3.5 Fuel Supply Plan

3.5.1 Study of Borsod Brown Coal Procuring Possibility

(1) Present Situation of Fuel Supply

Borsod Power Plant fires only coal of the following mines at present:

Lyukobanya, Feketevolgy, Putnok, Rudolfbanya, Rudolfkulfejtes

The above circle was broader in the near past, but due to high production costs and a government decision, several mines (Farkaslyuk, Vadna, Edeleny) were shut down, in spite of the fact that there are still large resources to be exploited.

Among existing sources the volume of production and coal reserves of two mines - Rudolfbanya and Rodolf open mining - are not worth mentioning. Large-scale coal production taking place in Lyukobanya, Feketevolgy and Putnok is producing a deficit. These mines cannot be regarded as long-term supplies due to the inefficiency of their coal reserves plus the costs of mining.

(2) Coal Mining Companies and Their Organizations

Hierarchy of management is the same with each mine, i.e. subordinated to the top manager under whom work the functional deputy managers.

- Production Manager, Technology Manager, Economic Manager, Sales Manager

Under the supervision of the Production Manager work those who carry out the production process. They form workshops of horizontal location each connected to each other.

- Excavation, Shaft Driving, Engineering, Transportation, Provision of Material, Electrical Works

Employees working under the direction of the Technological, Economic and Sales Managers form departments of horizontal connections.

Number of personnel at each coal mine is shown in Table 3.5.1.

Table 3.5.1 Number of Personnel at Each Coal Mine

Personnel		Lyuko	Feketevolgy	Putnok
White collar workers	Managers	5	5	5
	Workshop formen	15	15	11
	Production formen	125	26	68
	Others	88	39	33
	Subtotal	233	75	117
Composition of blue collar workers according to skills	Miner-skilled	439	194	344
	Miner-unskilled	178	36	143
	Mechanic-skilled	346	154	233
	Electrician-skilled	142	64	108
	Other skilled workers	151	46	95
	Semi-skilled workers	337	135	215
	Unskilled workers	309	47	95
	Subtotal	1,956	676	1,233
	Total	2,189	751	1,350

(3) Outline of Coal Mines

All three mines (Lyukobanya, Feketevolgy, Putnok) are exploiting coal based on a detailed research of the coal field.

- Production is made by broad profile exploitation secured with up-to-date self-moving shields.
- Cutting is done by high performance cutting machines.
- Underground transportation is modern with a sufficient capacity without limiting coal extraction works.
- The work at coal face is done by the method called " supplementary work" .
- Many open drifts, gangways, slopes are further away from the entrance.
- Coal of the size smaller than +20mm is separated at the mine and transferred to Berente grading station.
- Distance from the Berente grading station to the mines

Lyukobanya : 16 km
Feketevolgy : 15 km
Putnok : 23 km

- Danger factors in mines

Lyukobanya : pit gas (CH_4) level I (the lowest caustion level; it prohibits making a fire and limits using electric appliances that may catch fire)

Feketevolgy and Putnok : groundwater

- Mine entering facility

Lyukobanya : hanging shaft
Feketevolgy and Putnok : hanging shaft and sloping shaft

(4) Minable Reserves of Borsod Coal

The minable reserves of Borsod brown coal mines are shown below.

Name of mine	Industrial reserve	Heat value
Lyukobanya	28.0 Mt	11.0 GJ/kg
Feketevolgy	3.0	11.0
Putnok	3.0	12.0
Total	34.0	11.1

(5) Coal Production Plan

1) Problems in the mines

Feketevolgy banya excavation was started not right at the border of the coal reserves, but a bit nearer to the entrance of the mine. Coal left behind in this way, between the border of the mine and the end of the shaft, practically cannot be reached again because it would be very expensive. Accordingly, coal mining can not be continued.

A characteristic factor of the production plan in Putnok banya is that it has turned down the opportunity to lengthen production at the mine though the so called field connection, regarding exploitability of the formerly designed territory. As the results of the subsequent study, this coal mining plan was suspended due to the uneconomical and costly method.

2) Coal production plan

Production plan of each mine until the year 2000 is shown in the following table:

Unit: 1,000 t/y

Name/Year	1997	1998	1999	2000
Lyukobanya	880	880	880	880
Feketevolgy	260	260	260	260
Putnok	480	480	480	480
Total	1,620	1,620	1,620	1,620

The above production plan meets the intentions of mines and production possibilities. But the Government guaranteed financing deficit production of Feketevolgy and Putnok only until 1998. In consequence, regional coal production of local mines will fall below 1,000 kt/y by the year 2000.

After the year 2000, coal production will be continued only at Lyukobanya. Coal reserves of Feketevolgy and Putnok will have been exhausted by that time, and the Sajomercse II mining field currently under investigation will not produce coal due to large investment required although it has a minable coal reserve of 9.9 million tons.

After 2000 the following production figures are expected at Lyukobanya:

2001-2010: 800 kt/y, 2011-2012: 500 kt/y,

Its coal reserves will be exhausted thereafter.

Coal of domestic origin can be supplemented with imported coal having better quality, or it can be totally displaced by expanding natural gas service. The coal supply to Borsod Power Plant can be increased by 15~20 % from the present amount.

3) Development of a new coal mine

Sajomercse II mine, a new development coal mine, was already mentioned above. The development of Dubicsany banya was started in 1980, but suspended early in the 1990s due to the socioeconomic change. A total of 297 boring, inclined shafts, draining plant, electricity receiving facility and upper facility of entrance inclined shaft at the first layer have been already constructed. It was expected that the mine would be redeveloped in 1994, start operation in 1998 and produce the full capacity of 7,000,000 t/y in 2000. However, the redevelopment has not been started due to the following problems pointed out by of experts:

- Tectonics, especially smaller variances must be investigated.
- Water breaking in the mine, and other risks must be clarified.
- A sufficient environmental impact study is necessary.
- Further investment must be actuated.

Some characteristics of Dubicsany banya are as follows:

- Exploitable coal resources : 70,122,000t (This is approx. 5% of the equally qualified brown coal resources of Hungary)
- Depth of coal bed : 53~306m (average depth: 206m)
- Average thickness of coal seam : 3.2m
- Net heat value : 10.26~14.14 MJ/kg

(6) Coal Price at Borsod Power Plant

The coal price was decided based on the agreement between the government and sales union in the past according to the annual rate of inflation. However, coal pricing has been changed to the direct contract with Borsod Power Plant since 1997.

1995 : 300.05 HUF/GJ
1996 : 400.06 HUF/GJ
1997 : 507.00 HUF/GJ

(7) Problem

Borsod coal will be exhausted by 2012 unless a new coal mine is developed. Accordingly, in case Borsod Power Plant fires local coal, it is necessary to resume the development of Dubicsany banya by 2007 or secure necessary supply from neighboring mines.

3.5.2 Examination of Import Hard Coal Purchasing Possibilities

Power plants are prohibited from firing import coal from the viewpoint of the protection of domestic coal mines and have followed this regulation. At present import coal into Hungary is limited to raw coal. A part of import coal is supplied as the raw materials for the production of briquette and as the supplemental fuel for domestic use. However, it is assumed that import coal will be used as a fuel for CFB boiler.

The annual hard coal demand of the planned new unit of Borsod Power Plant is 200,000~250,000 t/y.

(1) The Greatest Coal Exporter Countries of the World, Mineral Reserves, Production Data

1) North America (U.S.A. and Canada)

Both the United States of America and Canada have significant coal reserves. Their production trends are rising and their exports are increasingly significant. The coal trade policy of the United States of America practically dominates the world trade of coal.

Two third of the USA's coal exports is coking coal and one third is boiler coal. Its supplies are primarily destined for Japan and Canada, but the share of European destinations is also considerable.

Coking coal represents 85% of Canadian exports, two third of which is taken over by Japan. The amount of exported boiler coal is about 4 million tons, 3.1 million tons of which are shipped to Japan and Korea.

Details of their production and sales are shown in Figures 3.5.1 and 3.5.2.

2) Poland

Poland is one of the most significant coal producer and exporter countries in the world, although its world market importance has notably declined during the past decade, mainly due to the dynamic progress of South-American, Asian and Pacific producers and also due to the decrease in Polish production.

The volume of hard coal production in Poland fell to 147.5 million tons by 1990. One decade before it was over 193 million tons. The quantity of exports has also considerably dropped, from 31 million tons in 1980 to 28 million tons in 1990. Poland's coal imports are negligible, they buy only a little coking coal for quality reasons.

Because of the favorable transportation distance and the free trade agreement in effect between Hungary, buying coal from Poland is worth considering.

Details of its production and sales are shown in Figure 3.5.3.

3) South Africa

Despite the provisions of international embargo, this country has always been a significant participant of international trade.

The Republic of South Africa contributes to world coal trade with high quality boiler coals and, to a lesser extent, with medium and low quality coking coals. Its exports are primarily destined for European countries.

Datails of its production, consumption and commercial positions are shown in Figure 3.5.4.

4) Australia

This continent-sized country also has significant coal production, the majority of which originates in huge open-cast mines, therefore, low production costs can compensate for long distances of transportation.

In the western part of Australia boiler coal is produced, while in the eastern coast coking and boiler coals are mined.

Australia is the greatest coal exporter country in the world (leading over the United States of America and the Republic of South Africa). Most of its exports are aimed at Eastern Asia, mainly Japan, but Australian coal is used also in Europe.

Details of its production and sales are shown in Figure 3.5.5.

5) China

China takes a leading position in international coal production. However, its geographical characteristics make its role less outstanding in world trade, because Chinese coal mines are far away from sea ports and the costs of long railway transportation impair the competitiveness of Chinese coal very much. Despite this, the world trade significance of Chinese coking and boiler coals is expected to increase in the next two decades.

Details of its production and sales are shown in Figure 3.5.6.

	1980	1990	2000	2010
Consumption	608,0	739,0	812,0	1007,0
Production	710,2	858,6	982,0	1223,0
Import	1,1	2,4	6,0	11,0
Export	83,2	96,0	176,0	227,0

in Mt

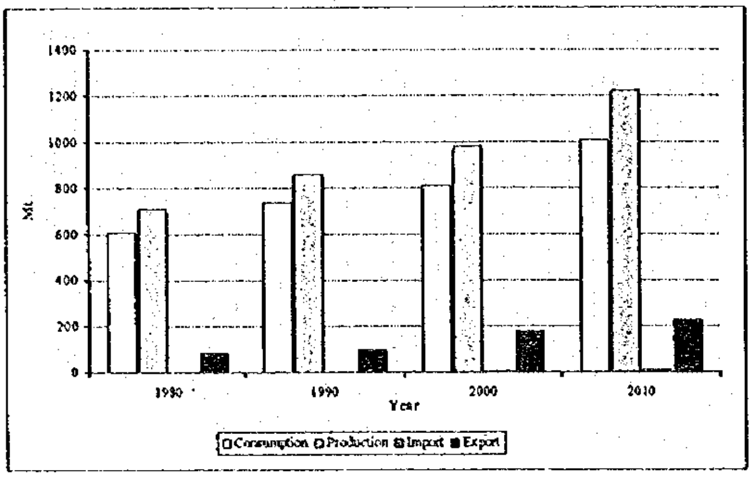


Figure 3.5.1 Hard coal production of the U.S.A. 1980-2010

	1980	1990	2000	2010
Consumption	21,4	18,8	31,0	34,0
Production	20,2	37,7	53,0	62,0
Import	15,6	14,1	13,0	14,0
Export	15,3	31,0	35,0	42,0

in Mt

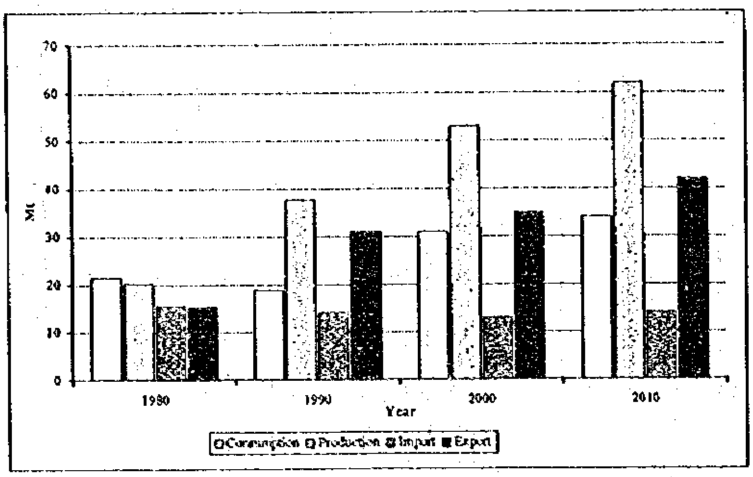


Figure 3.5.2 Hard coal production of Canada 1980-2010

	1980	1990	2000	2010
Consumption	159,1	120,0	132,9	122,0
Production	193,1	147,7	149,9	130,0
Import	1,0	0,5	0,0	2,0
Export	31,1	28,0	17,0	10,0

in Mt

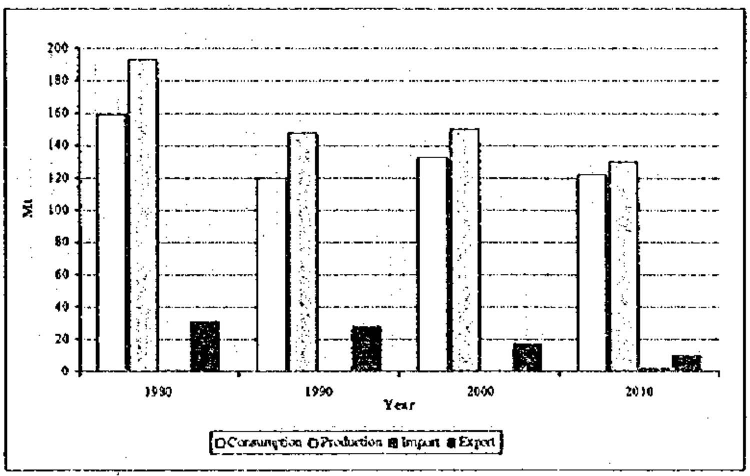


Figure 3.5.3 Hard coal production of Poland 1980-2010

	1980	1990	2000	2010
Consumption	84,5	135,5	150,0	150,0
Production	116,6	173,6	205,0	210,0
Import	0,0	0,0	0,0	0,0
Export	28,7	47,4	55,0	60,8

in Mt

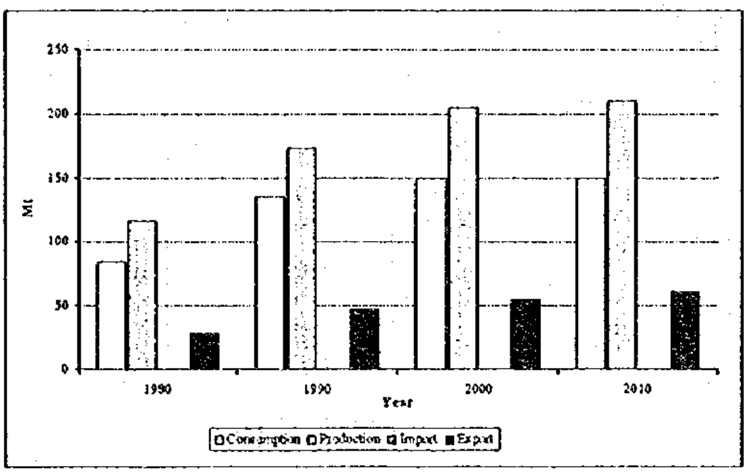


Figure 3.5.4 Hard coal production of South-frica 1980-2010

	1980	1990	2000	2010
Consumption	36,4	51,4	66,5	74,5
Production	78,5	165,2	205,0	218,0
Import	0,0	0,0	0,0	0,0
Export	42,8	106,6	140,0	144,0

in Mt

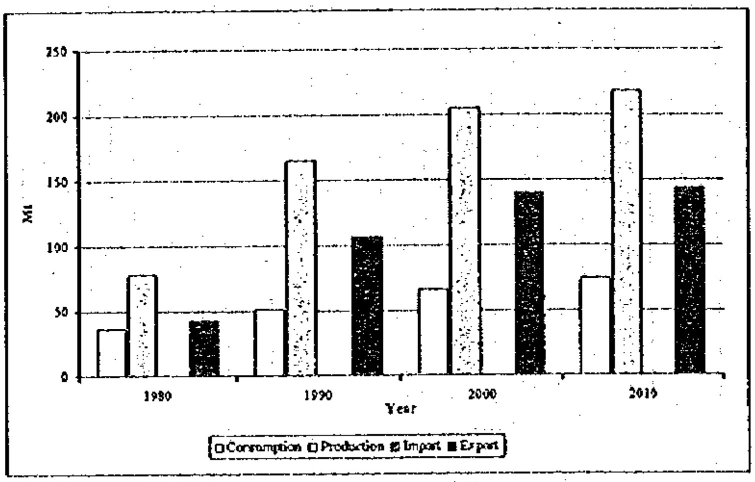


Figure 3.5.5 Hard coal production of Australia 1980-2010

	1980	1990	2000	2010
Consumption	589,5	980,0	1200,0	1300,0
Production	595,8	990,0	1227,0	1330,0
Import	2,0	2,5	3,0	5,0
Export	3,8	14,5	30,0	35,0

in Mt

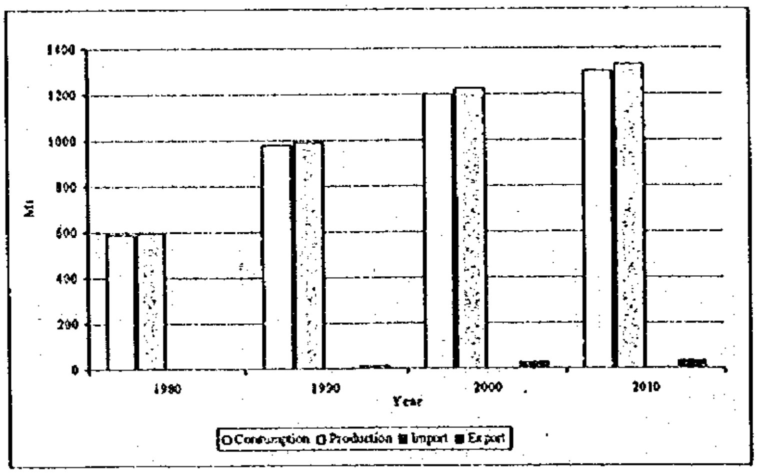


Figure 3.5.6 Hard coal production of China 1980-2010

6) Columbia

During the past decade, considerable investments have been made in the development of coal mining. However, the economy of Columbia is not based on energy intensive sectors, therefore most of its coal production is intended for export.

Columbia produces mainly high quality boiler coal which stands transportation and multiple transloading well.

Its exports are primarily aimed at the U.S.A. and Western European ports.

Details of its production and sales are shown in Figure 3.5.7.

7) CIS countries

The ex-republics of the former Soviet Union, Russia, the Ukraine and Kazakhstan have considerable coal production.

The crisis of the former super power affects also coal mining. Hard coal production fell from 475 million tons by over 14% in 1991, causing serious disturbances in supply.

Production dropped by 12.5% in Russia, by 21.5% in the Ukraine and by 0.8% in Kazakhstan.

Today the prospects of coal mining are unforeseeable. It is assumed that as a result of internal energy demands and the requirement to take freight costs into realistic account in future prices, coal exports of the former Soviet republics will sharply decrease, both for resource and for price reasons. Despite the above, their geographical proximity highlights the Russian and Ukrainian markets which must be surveyed and studied very accurately and carefully.

Details of their production and sales are shown in Figure 3.5.8.

8) Indonesia

A decade ago coal mining hardly existed in one of the most dynamically developing countries of the region. Due to the large-scale investments made in the eighties, Indonesia will have a remarkable share in coal production and international coal trade in the future.

Indonesian coal has an extremely high quality and deserves special attention for its low sulfuric content.

Details of its production and sales are shown in Figure 3.5.9.

(Table data source: "United Nations Economic and Social Council, Economic Commission for Europe - Energy/WP.1/AC.1/3")

(2) Coal Prices at Ports of Departure

Coal quality details and FOB port of departure prices for goods shipped from the available sources of supply to the Power Plant by various modes of transportation are shown in Table 3.5.2.

The table contains 1995 market prices, reflecting typical market conditions. The prices are taken from 1995 contracts.

Prices are understood FOB port of shipment and include extraction costs, transportation to the point of loading and loading charges.

Coal qualities shown on the table reflect current market demand and may vary from time to time.

Data source: Coal Week International, 3 October 1995.

(3) Expected Coal Prices and Ocean Freight Costs, Coal Price Forecasts

1) Coal price forecast I

According to a study entitled "World coal price outlook to 2010", published by the Directorate General for Energy, European Commission in 1993, analysts share the view that coal prices will be increasing up to the end of the next two decades. The only difference in opinion is in the level of expected increase. During the past two decades the demand for boiler coal has doubled, while coal prices have decreased to approximately half of their previous level. This decrease lead to a considerable shrinkage in supply, caused by a reduced output of the great producers and exporters (Australia and the USA), and had a key role in making the new, inexpensive suppliers appear on the market.

Therefore, this price decrease considerably reduced supply and export disposability. These tendencies are unlikely to continue in the next two decades.

	1980	1990	2000	2010
Consumption	4,2	5,5	6,2	7,4
Production	4,1	20,5	38,8	49,7
Import	0,0	0,0	0,0	0,0
Export	0,1	13,6	32,6	42,3

in Mt

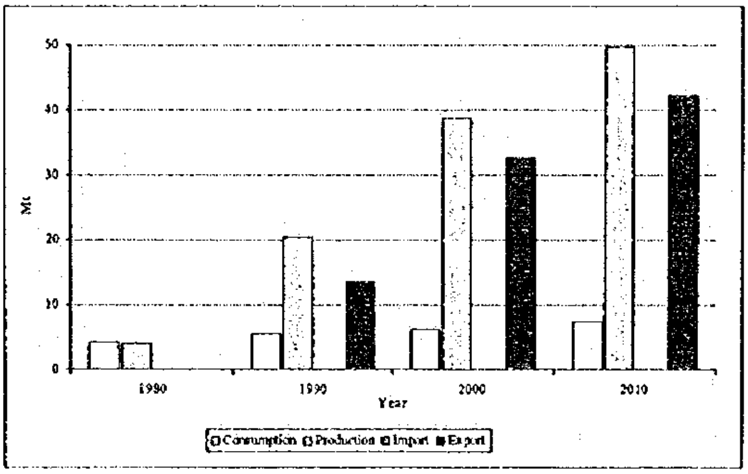


Figure 3.5.7 Hard coal production of Columbia. 1980-2010

	1980	1990	2000	2010
Consumption	532,5	548,7	500,0	450,0
Production	553,0	543,0	515,0	460,0
Import	6,2	8,7	10,0	10,0
Export	26,6	39,8	25,0	20,0

in Mt

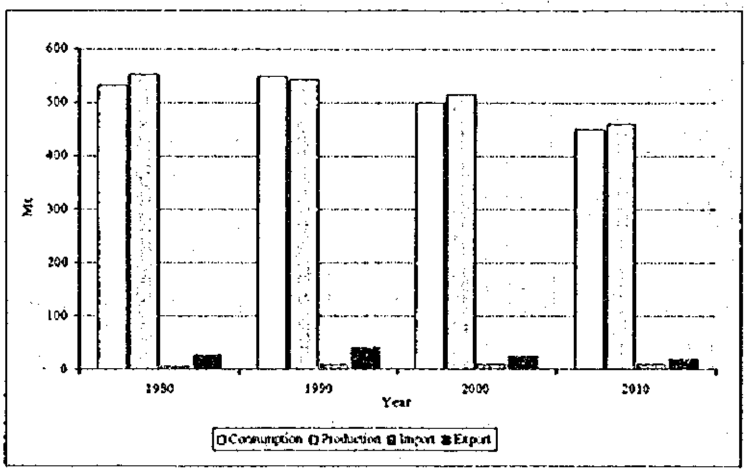


Figure 3.5.8 Hard coal production of the CIS countries 1980-2010

	1980	1990	2000	2010
Consumption	0,2	6,2	25,0	40,0
Production	0,3	6,0	50,0	70,0
Import	0,0	0,0	0,0	0,0
Export	0,0	0,6	25,0	30,0

in Mt

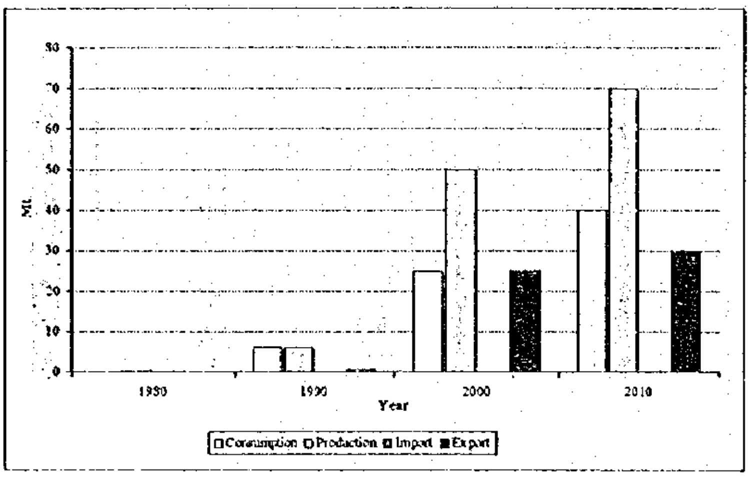


Figure 3.5.9 Hard coal production of Indonesia 1980-2010

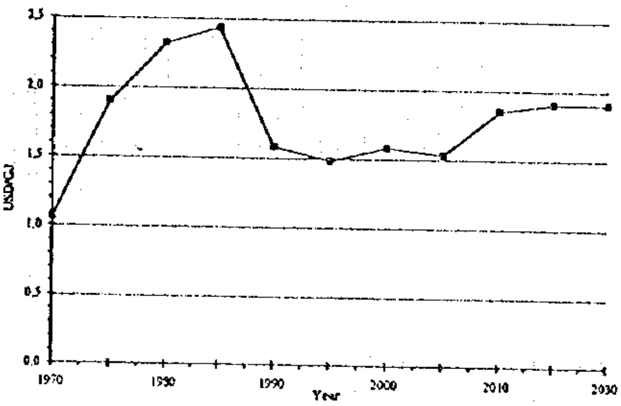


Figure 3.5.10 Trend of estimated hard coal price in world market

Table 3.5.2 Typical World Market Coal Prices

Mines	Gross Calorific Value		Sulfur Cont.	Ash Cont.	Coal Price			
					Average	Third quarter in 1995	Second quarter in 1995	First quarter in 1994
	Btu/lb.	GJ/t	%		USD/mt			
U.S.A.	13000	30.14	1.0	10.0	43.2-44.25	44.26	46.38	44.63
Hampton Roads	12500	29.10	1.0	10.0	41.55-42.5	42.68	44.75	43.56
	12000	28.05	1.5	12.0	36.0-38.9	39.40	41.31	42.31
Baltimore	12500	29.10	1.0	10.0	39.8-40.55	40.84	42.75	41.21
	12000	28.05	1.0	12.0	36.9-37.3	37.10	37.77	38.11
	12000	28.05	1.5	12.0	33.3-35.6	34.75	35.96	35.50
Gulf Coast	12500	29.10	1.0	12.0	39.5-40.1	39.95	40.95	41.42
	12000	28.05	1.5	15.0	32.9-33.6	33.25	35.73	38.58
	11500	26.80	1.5	15.0	31.5-31.7	31.60	32.07	34.34
	8800	20.52	0.4	0.5	23.0-24.0	23.50	23.75	23.50
West Coast	12000	28.05	0.6	10.0	41.0-42.0	41.58	38.74	37.50
	11500	26.80	0.7	10.0	39.1-40.1	39.90	34.87	33.52
Canada	13000	30.14	0.7	10.0	43.7-45.0	44.21	41.75	39.29
Vancouver	11500	26.80	1.0	14.0	35.0-38.8	36.81	32.83	33.20
Poland	12200	28.47	0.8	8.5	40.0-41.0	40.48	42.42	39.33
Baltic Ports	11500	26.80	0.8	11.5	36.8-37.6	36.52	39.48	35.75
South Africa	11500	26.80	1.0	16.0	35.1-36.7	35.78	34.92	34.21
Richard Bay	10800	25.12	1.0	16.0	32.9-34.5	33.74	33.05	32.25
Australia	12000	28.05	0.8	14.0	39.9-42.95	41.37	39.62	38.08
Newcastle/	11700	27.21	0.8	14.0	38.7-41.65	40.14	38.04	35.28
Port Kembla	11000	25.96	0.8	14.0	36.9-39.8	38.45	36.26	32.60
Gladstone	11700	27.21	0.6	14.0	39.8-42.8	41.29	39.26	35.75
China	11200	25.96	0.8	8.0	36.75-36.9	36.76	35.52	31.50
	10800	25.12	1.0	12.0	34.6-35.6	35.45	33.90	28.00
Colombia	12000	28.05	0.7	8.0	36.7-37.8	37.46	38.35	37.17
	11800	27.42	0.8	8.0	33.55-36.7	35.57	36.99	36.12
Europe	11500	26.80	1.0	16.0	48.4-49.4	48.33	47.11	42.92
ARA	10800	25.12	1.0	16.0	45.1-46.1	45.36	44.10	40.92
Russia								
Pacific	11500	26.80	1.0	15.0	37.0-38.6	37.80	36.12	31.21
Baltic	12250	28.05	1.0	16.0	34.3-35.4	35.31	36.26	34.67
	11500	26.80	1.0	16.0	32.5-33.5	33.50	34.38	32.67
Black Sea	11500	26.80	0.5	13.0	35.5-36.5	35.73	35.39	35.10
Venezuela	12600	29.31	0.8	7.0	36.4-37.2	36.68	36.70	36.25
Indonesia	12800	29.73	0.8	3.0	39.1-43.7	42.00	40.53	36.06
	12500	28.05	0.8	2.0	35.3-41.7	39.67	37.39	32.95
	10000	23.03	0.0	0.2	25.5-26.5	25.77	24.19	23.08

According to the "High demand" assumption of the first model of the study, demand for power plant coal will be continuously decreasing until 2000 and will be sustained later on. At whatever degree demand is going to rise in the next 3 decades, it will in any case be higher than the degree of supply shrinkage, therefore prices will be higher between 2000 and 2010 than today.

