3	3	3	3

Solid Fuel (Coal, Wood)	Unit	Thermal Capacity(MW/t) <100	100 - 300	300 - 500	>500
Soot	mg/Nm³	100	100	100	100
CO	mg/Nm³	250	250	250	250
SOx (as SO_2)	mg/Nm³	2000	2000-400(linearly variation)		400
NOx (as NO_2)	mg/Nm³	500	400	400	400
Total Carbon(C)	mg/Nm³	50	50	50	50
Oxygen conc.	%, vol	6	6	6	6

Natural Gas	Unit	Thermal Capacity(MW/t) <100	100 - 300	300 - 500	>500
Soot	mg/Nm³	5	5	5	5
CO	mg/Nm³	100	100	100	100
SOx (as SO_2)	mg/Nm³	35	35	35	35
NOx (as NO_2)	mg/Nm³	350	350	350	350
Oxygen conc.	%, vol	3	3	3	3

Note: The limit value is calculated after the following formula when multiple fuels are used: $C=\Sigma(Ci*Qi)/\Sigma Qi$

Table III.1-4. Comparison in Limit Values of Waste Gas, Thermal Capacity >500MW

Pollutants	ROMANIA: Type of fuel	ROMANIA: Limit (mg/Nm³)	EC Directive (NEW PLANT): Type of fuel	EC Directive (NEW PLANT): Limit (mg/Nm³)
SO_2	Gas: Natural gas	35, O_2 3%	Gaseous fuel in general	35, O_2 3%
			Liquefied gas	5, O_2 3%
			Low calorific gases from coke oven gas, BF gas	800, O_2 3%
			Gas: gasification of coal	not determined
	Liquid	400, O_2 3%	Liquid fuels	400, O_2 3%
	Solid : Coal, Wood	400, O_2 6%	Solid fuels	400, O_2 6%
NO_2	Gas : Natural ga	350, O_2 3%	Gaseous	350, O_2 3%
	Liquid	450, O_2 3%	Liquid	450, O_2 3%
	Solid : Coal, Wood	400, O_2 6%	Solid: general	650, O_2 6%
			Solid: volatile <10%	1300, O_2 6%
DUST	Gas: Natural gas	5, O_2 3%	Gaseous: steel industry	50, O_2 3%
			Gaseous: BF gas	10, O_2 3%
			Gaseous: as a rule	5, O_2 6%
	Liquid	50, O_2 3%	Liquid: ash > 0.06% < 500MW	100, O_2 3%
			Liquid: all plants	50, O_2 3%
	Solid : Coal, Wood	100, O_2 6%	Solid: ≧ 500MW	50, O_2 6%
			Solid: < 500MW	100, O_2 6%
CO	Gas	100, O_2 3%		
	Liquid	170, O_2 3%		
	Solid	250, O_2 6%		

2. PRESENT STATUS OF ENVIRONMENTAL POLLUTION IN SIDEX AND MEASURES

2.1 Waste Gas and Dust

2.1.1 Present status of waste gas emitted

The nationwide standards for emission of waste gas are effective by the Order 462/1993. Those limit values are for new facilities and grace period for the existing facilities is 7 years, and therefore we have set the target values of depollution system for waste gas as the same of the limitation by Order 462/1993 because the production plan of SIDEX is in 2002.

The instruments and methods used by the survey team for measurement of waste gas concentrations are shown in Table III.2-1. The measurements in the model plants are shown in Table III.2-2.

As the measurements show, problems lie in the SOx, NOx and soot of the coke oven batteries, SOx and soot of the sintering plants, and soot of the hot stoves.

For the soot of coke oven batteries, although the actual concentration could not be measured it is necessary to study the measures to improve combustion because black smoke was almost always observed from stacks during the survey and it is clear to be over the limit value $50mg/Nm^3$.

Regarding the dust, generation at charging of coal and discharging from the coke ovens, at discharging of sintered ore in the sintering plant, and at tapping in BF were conspicuous. These are attributable to no installation of dust collectors or not proper functioning of dust collectors.

Table III.2-1. Measurements and Instruments

Pollutants	Measurement	Instruments
SOx, CO, CO_2	none-dispersive infrared absorption method	HORIBA VIA-510
NOx	chemiluminescent method	HORIBA CLA-510S
O_2	magnetic method	HORIBA MPA-510
Soot	JIS Z8808	—

JIS: Japan Indusrial Standard

Table III.2-2. Results of Measurements in Model Plants and Limit Values

Model Plants	Pollutants	Emitted Concentration ppm	Emitted Concentration mg/Nm³ (as SO_2, NO_2)	O_2 in waste gas:%	O_2 3% converted	Limit Values in SIDEX mg/Nm³ (as SO_2, NO_2)	Limit Values in SIDEX O_2 (%)
No.5 COKE OVEN	SOx	70~80	200~230	8	280~320	50.0	3
	NOx	170	350		480	500	
	Soot [1]	—	—		—	50	
No.7 SINTERING PLANT	SOx	75~100	215~290	18	430~ 580	500	15 [3]
	NOx	100~130	205~270		410~ 540	500	15
	Soot	—	280~330		280~ 330	50	—
No.6BF HOT STOVE	SOx	30~60	86~172	5	97~194	500	3
	NOx	1~2	2~4		2~5	500	
	Soot	—	65 [2]		—	50	
No.3 HOT STRIP MILL R.F.	SOx	<10	29	13	65	500	3
	NOx	50	103		232	500	
	Soot	—	—		—	50	

Notes: 1) Black smoke is sometimes seen discharging from COB stacks, which suggests the need for improvement of combustion.

2) The concentration of soot emitted from hot stove is estimated from the concentration of soot in BFG(105mg/Nm³).

3) The converted values for SO_2 and NO_2 of No.7 Sintering Plant are calculated under the assumption that O_2 concentration of limitation is 15%, and the values of soot and dust are not converted.

2.1.2 Analysis of the problems found in the model plants and measures

It is supposed that SIDEX will violate the limitation for waste gas emission or/and discharged effluent and affects severly on the status of sedimented dust in Galati city than now, judging from the present status of operation and emission, if the production only will increase as it is, without measures for pollution prevention.

In 2002, the followings are supposed to exceed the limit values if measures are not taken:

(1)SOx from coke plant	: 420 ~460mg/Nm³ ≒ 500mg/Nm³ (O2 3%)
(2)NOx from coke plant	: 665 ~ 810mg/Nm³ > 500mg/Nm³ (O2 3%)
(3)Soot from coke plant	: 100 ~ 150mg/Nm³ > 50mg/Nm³ (O2 3%)
(4)SOx from sintering plant	: 950mg/Nm³ > 500mg/Nm³ (O2 15%)
(5)Soot from sintering plant	: 280 ~ 330mg/Nm³ > 50mg/Nm³ (Actual)
(6)Soot from hot stove	: 73mg/Nm³ > 50mg/Nm³ (O2 3%)

The items of environmental measures are listed in Table III.2-3.

Table III.2-3. Items of Measures for Air Pollution Prevention

Plants	Items of Measures
Coke Oven Batteries and Coke Chemical Plants	(1) Intensive operation by No.5, 6 and 7 COB (2) Combustion by mixed gas (3) Automatic combustion control (4) Installation of desulfurization equipment for COG of No.7 COB (5) Manufacturing plant of sulfuric acid (6) Dust collector for guide car and CDQ (7) Replacement of high pressure pumps for ammonia liquor (8) Improvement of ascession pipe sealing
Sintering Plants	(1) Reduction of coke breeze in sintering (2) Installation of moving electrode EP (3) Installation of desulfurization equipment for main exhaust gas (4) Improvement of dust collection at feeding & discharging part of sintering
Blast Furnaces	(1) Improvement in operation of RSW (2) Installation of dust collector for casthouse

After the above measures, the following results are expected:

(1)SOx from coke plant : 120 ~ 150mg/Nm³ < 500mg/Nm³ (O2 3%)

(2)NOx from coke plant : 400 ~ 490mg/Nm³ < 500mg/Nm³ (O2 3%)

(3)Soot from coke plant : <5mg/Nm³ < 50mg/Nm³ (O2 3%)

(4)SOx from sintering plant : 250mg/Nm³ < 500mg/Nm³ (O2 15%)

(5)Soot from sintering plant : <50mg/Nm³ < 50mg/Nm³ (Actual)

(6)Soot from hot stove	:	$<50mg/Nm^3$ (O2 3%)	$< 50mg/Nm^3$

2.1.3 Estimated effect of measures on the areas around SIDEX.

1) Atomosphere

The measures recommended so far will eventually meet the values of the standard in 2002 .

The contribution concentration of SOx and NOx by SIDEX in the atomosphere was calculated by means of diffusion model before and after excution of all measures which are listed in Table III.2-5 and the results are shown in the Fig.III.2-1,Fig.III.2-2,Fig.III.2-3 and Fig.III.2-4.

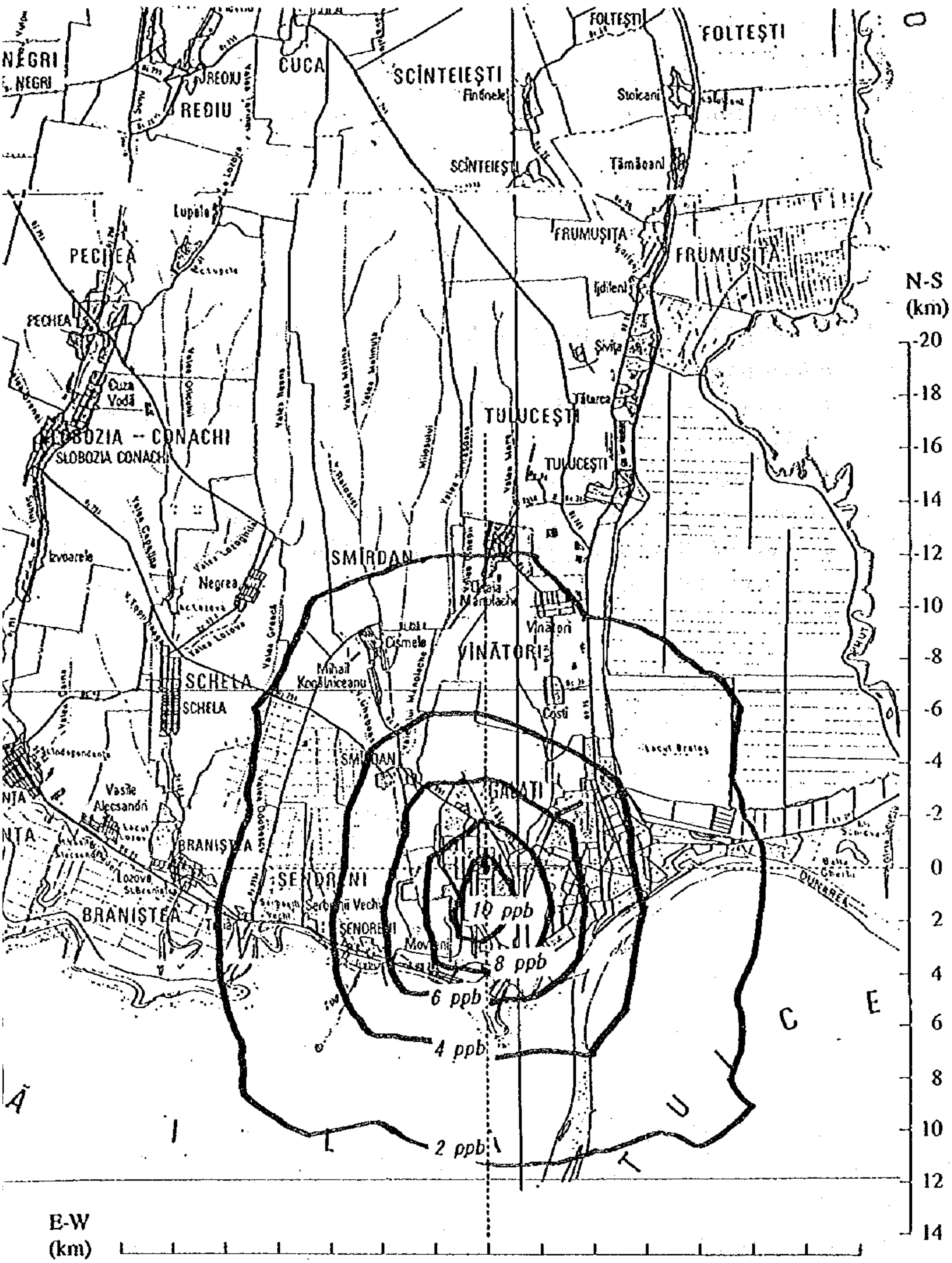

Fig.III.2-1 Contribution concentration (SO_2) by SIDEX
(2002 before taking measures
: equal concentration drawings : Plane)