A different assumption is made by another model which foresees that sellers' market will collapse after 2000 and prices will decrease to their regular level (Demand collapse).

The third model reckons with a slow, relatively steady growth in supply (Slow growth).

On the basis of the above mentioned study and the expected ocean freight costs, the forecast on FOB USA prices is shown in Table 3.5.3.

Table 3.5.3 The Forecast of Hard Coal Price on FOB U.S.A.

	FOB price (USD 1990/tce)		
Model types	1990	2000	2010
High demand	28-46	46-64 (39-64%)	54-72 (56-93%)
Demand collapse	28-46	41-59 (28-46%)	35-53 (15-25%)
Slow growth	28-46	38-56 (22-36%)	41-59 (28-46%)

The data of the forecasts should be considered only as a tendency, since actual daily market prices may greatly vary.

2) Coal price forecast II (Source: BWK Vol. 47. No. 9. 1995. p.358)

Figure 3.5.10 shows a long-term specific coal price forecast, based on the so-called Slow Growth Model. Considering 1990 as a base period (for possible comparison with the above price forecast) and expressing price variation in terms of per cent, prices are expected to rise by 16% until 2010, by 20% until 2020 and by 20% until 2030, compared to the base period.

(4) Transportation Costs

1) Ocean freight cost

Table 3.5.4 Freight at ARA Port

Departure-ARA port Netherlands	Quantity (t)	Freight(USD/t)
Australia	120,000 60,000	12.20 13.75
South Africa	140,000 60,000	8.00 8.50
Canada	120,000 60,000	12.20 13.75
U.S.A.	110,000 60,000	6.10 8.30
China	60,000	13.80
Columbia	130,000	6.40

(Source: Coal Week No.10, October 1995)

Table3.5.5 Freight at Adriatic Port & Black Sea Port

Departure - Adriatic port (USD/t)		Black Sea port (USD/t)
USA	10.10	11.50
South Africa	12.25	13.50
Australia	14.3	15.25

2) River freight costs (1996)

(Source: Mahart Seatrade Forw & Chring)

Routes

ARA (Netherlands)-Csepel (Budapest) 43.0 USD/t

Constanta (Romania)-Csepel (Budapest) 11.0 USD/t

The above rates do not include loading/unloading costs, and the following charges should also be added to these freights.

- transloading from ship to railway wagon at Csepel port: HUF 300/tons
- port haulage: HUF 1 700/railway wagon
- weighing: HUF 1 200/railway wagon
- filling in waybills: HUF 70/railway wagon
- port storage: HUF 10/tons/week
- unloading from ocean-liner1.5-2.0 USD /t

3) Railway freight costs (1996)

a) International freight (MAV)

Origin	Route	USD/t
i) Slovenia	Koper-Sredisce-Kotoriba-Murakeresztúr-Berente:	33
ii) Croatia	Rijeka - Koprivnica - Gyékényes-Berente:	25
iii) Poland	Katowice - Zebrzidowice - Lenartovce - Bánréve-Berente:	40
iv) Czech	Ostrawa - Lenartovce - Bánréve-Berente:	30

The above charges include railway freight, customs clearance procedural charges, forwarding agency customs clearance commissions, and are valid for a minimum load of 25 tons.

b) Freight charges of MAV in the territory of Hungary

Route	HUF/t
Bánréve frontier-Berente	260
Murakeresztúr frontier-Berente	2,020
Gyékényes frontier - Berente	2,120
Budapest port-Berente	1,060

The above charges include:
- reduced railway freights on MÁV lines
- MÁV TRANS Co. commissions

Additional costs:
- customs clearance procedural charge: HUF 800/wagon
- transloading charge: HUF 480/t (in Záhony border) (The rail gage of the CIS countries is different from that of Europe.)

(5) Expected Hard Coal Import Prices at Site of the Power Plant

In case of coal originating from overseas, the specific price in USD/GJ of a coal coming from certain countries is in proportion to the heat value. Around 50% of the price of import coal at Borsod Power Plant is transportation cost, which increases in inverse proportion to the heat value. In case of coal imported from Central Europe or the CIS countries, the percentage of the transportation in the coal price is significantly smaller than that of coals from other areas. Therefore, this case is advantageous for the Borsod project.

More accurate price figures of import coal can be determined according to the actual contract conditions such as the period, amount, terms of payment. Accordingly, based on the study results mentioned above, the Study Team estimated the coal prices arrived at the Berente station on the basis of several cost components of 1996. The estimated prices are shown in Table 3.5.6.

Based on the above mentioned, the Study Team assumes that the coal is imported from Central Europe or CIS countries, and the price of the coal per net heat value is 318 HUF/GJ.

Table 3.5.6 Price of Imported Coal at Borsod Power Plant (1997)

Place of origin	Gross Cal. Value	Route				
		I.	II.	III.	IV.	V.
	GJ/t	HUF/GJ				
Australia	28.1	524	460	413	-	-
South-Africa	26.8	496	429	380	-	-
U.S.A.	28.1	468	404	358	-	-
Columbia	28.1	468	404	358	-	-
Indonesia	28.1	512	449	402	-	-
Poland	26.8	-	-	-	281	-
Czech Republic	26.8	-	-	-	354	-
CIS countries	26.8	-	-	-	-	318

Route

I. - Rotterdam-water-carriage (DMR channel)-Port Budapest-railway transport-Berente

II. - Rijeka port-railway transport-Berente

III. - Constanta-water-carriage (Danube) -Dunaújváros-railway transport-Berente

IV. - Bánréve-railway transport-Berente

V. - Záhony-railway transport-Berente

(6) Design Heat Value and Price of Import Coal

Supposing that coal is imported from Poland, Czech and CIS, the net calorific value and the price at Borsod Power Plant are assumed to be 25.6 GJ/t and 318 HUF/GJ, respectively.

3.5.3 Design Fuels

(1) Coal

The coal types and mixtures to be considered are as follows.

Case a: 100% Borsod brown coals mixture
Net heat value : 9.0 MJ/kg
(when better quality portions are supplied to domestic use)

Case b: 50-50% mixture of Borsod brown coal and imported hard coals on the heat value basis
Net heat value: 13.32 MJ/kg
(74% brown coal and 26% hard coal on the weight base)

Case c: 100% Borsod brown coals mixture
Net heat value: 11.30 MJ/kg
(When better quality portions are also supplied to the Power Plant)

Case d: Lowest quality Borsod brown coal
Net heat value: 7.56 MJ/kg

The coal to be used in the new CFB boiler is assumed to be of Case b. Characteristics of coals to be used are shown in Tables 3.5.7 and 3.5.8.

(2) Natural Gas and Fuel Oil

The characteristic data of natural gas and fuel oil to be used are summarized in Tables 3.5.9 and 3.5.10.

Table 3.5.7 Characteristic Data of Coals to be Used

Characteristics	Borsod brown coal	Imported hard coal
Net calorific value, MJ/kg	7.56-9.16/ avg. 9.0	avg. 25.6
Grain size, mm	0 to 20	0 to 20
Coal analysis		
Ash %	36 to 42.8 avg. 36.45	6 to 16.5 avg. 11.25
Moisture %	21.6 to 25.7 avg. 24.8	6 to 13 avg. 9.5
Average carbon %	24.8	
Average hydrogen %	2.17	
Average oxygen %	9.08	
Average nitrogen %	0.5	
Average sulfur %	2.2	avg. 0.8
Ash analysis		
SiO_2 %	avg. 51.0	40 to 80
Al_2O_3 %	avg. 18.8	14 to 37.5
Fe_2O_3 %	avg. 13.2	2.5 to 20
MgO %	avg. 4.2	0.2 to 5.5
CaO %	avg. 8.0	0.54 to 12
Na_2O %	avg. 0.8	0.1 to 2.2
K_2O %	avg. 2.2	0.3 to 5
SO_3 %	avg. 1.8	0.3 to 8
TiO_2 %	-	0.6 to 3.1
P_2O_5 %	-	0.01 to 1.5

Table 3.5.8 Design Coal

Borsod/import coal	50:50 heat base
Net heat value	13.32 MJ/kg
Ash	29.9 %
Sulfur	1.8 %

Table 3.5.9 Characteristics Data of Natural Gas Used

Components	Content
c1 (% vol.)	98.51
c2 (% vol.)	0.32
c3 (% vol.)	0.13
c4 (% vol.)	0.05
c5 (% vol.)	0.02
c6 (% vol.)	0.01
CO_2 (% vol.)	0.04
N_2 (% vol.)	0.92
Relative density at 15 °C	0.563
Net heat value (MJ/m^3)	33.94

Table 3.5.10 Characteristics Data of Fuel Oil Used

Light fuel oil (FA-60/80)		
Viscosity		
at 20 C° (minimum)	(mm^2/s)	8
at 100 °C (maximum)	(mm^2/s)	4.4
Flash point by Cleveland's method, min.	(°C)	101
Pour point	(°C)	-20
Sulfur content	(%)	below 0.2
Relative density at 15 C°		1.005
Heat value	(MJ/kg)	41.0

3.6. Limestone Supply Plan

(1) Quality and Quantity Requirements

1) Quality requirement of limestone

a) Quality

The most important component of limestone as a desulfurization agent is $CaCO_3$, whose content should be at least 93 %.

b) Grain size

The raw limestone supplied from mines is crushed at the Power Plant. However, for the secured operation, the Power Plant will have also a facility to receive limestone grist.

- Raw limestone: 0 to 50 mm
- Limestone grist : 0 to 3.0 mm

2) Limestone grist consumption in CFB boiler

Qd = 442 t/d

(2) Procurement Possibility

The potential suppliers considered in the regions of interest as well as the limestone resources available in Hungary can be summarized as follows:

1) The limestone resources of Hungary lie distributed within the areas demarcated by solid lines in Figure 3.6.1. The Borsod Power Plant is located at the north/east end of this area. This geographic site - except one - is unfavorable even for the plants located in the direct surroundings; in fact, the railway lines by-pass the Bükk mountains.

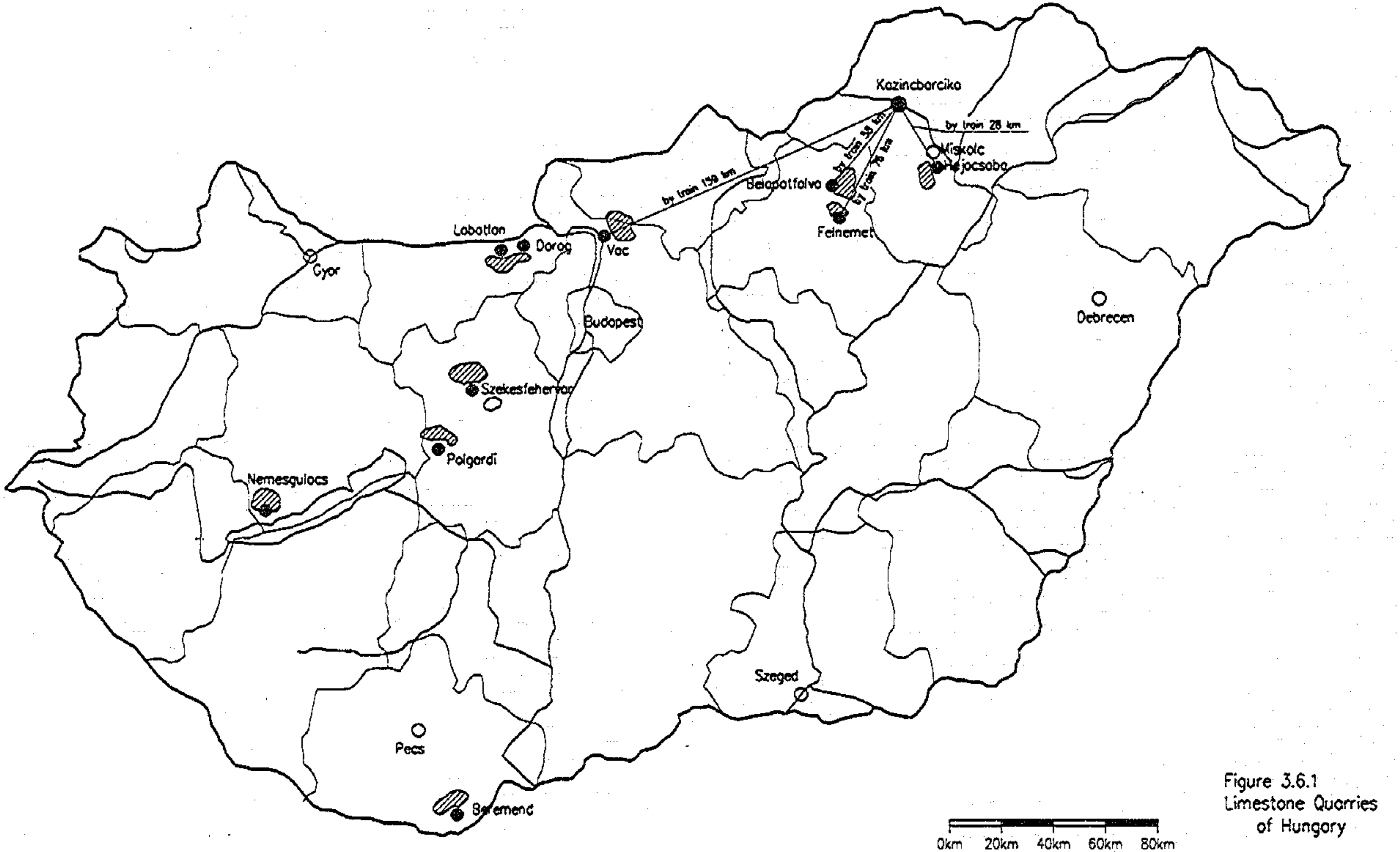


Figure 3.6.1
Limestone Quarries
of Hungary

2) In the northern region of Hungary, in the surroundings of Borsod Power Plant, there are four limestone processing plants whose limestone stocks are sufficient to cover the demands for decades. These are as follows (with their acronyms in parentheses):

- Hejôcsabai Mészkôfeldolgozó Rr. (HCM) Hejôcsaba: approx. 30km away by railway from Power Plant
- Bélapátfalvai Cement és Mészmû Rt. (BCM) Bélapátfalva: approx. 58km away by railway from Power Plant
- OMYA Eger Mészkôfeldolgozó és Értékesítô Kft. (OMYA) Eger: approx. 76km away by railway from Power Plant
- Duna Cement-és Mészmû Rt. (DCM) Vác: approx. 160km away by railway from Power Plant

3) There are four (4) more plants west of Budapest within the region of Dorog and Székesfehérvár (250 to 300 km) with sufficient resources of limestone.

4) Regarding quality, the limestone stock of each plant considered fulfills the requirements. The typical composition of the limestone available with the above listed producers is summarized in the Table 3.6.1.

Table 3.6.1 Grade of Lime Stone at Each Mine

	HCM	BCM	OMYA	DCM
CaO	51-54	52-54	52-54	55.2%
CO_2	41-43	41-43	41-43	41-42
MgO	1-2	max. 1	1-2	0.22%
SiO_2	max. 1	max. 1	max. 1	0.53%
Fe_2O_3	max.0.5	max. 1	max. 1	max. 1
Al_2O_3	max. 1	max. 0.5	max. 0.5	max. 1

5) Without further development, none of the potential plants listed above is capable of supplying limestone of suitable grain size in sufficient quantity to the Power Plant. For the daily quantity indicated, the plants listed are not provided with facilies for grading and wagon loading. The plants would have to install these facilities for the future expansion of production.

(3) Procurement Costs

At present, the plants engaged in limestone processing in the region produce lime and cement as main products instead of limestone. In order to specify the selling prices, the plants considered the time available insufficient to estimate the costs of establishing capacity for mining, processing and railway loading suitable to fulfill the requirements in respects of both quantity and quality.

Considering that no definite prices are available, the prices listed below are from Transdanubian limestone mines which, within the frame of similar modernization of the Transdanubian power plants, elaborated the costs necessary for their development and, with these cost taken into account, the prices to be expected. It is likely that similar prices will occur in the region of Borsod, in fact, the development tasks are approximately the same. Based on this, the probable limestone prices of the above listed potential vendors are as follows:

(a) Raw limestone (0 to 50 mm), loaded into wagons : 360 to 720 HUF/ton
(b) Limestone grist (0 to 3 mm), loaded into wagons : 1,300 to 1,600 HUF/ton

(4) Railway Transport

In consideration of quantity and environmental protection, only closed type railway wagons will be used. This type of four-axle self-dumping tankers suitable to be used for transporting bulk goods are not available to the MÁV at present (even open type wagons of type Fal, Fad are available only in a limited number). Nevertheless, MÁV considers the purchase of drop-bottom closed tankers of type Tals in a limited number, primarily for transporting cereals. Based on proper guarantees and a long-term contract, MÁV is ready to purchase and make available suitable wagons without excess fee (or even, in the case of large transport capacity contracted for long-term, at reduced rates).

So-called cement tankers capable of pneumatic discharge suitable to transport limestone powder are available to MÁV only in a limited number. The major part of wagons Uaces and Ucs passed into the hand of the forwarding company PULTRANS. As a result of the reduced needs for cement transport, PULTRANS is capable of transporting goods in a quantity exceeding 1,000,000 tons a year, by using about 1000 two-axle and four axle wagons.

(5) Transport Costs

Based on present MÁV tariffs, the costs of railway transport are summarized in the table below for batches exceeding 25 tons, broken down by railway lines:

Line	Distance	Basic rate
Hejôcsaba-Kazincbarcika (Berente)	28 km	370 HUF/ton
Bélapátfalva-Kazincbarcika (Berente)	58 km	530 HUF/ton
Felnémet-Kazincbarcika (Berente)	76 km	640 HUF/ton
Vác-Kazincbarcika (Berente)	159 km	1,160 HUF/ton

In the case of larger quantities transported during longer time, MÁV grants business policy allowances which, in this particular case, reduces the basic freight rates by about 35%.

(6) Limestone Prices Expected at the Power Plant

Based on the above, the limestone prices at the Power Plant are shown below.

(a) Raw limestone (0 to 50 mm) : 900 to 1,400 HUF/ton
(b) Limestone grist (0 to 3 mm) : 1,700 to 2,800 HUF/ton

It appears to be reasonable that the Power Plant itself make preparations for producing the milled product of limestone in the desired grain size. The reason is, that though a number of mines or lime works can prepare themselves for producing coarse limestone at a relatively low investment cost, thus increasing the safety of supply, the high energy costs of milling the coarse limestone can be significantly reduced if regarded as production costs of the Power Plant (electric energy at prime cost, use of waste heat for drying etc.).

3.7 Slag and Fly Ash Transport System

(1) Existing Slag and Fly Ash Transport Facilities

For transport slag slurry and fly ash from the slurry center to the storage place, two systems established at different times are provided in the Power Plant.

1) Thin slurry method

The thin slurry system was reconstructed during 1988 to 1990. Future use involves the problem of leachate infiltrating the ground. For the amount of leachate infiltrating the ground due to the storage of slag and fly ash according to this method, North Hungary Environmental Protection Inspectorate (ÉKF) and Northern Hungarian Water Management Authority instructed that the amount of leachate be not greater than 10 m3/day for the area of 34.2 ha. Accordingly, it is practically prohibited to store sludge using this method.

2) Thick slurry method

For solving the above problem, a thick sludge technique was developed in Hungary and its operation was started in the Plant in 1995 to 1996. The system consists of 2 mixing units, 2 reciprocating-piston delivery pumps and 3 different thick slurry pipelines (DN 100, DN 125, DN 150) that can be changed over according to the prevailing loads. The principle of the method is the following: firing residues will be mixed with low volumes of water (appr. in a ratio of 1:1 of solids/liquids).In a slag and fiy ash storage area, thick slurry is solidified by the same method of solidifying concrete. The technique reduces the amount of ash scattering from the sludge storage areas and the amount of water infiltrating into the soil.

According to the explanation by Borsod Power Plant, it completed trial runs using this technique and started full-scale operation in the summer of 1966. However, there still remain problems to be solved including the permeability of water.

(2) Possibilities for Slag, Bed Ash and Fly Ash Handling

In principle, there are three ways of transporting combustion residues to the disposal area. These are as follows:

1) Transport by vehicle (see Figures 3.7.1 and 3.7.2)

a) Method

Firing residues can be transported either in cement transport wagons or by trucks. This kind of transport can be considered only with smaller quantities or for sales for building purposes. When it is to be transported to a deposit, fly ash should be moistened with water of about 20 % mass ratio.

This way the moistened firing residues to be removed from the unit are:

- with mixed coal firing: 53 tons/h (slag +fly ash + water)
- with firing coal of poorest quality: 127 tons/h (slag +fly ash + water)

In the case of delivering in two shifts, provided that the time period that can be utilized for is 14 hours a day, 91 tons or 218 tons, respectively, should be delivered. For that purpose, 8 or 18 transport runs, respectively, are required using dump trucks of 12 tons load carrying capacity each. A transport run to and from amounts to about 6.4 km and it will take about half an hour, including the time required for getting the trucks into their parking places and starting them out. The intensity of moistening fly ash as well as the productivity of loading the trucks should be selected by taking the times required both for getting in and starting out into account as 2 minutes per loading 12 tons.

Therefore 44 or, respectively, 24 minutes are available for loading 91 or 218 tons of matter, respectively, to be delivered hourly by trucks.

The required capacity of the fly ash moisturizing screw is 124 t/h with mixed coal firing and 545 t/h with firing using brown coal of the poorest quality at an allowance of 20%. Considering that 30 minutes are required for a truck to cover the said distance plus 6 minutes of loading using mixed coal firing, it can start loading again after 36 minutes. Therefore the number of trucks being in operation at a time is six. Supposing that there are two reserve trucks available, the minimum required number of trucks is 8.

Similarly, with firing using brown coal of the poorest quality, the minimum required number of trucks is 12 including 2 reserve ones. The existing bridge over the Sajó River is not satisfactory for a traffic like that. The embankment, the road and the bridge must be reconstructed to have 2 traffic lanes. In addition, the road must be provided with solid pavement appropriate for that high stress. The minimally required storage capacity assuming a two-shift delivery (at least 16 hours) is 1,000 m3 and 2,500 m3, respectively.

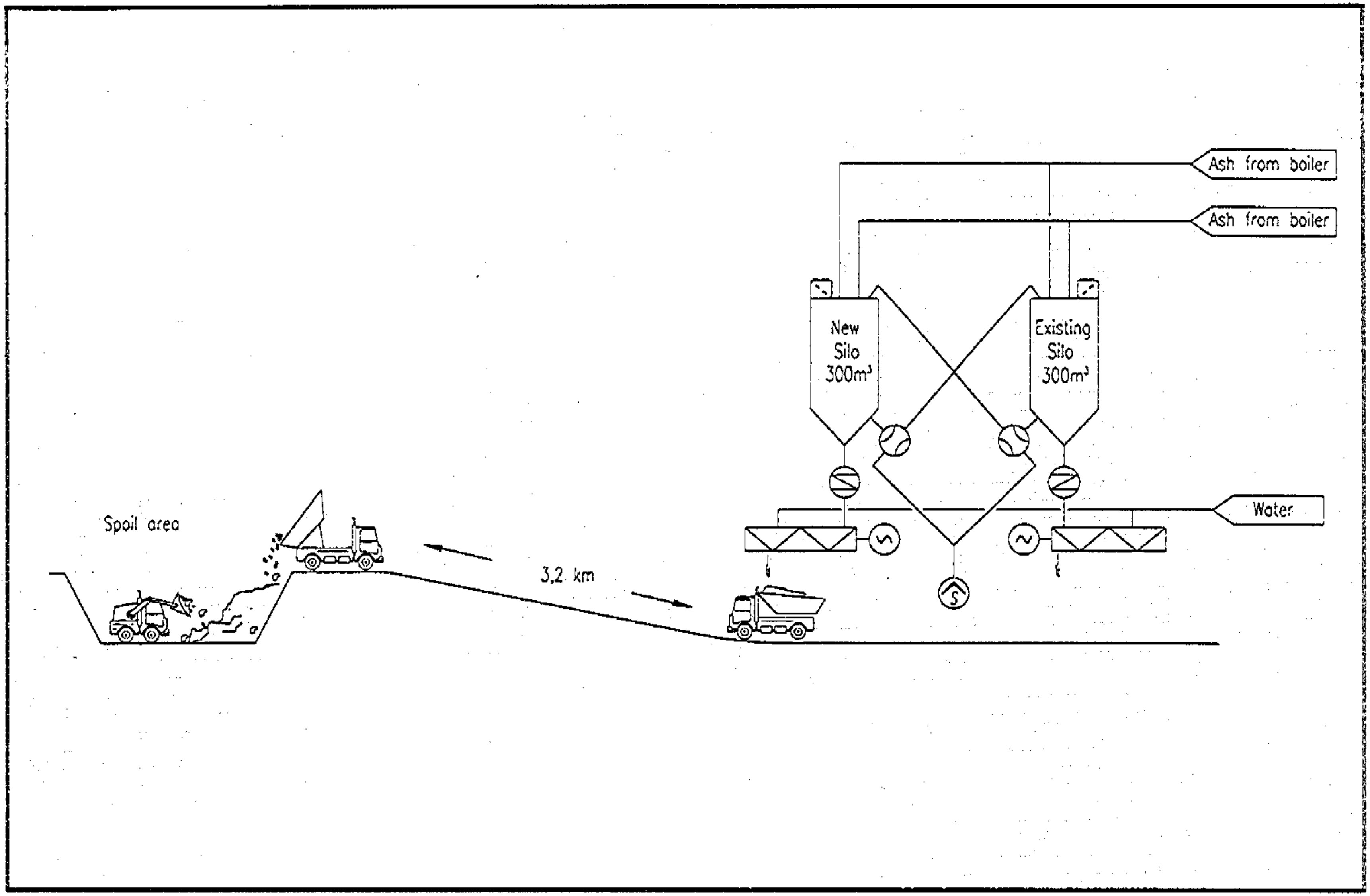


Figure 3.7.1 Slurry delivery by track

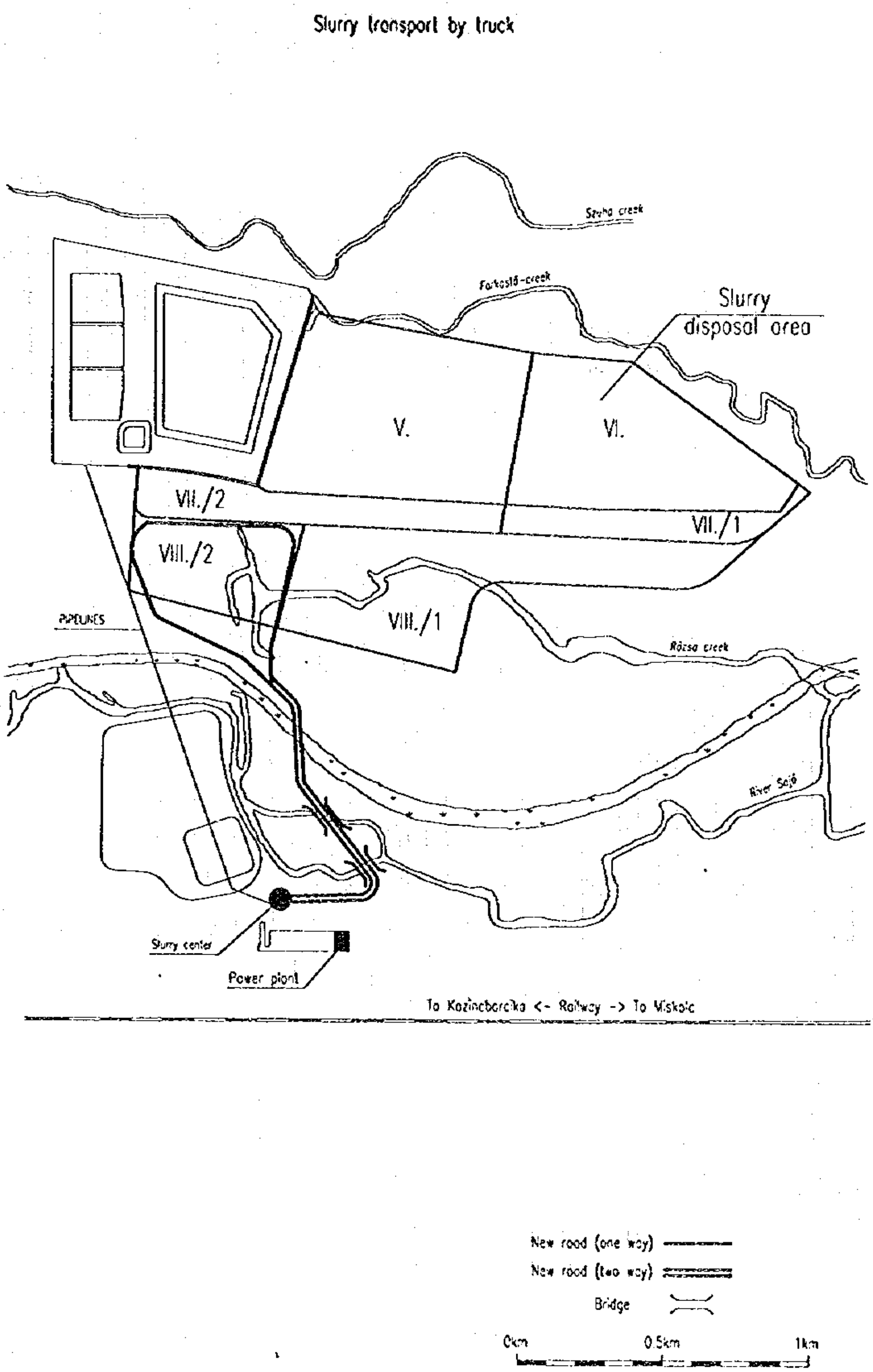


Figure 3.7.2 Site plan I

b) Road construction

Construction of a paved road having a load carrying capacity calculated for hourly traffic of 10 trucks of 12 tons load capacity each and consisting of two lanes of 1,2 km long and one lane of 2,0 km long is needed. The road running between the Power Plant and the deposit crosses both the main and the branch streams of the Sajó River therefore the construction of two new road bridges is also necessary. Considering that no cut is allowed in a flood-control dam, the new road should be run at an appropriate height by constructing an embankment. Naturally, the embankment must be provided with suitable water bypasses to ensure an unhindered removal of the high volumes of water appearing from time to time within the flood plain. It should be noted that after about ten years a new single-lane road of 2 km long will be necessary to reach the future deposit. Because of the two-shift operation, lighting of the road also should be provided for. In addition, demolition of a fence and erection of one new gate is also necessary. The right of running the road through the neighboring real estate must be secured.

2) Transport by conveyor belt (see Figures 3.7.3 and 3.7.4)

a) Problems in conveyor transport

Transport to a deposit can be accomplished also by means of a conveyor belt. To prevent the firing residue from dust, it should be moistened by water of 2 to 25%. The long-distance delivery belt can be established using several points of transfer. It must be transferable from its last point of transfer.

At the end of the transferable belt, using of a rock piling machine is necessary for spreading the matter. Once an area has been deposited the matter should be given an earth cover. Until completing it, the uncovered parts must be watered. Without compacting the firing residues, the deposit formed so is unsuitable for solidification. Its water-impermeability will not attain the values provided by a thick sludge deposit even by compaction.

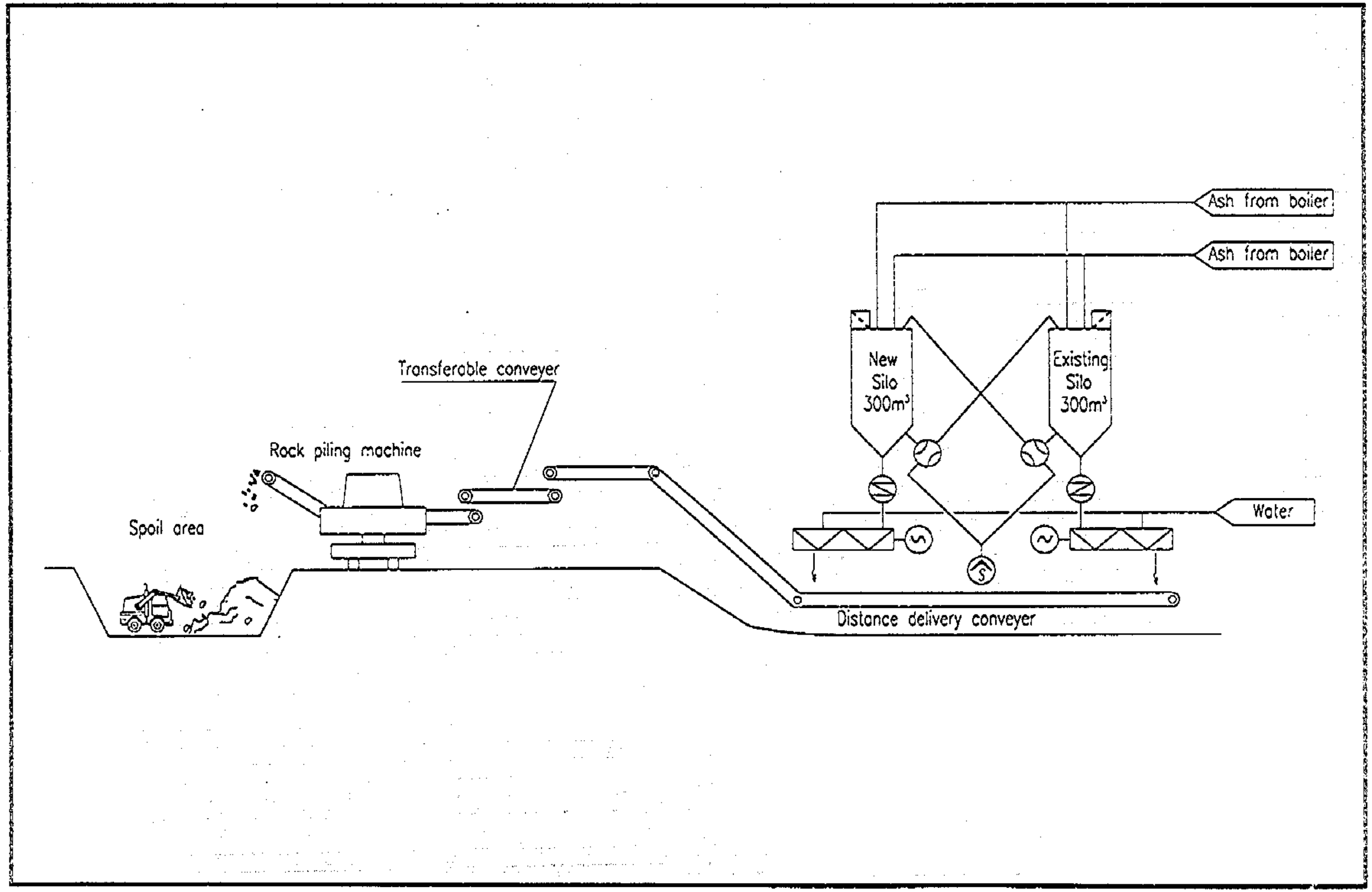


Figure 3.7.3 Slurry delivery by conveyer

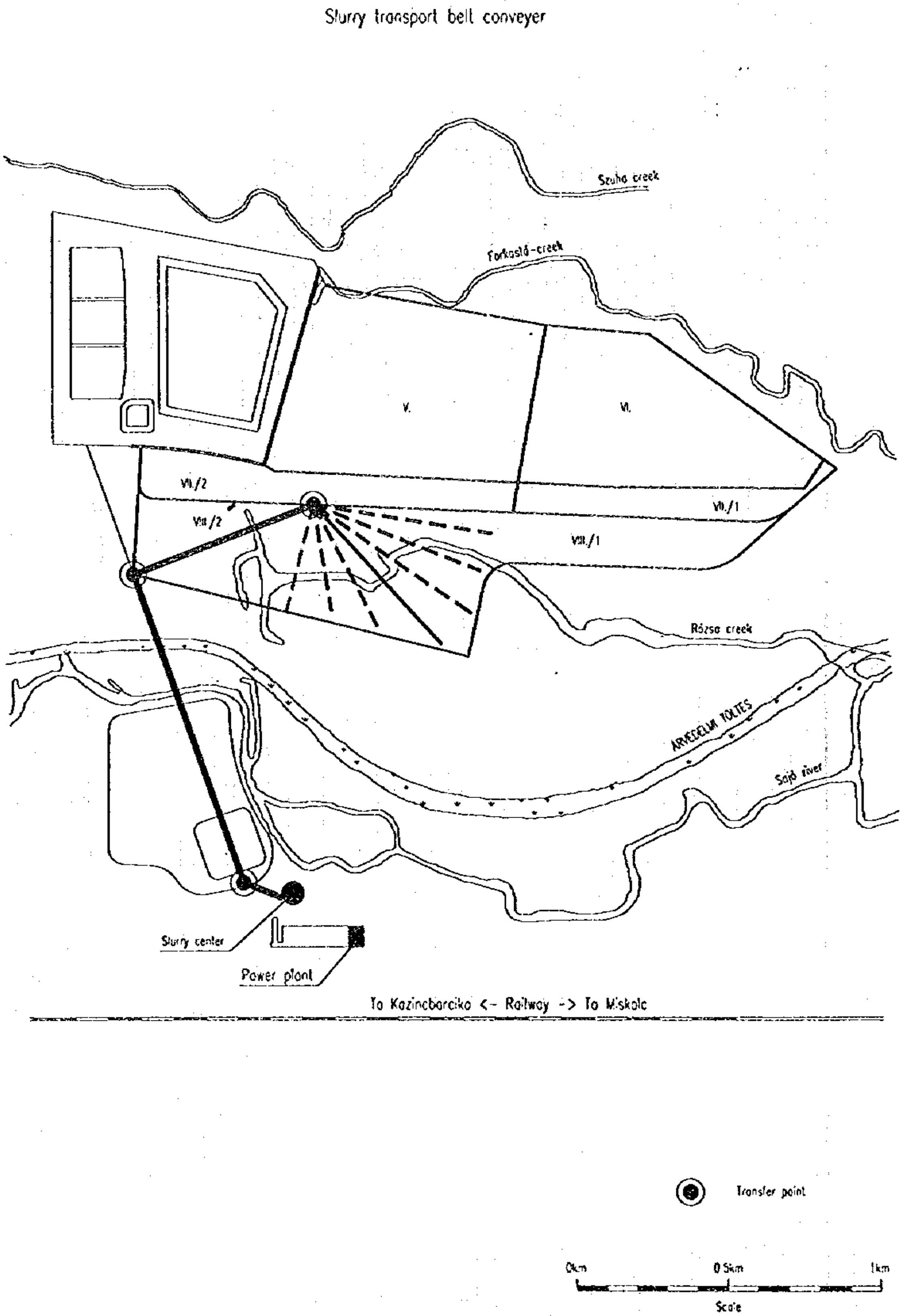


Figure 3.7.4 Site plan II

b) Construction of a conveyer bridge

In the case of transporting the fly ash by means of a belt conveyor, the following establishments are required: an overhead conveyor bridge of 2.0 km long equipped with steel pillars on concrete foundations at a spacing of about 25 m. The pillars to be erected on the flood plain should be constructed so that they may resist to ice drift.

3) Transport by extension of the existing system

To determine the necessity and the extent of extension, two cases should be investigated.

a) Mixed coal firing

The new boiler will have a firing residue of 44.2 t/h to be delivered. It is a figure lower than the amount produced with the current pulverized coal firing boilers. It is an amount that can be removed by the existing equipment without any extension provided that connections are established.

b) Lowest quality coal firing

The amount of the firing residue to be removed from the new boiler is 106 t/h. For handling residues, a minor reconstruction of the existing equipment installed in the slurry center and addition of a new reciprocating-piston pump of the same type as the existing ones is necessary. Owing to the higher minimum value in the future, delivery line DN 100 will loose importance. To replace it, running of another line DN 150 is advisable (resulting in two lines DN 150 and one line DN 125 altogether).

(3) Comparison of the Transport Methods

The comparison of the three methods of transporting combustion residues is shown in Table 3.7.1.

The thick slurry system is regarded as the stage of trial operation at present. However, this system is superior to other methods. In addition to the application of the thick slurry system, impermeable sheet and slurry water recovery and recycle system should be adopted in order to prevent the water from infiltrating into the ground. For the transportation of the slurry water to Borsod Power Plant, the exciting pipeline can be utilized. Slurry transport system by the pipeline is shown in Figure 3.7.5.

Table 3.7.1 Comparison of Transport Methods for Combustion Residue
(Transport between the power plant and the slurry area)

Concern	Transport by truck	Transport by conveyer	Transport by piping
Operation time	2 shifts	2 shifts	continuous
Investment cost	very high	very high	moderate
Maintenance demand	high	moderate	high
Operation cost	very high	moderate	moderate
Staff*	30 persons	18 persons	12 persons
Deposit watering	necessary	necessary	not necessary
Deposit solidification	none	none	expectable
Watertight block	not necessary	not necessary	necessary

* Only in the moisturizers and the slurry center

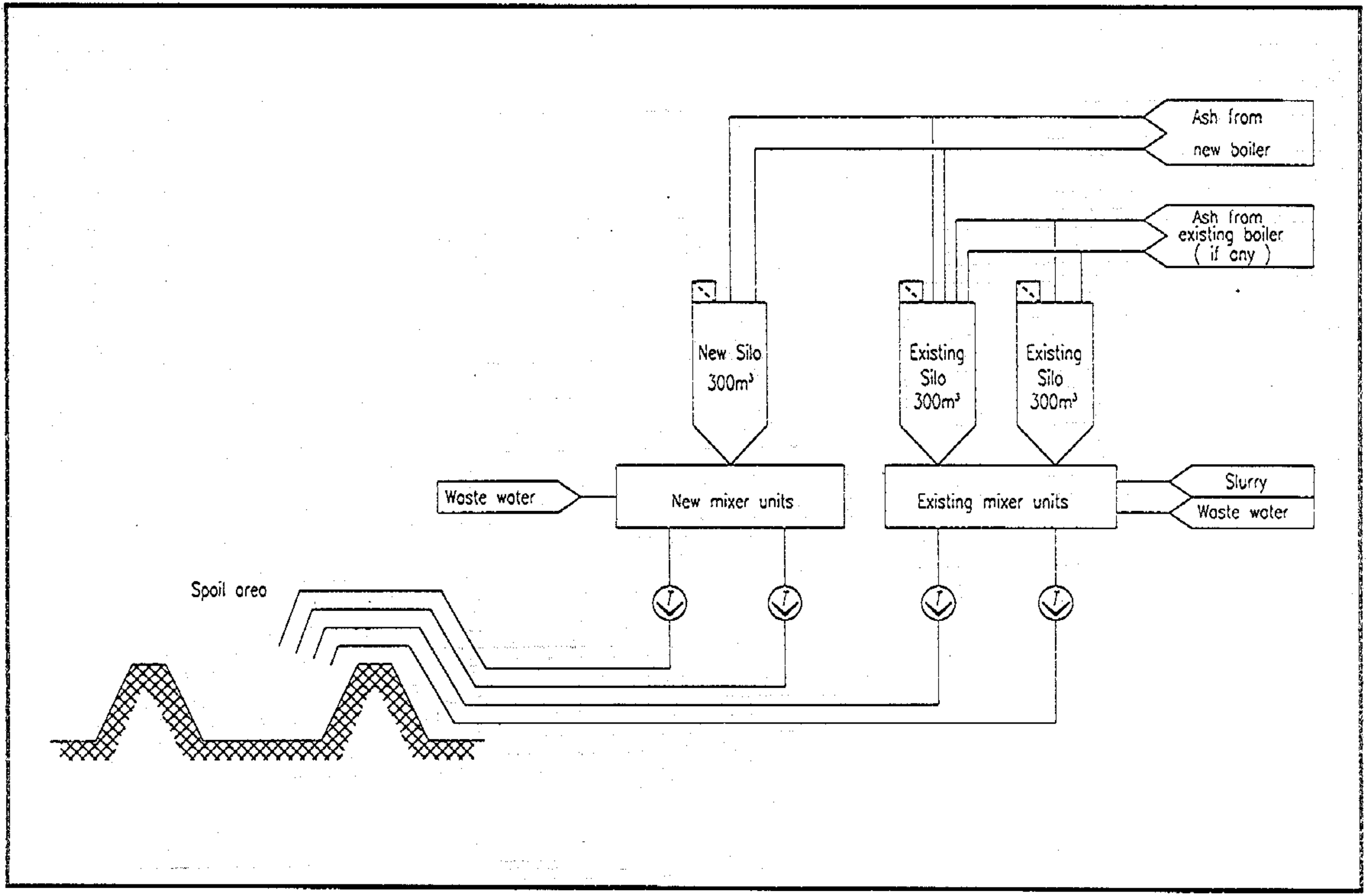


Figure 3.7.5 Slurry transport by conveyer

3.8 Renovation of Existing Facilities

3.8.1 Boilers

(1) Present State of Existing Boilers

The Power Plant in the closed boiler house involves 10 units of 100 t/h steam capacity each having been manufactured by MHD, equipped with all necessary auxiliaries. 8 of the boilers are of Borsod-100-M type, and the other two are of Borsod-100-R type. They are pulverized coal fired steam generators with gas and oil supplementary firing facilities.

The main technical parameters are shown in Table 3.8.1

Table 3.8.1 BORSOD-100-M and BORSOD-100-R Boilers

Denomination		BORSOD - 100-M	BORSOD - 100-R
		1 - 8	9, 10
Nominal output	t/h	100	100
Max. output (2x3 hours)	t/h	110	110
Surfaces -evaporating	m^2	467.5	506.6
- SH-I.		475.0	329.0
- SH-III.		89.0	160.0
- ECO		390.0	216.0
		1,460.0	1,703.0
Sum		2,881.5	2,914.6
Volume - water	m^3	36.5	60.0
- steam		17.0	
- ECO		12.0	
Operational pressure	bar	79.4	78.0
Design pressure	bar	82.35	82.35
Pressure test	bar	102.0	102.0
Steam temperature	°C	500.0	500.0
Feed water. temperature	°C	190.0	190.0
License of operation valid		2001.XII.31.	2014.XII.31.

In the period of 1978~1985 the boilers were reconstructed in four cycles, i.e. first Nos. 4-5-6, later on Nos. 3-2-1, 7-8 and finally Nos. 10-9.

Boilers Nos. 1 ~ 8. were rebuilt in such a way, that the steel structures were partly kept and the total pressurized part was replaced, i.e. the complete ECO, evaporator and superheater surfaces were changed with new drums resulting in a one-drum membrane-wall construction. The second pass is a panel structure.

At boilers Nos. 9 and 10, only the chambers were replaced by membrane-wall construction, the two drum system was kept and also the 2nd pass was unchanged.

(2) Consideration of Renovation Plan for Existing Boilers

1) Heat and power demands

Borsod Power Plant produces process steam for the surrounding enterprises and hot water for district heating. Existing boilers after the modernization will be provided mainly for the above mentioned use.

a) Heat Demands as Per Contracted Peaks

Heat demands as per contracted peaks for surrounding companies are shown in Table 3.8.2.

Table 3.8.2 Contracted Peak Heat Demands

Heat	Press./Temp.	t/h	MW
Steam	29 bar	135	119.48
	15 bar	11	8.96
	6 bar	42.8	34.44
	Sub-total	188.8	162.88
Hot water	(150/80 °C)	–	78.35
	Total :	188.8	241.23

b) Seasonal fluctuations

Heat demand of the seasonal fluctuations are shown in Table 3.8.3.

Table 3.8.3 Seasonal Fluctuations of the Heat Demand

Heat demand		Winter	Summer
29 bar. steam	MW	76	24
15 bar. steam	MW	8	2
6 bar. steam	MW	22	6
Total, steam	MW	106	32
Hot water	MW	33	6
Grand total	MW	139	38

c) Heat supply capacity after renovation

The heat supply capacity after the modernization is shown in Table 3.8.4.

Table 3.8.4 The Heat Supply Capacity After Renovation

Turbine	Steam consumption t/h	29 bar t/h	15 bar t/h	6 bar t/h	Hot water MW
V.	112	-	-	-	63
VII.	90	60	30	-	-
New 32MW	253	110	44		
Total output :		170	74		63

Based on the above data 4 steam producing units - 4x100 t/h capacity boilers - kept and reconstructed are sufficient for the projected heat demands.

After the 150 MWCFB unit is completed, two modes of operation are foreseen, and are detailed below:

A. Out of the four existing units three in operation. One is at stand-by or out of operation (outage). The new proposed block in a cogeneration mode - with restricted power production - supplies 130 MW heat, covering appr. 54 % of the contracted peak-demand 150MWe

B. The new block is out of operation; heat supply is from the existing four units.

Table 3.8.5 Operation Model Pattern After Commissioning of the New Unit

State of operation	A	B
- existing units: 4x100 t/h	1 is out of operation	in operation
- new unit: 444 t/h	condensing + cogeneration	out of operation

Table 3.8.6 Heat Production Capacity

		A	B
Existing boilers	MW	215	287
New boiler	MW	329	-
Production, total	MW	544	287
Consumption of condensing power production	MW	162	-
Cogen. power production	MW	72	36
Self consumption	MW	11	6
Losses	MW	8	4
Total consumption	MW	253	46
Heat to the grid	MW	291	241
Contractual peak demand	MW	241	241
Reserve/lack	MW	+50	0

2) Existing boilers to be renovated

In order to operate the boilers for a long time, Borsod Power Plant needs to obtain permission for the operation from the competent authorities because the managerial thickness of water tube of each boiler is regulated. Nos. 5, 7, 9 and 10 of the existing boilers to be renovated were selected based on the examination by the engineers of Borsod Power Plant and manufactures.

Permission for No. 1-8 will be valid by December, 2001 and for No. 9 and 10 by December. 2014.

Supervision of tube wall thickness of boilers are shown in Table 3.8.7.

Table 3.8.7 Tube Wall Thickness

Boilers	No. 5	No. 7	No. 9	No. 10
Chamber calculated measures straight/bended	Ø57 x.4 (1) 2.69/2.64 (2)	Ø57x4 2.69/2.64	Ø57x4 2.69/2.64	Ø57x4 2.69/2.64
ECO tubes	Ø32x3.2 1.42	Ø31.8x4.0 1.42	Ø32x3.2	Ø32x3.2
Suspension tubes	Ø32x5 1.35	Ø32x5 1.35	Ø32x5	Ø32x5
Superheater SH-1 tubes	Ø32x4 1.38	Ø31.8x4 1.38	Ø32x4	Ø32x4
Superheater SH-3 tubes	Ø38x5 3.03	Ø38x5 3.03		Schott Ø38x4
Qualification	License of operation + Out of operation	Preserved "Permanence shortage" Out of operation	Stand-by	Stand-by
Air preheaters	Combined steel plate lined box type (old fashioned) and cast iron. finned type.	After 1988 Tubular (bare)	Lower. inlet edges worn. permanent fixing needed Damaged. clogged. replacement difficult	

(1) According to original drawings (chosen dimension)
(2) Calculated dimension (dimensions)
All of the tubes checked proved that all measured thickness were well above the calculated values.

3) Facility renovation strategy

For the renovation of the existing boilers used for 30-40 years, several technologies are available.

- The Hybrid-Fluid technology - which is a unique technique - does not offer suitable emission levels, so for a long term extension this technology is not acceptable. HFBC, which is Hungarian original combustion technology, can satisfy the present emission standards. However, this HFBC was excluded because it can not be said that HFBC is sufficiently applicable technology, taking the use of boilers after 2005 into consideration.

- Gas firing with original boiler size needs increased turbine capacity and hence needs the repowering of turbines, so this technology is also feasible. In case of fuel conversion to natural gas without modifying the present heating surface, the turbines should be modified in order to enlarge the capacity. Accordingly, this case was excluded from the renovation strategy.

In the present Study, two alternatives were selected for the renovation of existing boilers. One is pulverized coal firing (PCF) with a water-saving type semi-dry flue gas desulfurization (FGD) system for sulfur emission control, another is reconstruction of the boilers into the type of gas/fuel oil firing with combustion chamber (heating surface) reduction.

Alternatives for boiler renovation and pending problems are shown in Table 3.8.8.

Table 3.8.8 Alternatives for Boiler Renovation

Item Alternatives	PCF+FGD	Gas/fuel oil firing
Fuel supply	Taking long-term operation into consideration, mixture of Borsod coal and import coal	Need to confirm stable supply of gas & fuel oil
Boiler remodeling	Not necessary	Down-sizing of combustion chamber
Environmental protection and emission control for exhaust gas	Water saving type semi-dry desulfurization system should be installed Need to study transport & final disposal of lime & gypsum slurry	Installation of low-NOx burners
Supplying system of fuel & material	New equipment to supply limestone to system	Installation of new fuel supply system
Control system	Improvement of existing control system	Newly installed

4) Pulverized coal firing (PCF)+flue gas desulfurization (FGD)

In case of coal combustion for a long term, the electrostatic precipitators have to be retrofitted to fulfill the requirements, i.e. 50 mg/m3 dust emission, and to install an effective desulfurization system.

Desulfurization technology is divided into wet, dry and semi-dry types.