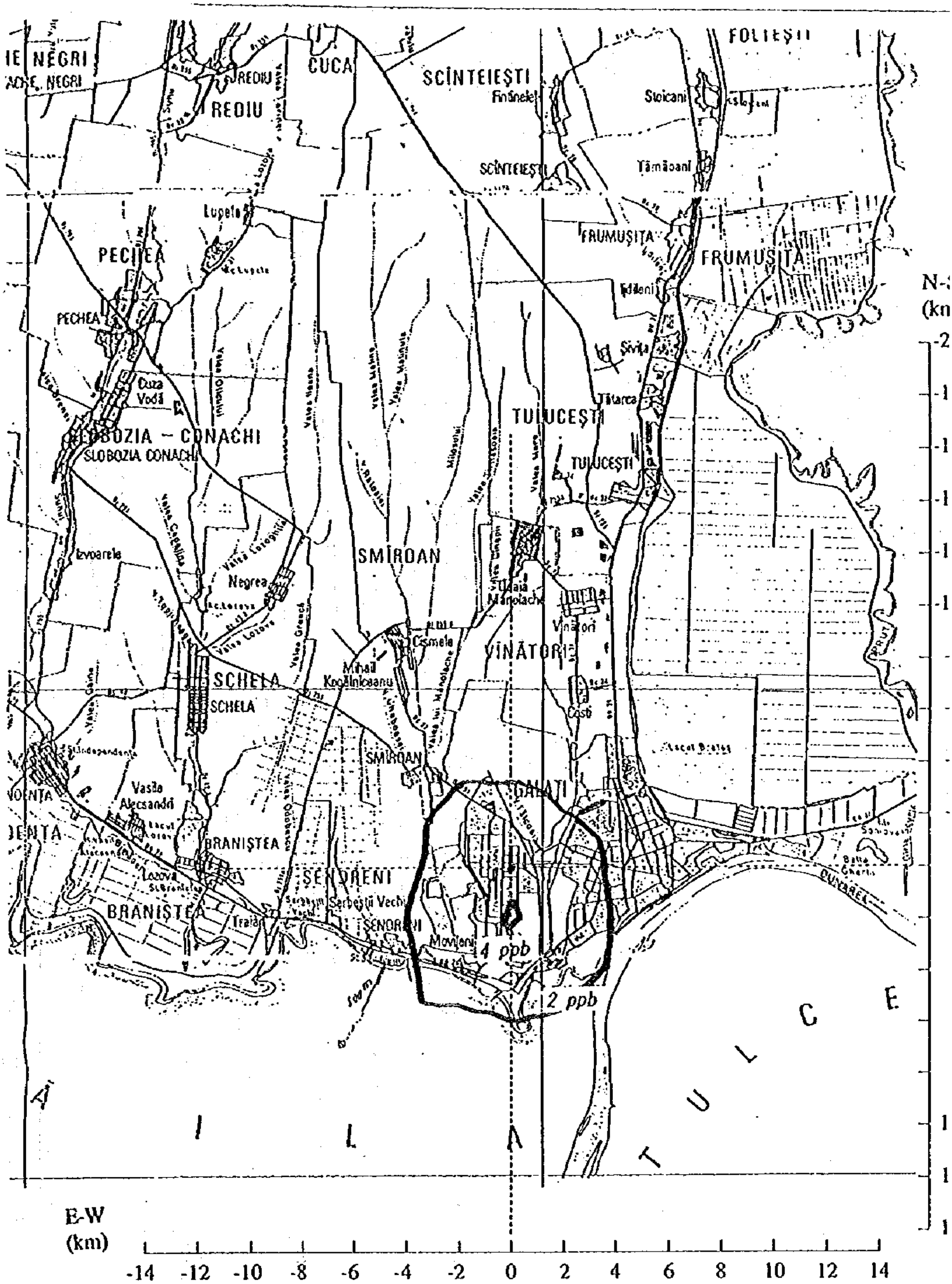

Fig.III.2-2 Contribution concentration (SO_2) by SIDEX
(2002 after taking measures
: equal concentration drawings : Plane)

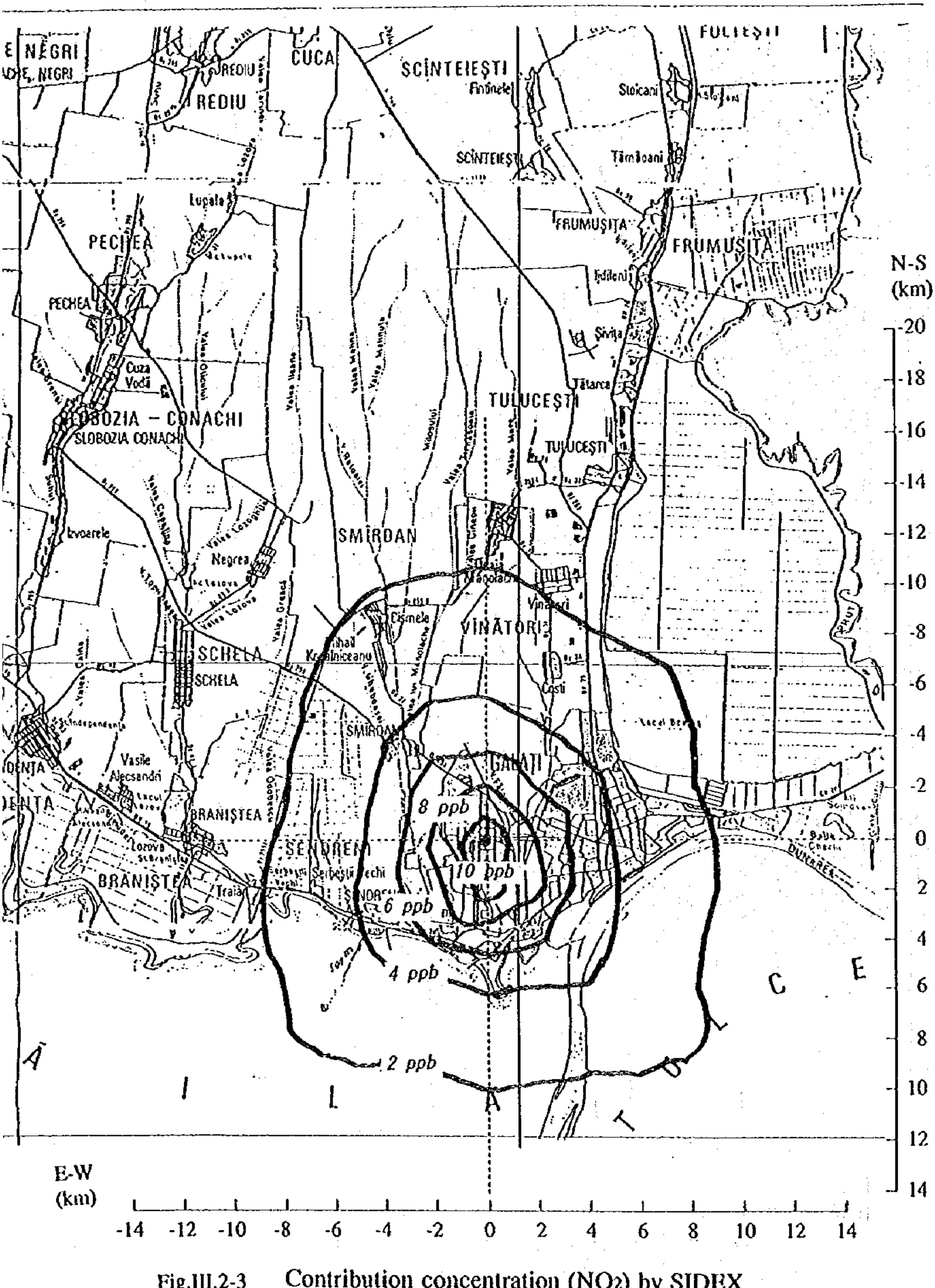

Fig.III.2-3 Contribution concentration (NO_2) by SIDEX
(2002 before taking measures
: equal concentration drawings : Plane)

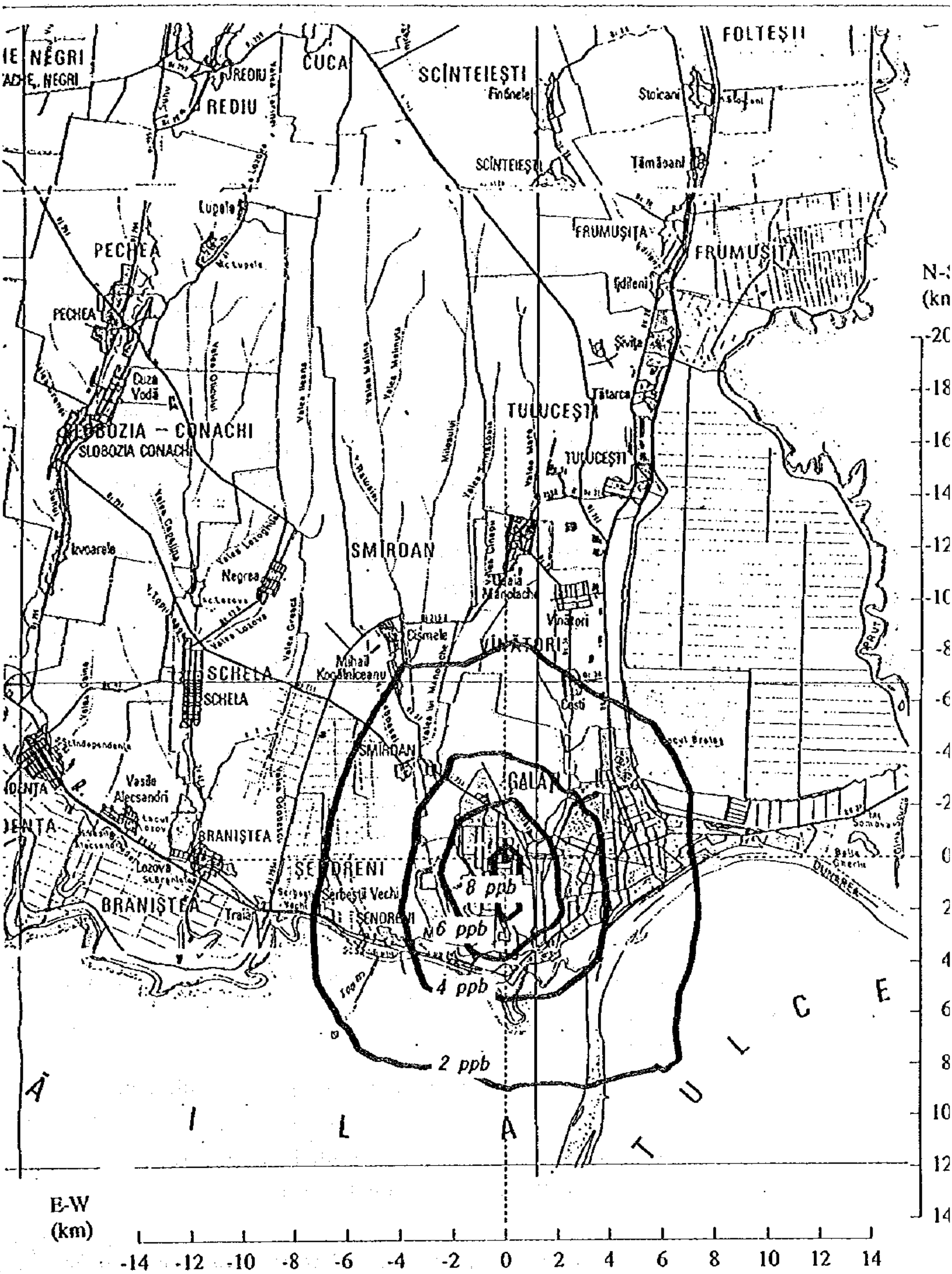

Fig.III.2-4 Contribution concentration (NO_2) by SIDEX
(2002 after taking measures
: equal concentration drawings : Plane)

2.2 Waste Water

2.2.1 Present status of waste water discharged

SIDEX has three final drainage outlets (C8, C4, and C7). Flow rate of effluent is 45,900m^3/day at outlet C8, 29,900m^3/day, 3,200m^3/day at C4 and C7, respectively.

Different from waste gas, nationwide standards for waste water are not enacted. For the waste water discharged from SIDEX, however, the Agreement on the concentration and discharge loads is concluded per the drainage outlet, reaching a maximum of 18 items per outlet. The values of the Agreement are quite satisfactory by comparison with those of the EU countries and Japan, proving no problems.

As there is large difference in the steel production between the present and the period when settled the Agreement No.18/1986, the negociation has been continuing to revise the limit values in the Agreement which will be suited to the present status of the operation.