Considering the following characteristics, a semi-dry, water-saving type FGD system was selected for examination because of the following reasons:

i) It is possible to recycle unreacted lime collected from CFB boilers.

ii) Water consumption is relatively small.

In the semi-dry desulfurization system, SO_2 in exhaust gas is contacted by slurry containing sprayed fresh slaked lime and absorbed by the slurry. Main products from this reaction are calcium sulfate and calcium sulfite.

a) SO_2 removal

The SO_2 removal efficiency of the semi-dry process is 90 % or more, roughly equivalent to that achieved by the wet scrubbing process.

Chemical reactions of semi-dry process are the following:

$$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + 1/2\ H_2O + 1/2\ H_2O$$
$$CaSO_3 + 1/2\ O_2 \rightarrow CaSO_4$$

b) Desulfurization agent

As the absorbent for desulfurization, fly ash from the CFB boiler is utilized. Assuming that the S content in the coal is 2.2%, the amount of lime required is as follows:

Ca/S mole ratio	1.35	2.00
Lime equivalent in t/h	15.80	23.43

c) By-product

The major by-products generated in the semi-dry desulfurization system are calcium sulfite, calcium sulfate, and fly ash from the boiler. The moisture content is surprisingly low, less than 1 %. Therefore, the scale accumulation on the walls of the reactor is very little. The total amount of the by-products generated depends on the amount of acid gases entering the system, the absorbing efficiency of acid gases, and the amount of lime supplied.

5) Natural gas and fuel oil combustion

Gas or fuel-oil combustion requires reduced area of heating surface. However, it no longer requires any electrostatic precipitator (EP), flue gas desulfurizer (FGD) or ash disposal facility. This is advantageous for securing environmental protection. It is also possible to shorten the time of reconstruction and associated outage.

As the constructions of 100-M and 100-R boilers are slightly different, detailed calculations were carried out to determine the size of the new chamber. The data of these calculations are given in Table 3.8.9. After the fuel conversion, the boiler keeps the original output - 100 t/h steam and for that reason reduces the evaporating surfaces.

This solution cuts off the original bottom and funnel of the boiler and also removes all equipment related to bottom-ash removal. A new membrane construction is welded air-tight to the vertical parts of the remaining walls. This solution also ensures the proper location of two pieces of alternative burners, while providing excellent access for the operators to the burners.

The flue-gas recirculating fan is also located below the new bottom plate. The connecting tubes to the bottom headers are relocated. Careful calculations of the second and third (half) passes will ensure the proper dimensioning of ECOs and air preheater surfaces. So the efficiency of the boiler could be guaranteed over 90 %.

Down-sizing of the combustion camber is shown in Figures 3.8.1 ~ 3.8.2.

(3) Selection of Boiler Renovation Method

Comparisons of two methods of boiler renovation described above are shown in Table 3.8.10.

As shown in Table 3.8.10, it is clear that natural gas and fuel-oil combustion is superior to PCF + FGD.

Table 3.8.9 Summary of Thermal Calculations

BORSOD - 100 - M boilers Nos. 5 & 7								
Fuel		Gas			Oil			
Boiler load	%	110	100	30	110	100	30
Boiler efficiency	%	92.3	92.6	91.0	92.3	92.2	90.7
Natural gas	Nm³/h	8,687	7,902	2,428	-	-	-
Oil	kg/h	-	-	-	7,215	6,688	2,066
Combustion air	Nm³/h	92,317	83,979	25,636	89,515	81,430	24,793
Recirc. flue gas	Nm³/h	0	0	48,000	0	0	48,000
Flue at boiler outlet	Nm³/h	118,806	108,076	32,992	112,240	101,193	30,811
Temp. of flue gas	℃	124	121	114	133	131	119
BORSOD - 100 - R boilers Nos. 9 & 10							
Fuel		Gas			Oil		
Boiler load	%	110	100	30	110	100	30
Boiler efficiency	%	92.1	92.3	90.5	91.7	91.7	89.9
Natural gas	Nm³/h	8,667	7,862	2,405	-	-	-
Oil	kg/h	-	-	-	7,398	6,726	2,057
Combustion air	Nm³/h	93,397	85,427	30,958	88,446	80,406	29,063
Recirc. flue gas	Nm³/h	0	0	50,000	10,000	10,000	50,000
Flue at boiler outlet	Nm³/h	128,284	117,336	40,742	117,708	107,008	37,200
Temp. of flue gas	℃	145	141	127	169	163	140

No calorifier but with hot air recirculation.
Nominal load 100 % = 100 t/h
Limited duration of operation at 110 % (max. allowed duration 2x3 hours)

Table 3.8.10 Comparison of Boiler Renovation Methods

Item	PCF+FGD	Gas and Oil Combustion
Main facilities	To install desulfurizer	To remove bottom of furnace To remove coal firing system To install EGR system To install gas/oil burners
Environmental protection facilities	Electrostatic Precipitator Semidry Desulfurizer	Low-NOx Burner
Ash disposal facility	Original	Not necessary
Fuel supply facility	Original	Extension of gas supply system To install fuel oil tanks
Operation technology	Though operation boiler is same, operational technology for FGD will be needed	Even conventional operation technology will be applied becouse of the automation
Environmental considerations	Not to exceed the Emission Standard in 2005	Not to exceed the Emission Standard in 2005
Facility cost	62,710,000 USD	46,818,000 USD
O & M cost	3.2%	2.5%
Operators	70persons	55 persons
Overall Evaluation	Fair	Good

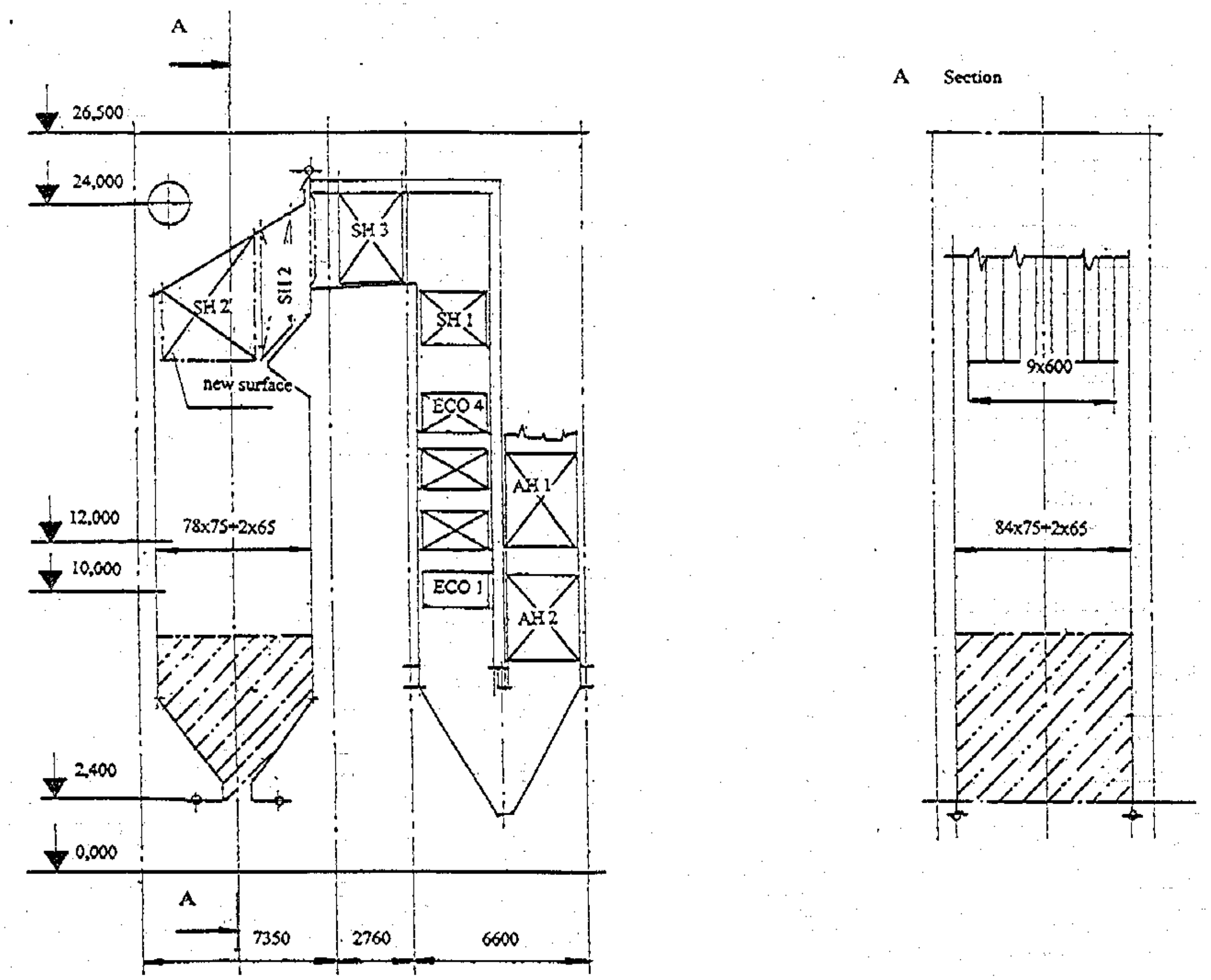


Figure 3.8.1 Downsize of combustion camber (100-R type)

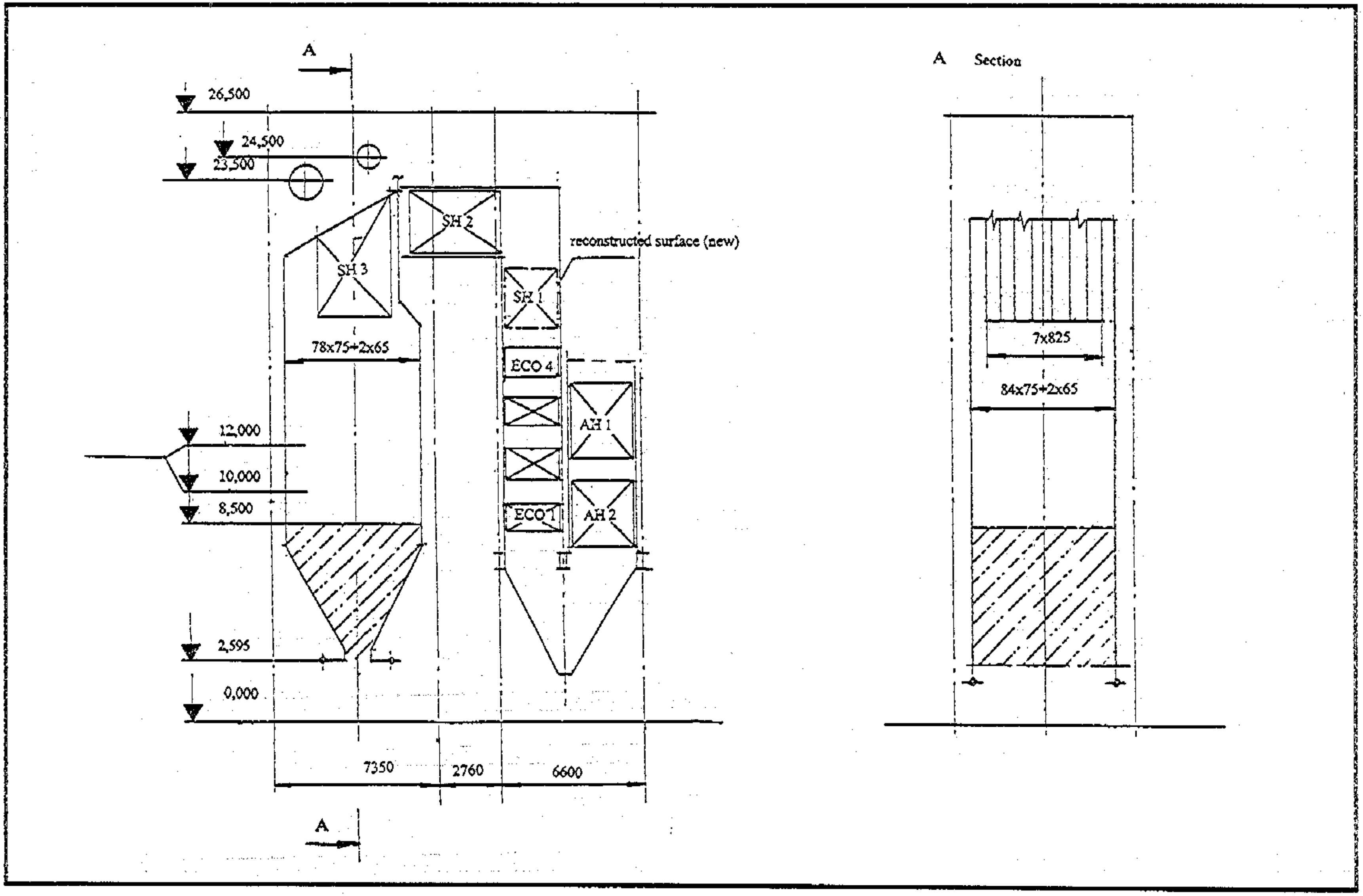


Figure 3.8.2 Downsize of combustion camber (100-M type)

3.8.2 Operation Plan of Turbines

For the operation plan of turbines corresponding to the reconstruction of four boilers, the following two cases were examined.

Case 1: Turbines No. VI, VII, and X will be used for steam supply, and No. V (and No. VII if necessary) will be used for heating. There will be no more condensing power production.

Case 2: A new 32 MW double extraction (29 bar and 15 bar) condensing type turbine will be introduced to supply steam and power, and No. V and VII turbines will be used for heating

By comparing above cases, Case 2 has following advantages over Case 1:

(1) Long-term supply of power and heat is ensured by the installation of the new turbine.

(2) The new turbine can be switched to the existing 40 MVA generator.

(3) The present income structure of Hungarian power plants makes this scenario more advantageous.

By considering above, Case 2 has been selected as the operation plan of turbines.

Chapter 4

Preliminary Design of the New Unit

Chapter 4 Preliminary Design of the New Unit

4.1 General Features

4.1.1 Main Components and Capacity

(1) Main Components

The new unit is an electricity generating unit also capable of delivering heat using steam obtained from steam turbine extractions. Main components of the unit are as follows:

- Coal fired, circulating fluidized bed (CFB) boiler
- Condensing steam turbine and generator
- Feedwater system
- Cooling system
- Hot water type heat delivery and heat supply system
- Coal receiving, storing, and transporting system
- Limestone receiving, storing, crushing, and transporting system

(2) Design Parameters and Capacity

Basic design parameters for the cooling system are determined for the conditions of ambient air temperature at 15 °C and without heat supply.

Rated parameters of the unit:

Installed electric capacity	150.0 MW
Available gross electric capacity	150.0 MW
Electric self-consumption	8.7 %
Net available electric capacity	137 MW
Maintenance requirement	720 hrs/yr
Forced outage (~10 %)	840 hrs/yr
Availability (theoretical)	7,200 hrs/yr
Actual available capacity	112.6 MW

The value of forced outage factor was determined on the basis that the unit, in addition to its own outage, also serves in peak heat periods as outage standby for the existing heat supply equipment.

The heat supply capacity of the unit is as follows:

Steam at 29 and 15 bar	max.	70 t/h	62 MW
Steam at 6 bar	max.	23 t/h	18 MW
Hot water (150/80 °C)	max.		50 MW
Total	max.		130 MW

The maximum amount of heat that can be obtained from the unit is lower than the contracted peak demand of heat. Therefore, it is necessary to deliver part of the heat from the existing plant in the peak period.

4.1.2 Energetic Characteristics

The P-Q diagram of Figure 4.1.1 shows the electricity and heat production of the unit in cogeneration. This figure illustrates the electric capacity limits of the unit in relation to heat delivery. As the heat delivery increases, not only the electric generation capacity but also the range of dispatchable capacity decreases.

Section AB of the diagram is the line for electricity generation in full condensing mode. Section AE is the line for unit's production at maximum boiler load, section BC for minimum boiler load, whereas section CD is the line for cogeneration mode increased by the minimum forced condensing operation.

Table 4.1.1 summarizes the energetic characteristics of the unit under different load conditions of the condensing operation mode and the cogeneration mode. Load conditions a. - e. for each operation mode in the table are as follows:

(1) Electricity generation in full condensing mode

a) Design condition, at nominal load, at +15 °C
b) Optimal load 75 %
c) Minimum load 30 %
d) Full load at -15 °
e) Full load at +30 °C.

(2) Cogeneration mode

a) Max. winter heat demand at -15 °C, full load
b) Winter heat demand at -5 °C, full load
c) Transition period heat demand at +10 °C, 75 % partial load
d) Summer heat demand at +15 °C, 30 % minimal load
e) Min. summer heat demand at +30 °C, 30 % minimal load.

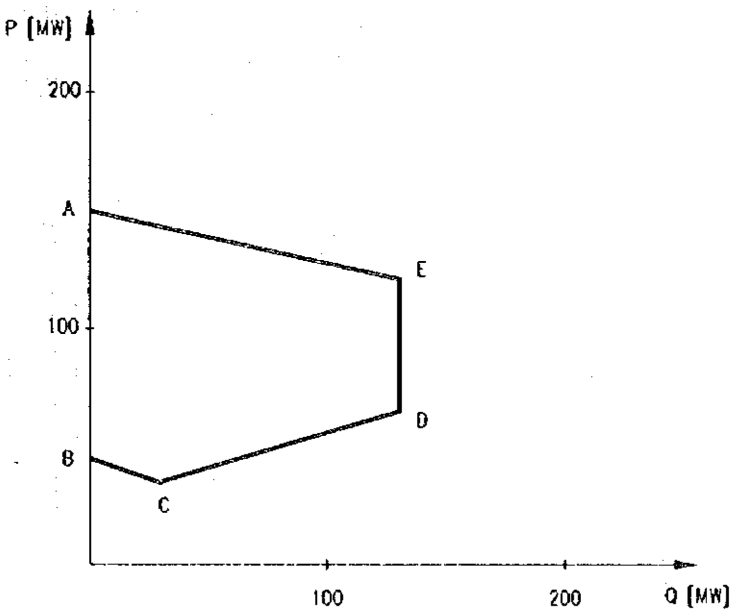


Figure 4.1.1 P. Q Diagram of the 150 MW Unit

4.1.3 Steam-Water Cycle

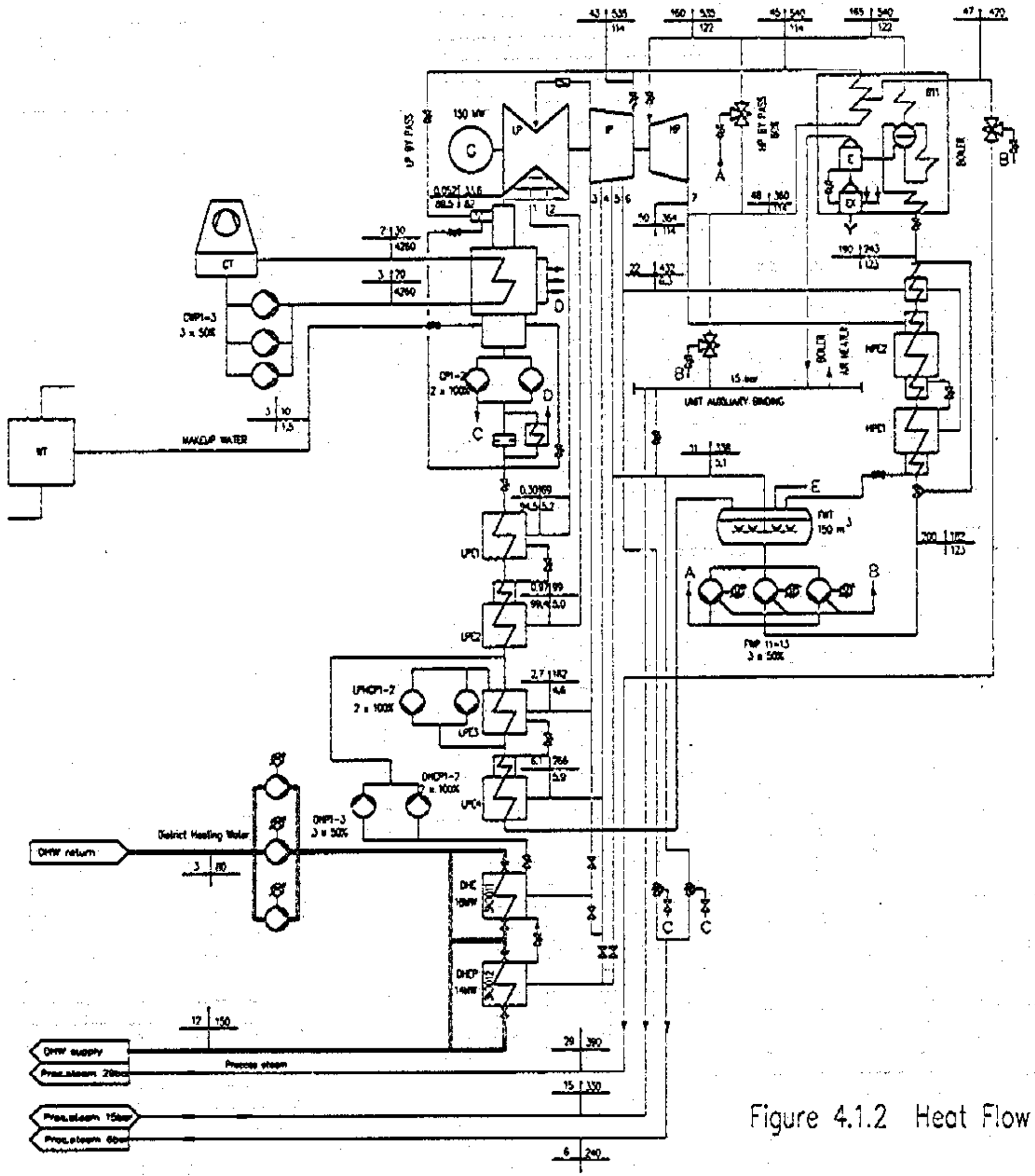
Table 4.1.2 shows main equipment in the steam-water cycle, and the heatflow diagram of Figure 4.1.2 shows the connection of the equipment.

Table 4.1.1 Energetic Characteristics of the 150 MW Unit

Operation mode		Condensing operation mode					Cogeneration mode				
Load condition		a.	b.	c.	d.	e.	a.	b.	c.	d.	e.
Fuel heat input	MW	382.0	278.5	135.8	382.0	382.0	388.0	387.5	280.0	135.6	135.7
Boiler efficiency	%	90.3	91.0	90.0	90.3	90.3	90.3	90.3	91.0	90.0	90.0
Heat transferred to steam	MW	344.9	253.5	122.2	344.9	344.9	350.4	349.9	254.8	122.1	122.1
Electricity generated in:											
- condensation	MW	150.0	112.5	50.6	152.9	147.7	81.7	87.1	81.2	45.0	46.3
- cogeneration	MW	-	-	-	-	-	40.2	37.3	17.6	3.6	1.9
Electricity produced total	MW	150.0	112.5	50.6	152.9	147.7	122.0	124.5	98.8	48.6	48.2
Electric self consumption	MW	13.0	11.2	8.3	13.1	12.9	11.7	11.8	10.6	8.2	8.2
Net electricity output	MW	137.0	101.3	42.3	139.8	134.8	110.3	112.7	88.2	40.5	40.0
Heat dissipated in condensation	MW	181.4	130.0	64.2	178.5	183.8	88.1	91.9	89.5	56.7	61.6
Heat delivery											
- 29 bar	MW	-	-	-	-	-	46.1	48.0	19.0	-	-
- 15 bar	MW	-	-	-	-	-	-	-	-	-	-
- 6 bar	MW	-	-	-	-	-	34.0	32.0	21.0	4.0	-
- hot water	MW	-	-	-	-	-	49.9	43.0	17.0	6.0	5.0
Heat delivery total	MW	-	-	-	-	-	130.0	123.0	57.0	10.0	5.0
Self heat consumption	MW	7.5	5.6	2.2	7.5	4.5	7.5	7.5	5.6	2.3	2.3
Losses (for boiler heat input)	MW	6.0	5.4	5.2	6.0	6.1	2.8	3.1	3.9	4.4	5.1
Heat rate:											
- for net electricity output	kJ/kWh	10037	9900	11547	9837	10203	7822	7892	8770	11025	11671
- for net heat output	kJ/kJ	-	-	-	-	-	1.141	1.142	1.141	1.177	1.182
Efficiency:											
- for net electricity output	%	35.9	36.4	31.2	36.6	35.3	46.0	45.6	41.1	32.7	30.8
- for net heat + electricity output	%	35.9	36.4	31.2	36.6	35.3	61.9	60.8	51.9	37.2	33.2

Table 4.1.2 Main Equipment in the Steam-Water Cycle

Equipment	Set	Main Parameters
CFB boiler system	1	460/430 t/h (reheat) 165/45 bar (reheat) 540/540 °C (reheat)
Steam turbine	1	460 t/h, 150 MW
HP by-pass	1	270 t/h (60%),165/50 bar
LP by-pass	1	330 t/h, 45/3/0.1 bar
Condenser	1	300 t/h, 0.09 bar, 186 MW
Vacuum pump	3	
Wet cooling tower	1	
Cooling water pump, 3 x 50%	3	3 x 11,000 m³/h
Condensate pump, 2 x 100 %	2	2 x 340 m³/h, 20 bar
LP feed water heater	4	3 x 12 MW, 1 x 14 MW
Heater condensate pump, 2 x 100 %	2	2 x 40 m³/h, 20 bar
Heat exchanger returning pump, 2 x 100 %	2	2 x 70 m³/h, 20 bar
Feedwater tank with deaerator	1	150 m³, 10 bar/180 °C
Feed pump, 3 x 50 %	3	3 x 320 m³/h, 210 bar
HP feedwater preheater	2	2 x 17 MW
Steam reducing station for auxiliary pipe	1	85 t/h, 50/15 bar
Hot water heat exchanger (base and peek)	2	28 MW(PN40) 22 MW(PN40)
Hot water circulating pump, 3 x 50 %	3	3 x 600 m³/h, 185 m, PN40
Condense tank	1	200 m³
Condense feed back pump, 2 x 100 %	2	2 x 30 m³/h, 40 m
Boiler filling pump, 2 x 100 %	2	2 x 40 m³/h, 80 m
Expander	1	10 m³
Expander	1	10 m³
Diesel aggregate	2	300 kW



DESIGNATION

B - boiler
HP - HP unit
IP - IP unit
LP - LP unit
G - generator
CP - condensate pump
LPE - LP preheater
DHCP- DHW base load heater condensate pump
LPHCP- preheater condensate pump
FWT - feedwater tank with deaerator
FWP - feed water pump
HPE - HP preheater
CWP - cooling water pump
DHP - DHW circulating pump
DHE - DHW base load heater
DHEP- DHW peak load heater
E - continuous evaporator
EX - startup expander
WT - water treatment plant
CT - cooling tower

bar | °C
X % | kg/s

Figure 4.1.2 Heat Flow Diagram for the New 150 MW Unit

4.2 Plant Layout

4.2.1 Plant Layout

The plant layout for the new unit was determined as described in Figure 3.4.2 in Section 3.4. The layout in the whole plant area is shown in Figure 4.2.1.

(a) The turbine building will be erected with the turbine axle parallel to that of the existing building, with 60 m x 27 m area and 27 m height. The front wall of the turbine building faces the railway and main road.

(b) The establishment of the turbine building involves the removal of the rail track to the existing main building. The tasks of transport to the old turbine building, and to the new 150 MW unit as well, are carried out by road.

(c) Between the turbine building and the boiler, a feedwater building of 9 m width and 15 m height is situated to accommodate the feedwater pumps. The feedwater tank of 150 m^3 of outdoor design is mounted on the top of the building.

(d) Next to the feedwater building, a bunker tract of 12 m width associated with the boiler accommodates the storage silos for daily stock of coal, limestone powder, and sand.

(e) The arrangement of the boiler of outdoor design follows the bunker tract. The boiler is provided with roof and side cover to ensure weather protection and prevent the access to controls by unauthorized persons. The covers are supported by the structure of the boiler itself, without needing any separate boiler building.

(f) The electrostatic precipitator, the 2 induced draft fans, and the stack of 4 m inner diameter and 130 m height made of reinforced concrete are installed at the elongation of the boiler axle.

(g) The central control building of 24 m x 30 m area and 15 m height will be built in the corner surrounded by the boiler house and the feedwater building.

(h) Any long term expansion of the power generation unit is possible in the south-east direction.

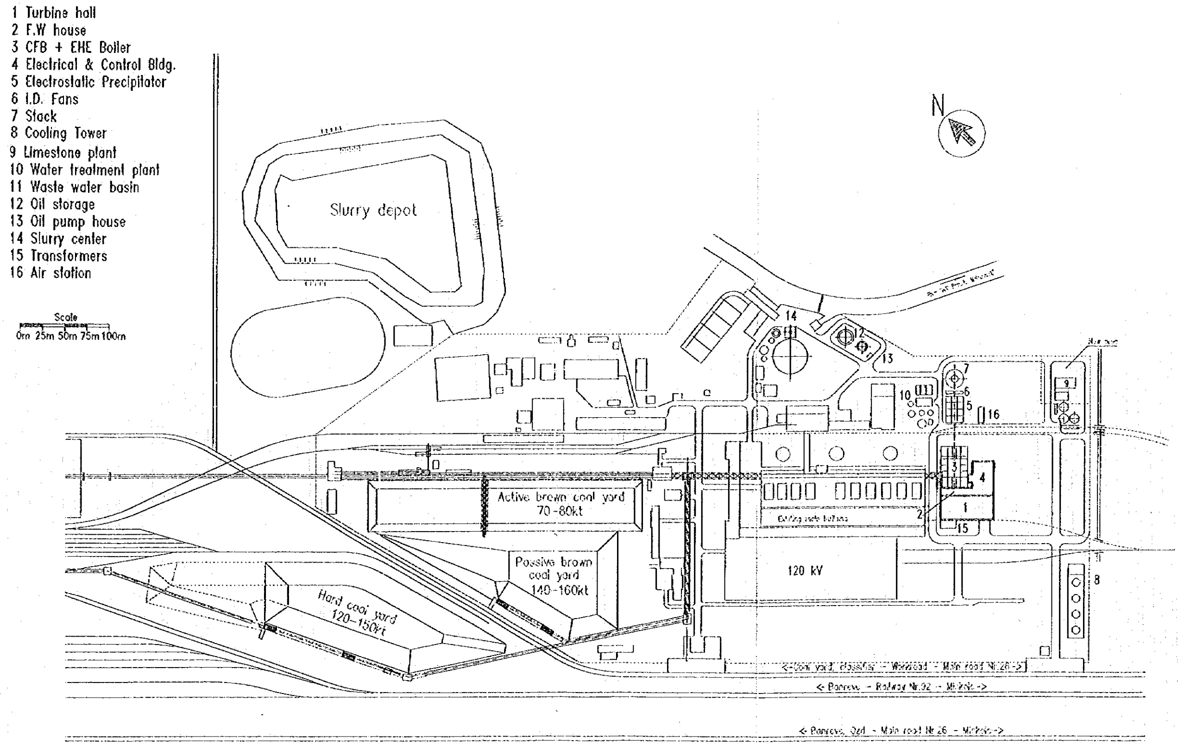


Figure 4.2.1 General Plant Layout

(i) The limestone processing plant will be established in a lot at the north-eastern corner of the site that should be newly acquired. The cooling tower will be installed at the south-eastern end of the site. The second cooling tower of the next 150 MW unit, if any, can be installed in the area at the north-east of the first one.

4.2.2 Arrangement of Major Equipment

(1) Turbine, Generator and Auxiliary Equipment

The turbine building is 60 m long, 27 m wide, and 27 m high. The operator level is at +9.70 m.

The turbine hall is served by an bridge crane of 50 tons, running along the hall. The rail top level lies at 21.5 m height (see Figure 4.2.4).

The equipment layout on the ground floor (±0.0 m) of the turbine building is as follows (see Figures 4.2.2 and 4.2.4).

1) The turbine supporting RC table (30 m x 11.5 m) is supported by 10 legs erected on the ground. The generator side faces the existing main building, while the assembly area is at the south-west part of the turbine building.

2) The condenser of steam turbine and the 2 district heating heat exchangers are installed below the turbine supporting table. Sufficient space is available to remove and install the tubes of condenser and heat exchangers for maintenance purposes.

3) The cooling equipment of the generator is installed below the generator.

4) The oil tank of the turbine is placed on the steel frames to be adjusted with the height of the turbine.

5) The 2 main condensate pumps are placed in the pit near the turbine supporting table in order to ensure the head required by the pumps at the inlet side.

6) The large-size cooling water pipelines are laid in the floor channel below the 0 level and leave the turbine building at its south-west wall below the ground level, to connect to the wet cooling tower.

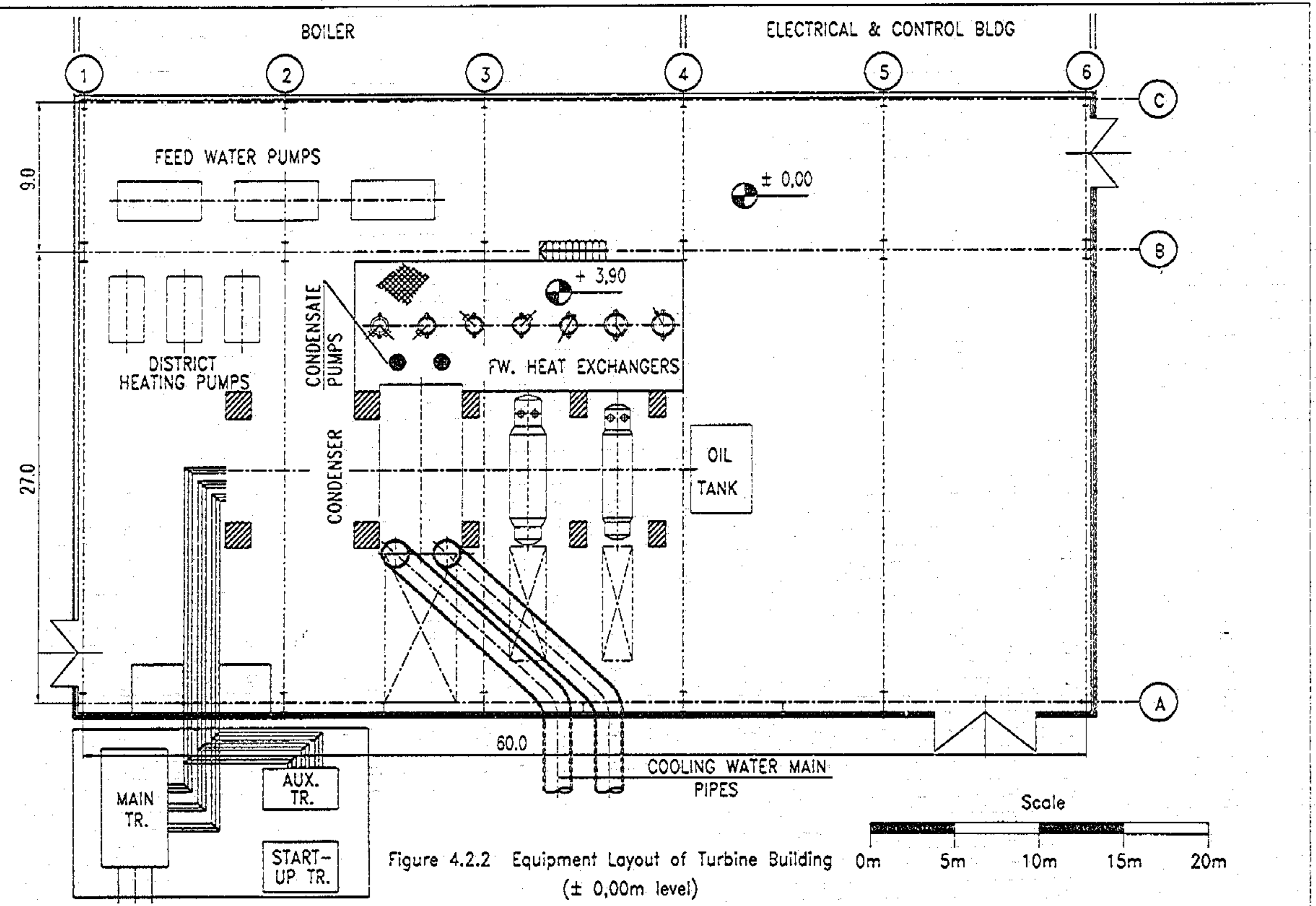


Figure 4.2.2 Equipment Layout of Turbine Building (± 0,00m level)

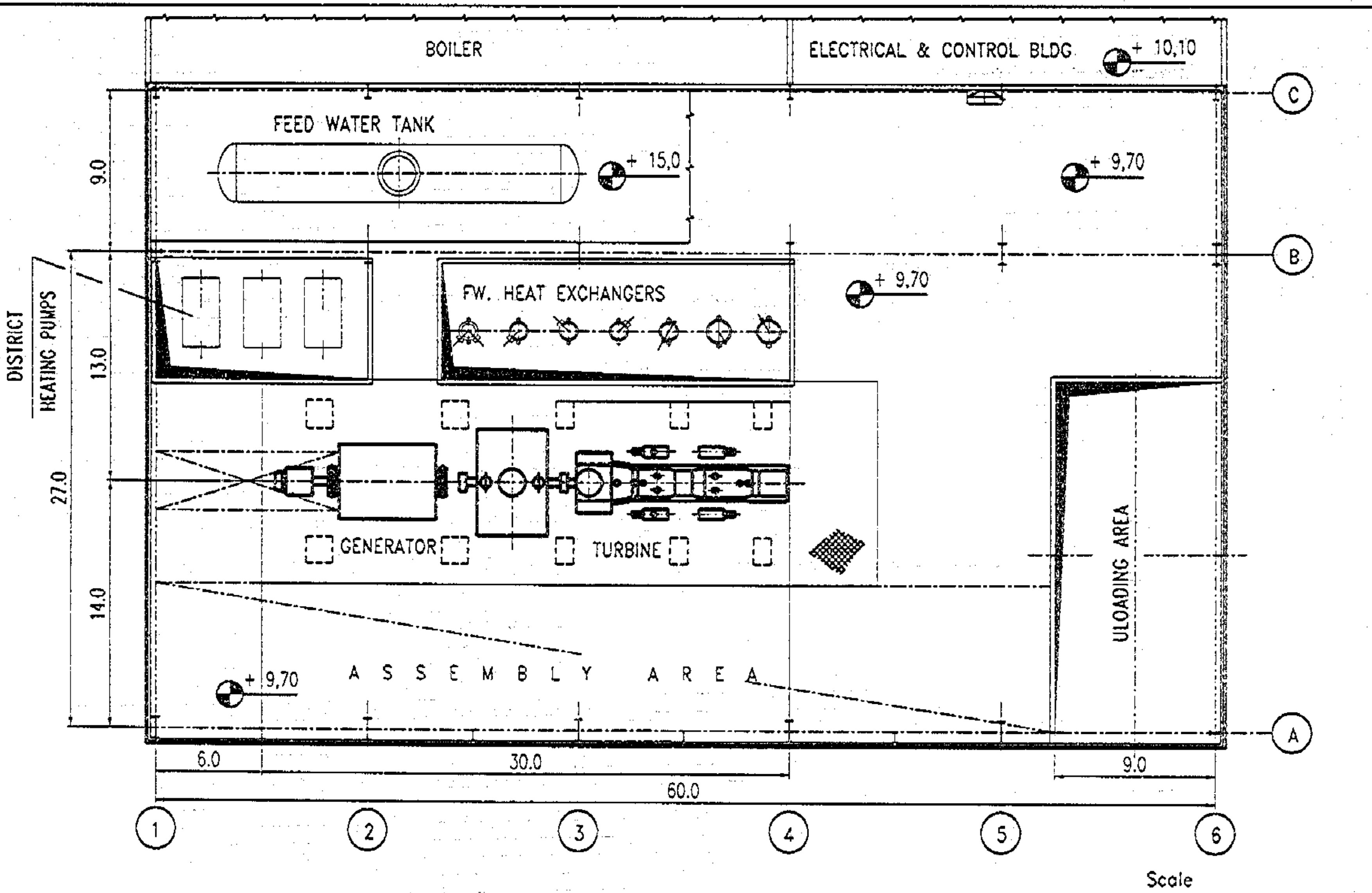


Figure 4.2.3 Equipment Layout of Turbine Building
(+ 9.70 m level)

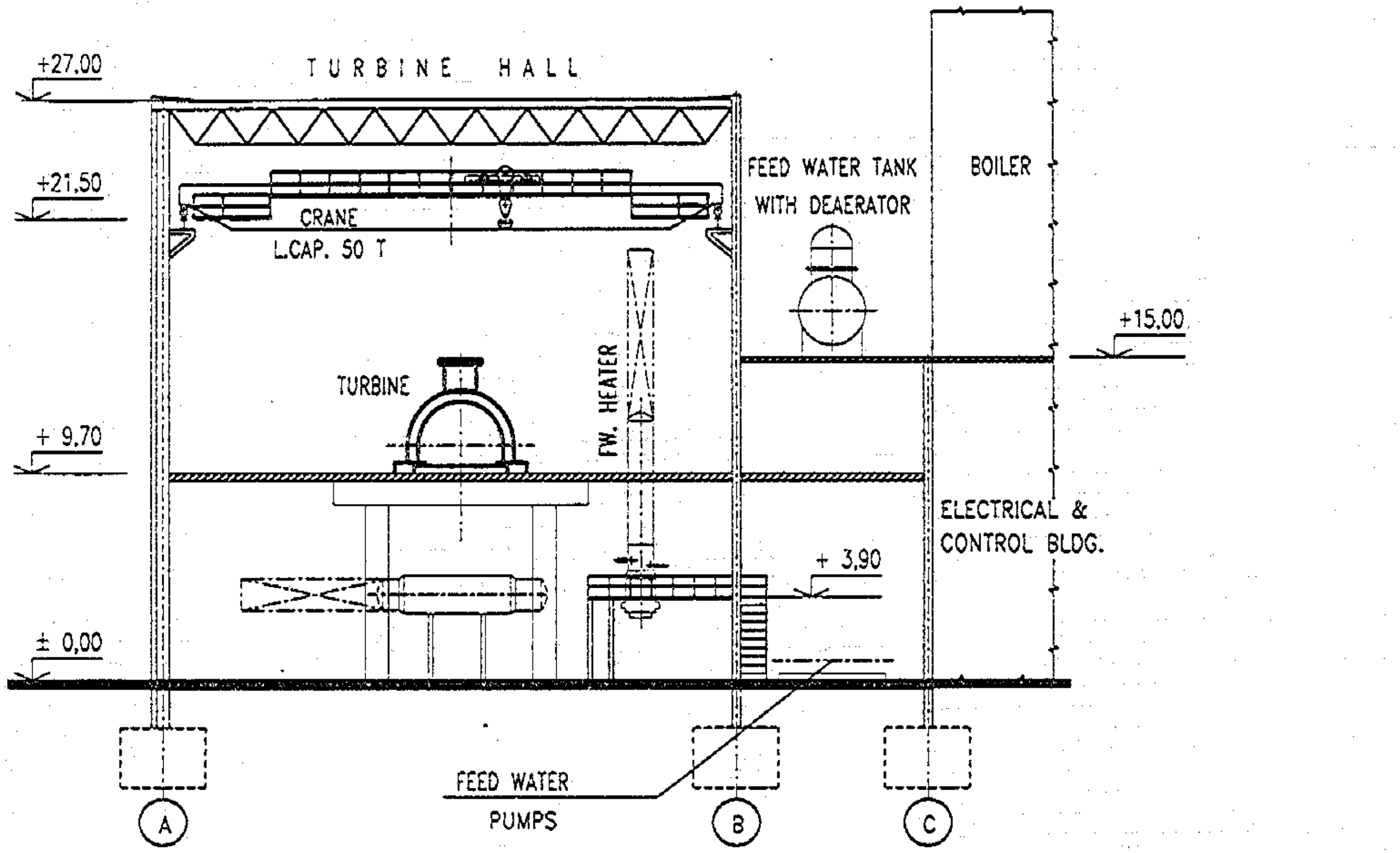


Figure 4.2.4 Side View of Turbine Building

7) Between the turbine supporting table and the feedwater building, the feedwater heaters are mounted on the auxiliary level, supported by the steel structure. The 4 low pressure and the 2 high pressure heaters of vertical design are arranged in a single row. The heat exchanger surfaces are accessible by pulling off the mantle by means of the built-in overhead crane.

8) The 3 circulating pumps for district heating are also installed at the ground floor level close to the feedwater pumps.

The equipment layout on the operator level (+9.70 m) is as follows (see Figures 4.2.3 and 4.2.4).

1) The center of the turbine shaft is at +11.0 m level. The steam turbine is of 2-housing design, of which the low pressure section has a double-flow outlet to be connected to the condenser.

2) The generator and the exciting unit follow on the same axis. Sufficient space is available within the turbine hall for wiring of the generator rotor.

(2) Equipment in the Feedwater Building

The feedwater building of 9 m span connected to the turbine hall is also of 60 m long with top height of 15 m. Its operator floor of reinforced concrete is at the same level as the turbine (+9.70m). The equipment layout is as follows (see Figures 4.2.2 through 4.2.4).

1) The space below the operator level is provided with an overhead crane of 10 tons with its rail top at +7.0 m.

2) The 3 electric motor driven feedwater pumps are installed symmetrically to the boiler axis.

3) The horizontal feedwater tank of 150 m^3 is mounted on the roof of the building in parallel with the turbine axis.

4) The feedwater building also accommodates the sections of the main steam and reheated steam pipes between the boiler and the turbine.

(3) Boiler and Auxiliary Equipment

The top view and the side view of the boiler and its auxiliary equipment are shown in Figures 4.2.5 and 4.2.6, respectively.

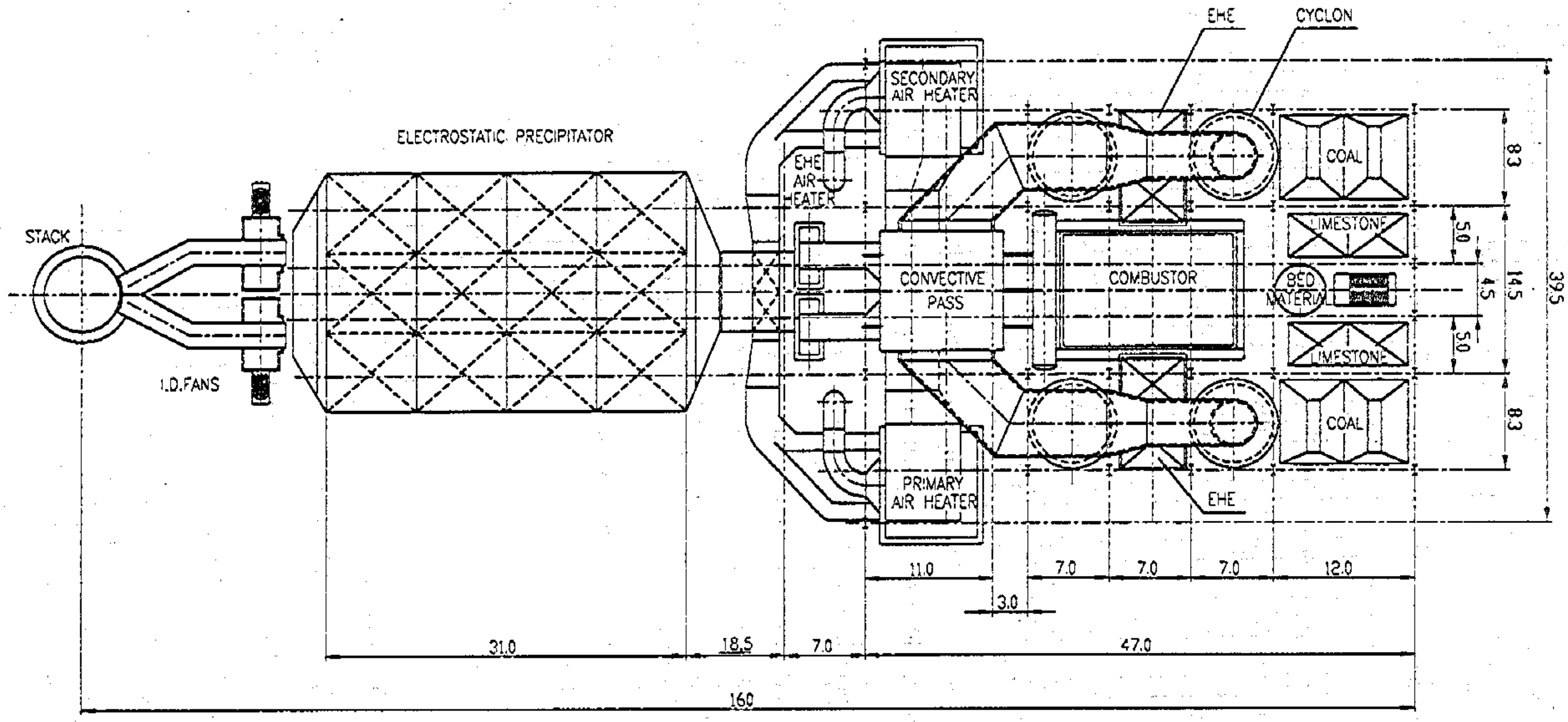


Figure 4.2.5 Top View of Boiler System (CFB + EHE)

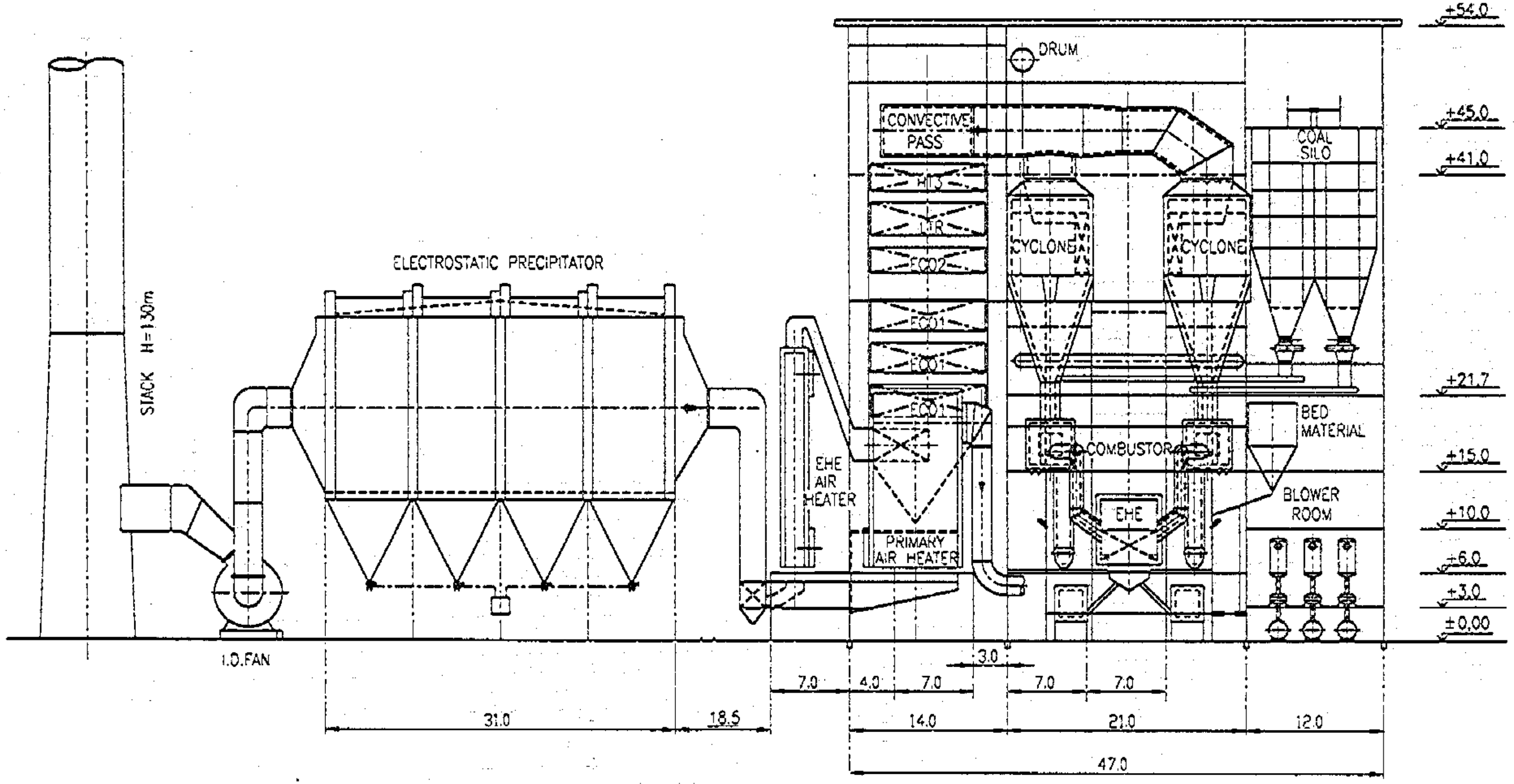


Figure 4.2.6 Side View of Boiler System (CFB + EHE)

1) The CFB+EHE boiler of outdoor design with 460 tons/h steam capacity is located parallel to the end wall of the existing power plant with a minimum distance of 18 m. The auxiliary units are arranged along the common axis extending to the stack. The distance from the bunker tract end to the stack center is 160 m.

2) A pair of railway tracks (one existing and another to be built) cross the ground space between the boiler and the electrostatic precipitator.

(4) Equipment and Facilities in the Central Control Building

The following equipment and facilities are installed in the central control building of 24 m x 30 m area and 15 m height (see Figures 4.11.3 through 4.11.6 in Section 4.11).

1) Ground floor

(a) Transformers, switching room, room for diesel aggregates, battery room for the D.C. auxiliary supply equipment, frequency converters for feedwater pump and circulating pumps.

(b) Below the ± 0.0 level, the cable junction cellar is arranged.

2) +6.40 m level

(a) 6 kV switchgear for internal supply
(b) Room for relays below the control room

3) +10.10 m level

(a) Central control room
(b) Offices, sanitary facilities for personnel

Between the central control building and the boiler house, a central staircase and a cargo lift leading up to the garret space of the boiler house are established.

4.2.3 Arrangement of Other Facilities

(1) Coal Yard

The existing coal storage and handling system will be extended for reception and transport of imported coal.

The existing external emergency coal yard will be converted for this purpose and completed by the necessary wagon unloading equipment and conveyor system. (See Section 4.5 for details.)

(2) Limestone Plant

The main components of the limestone plant are the reception and storage equipment, and the grinding and drying plants. The limestone handling plant will be installed close to the siding track No. VI which, in turn, will be supplemented by a new parallel track for the task of limestone transport. (See Section 4.6 for details.)

(3) Electric Equipment

The main, auxiliary, and starting transformers will be installed outdoors at the south-west side of the turbine building, immediately close to it. The 120 kV overhead lines connect in the area below the old machine building to the existing network. (In relation to the establishment of the new unit, no network development is necessary)

The 6 kV auxiliary switch-gear, the 6/0.4 kV transformers, the 0.4 kV switchgear, and the frequency converters of feedwater pump and circulating pumps will be installed in the central control building.

(4) Cooling Water System

The cooling tower and its pump station of 84 m x 18 m area will be established along the south-east fence of the Power Plant. Should the establishment of the second unit be necessary, its cooling tower can be sited north-east of the first one.