Table III.2-4 compares the measurements in 1992 with the values of the Agreement for concentration of effluent, and Table III.2-5 compares actual results and Agreement values for discharge load.

For the average concentration, the values of the following exceed the values of the Agreement:

At C8 : Dissolved iron, sulphate ion, ammonia, cyanide ion, and phenol
At C4 : Dissolved iron, ammonia, cyanide ion, phenol, suspended solids (SS), and total sulfur

The result of ammonia, cyanide ion, phenol, and total sulfur seems to be affected by the gas liquid (ammonia liquor) from the coke plant.

For the outlet C7, the flow rate is small, 3,200m³/day due to low operation of plants connected to this outlet and the concenration of pollutants is also low.

As for discharge load, ammonia, cyanide ion, phenol, soluble iron, and total sulfur exceeded the values of the Agreement, of which phenol occupied about 60%.

Restriction on discharge of waste water by means of COD or BOD that shows organic pollution is not applied and not measured in SIDEX. But, as these COD and BOD are stipulated in the water quality item in the Environmental Quality Standard for Water and the Environmental Control Agency of Galati checks these in the Siret and in the Donau, they may be placed under restriction in future. And so SIDEX had better measure these voluntarily.

2.2.2 Analysis of the problems found and measures

The target of SIDEX for the year 2002 will be not to discharge waste water whose restriction items exceed the values of the Agreement, and thus to decrease the discharge loads and corresponding penalty as much as possible.

Especially, the urgent measures is necessary for the reduction of phenol which is cosidered to affect the water quality of the Donau and the Siret.

The proposed measures for water pollution prevention are indicated at Table III.2-6.

Table III.2-6. Items of Measures for Water Pollution Prevention

Plants	Items of Measures
Coke Chemical Plants	(1) Improvement of pH Control in Ammonia Stripping (2) Improvement of Activated Sludge Process (3) Installation of Coagulation Precipitator

2.2.3 Estimated effect of measures on the areas around SIDEX

After the above measures, the discharge loads of phenol, ammonia, and cyanide are shown in Table III.2-7. and it is expected to satisfy the Agreement values.

Especially the concentration of phenol which presently affects the water quality of Siret and Donau will be decreased by 99%, thus greatly contributing to the improvement of the environment around SIDEX.

Table. III.2-7. Discharge loads of phenol, ammonia, and cyanide after measures in 2002.

	Unit	Before measures	After measures	Reduction
Phenol	loads(t/Y)	84.1	0.5	△99%
	rate(g/t-steel)	15	0.1	
Ammonia	loads(t/Y)	1,009	168	△83%
	rate(g/t-steel)	181	30	
Cyanide	loads(t/Y)	25.2	1.7	△93%
	rate(g/t-steel)	5	0.3	

Table III.2-4. Concentration of Effluent and Agreement Values (mg/l)

Indicator	Drainage Outlet C 8 Agreement	Data	(max.)	Drainage Outlet C 4 Agreement	Data	(max.)	Drainage Outlet C 7 Agreement	Data	(max)
Quantity (m^3/day)	102,384	45,894		120,096	29,856		239,328	3,166	
1. pH	7~8	7.9	(8.9)	7~8.5	7.9	(9.6)	6.5~8		
2. Ca ion	207	144	(198)	155	59	(100)	134	59	(80)
3. Mg ion	26	21.2	(58.4)	36	26	(51)	20	27	(48)
4. Soluble iron	0.3	0.96	(3.9)	0.5	2.2	(13)	0.3		
5. Cl^- ion	320	166	(248)	296	184	(320)	80		
6. SO_4^{2-} ion	198	274	(379)	152	137	(172)	104	94	(145)
7. NO_3^- ion	18	7.1	(14.5)	5	3.6	(10)	5	4.6	(5.6)
8. Ammonium ion	3	3.6	(11.1)	3	31.2	(197.5)	-	1.6	(3.3)
9. Cyanides	0.08	0.23	(3.02)	0.03	0.58	(2.24)	-	0	(0)
10. Phenols	0.15	0.87	(4.16)	0.14	20.03	(99.1)	-	0.048	(0.09)
11. Suspended solid	30	26	(155)	40	43	(84)	41	26	(62)
12. Total sulfur	0.3			0.27	1.9	(3.54)	-		
13. Na^+ ion	128			121			25		
14. Total chromium	-			-			2.8		
15. Cr^{6+}	0.006			-			-		
16. Zn^{2+} ion	0.009			0.12			-		
17. Free Cl_2	0.004			0.016			-		
18. Oil	0.5			0.4			0.3		

Re. Blank in each indicator means that SIDEX has not analysed.

Table III.2-5. Discharge Loads and Agreement (kg/day)

Indicator over Agreement	Drainage Outlet C 8 Agreement	Data	Drainage Outlet C 4 Agreement	Data	Outlet C7 Agreement	Total Agreement	Data	Unit Price (Lei/kg)
4. Soluble iron	35	124	57	129	5	97	253	57.77
6. SO_4^{2-} ion	20,100	35,249	18,300	8,014	1,740	40,100	43,263	4.35
8. Ammonium ion	300	464	340	1,823	-	640	2,287	173.30
9. Cyanides	8	30	4	34	-	12	64	1,733.70
10. Phenols	15	112	17	1,172	-	33	1,284	2,889.52

2.3 Solid Wastes

2.3.1 Present status of solid wastes discharged

As standards on the disposal of solid wastes such as by landfill, there exists only the Basel Treaty which restricts cross-border transportation of harmful wastes, and no detailed standards for the storage, transportation, and disposal according to the properties of wastes. Correspondingly, there are no special restrictions applied in SIDEX. Establishment of treatment standard, regulation and promotion scheme for solid wastes are desired in the future.

Solid wastes generated in SIDEX such as slag, dust, and waste refractories are basically thrown away to the special disposal area (slag yard) to the west of the works. It is maybe because of more availability of disposal areas compared with Japan, most solid wastes and byproducts except part of slag and dust are disposed of by throwing away.

2.3.2 Analysis of the problems found and measures

Though SIDEX has a vast disposal area, expansion of the existing disposal area and ponds should be limited in terms of environmental protection. More concretely, the following are recommended:

(1) The air cooled slag generated in BF and BOF hardly can be reused as materials in road construction or civil engneering fields. The BF water granulated slag can be reused as materials for blast furnace slag cement or in civil engneering.

(2) To reuse the dust and sludge as iron source in sintering process is necessary. In addition, SIDEX has to install dehydration equipments in order to limit expansion of the present ponds and retain its long period of dumping area.

(3) Not to allow careless disposal of solid wastes, a control system which requires efforts at recovery and reuse of solid wastes at the generation source should be established. One good starting point is to expand the present system in SIDEX's Modernization and Environmental Control Department, in which the kinds, volume, generation source, the plant in charge, recovery cost, etc. of the waste to be brought into the slag yard are required to be recorded in a card and submitted to the Department.

2.4 Measures for Incidental Pollution

There are new generations of dust, sulfur and sludge according to installations of dust collectors, desulfurization facilities and dehydration equipments for the environmental protection measures in 2002.
Each solid wastes and their treatment are listed in Table III.2-8.

Table III.2-8 Outline of utilization of dust, sulfer and sludge generated from new depollution facilities in 2002

Plant	Depollution facilities	Solid wastes	Generation	Utilization or treatment
Coke oven batteries and coke chemical plants	No.2, 3 CDQ : Dust collector No.5, 7 COB : Dust collector of guide car	Coke dust	(total) 14,500 t/y	Reuse as raw material in sintering plant
	No.7 COB : COG-Desulfurization equipment	Sulfer	2,200 t/y	Recover as sulfuric acid of 6,300 t/y
	No.5 & 6 COB, No.7 COB : Sludge from activated sludge process	Dehydrated sludge	(total) 5,400 t/y 85 % hydrated	Incinerate by COB mixing with coal
	No.5 & 6 COB, No.7 COB : Sludge from new precipitator	Dehydrated sludge	(total) 5,600 t/y 85 % hydrated	
Sintering plants	No.5 & 6, No.7 : Desulfurization equipments	SOx gas	3,335 kNm³/y	Recover as sulfuric acid with sulfur of COG desulfurization
	No.5 & 6, No.7 : New electric precipitator of main exhaust gas	Collected dust	13,600 t/y	Reuse 12,600 t/y in sintering plant, but the residue (1,000 t/y) is dumped because its high alkalinity
Blast furnace	No.5, 6 BF : Dust collector of casthouse	Collected dust	36,500 t/y	Send as slurry to thickener and precipitator

IV. CONCEPTUAL DESIGN OF MODEL PLANT AND ITS APPLICATION

In order to more concretely show the contents of measures for energy saving and for environment pollution control to each model plant mentioned in Chapters II and III, the outlines are designed as follows. In addition, the possibility of application of those designs to other plants than the model plants is studied. Since the scheme of renovating the present two reheating furnaces costs higher than the expenses for building a new furnace for the effects, the outline is designed only for constructing the new furnace.

1. NO.5 COKE OVEN (INCL. NO.2 CDQ) AND NO.1 COKE CHEMICAL PLANT

Fig. IV.1-1.shows the whole outline of measures for energy saving and for environmental pollution control regarding No.5 Coke Oven (incl. No.2 CDQ), and Fig.IV. 1-2. shows the whole outline of environmental measures for No.1 Coke Chemical plant. The conceptual designs for the coke oven and coke chemical plant consist of the followings:

(1) Facilities of energy saving and technology

Item No.	Name of facilities
111.	Installation of a gas chromatography
121.	Installation of new BFG piping and a mixer of BFG/COG
131.	Installation of semi-automatic combustion control system
141	Complete renewal of No.2 CDQ

(2) Facilities with environmental measures and technology

Item No.	Name of facilities
151. & 152.	Installation of facilities to reduce dust emission during charging
161.	Installation of a dust collector for pushing and for CDQ
171.	Improvement of the activated sludge facilities