(5) Water Treatment Building, Sewage Treatment Basin, and Outdoor Reservoirs

The water treatment building will be established in the area of the existing oil tank since new oil tanks will be installed in another site.

The water treatment building is of 24 m x 12 m area, with its longer side being parallel to the existing rail track. The outdoor storage tanks are situated between the building and the rail track. Behind the building, the sewage treatment basin and its pumps are installed.

(6) Oil Tanks

A storage capacity of 3,000 m^3 for light fuel oil is necessary instead of current 200 m^3. One oil tank of 2,000 m^3 capacity and one with 1000 m^3 capacity, both of vertical design provided with double bottom, will be installed together with their transfer pump station in the area between the slurry center and the fence of Power Plant. The tanks are surrounded by service road reserved for fire fighting purposes, which is connected to the existing roads and pavements. The pump building is of 6 m x 4 m area

(7) Rail Network

Modification of the existing rail network within the Power Plant is described in Section 4.11.

4.3 Boiler System

4.3.1 Basic Data for Planning

Unit capacity	:	150 MWe
Type of boiler	:	Circulating fluidized bed (CFB+EHE)
Steam parameters:		
Max. steam generating capacity(MR)	:	127.8 kg/s (460 t/h)
Max. permanent steam generating capacity (MCR):		126.1 kg/s (454 t/h)
Live steam parameters at boiler outlet:		
pressure	:	165 bar
temperature	:	540 ℃
Reheated steam parameters:		
mass flow	:	117.9 kg/s (424 t/h)
outlet pressure	:	45 bar
outlet temperature	:	540 ℃
Steam extraction between the reheater stages:		
mass flow	:	max. 19.4 kg/s (70 t/h)
outlet temperature	:	420 ℃
Feed water temperature at ECO. inlet	:	243 ℃

Emission limits of air pollutants for dry flue gas of 273°K and 101.3 kPa with 6% oxygen content:

SO_2	:	max. 400 mg/Nm^3
NOx	:	max. 200 mg/Nm^3
Dust	:	max. 50 mg/Nm^3

4.3.2 Boiler Specifications

(1) Boiler Equipment

1) Parts Under Pressure

Combustion chamber	Natural circulation, water cooled, welded membrane wall structure
Drum	Single-drum, with drop separator, welded structure
Cyclone	Centrifugal separator Efficiency: better than 99.5%
Bed ash circulating system	External fluidized heat exchanger
Superheater	Heat transfer by means of convection
Reheater	Heat transfer by means of convection
Fuel pre-heating	Blank pipe

2) Boiler Casing	Corrugated steel sheet
3) Air Preheater	Regenerative
4) Steam Heated Air Heater	Fine-ribbed
5) Soot Blower	Steam injection type with automatic or manual operation
6) Air and Flue Duct	Steel plate, welded structure

(2) Coal and Limestone Supply System

1) Coal Supply System

Coal Bunker	Steel plate with water resistant cover Quantity: 4 units Capacity: 20 hours of operation at MCR load
Coal feeder	Trough-chain conveyor Quantity: 4 units Capacity: 110 t/h in total

2) Limestone Supply System

Limestone bin	Steel plate
	Capacity: 1 day of operation at MCR load
Limestone powder fluidizing compressor	
	Screw type compressor
	Capacity: 2,300 m^3/h

(3) Fuel Oil Fired Equipment

Fuel oil burners	Steam atomizing gun
	Capacity: 30% of MCR in total

(4) Gas Fired Equipment

Ignition burners	Burner with electric ignition
	Capacity: 15% of MCR in total
Main gas burners	High pressure gas burner
	Capacity: 100% of MCR in total

(5) Air Supply Equipment

Primary air fan	Centrifugal
	Quantity: 2 units (2x60%) with inlet-side AH by steam
Secondary air fan	Centrifugal
	Quantity: 2 units (2x60%) with inlet-side AH by steam
Flue gas fan	Centrifugal
	Quantity: 2 units (2x60%) with cooled bearings
Bed ash fluidizing blower	Blower
	Quantity: 2 units

4.3.3 Outline of the Boiler

Top view and sectional view of the boiler were shown in Figures 4.2.5 and 4.2.6.

(1) Main Parts of the Boiler

Combustion chamber
Water cooled air distribution box
Cyclone and bed ash return system
Convection part with superheater, reheater, economizer and air heater.

(2) Main Characteristics of the Boiler

Max. steam generating capacity (MR)	:	127.8 kg/s (460 t/h)
Max. permanent steam generating capacity (MCR)	:	126.1 kg/s (454 t/h)
Live steam parameters at boiler outlet:		
pressure	:	165 bar
temperature	:	540 ℃
Reheated steam parameters	:	
mass flow	:	117.9 kg/s (424 t/h)
outlet pressure	:	45 bar
outlet temperature	:	540 ℃
inlet temperature	:	360 ℃
Steam extraction between the reheater stages:		
mass flow	:	max. 19.4 kg/s (70 t/h)
outlet temperature	:	420 ℃
Feed water temperature	:	243 ℃
Pressure rating	:	188 bar
Pressure drops:		
superheater	:	8.0 bar
reheater	:	3.0 bar
economizer	:	1.0 bar
Combustion air flow	:	135 Nm^3/s
Flue gas flow	:	157 Nm^3/s
Flue gas outlet temperature	:	130℃
Boiler efficiency	:	90.3 %
Fuel consumption mixed coal	:	103.2 t/h
Limestone powder consumption	:	18.4 t/h
Fuel residues approx.	:	44 t/h

(3) Firing Equipment

1) The quality of solid fuel may show a relatively wide variety. As a basis for planning and with environmental aspects also taken into consideration, Borsod brown coal from mines of Borsod mixed with imported hard coal up to the maximum of 50% heating value is envisaged. The ratio of 50/50 % is related to the thermal equivalent of the fuel used.

Characteristic data of coal types used and design coal are shown in Tables. 3.5.7~3.5.8, respectively.

2) In the fluidized free board, the coal is burnt at a temperature of about 850 C°. The fluidized medium consists of coal, bed ash and limestone. Air and flue gas serve as fluidizing media. Part of the air - the primary air - will enter at the bottom of boiler, while the remaining part will be fed at the conical part of the combustion chamber. The low temperature in the combustion chamber and the multi-stage air inlet have a favorable effect on the generation of thermal NOx in small quantity. Sulfure content in fuel is fixed through the reaction with added limstone and 90 % or more of sulfure is recovered from the exhaust gas.

3) The bed ash will be separated from the combustion products that leave the fluidized free board by means of external cyclones. The bed ash thus separated will be fed back directly, on the one hand, and through the fluidized external heat exchanger to the combustion chamber, on the other hand.

4) The lower part of the squared combustion chamber is coated with ceramic material. The secondary air inlet openings are located above the bed ash return openings. The ignition burners and the burner guns serving for heating up the fluidized stone are also located here.

5) The flue gas will be cooled down to about 130 C° through the heat transfer surfaces located in the second pass and the air preheater.

6) High capacity natural gas burners
In the case of prolonged failure of the coal supply line and the system used to remove the fuel residues - if the capacity of coal bunkers as well as the ash- and flue ash storage capacity is insufficient for continuous coal firing -, the full (100%) heat production capacity of the boiler system can be maintained by natural gas firing.
Production of 460 tons of live steam requires 41,000 Nm^3/h natural gas to be fired. Taking the size of the combustion chamber (fluidized bed) into consideration (15 x 9.7 m area), 8 high capacity natural gas burners capable of burning 5,125 Nm^3/h natural gas each, shall be built in. The burners can be located on the longer sides of the combustion chamber, 4 burners along the opposite sides each, at the level above the fluidized bed. The burners are of gun type which direct their flame onto the fluidized bed. (Due to the external fluidized heat exchangers, the fluidized system shall be in operation even in the gas fired mode).

The handling of the burners and their compulsory safety devices shall be ensured by establishing suitable pathways on the boiler. The ignition burners associated with the main burners are also natural gas fired.

(4) Limestone System

For desulfurizing, limestone grist will be added by means of a pneumatic system. The daily bin contains limestone grist sufficient for 24 hours of operation. The dosage will be performed automatically, according to the desired rate of desulfurization.

(5) Water & Steam System (Figure 4.3.1)

1) The feed water will be fed through the economizer located in the second pass and the water level controller of the drum into the drum.

2) The feed water fed through perforated pipe into the boiler drum will be mixed with the boiler water.

3) Within the drum, a separator separates the water and the steam. The water will be fed back to the circulating system.

4) Quality requirements for the feed water:

pH value at 25 C°		8.5 to 9.5
Dissolved oxygen	max.	0.01 mg/kg
Total hardness	max..	0.001 me/kg
Total iron content	max.	0.02 mg/kg
Total copper content	max.	0.003 mg/kg
Oil + suspended		0

5) Quality requirements for boiler water

pH value at 25 C°		8.5 to 9.5
SiO_2 content	max.	0.30 mg/kg
p-value (P-alkali)	max.	0.05 me/kg
Conductivity at 25 C°		4.0 mS/m
PO_4 content	max.	6.0 mg/kg
$KMnO_4$ consumption	max.	5.0 mg/kg

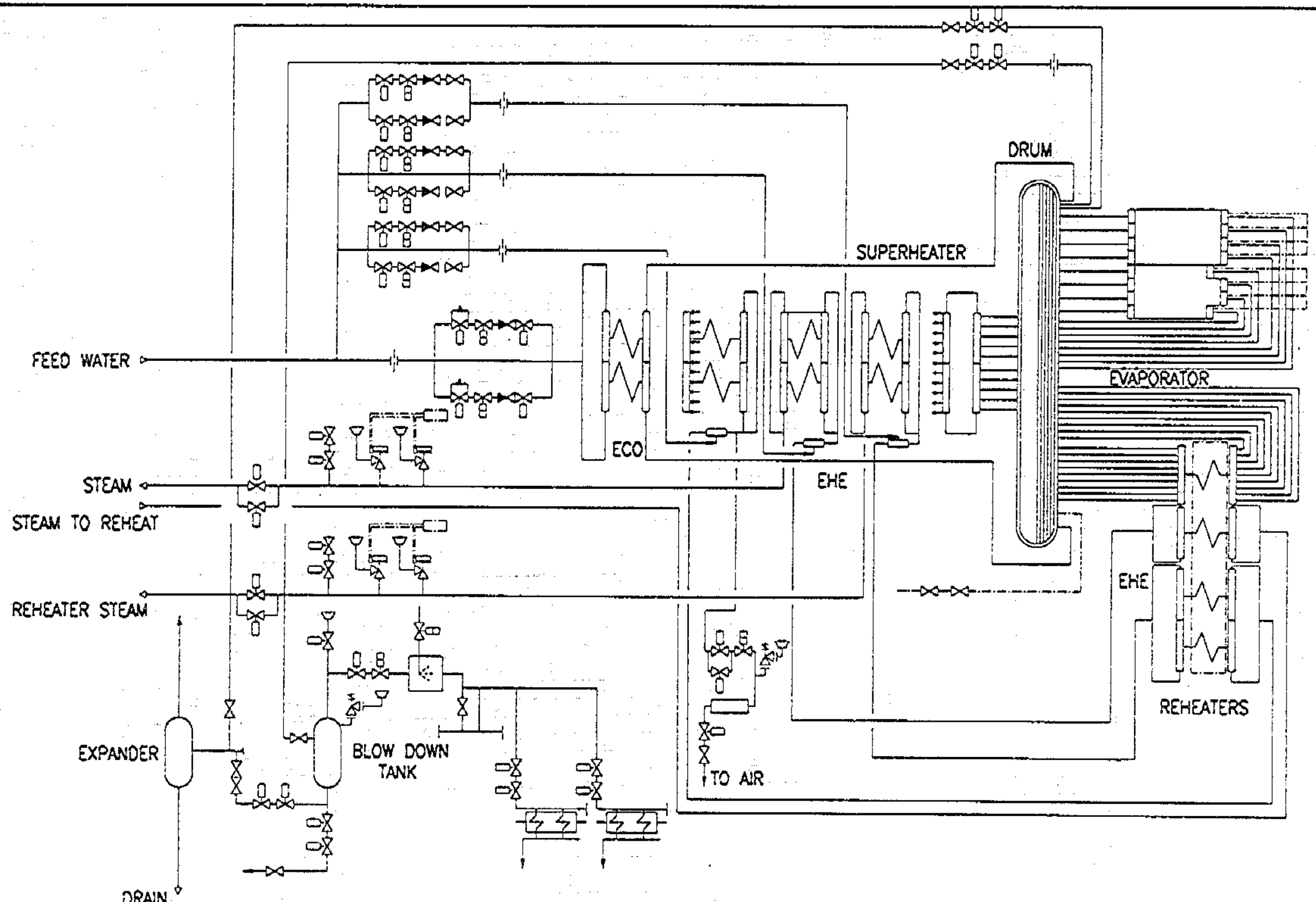


Figure 4.3.1 Boiler-water/steam system

(6) Boiler Steam System (Figure 4.3.2)

The boiler is of natural circulation and membrane wall design, suspended from above, freely expanded downwards. In the second pass, two superheats for live steam and one superheater for reheated steam are mounted; with one stage of each superheater submerged into the cooler of the external bed ash.

The steam temperature is controlled by water injection between the two stages.

(7) Bed Ash Handling (Figure 4.3.3)

The bed ash cooler is connected to the lower part of the fluidized free board in order to remove the bed material in excess. Material draining possibilities also exist at the siphon of the bed material return system. The bed ash will be cooled by using air and cooling water down to 130 °C

(8) Combustion Air Supply System

1) The primary air will be delivered by means of centrifugal fans (2 units) through the steam heated preheater and the air heater of the boiler into the fluidized bed. The primary air ensures the fluidization in the combustion chamber. The control function is implemented by means of a swirl regulator.

2) The secondary air will also be delivered by means of centrifugal fans (2 units) through the steam heated preheater and the side openings of the combustion chamber into the combustion chamber. The secondary air flow provides for the air volume necessary for the burning process (in addition to the primary air volume), on the one hand, and ensures the optimum temperature distribution by means of the blow-in point arranged appropriately, on the other hand. The air supply to the ignition burners is also ensured here. The air flow is controlled by means of a swirl regulator.

3) The high pressure fluidizing air flow is ensured by air blowers to the free board and bed ash cooler.

(9) Flue Gas System

1) Flue gas from the free board will enter into a cyclone first, in order to separate the bed ash and feed back to the free board. The flue gas that contains fine fly ash flows through the convective surfaces of the boiler into the EP.

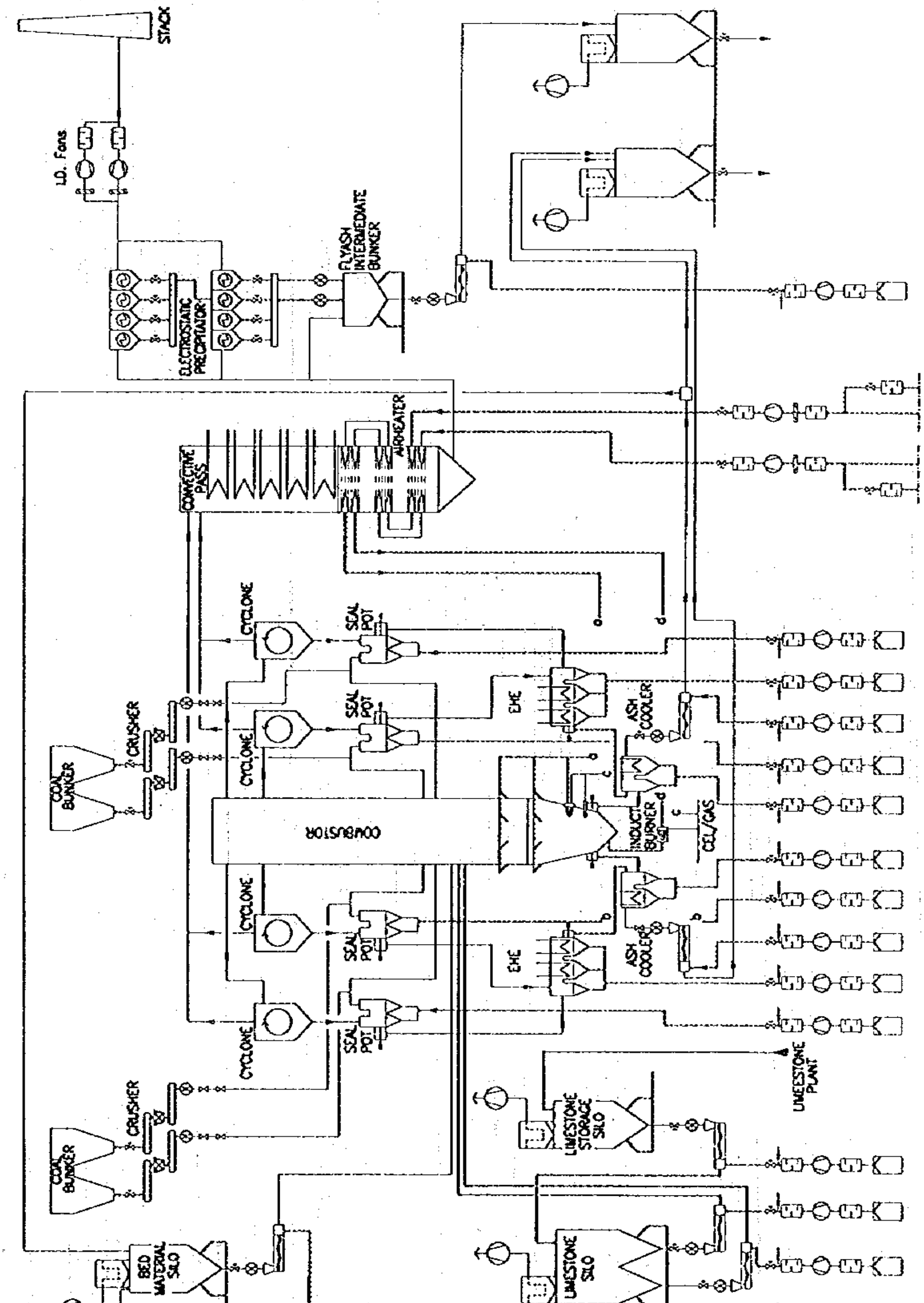


Figure 4.3.2 Boiler-solid supply system

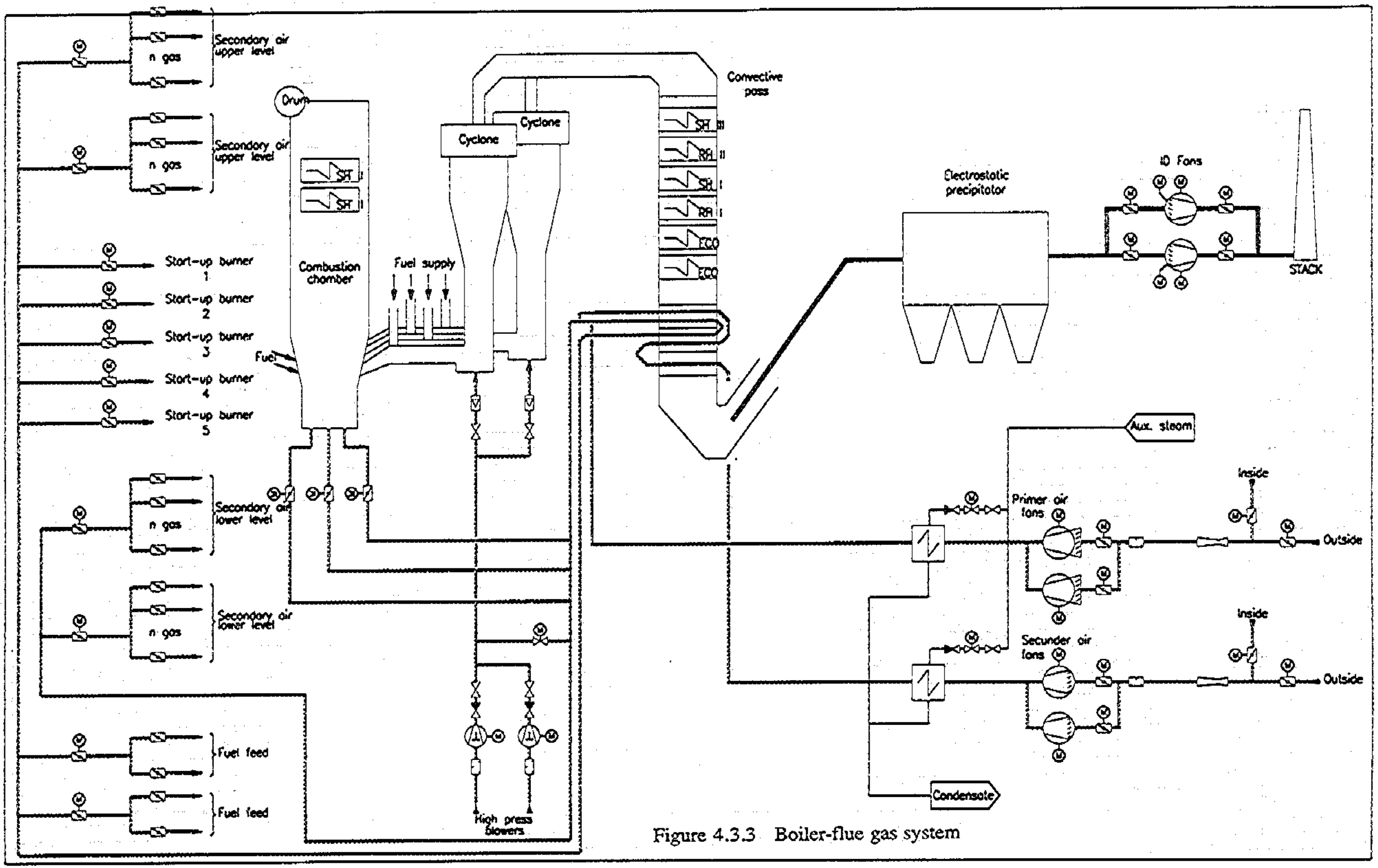


Figure 4.3.3 Boiler-flue gas system

2) Flue gas cleaning equipment

a) Type: Electric precipitator
Quantity: 1
Outline dimensions: 31 x 22 x 31 m

b) Main components

The EP consists of a filter housing made of steel plate, a fly ash collecting funnel mounted below the filter housing, a flue gas inlet and outlet stubs and a supporting steel structure.

c) Operation

The flue gas containing fine fly ash entering the filter housing flows between high voltage electrodes. The electric field ionizes the gas and the solid particles, thus separating the latter from the flue gas.

The electrodes will be continuously cleaned by means of a hammer-type vibration device in order to remove the dust accumulated. The fly ash accumulated in the lower funnels will be removed through a drop-bottom flap from the EP.

Then, the fly ash will be transported through pneumatic transport vessels into the fly ash storage bins.

3) The flue gas will be delivered by the 2 flue gas fans (the swirl regulator of which controls the free board pressure) through the stack into the atmosphere. Both the inlet- and outlet ducts of the flue gas fans are made of steel plate, provided with a heat insulating mattress and protected by means of an aluminum mantle.
Flue gas from the boiler will be directed into the new stack. The O_2, CO, NOx, Dust and SO_2 contents shall be continuously measured.

(10) Fuel Supply System

The fuel supply will be implemented through the return system located below the cyclone from the bunkers. According to the actual steam demand, 4 new coal bunkers will be established for the boiler. The two fuels will be mixed before the bunkers, by loading the coal on the conveyor, with the different layers superimposed. Through-chain conveyors provided with speed control as well as rotary feeders prevent the combustion products from escaping into the atmosphere. This is also promoted by the secondary air inlet.

(11) Limestone Dosage System

Limestone dosage will be performed by automatic feeding with ratio control, adjustable according to the coal quality.

(12) Soot Blower System

The soot blower system is required only in the convective part of the boiler. The cleaning medium is steam.

4.3.4 Emission of Pollutants

(1) Grantee of Suppliers

Based on preliminary data acquired from suppliers as well as air quality limit values, the emission values to be expected in the case of dry flue gas of 273 K temperature, 101.3 kPa pressure and 6% oxygen content will be:

SO_2: max. 400 mg/Nm^3
NOx: max. 200 mg/Nm^3
Dust: max. 50 mg/Nm^3

(2) SO_2 Concentration and Emission Standards

Mixed coal used for design contains 13.32 GJ/t (Hl) and 1.8% of sulfur. Therefore, supposing that the rate of desulfurization is 90%, SO_2 concentration in exhaust gas is 694 mg/Nm^3. This figure meets 872 mg/Nm^3, the emission standard applicable to the new 150MWe units (382MWth).

4.4 Turbine System

4.4.1 Steam Turbine

(1) Basic Design Data

1) Rated output (design condition)

The rated output of the steam turbine is 150 MW on the generator terminals with feed water heating, but without any heat output under the following conditions.

Ambient temperature:	+15 °C
Cooling water inlet temperature to the condenser:	20 °C
Temperature within the condenser:	38.9 °C
Pressure:	0.07 bar (abs)

2) Output for typical operating modes

The output of the turbo-generator have been studied for the following operational modes

(i) Condensing operating mode

a. +15 °C ambient temperature (the above design condition)
b. Optimum load at 75%
c. Maximum load at -15 °C ambient temperature
d. Maximum load at +30 °C ambient temperature

(ii) With heat output

a. Maximum heat demand during winter:
Max. load at -15 °C ambient temperature

b. Heat demand during winter:
Max. load at -5 °C ambient temperature

c. Heat demand during summer:
Min. load (30%) at +15 °C ambient temperature

d. Minimum heat demand during summer:
Min. load (30%) at +30 °C ambient temperature.

The studied output of the steam turbine under the above loads is summarized in Table 4.4.1.

Table 4.4.1 Steam Turbine Output

Operational condition / Parameter		Pure condensing operation				With heat output			
		a	b	c	d	a	b	c	d
Output on generator terminals	MW	150.0	112.5	152.9	147.7	122.0	124.5	48.6	48.2
Electric output	MW	137.0	101.3	139.8	134.8	110.3	112.7	40.5	40.0
Total heat output	MW					130.0	123.0	10.0	5.0
Heat transfer in the condenser	MW	181.4	130.0	178.5	183.8	88.1	91.9	56.7	61.6

(2) Steam Parameters

In respect of the steam turbine efficiency, it is advantageous to select the inlet steam pressure and steam temperature as high as possible.

Due to the quality of materials used in the circulating fluidized bed fired boilers at present as well as based on experiences gained through operation and availability of the unit, subcritical steam parameters are selected as follows.

Main steam pressure at turbine inlet: 160 bar(a)
Main steam temperature at turbine inlet: 535 °C
Main steam mass flow at turbine inlet: 126 kg/s
Reheated steam pressure at turbine inlet: 43 bar(a)
Reheated steam temperature at turbine inlet: 535 °C
Reheated steam mass flow at turbine inlet: 118 kg/s

Extraction pressure (bar)	50	22	11	6.1	2.7	0.97	0.3
Extraction temperature (°C)	364	432	338	267	182	99	69

(3) Steam Pressure at the Turbine Outlet

The outlet pressure of steam turbine is 0.07 bar (abs) under the design condition with inlet water temperature of 20 °C to the condenser. Within the condenser, the cooling water temperature rise will be 8 °C.

Steam quality requirements are shown in Table 4.4.2.

Table 4.4.2 Steam Quality Requirements

Parameter	Unit	Continuous operation	Starting condition
Conductivity (at 25 °C, CO_2 free)	μ S/cm	≤ 0.2	< 0.5
SiO_2	ppm	< 0.02	< 0.05
Total iron (Fe)	ppm	< 0.02	< 0.05
Copper (Cu)	ppm	< 0.003	< 0.01
Soda + Phosphate	ppm	< 0.01	< 0.02

(4) Steam Turbine

Type : Three-housing of condensing and reheating operation with both controlled and uncontrolled extraction

Rated capacity : 150 MW at the generator terminals in the condensing mode

Steam parameters at turbine inlet:

Main steam pressure at turbine inlet : 160 bar (abs)

Main steam temperature at turbine inlet : 535 °C

Reheated steam pressure at turbine inlet : 43 bar(abs)

Reheated steam temperature at turbine inlet : 535 °C

Outlet pressure:

0.07 bar(abs) under the design condition

0.09 bar(abs) at rated load and +30 °C ambient temperature

Speed: 3000 rpm

Control system : Electro-hydraulic conforming UCPTE

The flow diagram of steam/water system is shown in Figure 4.4.1.