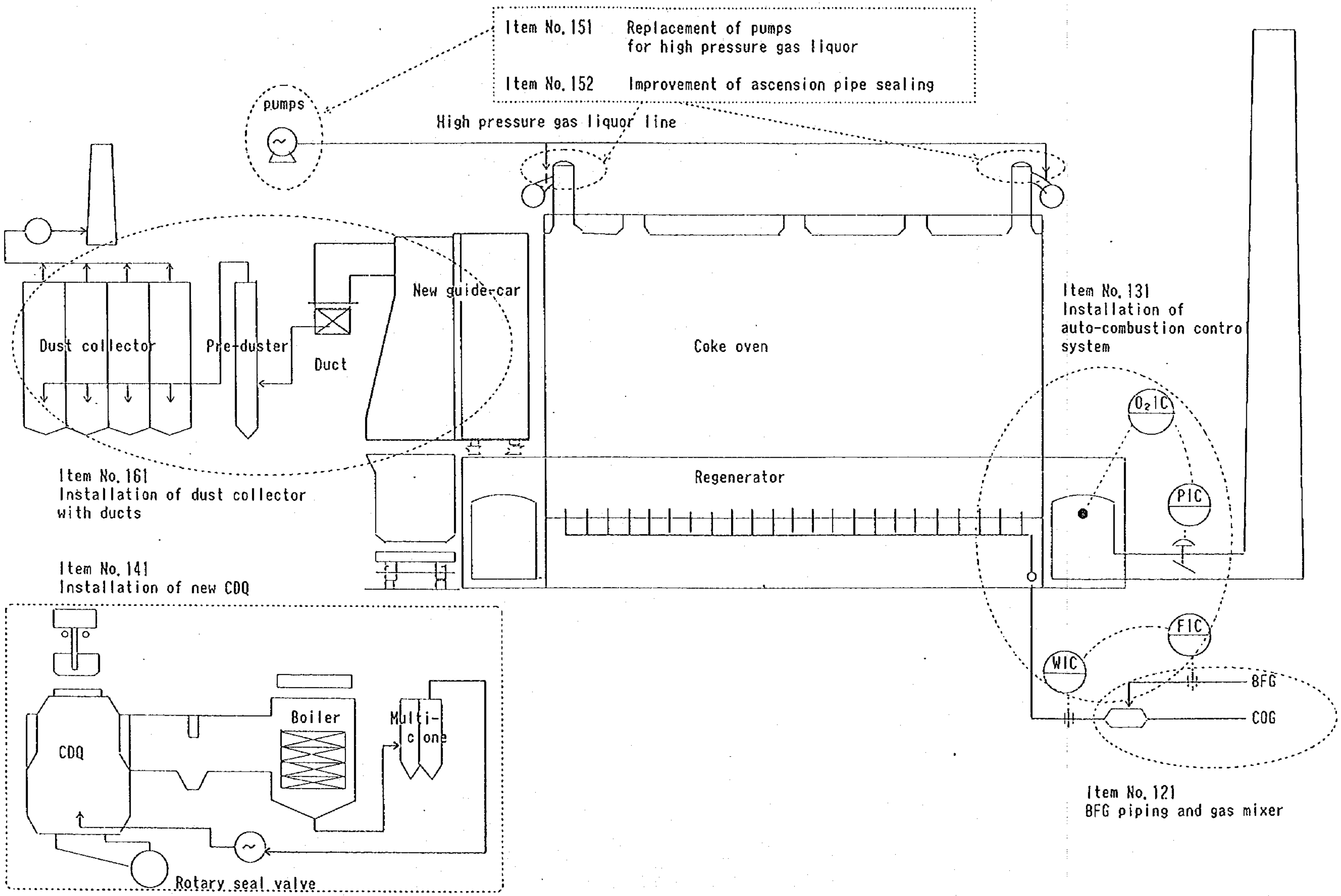

Fig. IV. 1-1. OVERALL VIEW OF ENERGY-SAVING & ENVIRONMENTAL PROTECTION IN No. 5 COKE OVEN BATTERIES

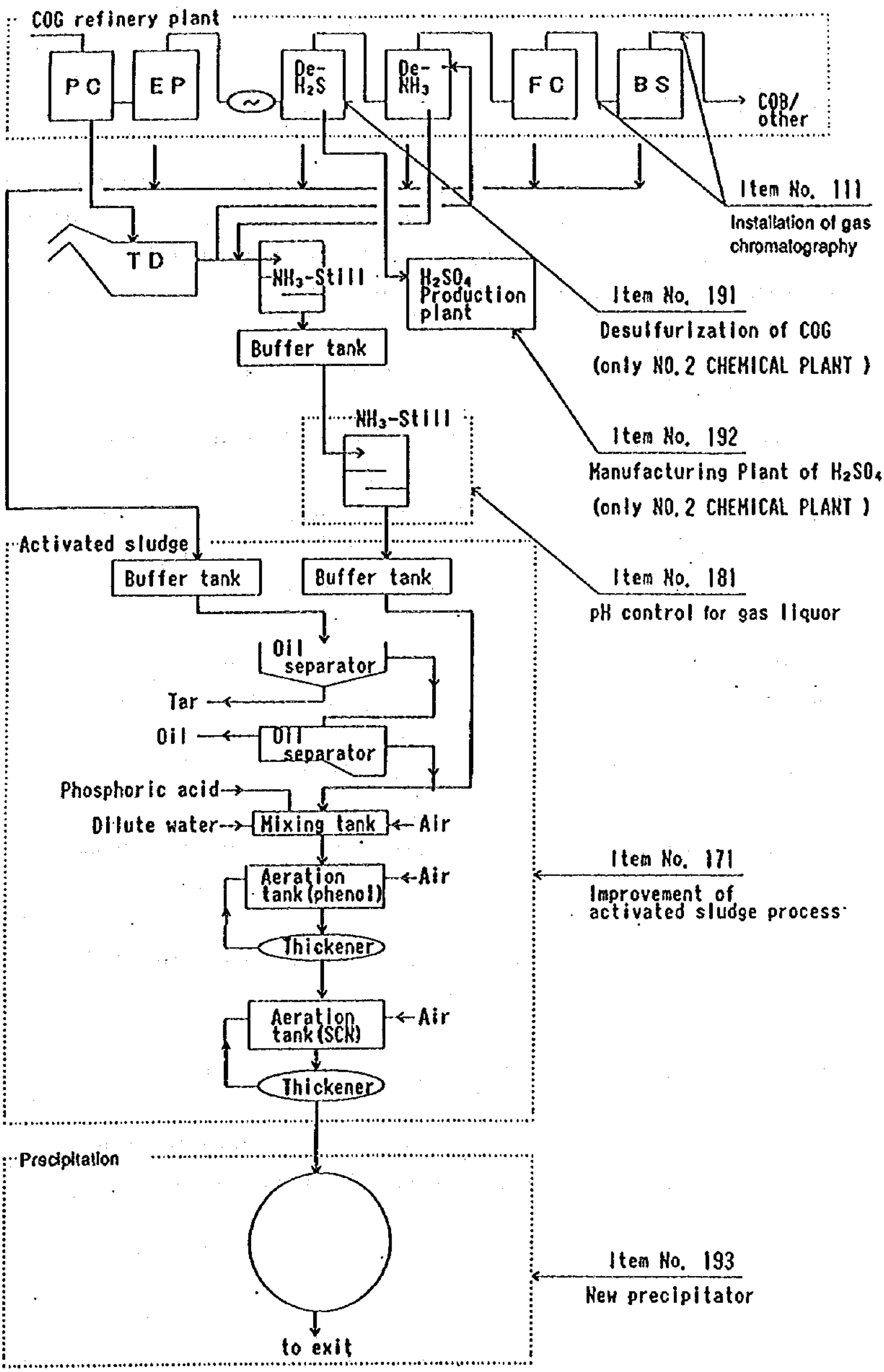

Fig.IV.1-2 Overall view of Environmental Protection No.1 Coke Chemical Plant.

2. NO.7 SINTERING PLANT

A schematic diagram about outline of total conceptual design for No.7 sintering plant is shown in Figure IV.2-1. As the basic condition for designing, the production capacity is settled 15,000 t/d (30 t/d/m2).
The conceptual designs consist of the followings:

Class		Equipment Item
Enhancement of the operational control system	211	Measurement of the cold strength of sinter product (Shutter Tester)
	213	Constant feeding weigher of raw materials and coke breeze
Improvement of burning coke breeze	221	Intensified Sifting Feeder
	224	Coke breeze recrushing system
Ignition furnace	231	Compact furnace
Recovery of cooler waste heat	241	Reusing system of cooler waste gas
	242	Waste heat recovery boiler
Pollutants control of main waste gas	251	De-dusting (Moving electrode E.P.)
	252	De-sulfurization
De-dusting of plant	261	On strand suction system
Increasing productivity	271	Yard stock system for sinter product
	272	Quick lime adding system

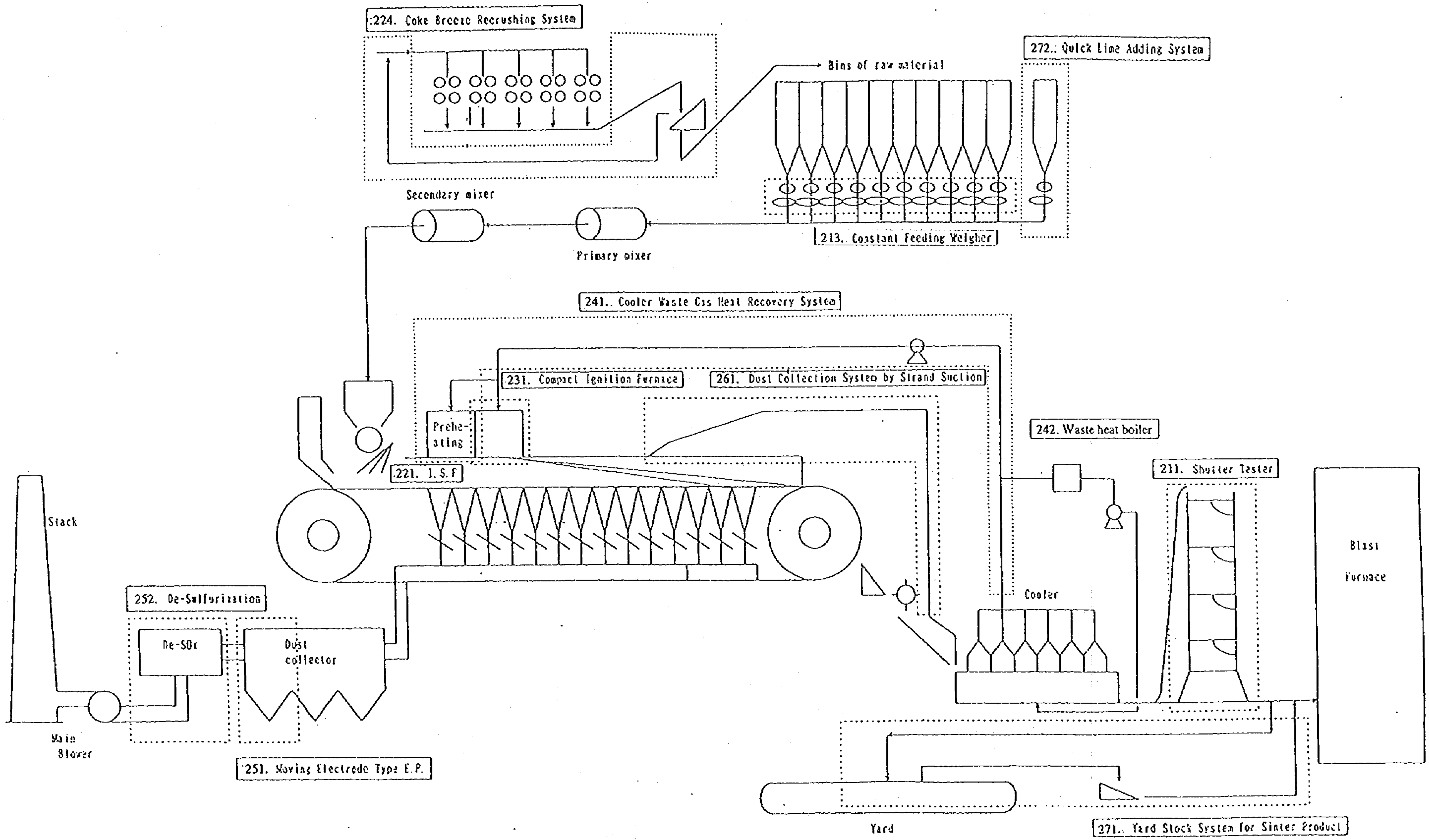

Fig.IV.2-1. Schematic diagram of Energy Saving and Pollution Control Measures for No.7 Sintering Plant

3. NO.6 BLAST FURNACE (INCL. HOT STOVES)

Fig. IV.3-1. shows the outline of the whole measures for energy saving and Fig. IV.3-2. shows the outline of the whole environmental measures. The conceptual design is composed of the followings:

(1) Facilities of energy saving and technology

Item No.	Name of facilities
311.	Introduction of a control system for hot stoves
321.	Renewal of tuyere
331.	Installation of PCI facilities
332.	Application of technology of charging coke
341.	Installation of TRT facilities for power generation
361.	Installation of preheating equipment for fuel
362.	Installation of preheating equipment for combustion air

(2) Facilities with environmental measures and technology

Item No.	Name of facilities
371.	Renewal of dust collecting system for casting floor

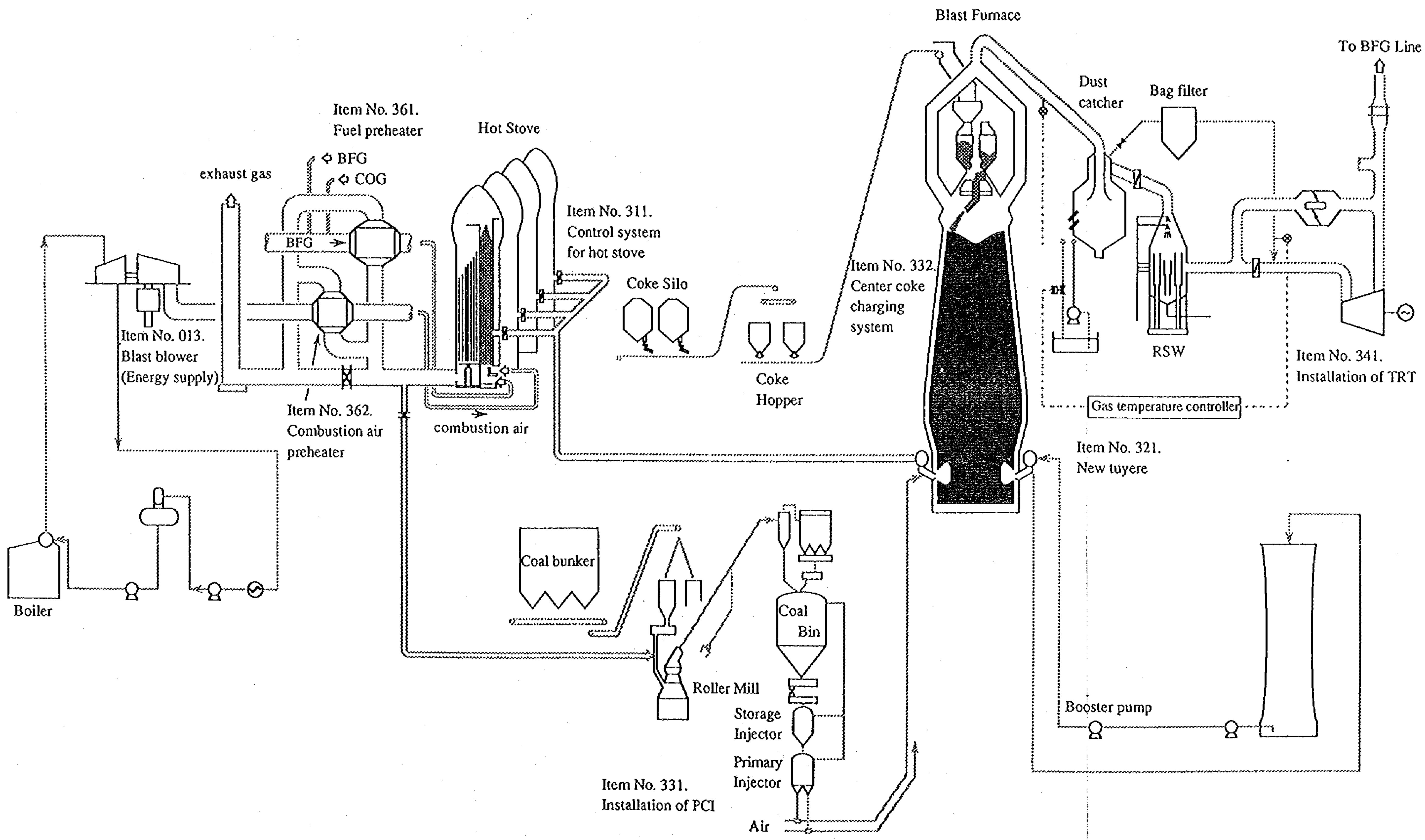

Fig. IV.3-1. Overall view of energy saving in blast furnace

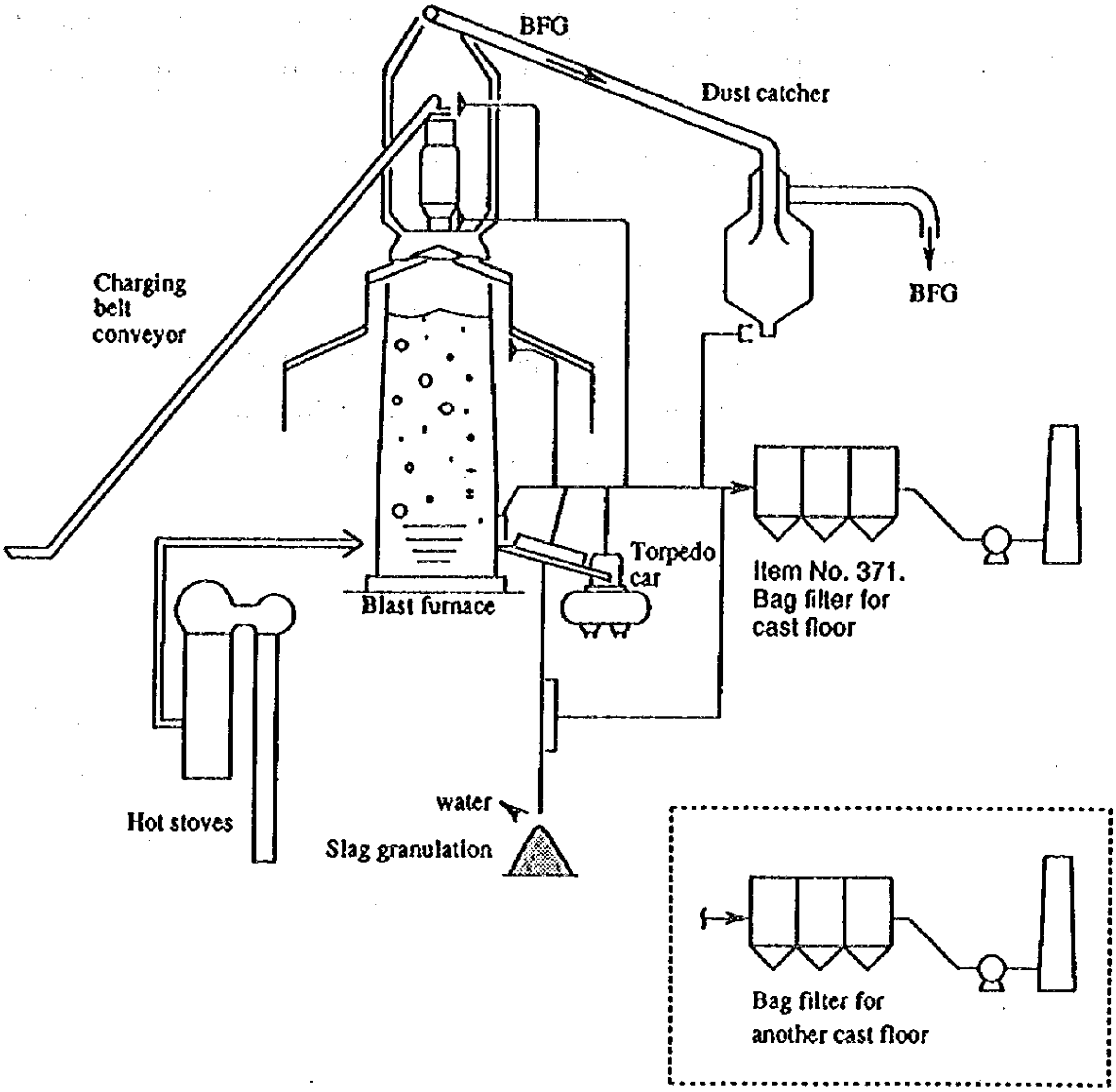

Fig.IV.3-2. Overall view of environmental pollution control in blast furnace

4. HOT STRIP MILL NO.3 REHEATING FURNACE

Fig. IV.4-1 shows the whole outline of the conceptual design for No.3 reheating furnace . The concept is to replace the present two operating furnaces with a new furnace, and purposes to meet the production (1,880,000 t/y) in year 2002. Hence, a great deal of effects on energy saving is expected. The measures for facilities consists of the followings:

• Facilities of energy saving and technology

Item No.	Name of facilities
411.	Installation of high performance reheating furnace
412.	Installation of high efficient air recuperator
413.	Installation of fuel gas recuperator

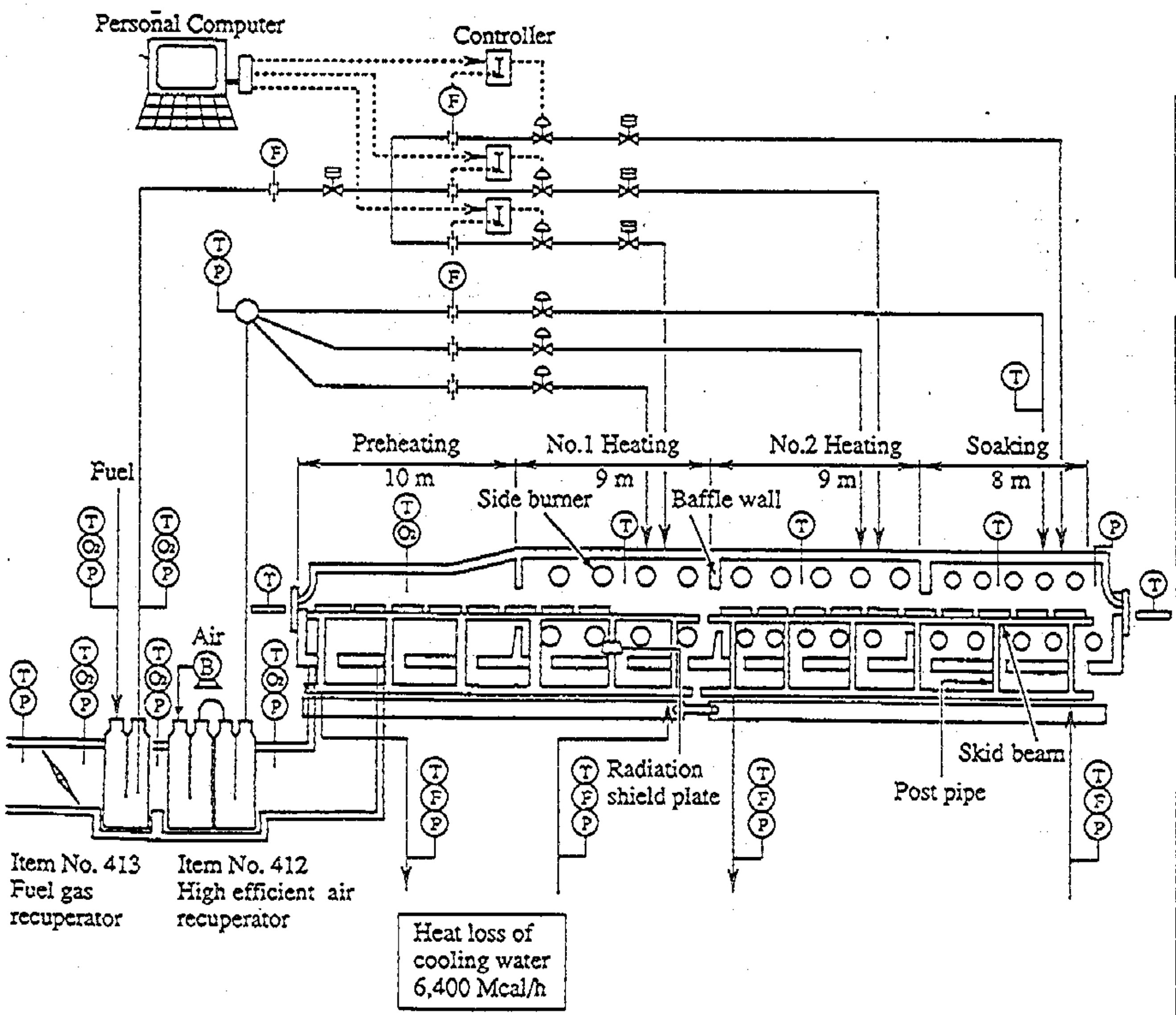

Fig.IV.4-1. Outline of New Reheating Furnace

Item No. 411.
New Reheating Furnace

1. Promotion of Heat Transfer

- Box type furnace without the nose
- Skid shift at the soaking zone
- Optimizing the height of baffle wall
- Making higher the skid rider

2. Energy Saving

Heat Loss of Furnace Wall

- Ceramic fiber lining

Heat Loss of Cooling Water

- Ceramic fiber lining of skid bean and post
- Natural convection cooling of skid post

Sensible Heat of Exhaust Gas

- Low excess air ratio by O_2 % control and cross-limit control
- Thinned-out burner control
- Firing ratio increases toward discharge side

Radiation Loss

- Radiation shield plate at the hearth
- Closed type charging door

Heat Recovery

- Furnace pressure control
- Closed type charging door

5. ENERGY SUPPLYING FACILITIES

The conceptual design for the energy supplying facilities are consist of the followings:

• Facilities of energy saving

Item No.	Name of facilities
011.	Installation of gas holders
012.	Installation of gas mixing device
013.	Renewal of blower, turbine and boiler

1) Item No.011 Gas Holder

The capacities of the gas holders are 100,000 m3 for BFG and 50,000m3 for COG.

2) Item No.012 Gas Mixing Device

Fig. IV.5-1 shows a flow sheet for the gas mixing device.

3) Item No.013 Blower, Turbine and Boiler

Fig. IV.5-2 shows image of new power station. One blower works for No.6 BF, and a blower for No.5 BF (previously used for No.6 BF) shall partly supply air if the blower trips.