(a) Live steam from the boiler flows through the control valves of steam turbine into the high pressure section of turbine casing. From the high pressure section, the steam will be fed back to the reheater of boiler. A control flap is installed in the pipeline connecting the medium pressure and low pressure sections of casing in order to make the heat output independent of the condensing load.

(b) Steam supply to the high pressure steam system is ensured through a reducer from the multi-stage reheater. The medium pressure steam system is provided with steam through reducing valve from the cold branch of the reheater. The pressure of reheated steam is selected so as to enable the demand of steam consumers to be fulfilled within a wide load range of the unit.

(c) The heating of de-aerator is of floating parameter without regulation.

(d) The synchronous generator of 150 MW rated power is coupled to the turbine shaft at the high pressure side through clutch. The generator is provided with static excitation equipment. (Details of the generator is given in Section 4.8.)

(e) The control and protection system of the turbine conforms the provisions of UCPTE. The control system limits the rate of load changes by the maximum permissible mechanical stresses. Automatic equipment controlling the starting and warming-up process is also provided.

4.4.2 Auxiliary Equipment of Steam Turbine

(1) Condenser

The condenser will be mounted below the low pressure section of turbine casing provided with double outlet.

Type: Horizontal, single flow, with condensate sink

Rated steam flow:	83 kg/s
Rated pressure at 15 °C:	0.09 bar(abs)
Cooling water inlet temperature:	32 °C
Cooling water outlet temperature:	40 °C
Cooling water flow:	20 000 m^3/h

The flow diagram of the condenser is shown in Figure 4.4.2.

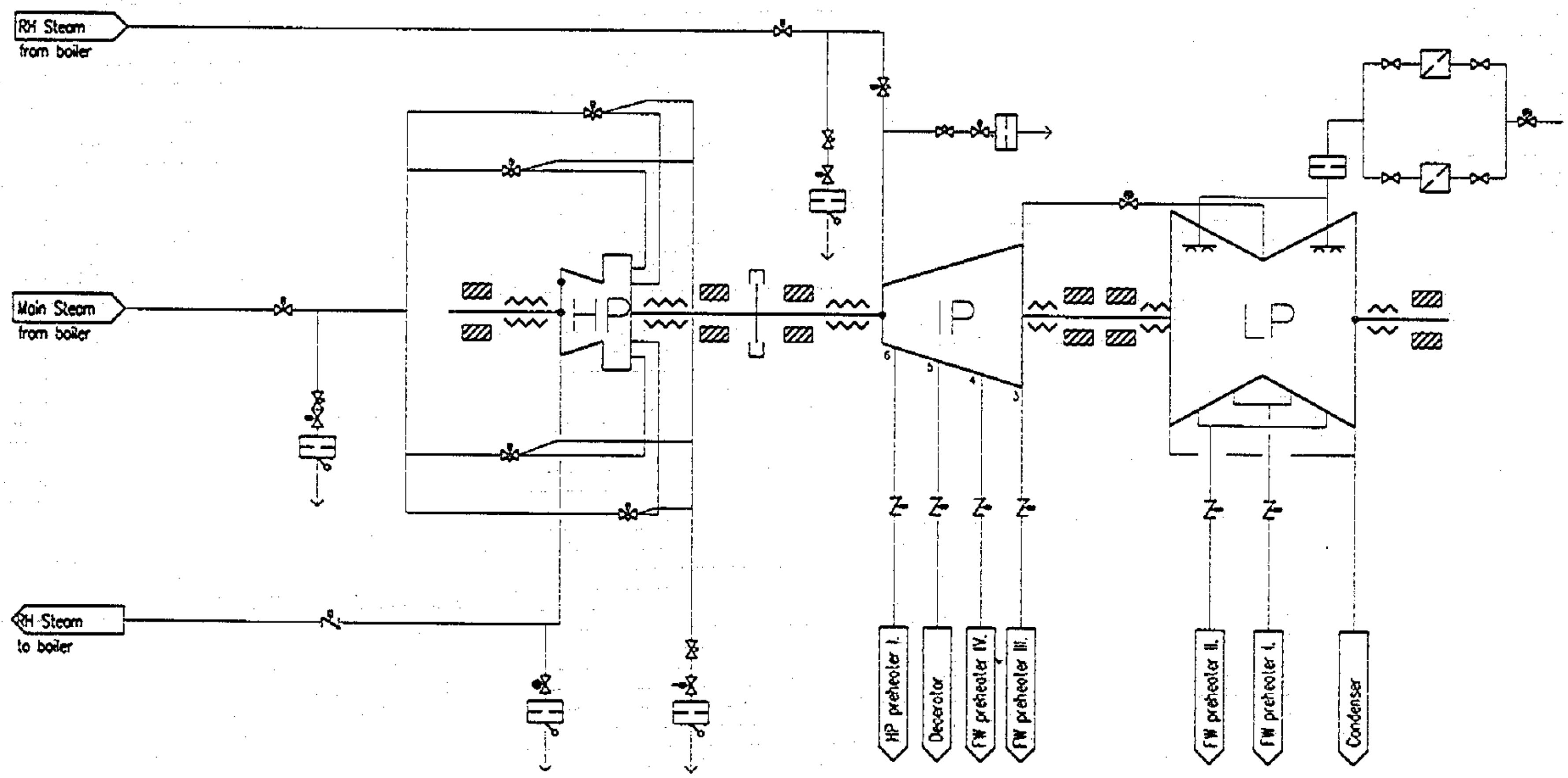


Figure 4.4.1 Steam Water System

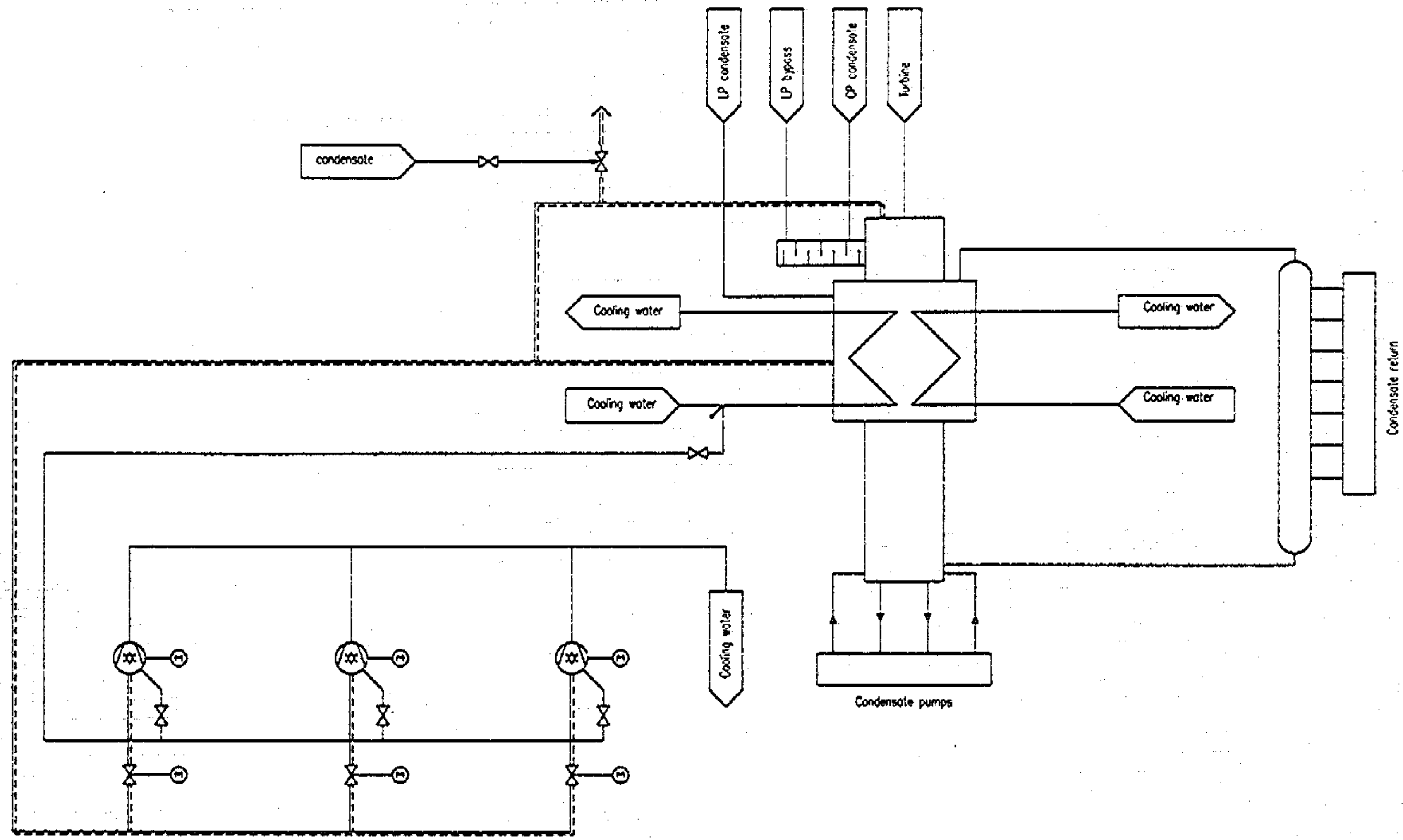


Figure 4.4.2 Flow Diagram of Condenser

(a) The condenser serves for condensing the exhaust steam leaving the turbine. The condenser also receives steam arriving through energy absorber from the low pressure by-pass system. Its pressure is determined by the temperature and flow of cooling water as well as the inlet steam flow. The de-aeration is implemented by the vacuum system.

(b) The condensed water is removed by the condensate pumps. A water level controller maintains the constant level of condensate in the sink, by means of condensate recirculating and overflow control.

(c) Air exhaust system (vacuum system)

The water ring sealed vacuum pump system provides the de-aeration of the condenser. The cooling is ensured from the cold branch of cooling water circuit.

(2) Feed Water Heaters (see Figure 4.1.2 for circuit diagram)

The turbine is provided with 7 extraction taps which are used for heating 2 high pressure feed water heaters, 1 mixing type pre-heater and 4 low pressure feed water heaters. Two heat exchangers used for district heating are also supplied with steam from these extraction taps, with 50 MW heat output to the district heating hot water system. The steam supply to the district heating heat exchangers can be implemented through alternating valves, even by using more than one extraction at the same time.

Both the low pressure and high pressure feed water heaters are designed with U-pipes arranged horizontally in order to meet the operational and maintenance requirements.

Number of low pressure feed water heaters: 4
Number of high-pressure feed water heaters: 2
The tray type de-aerator serves as low pressure mixing feed water heater.

(3) Lubrication and Regulator Oil System

- Oil tank with auxiliary pump and shaft lifting pump
- Main oil pump
- Auxiliary oil pump
- Emergency oil pump
- High-pressure regulator oil pump
- Lubrication oil system
- Regulator oil system
- Oil filter and cooler system
- Oil centrifuge

The turbo-generator unit uses the common lubrication system which serves the turbine system. The lubrication system is common to the regulator and shaft lifting oil system.

The main oil pump is directly driven from the turbine shaft. The auxiliary pumps and shaft lifting pumps that usually operate during start and stop are driven by AC motors while the emergency oil pump put into service during operation troubles are driven by DC motors. The lubrication system also includes the oil reservoir, the oil cooler, filtering and heating equipment as well as the oil centrifuge. The high pressure regulator oil pumps supply the high pressure oil necessary for the operation of electro-hydraulic control and safety system.

Details of lubrication system is shown in Figure 4.4.3, the shaft lifting system is shown in Figure. 4.4.4, and the regulator oil system is shown in Figure. 4.4.5.

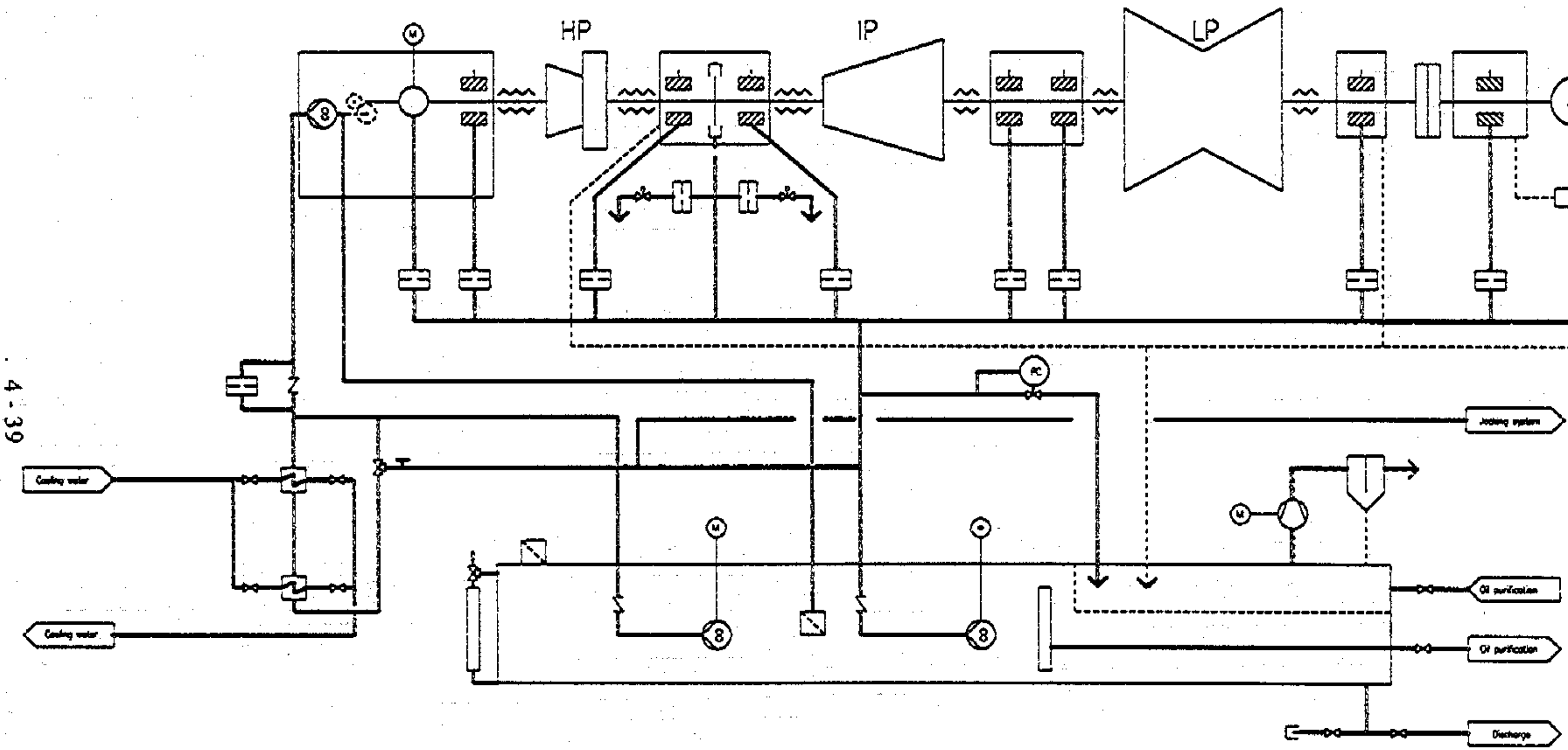


Figure 4.4.3 Lubrication System

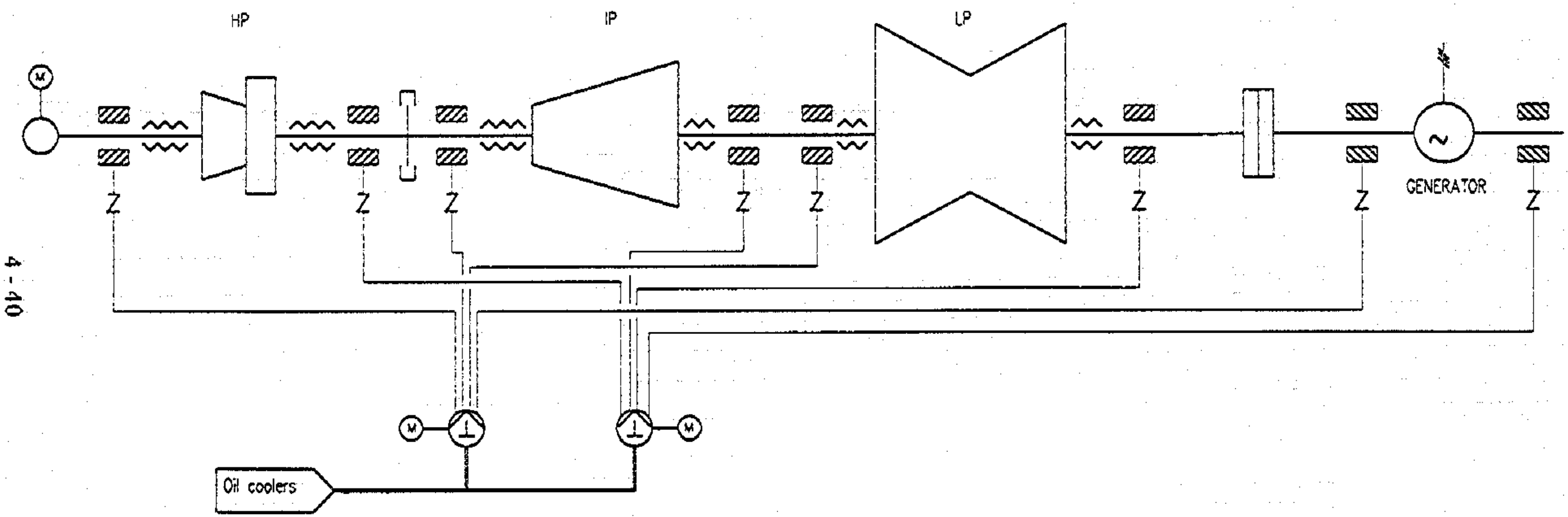


Figure 4.4.4 Rotor Shift System

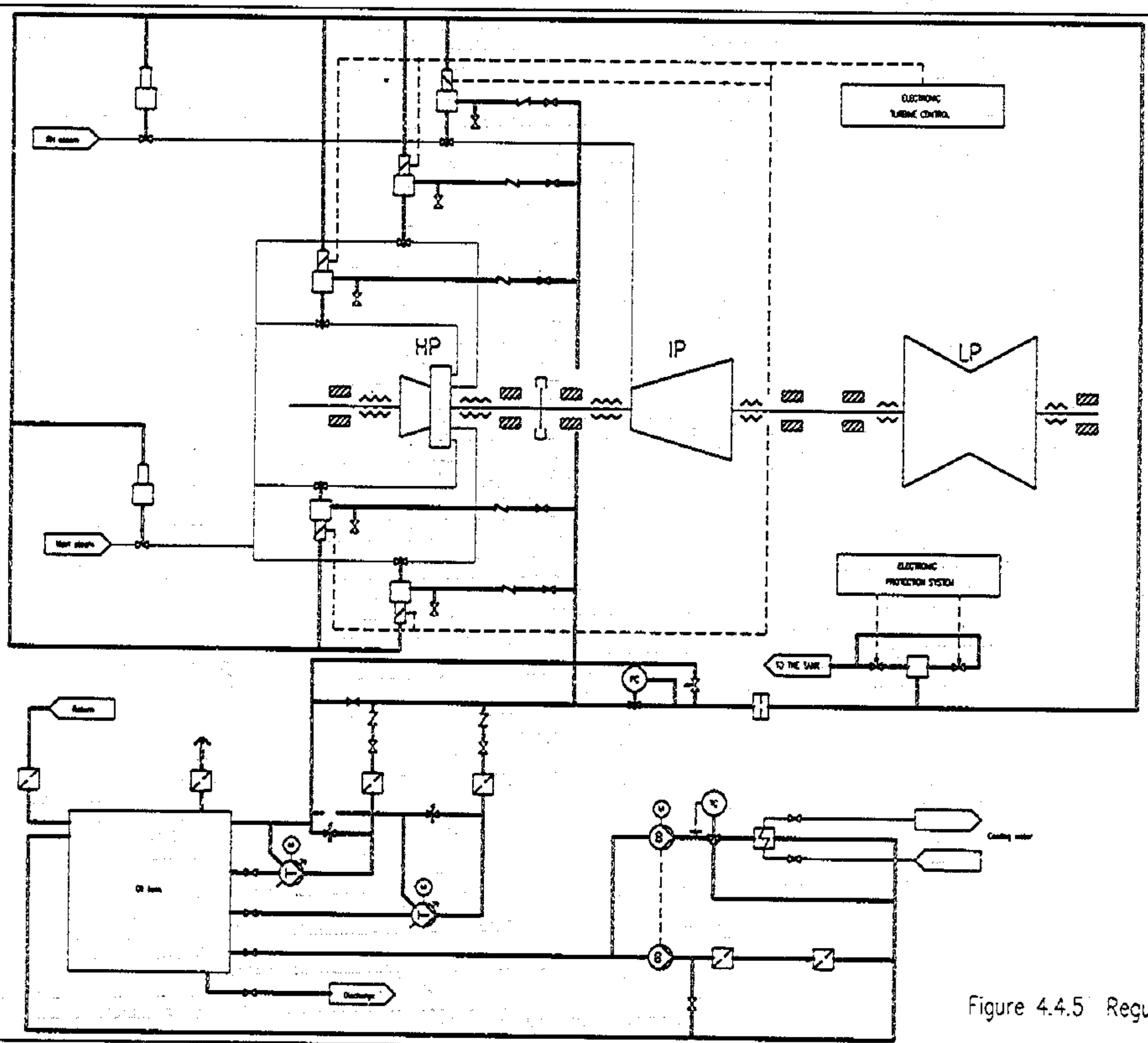


Figure 4.4.5 Regulator Oil System

(4) Steam Turbine By-pass System (see Figure 4.1.2 for flow diagram)

The high-pressure and low-pressure by-pass system is installed for the following reasons:

- improving the starting parameters of the unit
- protecting the boiler in case of emergency stop of the unit
- ensuring steam output in case of steam turbine failure

(5) Condensate Pump

Multi-stage pumps are mounted below the condensate level in the sink. It is specifically designed for removing condensed water from the condenser.

Type : Vertical, multi-stage with inlet filter
Capacity : 100% of the desired quantity of condensate

In order to achieve high safety level of the unit, two pumps will be installed. The pumps are of proper material quality with a low NPSH value.

(6) Stuffing Box Steam Condenser

One stuffing box steam condenser is required. The stuffing box steam system is shown in Figure. 4.4.6.

It serves for limiting and utilizing the steam escaping through the shaft bushings as well as for protecting the spaces under vacuum against air intrusion. Condenser will be cooled by condensate.

(7) Air Exhaust System (Vacuum System)

In regard to initial investment and operating costs as well as availability and reliability, the use of water ring sealed vacuum pump system is recommended.

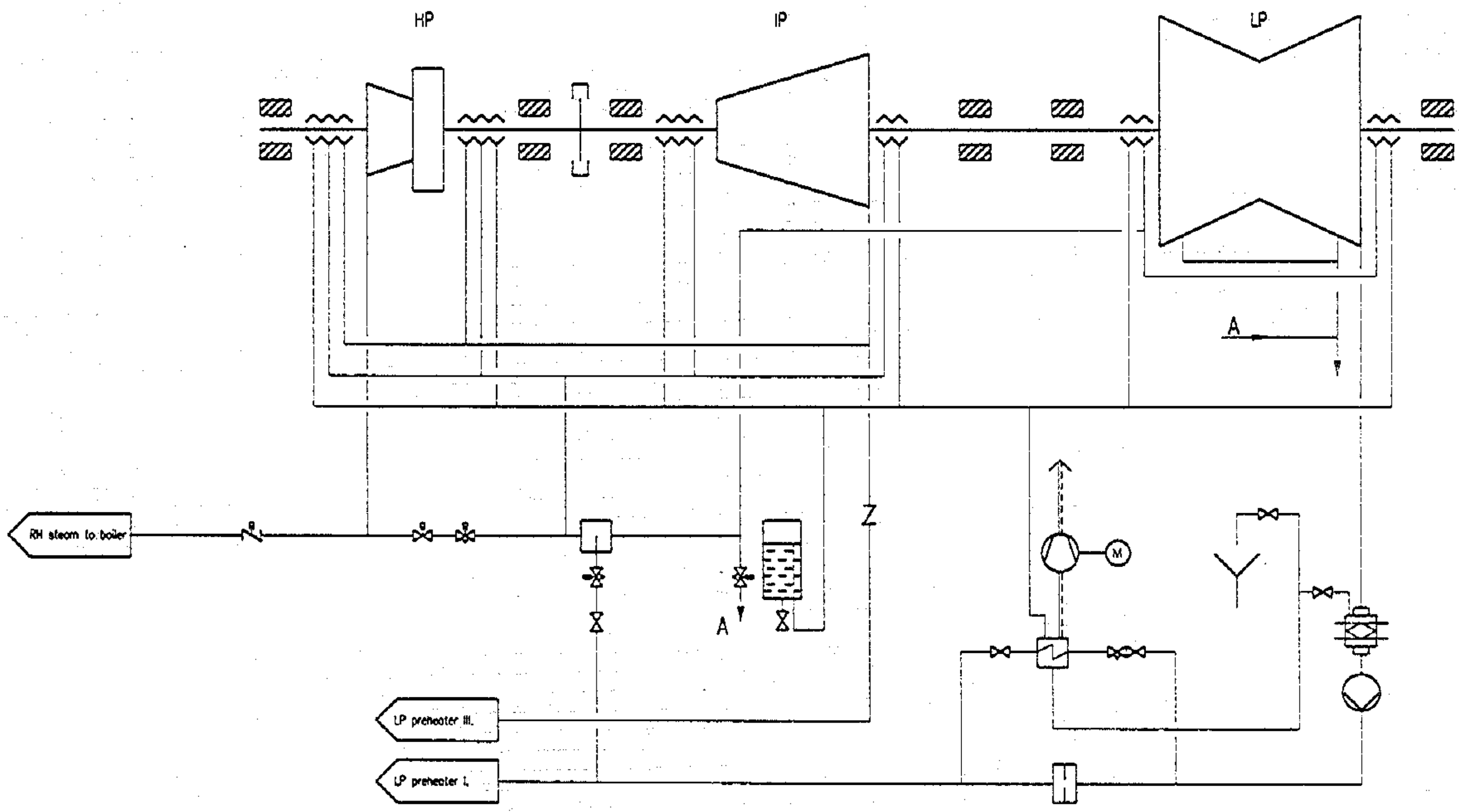


Figure 4.4.6 Stuffing Box Steam System

4.5 Fuel Supply and Handling System

4.5.1 Coal Supply System

(1) Outline

1) Coal consumption

The maximum coal requirement of the Power Plant is as follows:

• Boiler load	1 x 460	t/h	
• Heat input with fuel	382	MWth	
• Coal consumption	103.2	t/h	(2,477 t/d)
Borsod brown coal	76.4	t/h	(1,834 t/d)
Import hard coal	26.8	t/h	(643 t/d)

2) Capacity of coal transporting facility

The nominal delivery capacity of the existing coal system is 450 t/h, but its components (other than the grabbing bridge crane) can handle up to 600 t/h. The equipment is suitable for another 30 years of service only upon full renewal.

For determining the delivery capacity, the following conditions shall be applied. Operating time: eight hours, Efficiency: 75%, Therefore, the delivery capacity necessary for the coal handling system is calculated as follows.

$$(24 \text{ h} \times 103.2 \text{ t/h}) / (0.75 \times 8 \text{ h}) = 413 \text{ t/h}$$

On the above basis, transporting capacity is determined at 600 t/h.