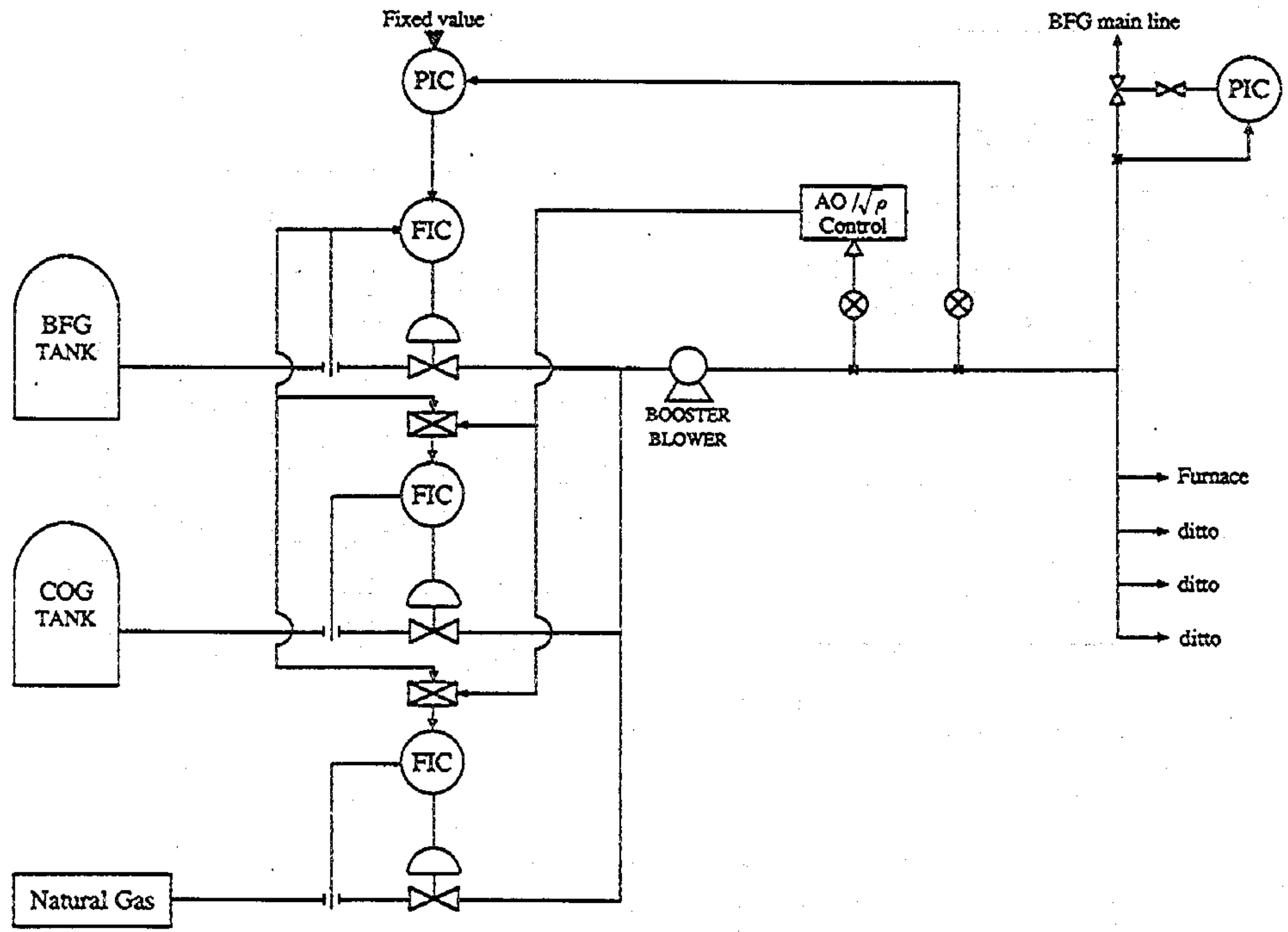

Fig.IV.5-1. Schematic flow of gas mixing system

Present

No.2 Station	
Boiler	7 units
Blower	5 units
Generator	———

No.3 Station	
Boiler	7 units
Blower	3 units
Generator	2 units

After modemization

(Final stage)

New station	
Boiler	3 units
Blower	3 units
Generator	1 units

Features
- Large-scale-plant
- High efficiency
- High flexibility
- Combined

Schematic diagram

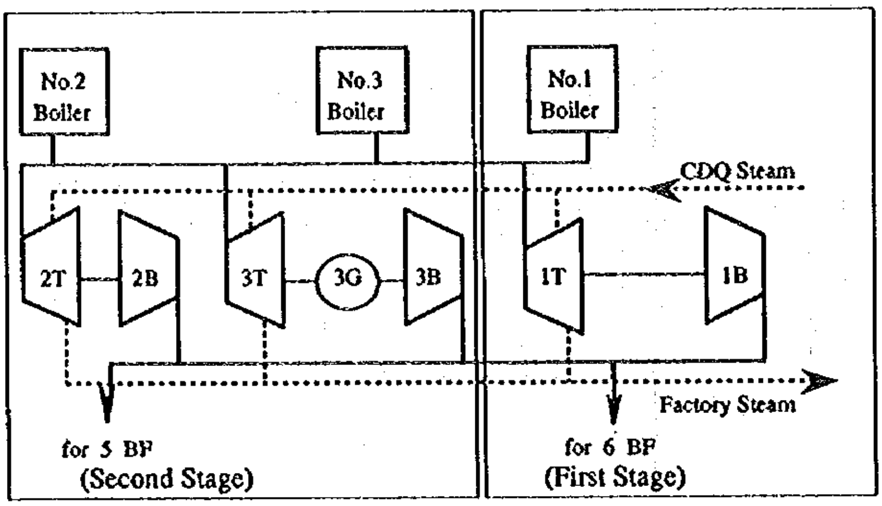

Fig.IV.5-2. Image of new power station

6. IMPROVING MEASURES WITH TECHNICAL TRANSFER

In the measures for energy saving, there are items that can save energy under only operation assistance, without facilities investment. Table IV. 6-1 shows two plants out of them, that need the technical assistance especially from other countries.

The effects of energy saving mentioned here is on condition that technology is 100 % transferred to the assisted party. As to the period of technical transfer, the mentioned values are indicated for experienced motivated persons with good knowledge.

Table IV. 6-1 Technical transfer items by Operation assistance from outside

Name of Plant	Items of technical transfer	Expected effects for energy saving	Expected period for technical transfer
No.5 COB	(1) Reduction of fuel unit consumption by enhanced operation control and combustion control (2) Reduction of dust generating in extracting material from and charging into the furnace. (3) Reduction of troubles/accidents by improved repair method	Reduction of 35 Mcal/t-coal △COG = 6.88×10^6 Nm^3/y	6.2 Man-month
No.6 BF	(1) Reduction of BF fuel ratio owing to optimization of distributions of materials and gas in the furnace	Reduction of coke ratio 41 kg/t △Coke = 110,987 t/y	5 Man-month

7. INVESTIGATION OF APPLICABILITY OF MODEL PLANT MEASURES TO RELATED PLANTS

With regard to the aforesaid measures taken to the model plants, whether the measures are applicable to other plants (i.e. coke oven incl. CDQ, coke chemical plant, sintering plant, blast furnace), how the measures should be modified providing it is applicable and how much effects can be expected, and so on are investigated. As a result, the followings are obtained.

7.1 Coke oven (incl. CDQ) and coke chemical plant

Based on the operation plan in year 2002, the following plants are selected as subjects of investigation for the applicability of model plant measures.

	Model plant	Subject of investigation for applicability
Coke oven	No.5	No. 6, No.7
CDQ	No.2	No.3
Coke chemical plant	No.1	No.2

The similar measures can be applied to the related plants and fairly large effects can be expected. No.2 coke chemical plant (for No.7 coke oven) differs very much from the model plant, and desulfurization facilities and sulfuric acid facilities should be renewed.

7.2 Sintering plant

Based on the operation plan in year 2002, the following plants are selected as subjects of investigation for the applicability of model plant measures.

	Model plant	Subject of investigation for applicability
Sintering plant	No. 7	No. 5, No. 6

The similar measures can be applied to the related plants and similar effects can be expected. In the sintering plant, the following facilities installed in the model plant can be shared in use.

(1) Cold strength measurement device
(2) Coke breeze recrushing system
(3) Yard stock system for sinter product

Waste heat of cooler can be completely collected in steam because of its high efficiency.

7.3 Blast Furnace

Based on the operation plan in year 2002, the following plant in blast furnace is determined as a subject of investigation for the applicability of model plant measures.

	Model plant	Subject of investigation for applicability
Blast Furnace	No. 6	No. 5

The similar measures can be applied to No.5 blast furnace. Apart from the model plant, the No.5 BF should have the center coke charging equipment because the type of blast furnace is not the same.
Further, the following table shows the performance of No.5 BF after the energy saving measures are taken, which is estimated from the production balance.

Operation item	No. 5 Blast Furnace
Inner volume (m^3)	3,128
Production (t/y)	2,063,000
Production (t/calender day) (t/operation day)	5,652 6,000
PC ratio (kg/t)	150
Coke ratio (kg/t)	370
Fuel ratio (kg/t)	520
Unit consumption of air blast (Nm^3/t)	1,220
Blast air quantity ($Nm^3/min.$)	4,910
Furnace top pressure (kg/cm^2)	2.0
Blower pressure (kg/cm^2)	3.75

V. IMPLEMENTATION OF MEASURES

In order to make the schedule of reasonable energy saving and of measures to prevent the environmental pollution, that is linked with the modernization plan of SIDEX. In the second site survey, the Study team. succeeded in arriving at an agreement with the Ministry of Industry and SIDEX in Romania. Table V. 1-1 shows the implementation schedule.

Further, the measures to save energy and to protect the environmental pollution seem to have a great influence on not only SIDEX but also the whole industry in Romania, and virtually are expected to be implemented as early as possible.

Table V.1-1. Implementation schedule

Purposes	Countermeasures	1995	1996	1997	1998	1999	2000	2001	2002
I. ENERGY SAVING I.1 Coke oven & Coke chemical plant									
To increase BTX recovery rate	111. Installation of gas chromatography		■	■	■				
To change fuel gas from COG to Mixed gas	121. Installation of BFG piping and gas mixer		■	■	■				
To decrease COG consumption by semi-automatic combustion control	131. Installation of control system		■	■	■				
To increase recovery of steam by overall revamping of CDQ	141. Installation of a new CDQ		■	■	■				
I.2 Sintering plant									
Enhancement of the operational control system	211. Measurement of the cold strength of sinter product	■	■						
	213. Improvement of weighing accuracy of raw material and coke breeze	■	■						
Improvement of burning coke breeze	221. Installation of intensified sifting feeder	■	■						
	224. Coke breeze recrushing system	■	■						
Ignition furnace	231. Installation of compact furnace	■	■						
Recovery of cooler waste heat	241. Reusing system of cooler waste gas	■	■						
	242. Installation of waste heat boiler	■	■						
To increase productivity	271. Yard stock system for sinter product	■	■						
	272. Quick lime adding system	■	■						

Table V.1-1. Implementation schedule

Purposes	Countermeasures	1995	1996	1997	1998	1999	2000	2001	2002
I.3 Blast furnace									
Decrease the fuel consumption of hot stove	311. Employment of control system for hot stove	■	■						
To increase the operational availability of blast furnace	321. Replacement of tuyeres	■	■						
To lower BF energy cost & to integrate COBs	331. Installation of PCI system		■	■					
	332. Center coke charging system		■	■					
To recover top gas pressure	341. Installation of top gas recovery turbine (TRT)		■	■	■				
To decrease the fuel consumption of hot stove	361. Installation of fuel preheater	■	■						
	362. Installation of combustion air preheater	■	■						
I.4 Reheating furnace									
To improve performance such as heat unit consumption by replacing with high performance reheating furnace	411. Installation of new reheating furnace	■	■						
	412. To install highly efficient air recuperator	■	■						
	413. To install fuel gas recuperator	■	■						
I.5 Energy supply equipment									
For stable supply of fuel gas	011. Installation of gas holders		■	■	■				
	012. Installation of gas mixing equipment		■	■	■				
Improvement of blast air supply	013. Replacement of blast blower, boiler & turbine		■	■	■				

Table V.1-1. Implementation schedule

Purposes	Countermeasures	1995	1996	1997	1998	1999	2000	2001	2002
II. ENVIRONMENTAL POLLUTION CONTROL II.1 Coke oven & Coke chemical plant									
To decrease dust from COB & CDQ	151. Replacement of pumps for injection of high pressure gas liquor		■	■	■				
	152. Improvement of sealing of ascension pipes		■	■	■				
	161. Installation of dust collector with ducts		■	■	■				
To decrease the pollutants in waste water	171. Improvement of activated sludge process	■	■	■	■				
	181. Employment of pH control for gas liquor	■	■	■	■				
	191. Installation of new precipitator	■	■	■	■				
II.2 Sintering plant									
Pollutants control in main waste gas	251. Improvement of dust collector	■ 3rd field	■			■ 2nd field	■		
	252. Installation of desulfurization system				■	■	■		
De-dusting of surrounding area	261. Enhancement of dust collection	■	■						
II.3 Blast furnace									
De-dusting of cast floor	371. Enhancement of dust collection for cast floor	■	■						

Table V.1-1. Implementation schedule

Purposes	Countermeasures	1995	1996	1997	1998	1999	2000	2001	2002

VI. ESTIMATION OF CAPITAL COST

1. BASIC CONCEPT FOR ESTIMATION

Capital costs are estimated based upon the following basic concept, maximizing as much domestic procurement from Romania as possible taking into consideration capabilities of Romanian companies in terms of engineering, supplying equipment, and construction. Engineering and equipment/materials to be procured from outside Romania, in principle, are estimated based upon procurement contracts entered on an international competitive bidding basis.

In relation to the conceptual designs of model plants described in Chapter IV, capital costs for model plants are estimated primarily. In addition, capital costs for other related plants to which the same measures as those of model plants are applied are roughly estimated for reference.

2. SPLIT OF WORK

In line with the above basic concept, we have evaluated the capabilities of local manufacturing companies at first. Based upon the evaluation, the split of work was discussed and agreed with Romanian counterparts at the second site survey.

3. ESTIMATION BASIS

1) Currency and Exchange Rate

This study uses the US Dollar as the unit currency for all costs. Additionally, the costs in Romanian Lei and other currencies are at once converted into the US Dollar. The exchange rate of Lei to US Dollars to be used for the conversion in this study is 1,650 Lei/US$ which was the exchange rate when official and free market exchange rates united again, after a year and a half of divergence, at the level of the December 1993 free market rate. Since the Yen has appreciated highly against the Dollar since the end of June 1994, the study uses Y100/$1 as of the end of September 1994.

Exchange Rate	Rate/1 US$
Romanian Lei	1,650.00
Japanese Yen	100.00

2) Import duty

Since this project is related to environmental pollution control and energy saving, it is assumed in this study that importation of equipment and materials necessary for the project will be exempted from any Romanian duties in accordance with Romanian law.

3) Escalation

In this study, costs and prices after converted and unified into US dollars are used as case of without-escalation. Alternatively, after converted and unified into US dollars, the costs and prices are further adjusted for escalation at a yearly rate of 3% for periods between the time of the estimation and each actual point of spending, as case of with-escalation. As around 65% of the capital cost is estimated to come from OECD countries, the escalation rate applied uses the rate of the OECD records from the 1993 escalation rate of the producers price, and the escalation rate of Romania is not considered in this study. Domestic escalation in Romania is considered to be absorbed by the foreign currency exchange rate. Therefore, costs in the first period of this project, 1995, are escalated by 1.03, in the second period by 1.0609 and the third period by 1.0927, and so forth. However, such escalation shall not be considered for any spending or revenue after the commencement of commercial operation.

4) Period of Construction and Erection

The period of construction and erection for model plants is 4 years from 1995, and that for other related plants to which the same measures as those of model plants is 4 years as well. As regards the details schedule for model plants, please refer to Chapter V, "Implementation Schedule."

Plant Construction for Model Plants

Effective date of contract	: January 1,1995
Completion of the process conversion project	: December 31, 1998

5) Engineering

The cost of engineering services consists of the following :

(1) Basic Engineering

(2) Part of Detailed Engineering (listed in the attached Appendix-3)

(3) Project Management Fee from effective date of contract to taking over the plant

6) Equipment and Materials

The cost of equipment and materials consists of providing equipment and their appurtenances, materials on FCA named terminal basis, and supervision for installation works and commissioning.

7) Transportation

The cost of transportation consists of customs clearance of equipment, insurance and transportation of the equipment from overseas ports to Romanian ports.

8) Construction and Erection

The cost of construction and erection consists of laying the foundation, and building the plant, warehouses, roads, and sewerage as civil work, and assembly and installation of equipment, wiring, and piping as erection work.

9) Contingency

5% of the equipment and materials and the engineering fee is included in the estimation of capital cost to complement the accuracy of the capital costs.

4. SUMMARY SHEET OF CAPITAL COST

The capital costs for energy saving as well as environmental pollution control in an estimate that dose not account for escalation but is based on the above premises, both for model plants and other related plants, are shown below. As regards the details for those capital costs, please refer to Table VI.1-1. Please note that the capital costs for other related plants that are relatively rough estimation does not include those for model plants.

< Capital Costs for Model Plants >

	(Unit: K US$/Year)
A) Energy Saving	
a) Modification of Equipment	6,345.-
b) Renewal of Equipment	179,887.-
Sub-Total	186,232.-
B) Environmental Pollution Control	
a) Modification of Equipment	32,121.-
b) Renewal of Equipment	45,979-
Sub-Total	78,100.-
A) + B) Grand Total	264,332.-

< Capital Costs for Other Related Plants >

	(Unit: K US$/Year)
A) Energy Saving	
a) Modification of Equipment	6,550.-
b) Renewal of Equipment	120,689.-
Sub-Total	127,239.-
B) Environmental Pollution Control	
a) Modification of Equipment	28,362.-
b) Renewal of Equipment	67,306-
Sub-Total	95,668.-
A) + B) Grand Total	222,907.-

Please note that the cost of replacing the blast blower, boiler, and turbine listed in Chapter IV, Section 5., Item No.13 is included in that of blast furnace No.6 for calculation.

Table VI. 1-1. Summary of Capital Cost for Model Plants and Other Related Plants (1/3)

1) Energy Saving for Model Plants

1-1) Without Escalation

(Unit: K US$)

	No. 5 Cokes Oven Battery			No.7 Sintering Plant			No.6 Blast Furnace Plant			No.3 Reheating Furnace Plant			Energy Supply			Total for Energy Saving		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	1,121	0	1,121	884	0	884	4,857	0	4,857	1,000	0	1,000	1,931	0	1,931	9,793	0	9,793
Equipment & Materials	5,150	9,982	15,132	6,304	3,380	9,684	59,507	6,068	65,575	8,320	5,180	13,500	25,181	888	26,069	104,462	25,498	129,960
Transportation	241	0	241	328	0	328	3,280	0	3,280	439	0	439	1,396	0	1,396	5,684	0	5,684
Civil & Erection	0	7,147	7,147	0	4,050	4,050	0	13,202	13,202	0	3,404	3,404	0	7,770	7,770	0	35,573	35,573
Contingency	257	0	257	314	0	314	2,976	0	2,976	416	0	416	1,259	0	1,259	5,222	0	5,222
Sub Total (1)	6,769	17,129	23,898	7,830	7,430	15,260	70,620	19,270	89,890	10,175	8,584	18,759	29,767	8,658	38,425	125,161	61,071	186,232

1-2) With Escalation

(Unit: K US$)

	No. 5 Cokes Oven Battery			No.7 Sintering Plant			No.6 Blast Furnace Plant			No.3 Reheating Furnace Plant			Energy Supply			Total for Energy Saving		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	1,230	0	1,230	932	0	932	5,283	0	5,283	1,046	0	1,046	2,092	0	2,092	10,583	0	10,583
Equipment & Materials	5,653	10,946	16,599	6,644	3,567	10,211	64,730	6,546	71,276	8,698	5,415	14,113	27,281	962	28,243	113,006	27,436	140,442
Transportation	265	0	265	346	0	346	3,568	0	3,568	459	0	459	1,512	0	1,512	6,150	0	6,150
Civil & Erection	0	7,837	7,837	0	4,274	4,274	0	14,243	14,243	0	3,559	3,559	0	8,418	8,418	0	38,331	38,331
Contingency	282	0	282	331	0	331	3,237	0	3,237	435	0	435	1,364	0	1,364	5,649	0	5,649
Sub Total (1)	7,430	18,783	26,213	8,253	7,841	16,094	76,818	20,789	97,607	10,638	8,974	19,612	32,249	9,380	41,629	135,388	65,767	201,155

Table VI. 1-1. Summary of Capital Cost for Model Plants and Other Related Plants (2/3)

2) Environmental Pollution Control for Model Plants (without escalation)

(Unit: K US$)

	No. 5 Cokes Oven Battery			No.7 Sintering Plant			No.6 Blast Furnace Plant			No.3 Reheating Furnace Plant			Energy Supply			Total for Env. Pollution Cntl		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	550	0	550	2,838	0	2,838	524	0	524	0	0	0	0	0	0	3,912	0	3,912
Equipment & Materials	5,571	1,852	7,423	37,628	680	38,308	3,524	3,552	7,076	0	0	0	0	0	0	46,723	6,084	52,807
Transportation	301	0	301	2,087	0	2,087	180	0	180	0	0	0	0	0	0	2,568	0	2,568
Civil & Erection	0	3,369	3,369	0	10,740	10,740	0	2,368	2,368	0	0	0	0	0	0	0	16,477	16,477
Contingency	279	0	279	1,881	0	1,881	176	0	176	0	0	0	0	0	0	2,336	0	2,336
Sub Total (2)	6,701	5,221	11,922	44,434	11,420	55,854	4,404	5,920	10,324	0	0	0	0	0	0	55,539	22,561	78,100

3) Total of Energy Saving and Environmental Pollution Control for Model Plants (without escalation)

(Unit: K US$)

	No. 5 Cokes Oven Battery			No.7 Sintering Plant			No.6 Blast Furnace Plant			No.3 Reheating Furnace Plant			Energy Supply			Grand Total		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	1,671	0	1,671	3,722	0	3,722	5,381	0	5,381	1,000	0	1,000	1,931	0	1,931	13,705	0	13,705
Equipment & Materials	10,721	11,834	22,555	43,932	4,060	47,992	63,031	9,620	72,651	8,320	5,180	13,500	25,181	888	26,069	151,185	31,582	182,767
Transportation	542	0	542	2,415	0	2,415	3,460	0	3,460	439	0	439	1,396	0	1,396	8,252	0	8,252
Civil & Erection	0	10,516	10,516	0	14,790	14,790	0	15,570	15,570	0	3,404	3,404	0	7,770	7,770	0	52,050	52,050
Contingency	536	0	536	2,195	0	2,195	3,152	0	3,152	416	0	416	1,259	0	1,259	7,558	0	7,558
Grand Total	13,470	22,350	35,820	52,264	18,850	71,114	75,024	25,190	100,214	10,175	8,584	18,759	29,767	8,658	38,425	180,700	83,632	264,332

Table VI. 1-1. Summary of Capital Cost for Model Plants and Other Related Plants (3/3)

4) Energy Saving for Other Related Plants (without escalation)

	No. 6 & 7 Cokes Oven Battery			No.5 & 6 Sintering Plant			No.5 Blast Furnace Plant			Reheating Furnace Plant			Energy Supply			Total for Energy Saving		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	1,419	0	1,419	816	0	816	5,202	0	5,202	0	0	0	0	0	0	7,437	0	7,437
Equipment & Materials	8,257	10,909	19,166	5,976	5,050	11,026	68,421	1,800	70,221	0	0	0	0	0	0	82,654	17,759	100,413
Transportation	410	0	410	314	0	314	3,793	0	3,793	0	0	0	0	0	0	4,517	0	4,517
Civil & Erection	0	870	870	0	2,810	2,810	0	7,060	7,060	0	0	0	0	0	0	0	10,740	10,740
Contingency	413	0	413	299	0	299	3,420	0	3,420	0	0	0	0	0	0	4,132	0	4,132
Sub Total (1)	10,499	11,779	22,278	7,405	7,860	15,265	80,836	8,860	89,696	0	0	0	0	0	0	98,740	28,499	127,239

5) Environmental Pollution Control for Other Related Plants (without escalation)

	No. 6 & 7 Cokes Oven Battery			No.5 & 6 Sintering Plant			No.5 Blast Furnace Plant			Reheating Furnace Plant			Energy Supply			Total for Env. Pollution Cntl		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	1,518	0	1,518	3,133	0	3,133	320	0	320	0	0	0	0	0	0	4,971	0	4,971
Equipment & Materials	13,704	6,786	20,490	37,923	4,370	42,293	2,520	1,800	4,320	0	0	0	0	0	0	54,147	12,956	67,103
Transportation	731	0	731	2,087	0	2,087	132	0	132	0	0	0	0	0	0	2,950	0	2,950
Civil & Erection	0	7,207	7,207	0	9,530	9,530	0	1,200	1,200	0	0	0	0	0	0	0	17,937	17,937
Contingency	685	0	685	1,896	0	1,896	126	0	126	0	0	0	0	0	0	2,707	0	2,707
Sub Total (2)	16,638	13,993	30,631	45,039	13,900	58,939	3,098	3,000	6,098	0	0	0	0	0	0	64,775	30,893	95,668

6) Total of Energy Saving and Environmental Pollution Control for Other Related Plants (without escalation)

	No. 6 & 7 Cokes Oven Battery			No.5 & 6 Sintering Plant			No.5 Blast Furnace Plant			Reheating Furnace Plant			Energy Supply			Grand Total		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	2,937	0	2,937	3,949	0	3,949	5,522	0	5,522	0	0	0	0	0	0	12,408	0	12,408
Equipment & Materials	21,961	17,695	39,656	43,899	9,420	53,319	70,941	3,600	74,541	0	0	0	0	0	0	136,801	30,715	167,516
Transportation	1,141	0	1,141	2,401	0	2,401	3,925	0	3,925	0	0	0	0	0	0	7,467	0	7,467
Civil & Erection	0	8,077	8,077	0	12,340	12,340	0	8,260	8,260	0	0	0	0	0	0	0	28,677	28,677
Contingency	1,098	0	1,098	2,195	0	2,195	3,546	0	3,546	0	0	0	0	0	0	6,839	0	6,839
Grand Total	27,137	25,772	52,909	52,444	21,760	74,204	83,934	11,860	95,794	0	0	0	0	0	0	163,515	59,392	222,907

VII. COST EFFECTIVE ANALYSIS

1. GENERAL

1.1 Basic Concept of Cost Effective Analysis

1.1.1 Energy saving

The profitability on energy saving for each model plant in each sector is analyzed and evaluated for net effect of saving energy (namely, amount of savings of purchasing energy) by using a method of financial internal rate of return (FIRR) from a company point of view as well as economic internal rate of return (EIRR) from a country point of view. Additionally, the profitability for other related plants, to which most of the same measures on model plants are applied, is also roughly evaluated in the same manner as that in the model plants for reference.

1.1.2 Environmental pollution control

It is not easy to evaluate the impact of investment for environmental pollution control on the operation of plants and on the surrounding in such manner as the FIRR as well as EIRR due to limited data or insufficient knowledge concerning the link between environmental damage and human health and welfare, for sustainable development. So, in this study, it is considered that a method of "cost-effectiveness analysis" described in Economic Analysis of the Environmental Impacts of Development Projects published by the Asian Development Bank, is of the most suitable ones for evaluating the effect of investment in terms of environmental pollution control.

In the cost-effectiveness analysis, the first step is deciding upon a target to achieve. For example, in the environmental field this may be a certain ambient air quality, a maximum level of exposure to a waterborne disease agent, or an emission standard for industrial facilities. Once a target or standard is chosen, the cost-effectiveness analysis is performed by examining the various ways of reaching this target. Each project will involve different alternatives and must be dealt with differently. Analysis must ensure that a wide range of alternatives are considered but the basic goal is the same - identify the least-cost alternative available for meeting a given goal.

The cost-effectiveness analysis, in that no attempt is made to measure benefits in money, would be suitable in this study, because the method can present alternatives to the decision maker who will make a decision based upon his experience and knowledge in the field of steel industry.

Some investment for energy saving, whose effects are closely related to environmental pollution control, are classified in those for energy saving in the study

1.1.3 Operational assistance

The operational assistance is classified independently of energy saving and environmental pollution control in terms of investment in the study due to the difficulty of evaluating the impact of the operational assistance on energy savings and environmental pollution control. Such effects vary depending upon to what extent the operational assistance would technically be transferred. Therefore, in the study, the cost of operational assistance is estimated under normal practice, and its effect on energy saving is evaluated on a 100% technically transferred basis.

1.2 Basis of Cost Effective Analysis

The financial analysis has been carried out with the following preconditions.

(1) Currency and Exchange Rate

Please refer to Chapter VI, Article 3.

(2) Escalation

Please refer to Chapter VI, Article 3.

(3) Project Period

The project life for model plants is considered to be 15 years from the commencement of commercial operations which are scheduled from January 1, 1999. The plant construction contract is scheduled to enter into effect from January 1, 1995.

(a)Plant Construction for Model Plants

: Effective date of contract:	January 1, 1995
: Completion of the process conversion project:	December 31, 1998

(b) Plant Operation for Model Plants

: Commencement of commercial operations:	January 1, 1999

(4) Tax

According to Law No.25 of January 12, 1991, taxes on profits from enlarging and updating equipment/technology, extending activities to obtain supplementary profit, or protecting the environment, should be reduced by 50%. That is, the tax on profit in the first year of operation is calculated without any reduction, but the same value as the amount of a 50% reduction of tax in the first year is added to the profit after tax in the 2nd year, and this method of calculation will be followed from the 2nd year through the end of operations, which was confirmed at the 2nd site survey. Although this kind of incentive method still has unknown factors from a technically operational point of view, this study assumes to estimate 45 % for profit as profit tax which would be paid in the following year.

(5) Overheads

Fixed costs, such as labor costs, depreciation costs, for office buildings and company houses, and other costs associated with the following affairs and departments are estimated to be nil, because those costs under the existing operational system can be utilized and be assumed as sunk ones.

a) Top management affairs

b) Administration dept.

c) Personnel dept.

d) Finance dept., and SIDEX financial control dept.

e) Commercial dept.

f) Juridical dept.

g) Economic policy & programming dept.

2. FINANCIAL AND ECONOMIC ANALYSIS FOR ENERGY SAVING

2.1 Scope of Analysis

Analysis of energy saving is presented for the following model plants item by item, while the analysis of total model plants for energy saving is presented at the end.

a) No.5 Cokes Plant (including No.2 CDQ)
b) No.7 Sintering Plant
c) No.6 Blast Furnace Plant
d) No.3 Reheating Furnace Plant
e) Energy Supply
f) Total for Energy Saving

2.2 Amount of Savings

2.2.1 Basis for calculation of amount of savings

As described in Chapter II, the purpose of cost in energy saving for model plants is to decrease the purchase of energy such as natural gas in foreign currencies. It is assumed in the cost effective analysis that savings are defined in a manner similar to return on sales, as follows:

Amount of savings = < Purchasing amounts of energy under the existing system > - < Purchasing amounts of energy after modernization for energy saving >

In this study, two kinds of the amount of savings are considered, non-adjusted one with escalation and adjusted one with an escalation factor of 3% per annum until the point of each actual calculation. Savings for all model plants start to be concurrently calculated from 1999 in connection with that the fund for investment being assumed to be procured as one package for the total energy savings project. Savings in the first operation year, 1999 is assumed at 75%, and those in the following years through the end year of operation, 100%. The production amount for each model plant in 1999, which is the basis of calculation for amount of savings, is considered equivalent to that in 2002 provided that the investment for energy saving can preferentially be utilized and operated due to its high efficiency.

2.2.2 Calculation of energy prices

Energy prices, which are calculated based on the mean value of energy for the six months prior to September 1994, given by SIDEX and on which the following re-evaluation is added, are applied in calculating the effects of energy saving. The results are mentioned in Table VII.2-1.

(1) Coking pit coal and energetic coal

Prices of coal for coke making and energetic coal for PCI, approximately 70% of which are imported for SIDEX, are assumed at the mean import price in the recent six months prior to September 1994.

(2) Coke

The purchase unit prices of coke suggested by SIDEX are respectively 128 $/t (lump coke) and 84 $/t (coke breeze), which differ significantly from normal price of coking pit coal. It seems that the unit prices are for sales and they include the fixed cost. The coke that SIDEX will purchase from other countries in the future seems to be very little as long as the coke is produced in SIDEX. Therefore, 83.7 $/t (lump coke) and 55.3 $/t (coke breeze), calculated on the base of variable cost, excluding the fixed cost, (as noted in Diagram VII.2-1.) are adopted as the unit prices for coke in this study. Further, those are assumed import prices, because the imported coking pit coal comprises a large portion of the coke unit price.

(3) Natural gas, electric power, and byproduct gas

Imported natural gas accounts for around 13 % of the total needed for the whole country Romania, but approximately 100% for SIDEX. Electric power is imported by approximately 60 % of the amount necessary for SIDEX. Both the price of natural gas and that of electric power greatly fluctuate respectively, but their import and domestic prices will probably converge in the near future. As regards natural gas, the import price, 90$/KNm^3 is adopted in this study, because the quantitative import of natural gas is supposed to decrease after implementation of the measurements for energy saving. As regards the electric power, the domestic price converted in US$, 40.61$/MWh is adopted on the premise that its purchase from a domestic electric company (RENEL) will decrease after the modernization for energy saving because the selling price of RENEL is, in U.S. dollars base, higher than that of the foreign company that SIDEX directly contracts from. Further, as regards byproduct gas, the equivalent value to the import price of natural gas that is calculated in terms of calories of byproduct gas is adopted since the byproduct gas is closely related to natural gas. Then, the price of BFG is 14,760 Lei/KNm^3 and that of COG 78,400 Lei/KNm^3.

(4) Steam

Though steam is basically produced by the existing facilities in SIDEX, 10 % of the necessary amount is purchased from RENEL. The purchase price of steam relatively shows a higher value compared to the prices of fuel and electric power. Since recovery steam with the installation of a new CDQ directly leads to a reduction of payments for steam, the energy cost of steams, 27,030 Lei/Gcal for high pressure steam and 17,700 Lei/Gcal for middle pressure steam, are calculated based upon the domestic purchase price.

(5) Oxygen and nitrogen

The prices of oxygen and nitrogen mentioned by SIDEX respectively include the fixed costs, and those prices seem to be ones for sales purpose because they are set much higher compared with the variable costs. Seeing that oxygen and nitrogen are produced by electric power, it is judged at this time that their prices should be calculated based on the variable costs (import price base) by multiplying the price of electric power and the necessary energy unit consumption together. Then the price of oxygen, 46,750 Lei/KNm^3 is adopted as domestic price converted from import price, and that of nitrogen 27,341 Lei/KNm³

2.2.3 Calculated results of energy saving effects

Based upon the above 2.2.1 and 2.2.2, the summary for amount of savings for model plants is shown in the Table VII.2-2. The effects of energy saving due to renewal of the blast blower (Item No.013) is included in section of blast furnace in the same manner as the estimation of cost.

2.3 Project Costs

2.3.1 Project Cost Before Operations

1) Capital cost

The capital cost for energy savings for model plants is US$ 186,232,000.- . As regards the details, please refer to Table VI.1-1 which shows the original total plant costs as of July, 1994, and as well as the costs with the escalation factor as of July 1994.

2) Pre-operation Cost

The required costs prior to the start-up of the plant's commercial operation should cover the following costs.

a) Consultant fee
b) Training fee

The consultant fee is composed of personnel expenses, document fees, and travel expenses of the consultant. The scope of the consultant is the preparation of tender documents, and tender evaluation until the selection of contractor. The training fees include the absence fees, the accommodation fees, and the travel expenses for trainees provided to four persons for the coke oven battery, three persons for the sintering plant, four persons for the blast furnace, and two persons for the energy saving and the environmental pollution control, who would be dispatched to Japan for training in a similar factory for one month before the operation of each plant. This pre-operation cost is assumed to be amortized equally during a period of five (5) years after the start-up of the facilities after appropriation to deferred assets.

3) Working Capital

Cash on hand is estimated to be nil, and a short-term loan with the annual interest of 20% will be utilized to make up for the shortage, should these be a shortage of funds after the plant operations begin. Because the amount of energy savings are calculated as return like sales amounts, accounts receivable, advances to suppliers, and semi-finished products are estimated to be nil in the study. Finished products are estimated to be nil as sunk costs, based upon that those products under the existing facilities can be utilized. As regards accounts payable-trade, payments for purchase of raw materials and supplies including manufacturing supplies and other repair parts, are assumed to be made until receipt of goods. The resulting accounts payable are estimated to be nil at the end of year.

4) Interest During the Construction (IDC)

Interest on long-term borrowing during the plant construction period, IDC is assumed to be procured from foreign long-term loans and is capitalized in the end of 1998 when the construction of facilities is completed. This IDC is assumed to be amortized equally during a period of five years after the start-up of the facilities after its appropriation to deferred assets.

5) Summary for the Project Costs

Based upon the above conditions, the summary of the project costs for energy savings for model plants is shown in Table VII.2-3-1 (without escalation) and Table VII.2-3-2 (with escalation), and is sorted in foreign currency and local currency. Table VII.2-4-1 (without escalation) and Table VII.2-4-2 (with escalation) show the annual cost breakdown of the project costs.

2.3.2 Operational cost

1) Variable Cost

Consumable and variable costs such as lubricant are estimated at 0.1% of each capital cost for model plant on the basis of cash delivery.

2) Labor Cost

Labor costs such as salaries, income taxes, and pensions related to the employees are set on the basis of actual results carried out by SIDEX in 1993 and classified in Table VII.2-5. Labor costs in the No.5 coke oven battery, the No.3 reheating furnace, and the energy supply are estimated to be nil as sunk costs based upon that labor costs under the existing facilities can be utilized.

3) Maintenance Cost

2% of the each capital cost for model plant is assumed to be the annual maintenance costs, including repairing materials costs, labor costs, and other relative costs.

4) Depreciation

The objects of depreciation can be divided in two categories, which are material rights, and equipment & materials, shown below.

(1) Rights on know-how:	Equal installments for five years
Content:	Engineering Fee
Method:	Straight-line method
(2) Equipment and Materials:	Equal installments for fifteen years
Content:	Machinery and Equipment
Method:	Straight-line method