The bunker charging times will be as follows:

$$(24 \text{ h} \times 103.2 \text{ t/h}) / (0.75 \times 600 \text{ t/h}) = 5.5 \text{ h}$$

In this case the 600 t/h transporting capacity seems to be excessive, but as the total capacity of the bunkers of the new boiler allows 20 hours of continuous operation, the 600 t/h delivery capacity enables single-shift charging, which may result in labor saving.

The coal handling system in its present condition is not suitable for 30 years of further operation without renewal. However, renewal to a capacity of 600 t/h instead of 450 t/h costs only a few per cent more, while system safety improves.

3) Quality of mixed coal

The new CFB boiler is not too sensitive to the homogeneity and heating value fluctuation of the charged coal. It is important to know, however, the sulfur content of the coal mixture at all times.

4) Coal storage

Storage must take place at the Berente grading plant. There is no sufficient space for it on the premises of the Power Plant.

5) Required days of coal reserve

Power Plant coal stockyard: 30 days
External coal stockyard: 60 days

6) Daily storage capacity of the coal bunkers in the boiler house

The net volume of the coal bunkers of the boiler type that will probably be installed is 650 m^3. Assuming a bulk density of 0.8 t/m^3, this enables the storage of 520 t of coal in each bunker. So, the total storage capacity of the bunkers of the new boiler is

$$4 \times 650 \; m^3 \times 0.8 \; t/m^3 = 4 \times 520 \; t = 2,080 \; t$$

In maximum output operation, this capacity is 4 x 520 t / 103.2 t/h = 20 hours of continuous service without recharging.

(2) The Rating Data of the Coal System

On the basis of the above theoretical data, the requirements against the coal receiving, storage and feeding system are the following:

1) The existing parts of the coal system require full renewal, but such renewal can make them fit for 30 years of operation. Renewal practically means the replacement of all mechanical elements, but the conveyor frame structures, the crane bridge and the conveyor bridges can still be used upon if adequately maintained (derusting and corrosion protection). Unlike the capacity of grabs, the capacity of conveyor belts can easily be increased to 600 t/h by changing the driving heads (which is necessary anyway).

2) Calculations show that conveyor belts Nos. 1, 2, 3, 4, 5, 6, 7 and 8, which constitute the main delivery route for brown coal, can currently achieve the capacity of 600 t/h, but in order to provide a uniform strength to the delivery system, the capacity of discharge conveyors Nos. 11 and 16, which are on the crane bridge, must be raised to 600 t/h. Interrelated conveyor belts within a transport system must have equal capacities, otherwise materials may overflow at points of transfer. By renewal, the existing conveyors of the grabbing bridge can be enabled to handle the increased discharge capacity. It is not reasonable to raise the capacities of the rest of existing conveyor belts: conveyors Nos. 9 and 10 only serve two stand-by wagon tippers on the Power Plant's premises, and conveyor belts Nos. 12, 13, 14 and 15 are used for discharging the bucket cars of the grabs which still have a total capacity of 320 t/h.

3) The 320 t/h pickup capacity of the crane bridge is not sufficient, therefore feeding capacity from the stockyard within the Power Plant's fences has to be increased by installing a pickup system that is independent of the grabbing crane. The Study Team rated the capacity of the pickup system to 600 t/h, in order that it can perform delivery also independently, without the operation of grabs.

4) Import coal and brown coal mixing is made during feeding, by adding hard coal to the brown coal arriving on the belt conveyor. Based on 16 hours of charging time and 75% transporting efficiency, required hard coal transporting capacity would come to 112 t/h. In order that import coal delivery should not reduce mixed coal delivery capacity, the pickup and charging system is rated at 400 t/h. This can assure that the hard coal stockyard can occasionally be used for storing brown coal as well.

5) Due to its low volatile matter content, hard coal is not flammable, maintains quality, and can be stored for a long of time. During long periods of storage and great droughts, however, it must be watered to avoid sparking and dusting. For its high volatile matter content, brown coal is flammable and its heating value diminishes in function of storage time. Without compacting, it cannot be stored for long.
Mixtures of various (hard and brown) coal types cannot be stored, because they are extremely flammable.

6) For the separate storage of different quality coal types, two areas have to be taken into consideration:

   a) The current active and passive coal stockyards on the Power Plant's premises, where about 260,000~300,000 m^3 of coal can be stored.

b) The current auxiliary coal storage area of the grader, situated outside the Power Plant's premises, between the rail track and the road to the grading plant, where 150,000~180,000 m^3 of coal can be stored.

7) In the above stockyards, different quality coal types are stored in the following way:

a) Brown coal is stored at the Power Plant's existing stockyards, of which the internal active stockyard can accommodate about 70,000~80,000 t of loose condition brown coal and the external passive stockyard can store some 140,000~160,000 t of compacted brown coal, making up a total of 70~90 days' reserve of average quality Borsod coal.

b) About 120,000~150,000 t of import coal is stored in the area of the grading plant and it constitutes a 180~230 days' stock.

8) The composition of brown coals is continuously checked in the grading plant. For the inspection of the net heating value of brown or mixed (import and brown) coals, the sampler between belt conveyors No. 1 and 2 is used. For the checking of import coal quality, a sampler should be installed in the new railway receiving system.

9) The net heating value and ash content of the incoming coal are defined by the laboratory of the Power Plant. The coal samples required for the tests are provided by automatic samplers which are built into the transport system at several points.

10) As far as present knowledge goes, there is no equipment that could continuously measure and analyze the sulfur content of coal during handling, therefore sulfur content evaluation for defining the approximate amount of limestone powder to be added is made by calculation, based on source of supply and coal mixture proportion details.

11) The coal particle size that is suitable for feeding the used boiler types is 0 ~20 mm. For Borsod brown coals, this size is now provided by the grading plant and in case of imported hard coal, comparable fractions must be delivered to the site.

12) For the reception during the summer months of a coal quantity equal to the full capacity of the hard coal stockyard, a 2,000 ~ 2,500 t/d railway reception capacity is necessary. Assuming a discharge time of 12 hours with a 75% transporting efficiency, this requires a minimum of 320 t/h discharging capacity.

13) The delivery capacities of the Power Plant's planned coal handling system by the main transporting routes are the following:

a) From the 600 t/h discharge capacity 2 x 100 t wagon tippers to the external import coal stockyard: 600 t/h

b) From the coal stockyard of the import coal pickup and transport system to the vibrating charger of the feeder bunker: 400 t/h

c) The existing transport system from the grading plant to the boiler daily bunkers: 600 t/h

d) The passive brown coal stockyard pickup and transport system from the conveyor to the boiler daily bunkers: 600 t/h

e) The discharge system of the coal stockyard loading bridge: 600 t/h

f) The active brown coal stockyard pickup and transport system on the bridge of grabbing cranes (unchanged): 320 t/h

g) From the 40 tons + 40 tons stand-by wagon tippers on the Power Plant's premises to the point of transfer to the existing transport system: 320t/h

(3) Receiving of the Coal

1) The Power Plant receives the coal basically by conveyor belt from the coal grading plant, although direct railway reception and even road truck delivery through the grabbing bridge storage - pickup system are also possible. However, because of their limited capacities, these latter are only practicable in cases of emergency. This is especially true for railway reception which is based on two 40 tons front tippers and is only suitable for two-axle front tipper railway wagons. Since the already limited capacity of the rail track system around the area will be loaded by limestone trains all the time, this way of coal reception can really be considered only as a response to future emergency (e.g. delivery by truck) and should be reserved for that.

2) Coal can arrive at the grading plant outside the Power Plant's premises on several routes:

a) by the operating cable-way from Lyukóbánya,
b) by rail to the receiving system of Berente railway station,
c) by tipping road trucks through the receiving bunkers.

3) The railway receiving system of the grading plant consists of five 2 x 50 tons capacity twin front tippers which are partly in proper working condition, partly renewable. The discharge capacity of six 29 tons /wagon/tipper/hour means that the necessary capacity is already available with two wagon tippers. Quantitative acceptance of coal arriving by two-axle railway wagons is possible with the officially certifiable railway weigh-bridges of the grading plant and truck consignments can be weighed by a road weigh-bridge. For the agitation of coal frozen or stuck into the railway wagons, 2 wagon cleaners are in service, of which one is used for two tippers.

4) Unfortunately, the existing front tippers are able to receive only two-axle 29 t load capacity railway wagons, or four-axle side tipper wagons the doors of which open in pairs. As imported coal may also come from Poland and the Czech Republic, reception capability must be installed for the four-axle wagons used in international traffic. By MÁV those two-axle front tipper wagons will be available for domestic purposes on the long term - including for coal transportation from the CIS countries with transloading in Záhony - although many of them have been recently scrapped. In the future MÁV will only buy four-axled wagons, mostly with front tipping, although under long term contracts with forwarders they are also willing to buy special-bodied (e.g. gravity side-discharge, open Fal or Fad type and closed Tals type) wagons of which they have only a limited number now. It must be reckoned with that both front tipper and gravity self-discharge wagons will be used in international traffic. The doors of most latter type wagons are opened centrally, therefore their contents cannot be discharged into the short bunkers of the wagon tippers in the existing grading plant.

5) For the above reasons, even though it is not justified by any need for capacity extension, the 2 x 50 tons wagon tipper No. VI shall be replaced and located on track V of the Berente coal grading plan with a 2 x 100 tons combined twin front tipper with a 450~600 t/h average operational capacity and a discharge bunker that can also receive gravity self-discharge wagons. Therefore, the wagon tipper and the related 600 t/h capacity discharge system will be able to receive any kind of wagons and a new, more modern mechanism will considerably increase operational safety on the long term.

6) For the time after the renewal, we designated the existing wagon cleaner for the agitation of coal eventually frozen into the wagons.

7) For the quantitative acceptance of coal arriving by new four-axle railway wagons, it is necessary to install a 120 tons capacity railway weigh-bridge in the wagon tipping area of the grading plant's railway station.

(4) Storing, Mixing and Transport to the Boiler

The layout of the coal handling system is shown on Figure 4.5.1 and the flow diagram of the coal receiving, storing, mixing and handling system is shown on Figure 4.5.2. The equipment list of the coal handling system is contained in Tables 4.5.1~ 4.5.2.

1) Outlines of the storing, mixing and transporting system

a) Berente coal grading plant, with its several well structured, interconnectable coal lines, is fit for making coal mixtures of the received coals in almost any composition. In case of using Borsod coals only, the present technology is suitable for the adjustment of coal quality, therefore, this study will hereinafter deal mainly with the questions of receiving and grading import coal.

b) The coal grading plant has all the technical conditions required for the mixing of arriving import coals, and its well equipped railway station make it the most reasonable place for coal reception. However a need may arise for blending domestic and import coals also there. Unfortunately, this is only partly feasible for the following reasons:

i) Mixtures of different (brown and import hard) coal types cannot be stored, such mixtures must be immediately delivered to the boilers.

ii) Due to the extreme fluctuation and seasonal peaks in supply, it must be possible to receive and store brown and import coals separately at the same time. For the delivery of a coal mixture, the supply of one coal type cannot be adjusted to the supply schedule of another.

iii) Since there is no mechanized stockyard on the grading plant site, the currently used external auxiliary area could be a possible place for it. The retransfer of the coal from here to the grading plant is not reasonable.

iv) In the mine - grading plant - power plant chain, only the Power Plant has a proper (mechanized) coal stockyard, from where coal can be delivered only to the boilers and not back to the grading plant.

v) The new unit must be supplied with a mixture of domestic and import coals.

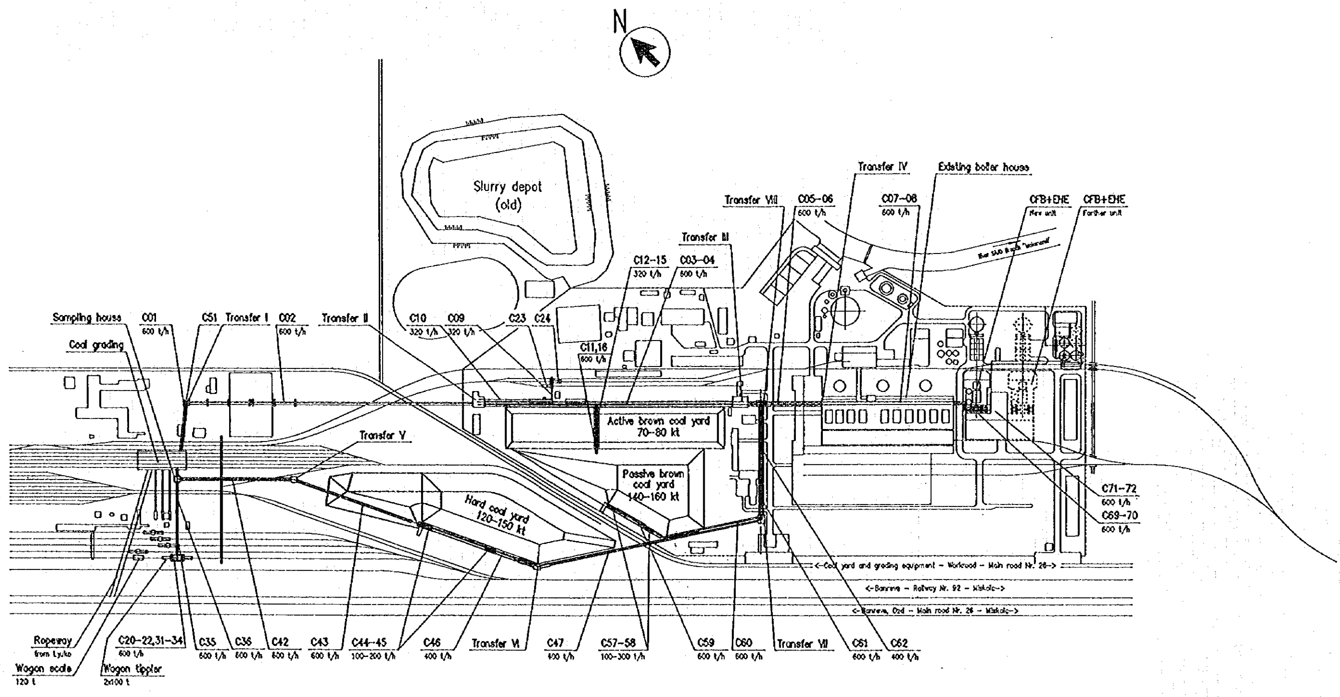


Figure 4.5.1 Coal handling system layout

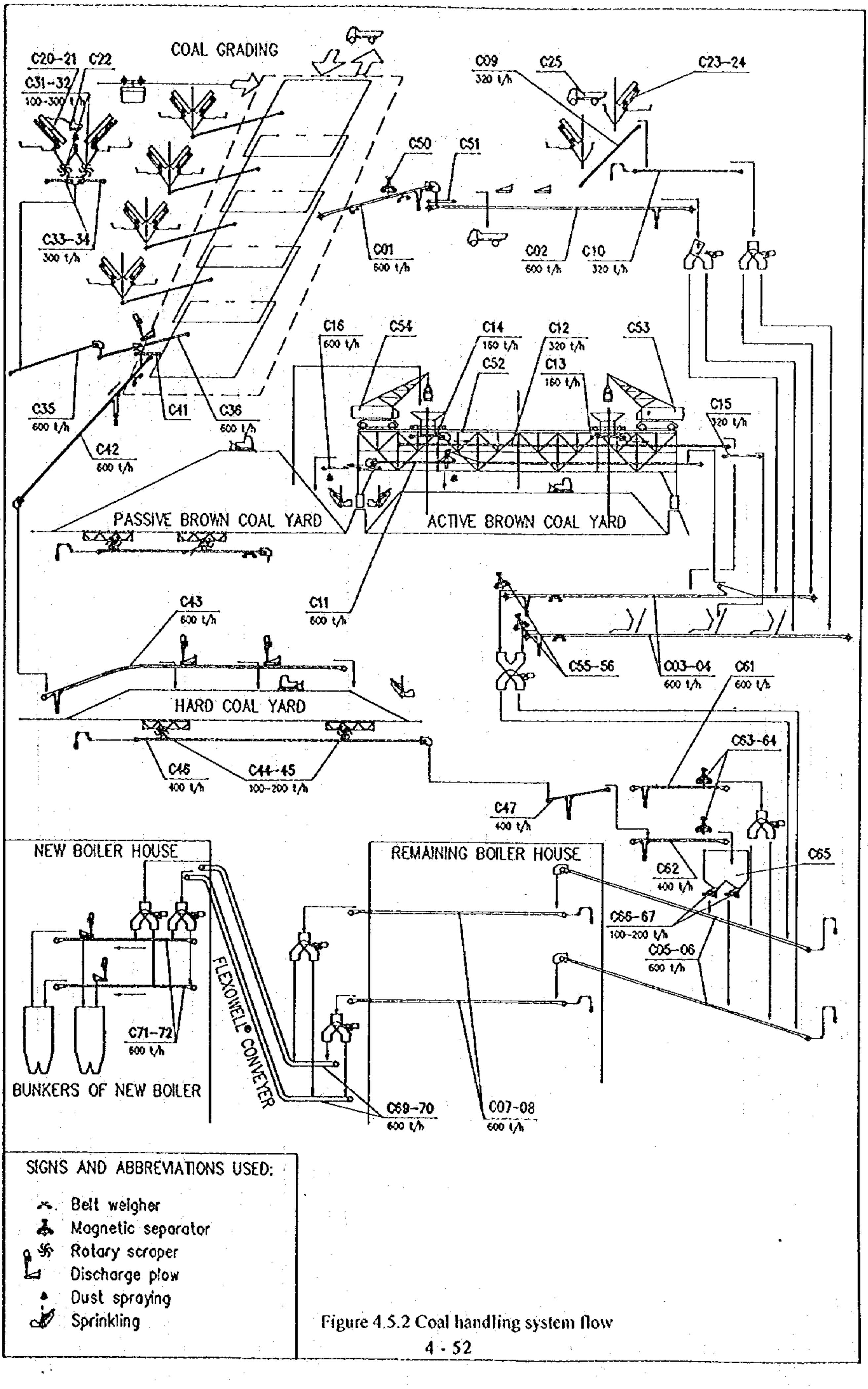


Figure 4.5.2 Coal handling system flow

Table 4.5.1 List of Equipment and Objects for Coal Handling System (1)

Unit	Code	Equipment or object	Quantity pcs	Type	Technical data				Installed Capacity kW 4105	Condition
					Capacity t/h	B mm	L m	H m		
Wagon tripplers										
	C20, C21	Twin type wagon trippler 2x100t	1	Hydraulic	600				140	New
	C22	Agitating equipment	1	Grab bucket type					58	To be renovated
	C23, C24	Wagon trippler 40+40t	2		320				90	To be renovated
	C25	Unloading grate for trucks	1							To be renovated
Internal coal feeding										
	C09	Belt conveyor	1	Steel apron type	320	1400	20	2.5	20	To be renovated
	C10	Belt conveyor	1	Belt type	320	1000	107	16.8	45	To be renovated
Feeding to the coal grading equipment										
	C31, C32	Fix scraper	2		100-300				44	New
	C33, C34	Belt conveyor	2	Belt type	300	1000	4.4	0	110	New
	C35	Belt conveyor	1	Belt type	600	1000	45	8.8	45	New
	C36	Belt conveyor with discharge plow	1	Belt type	600	1000	83	23	95	New
Hard coal unloading										
	C41	Sampling and preparation	1						15	New
	C42	Belt conveyor with scale	1	Belt type	600	1000	162	3.6	56	New
	C43	Belt conveyor with discharge plows	1	Belt type	600	1000	350	7.3	100	New
Hard coal feeding										
	C44-C45	Moving scraper	2		100-200				50	New
	C46	Belt conveyor	1	Belt type	400	1000	172	0	37	New
	C47	Belt conveyor	1	Belt type	400	1000	322	13.5	78	New
	C62	Belt conveyor	1	Belt type	400	1000	164	17.3	90	New
	C63, C64	Magnetic separator	2						15	New
Brown coal receiving										
	C01	Belt conveyor with scales	1	Belt type	600	1000	93	0	39	To be renovated
	C50	Magnetic separator	1						7.5	To be renovated
	C51	Sampling and preparation	1						15	To be renovated
	C02	Belt conveyor with discharge plows	1	Belt type	600	1000	397	4	100	To be renovated
Brown coal deposition/gathering										
	C52	Grabbing cranes's bridge	1						160	To be renovated
	C53, C54	Grab trolley (6,3m3 each)	2		160				190	To be renovated
	C12	Belt conveyor	1	Belt type	320	1000	44	0	22	To be renovated
	C13, C14	Scraper belt	2	Steel apron type	160	800	4.5	0	22	To be renovated
	C15	Belt conveyor	1	Belt type	320	1000	3	0	2	To be renovated
	C11	Belt conveyor	1	Belt type	600	1000	51	0	30	To be renovated
	C16	Belt conveyor	1	Belt type	600	1000	9	2.5	11	To be renovated

Table 4.5.2 List of Equipment and Objects for Coal Handling System (2)

Unit	Code	Equipment or object	Quantity pcs	Type	Technical data				Installed Capacity kW	Condition
					Capacity t/h	B mm	L m	H m	1209	
Brown coal feeding										
	C03,C04	Belt conveyor with discharge plows	2	Belt type	600	1400	379	0	193	To be renovated
	C55,C56	Magnetic separator drum	2						15	To be renovated
	C61	Belt conveyor	1	Belt type	400	1000	164	17.3	55	New
Coal blending										
	C65	Blending bunker	1	Steel structure	80m3					New
	C66, C67	Vibrating feeder	2		100-200				20	New
Feeding to the boiler house										
	C05, C06	Belt conveyor	2	Belt type	600	1000	113	36.6	264	To be renovated
	C07, C08	Belt conveyor	2	Belt type	600	1000	190	0	180	To be renovated
	C69, C70	Belt conveyor	2	Case type	600	1200	12	25	264	New
	C71, C72	Belt conveyor with discharge plows	2	Belt type	600	1000	40	0	40	New
Auxiliary plants, equipment and buildings										
		Local vacuum cleaner	47		300				100	New
		Dust retention: spraying and spinkling	3						35	New
		Motor-driven lifting tackles	8						28	New
		Hand-operated lifting tackles	6						15.4	New
		Sampling house	1			5.2	5.2	16		New
		Conveyor bridge	1				156	0		New
		Transfer building V.	1			6.4	6.5	10		New
		Conveyor bridge	1				346			New
		Water treatment building	1			6	6.5	13		New
		Conveyor bridge	1				292			New
		Transfer building VII.	1			5.9	8.2	9.6		New
		Feeding hopper	1							New
		Transfer building VIII.	1			7	6.7	21.5		New
		Inclined conveyor bridge	1				26			New
		Twin type conveyor bridge	1				155			New
		Conveyor bridge	1				32			New

Therefore, import coal must be also added to the brown coal stored on the Power Plant premises. This blending must be performed immediately before delivery to the boiler house.

Consequently, the blending of brown and hard coals is not expected to take place exclusively in the grader. Domestic and import coals can be mixed there only to the extent of immediate delivery. On the other hand, it is practical to maintain the coal blending function of the grading plant also in the future, because this can enable the blending and homogenization of brown coals originating from various sources of supply (possibly from other Hungarian mines).

2) Coal storing, grading and transport system

On the basis of the above, a system had to be designed which is able to prepare the right mixture both in the event of continuous external supply and in the case of transporting stored coal.

a) If import coal arrives to the new wagon discharger in the railway station of the grading plant together with domestic coal, a part of it can be directly mixed with domestic coals (50-50%) and can be transported to the daily coal bunkers of the old Power Plant and of the new unit belt by conveyors C01, 02, 03, 04, 05, 06, 07, 08 and C69, 70, 71, 72, respectively. As the amount of import coal that can be mixed and delivered immediately is considerably less than the wagon discharging capacity, discharging should not be delayed by mixing. Excessive amounts of import coal can be discharged to the external hard coal stockyard by belt conveyors C41, 42, and 43.

b) If the grading plant is fed with domestic coal only, then belt conveyors C01, 02, 03 and 04 can transfer it to belt conveyors C05 and C06. Upon continuous measuring of the amount of brown coal transferred, the adjustable capacity chargers of the hard coal bunker above these conveyors feed them with hard coal to an extent adequate to the predetermined composition of the mixture. The mixture so made is forwarded to the daily coal bunkers of the old unit and of the new unit via belt conveyors C07, 08 and C69, 70, 71, 72, respectively. The mixing of the coal takes place at the points of transfer, at charging to the daily coal bunkers of boilers and in the mills.

It is to be noted here that due to the installation of the new boiler, neither the routing nor the level of the existing coal bunker charging conveyors (C07-08) correspond to those of the bunker charging conveyors (C71-72) of the new boiler. The horizontal distance between routings is about 10 m and levels are 15 m away from each other. The problem caused by such narrow space can be only solved by a bucket elevator or sectional belt conveyor. Since coal is more likely to stick into the rigid-wall elevator buckets, and carries a higher risk of operating trouble than a sectional belt, and a sectional belt can provide the required delivery capacity with a smaller structure, we have chosen this latter, more up-to-date solution. Of course, the sectional belt conveyor will operate in a closed casing, similarly to a bucket elevator, therefore the risk of contamination will be minimal. Accordingly, conveyors C69-70 will be so-called sectional belt conveyors.

c) If there is no need for the immediate transport of arriving coals, then domestic coal can be directed either to the active brown coal stockyard by belt conveyors C01, 02, 03 and grabbing crane bridge conveyor C11, or to the passive brown coal stockyard by belt conveyor C16 which can be put on duty.

d) If delivery to the boiler house must be provided from the coal stockyards, then brown coal,

   i) can be picked up by grabbing cranes C53 and 54 from the active coal stockyard to belt conveyor C12 which transfers it to belt conveyor C03 or, by auxiliary belt conveyor C15, to belt conveyor C04, from where it can be directed through a cross-chute to belt conveyor C05 or C06 on the one hand, and

   ii) can be transported from the passive coal stockyard by variable capacity scraper conveyors C57 and 58 to conveyor C59, and then by belt conveyors C60 and C61 to belt conveyors C05 or C06 again, on the other hand.

e) Import coal can be picked up to belt conveyor C46 also at the external coal stockyard by mobile scraper conveyors C44 and 45, from where it is transported to the feeder bunkers above belt conveyors C06 and 06 by conveyors C47 and C62. In order to avoid frequent stops and restarts of the conveyor system, the capacity of each scraper conveyor is adjustable between 100~300 t/h.

With the above described discharging, storing and handling systems, various versions of coal reception, coal storage and coal handling can be implemented, including a number of combinations thereof. Only parts of the handling system are duplicate (the equipment transporting to the boiler house), but with the simultaneous operation of certain sections not only the handling capacity can be increased but it is also possible to transport coal from two different locations at the same time or to transport coal from one place to two destinations.

The delivery routes as a whole can provide a steady coal supply to the Power Plant, even if any of them breaks down. In case of emergency, it is also possible to deliver both brown and hard coal by road, through the existing wagon tipper bunkers and the handling system of the Power Plant. It is not necessary to develop any additional routes.

It suggest that the common bridge of belt conveyors C61 and C62 should be constructed with two conveyors for possible future extension. Using the coal handling system, the Power Plant can supply with the equipment already in service for 30 years in the future. Borsod Power Plant can supply with brown coal for 30 years in future, using this coal conveying system.

(5) Instrumentation and Control

1) CFB boiler is not sensitive to the net heating value of charged coal, but it is very important to know its sulfur content. Therefore, coal analysis has to be performed at the supplier's side and its results must be attached to the bill of the coal consignment. For the verification of the documented quality, samples can be taken at two points: after the new wagon tipper, and after discharging from the wash-house to conveyor No. C2. Such coal samples must be analyzed in the Power Plant laboratory by tests prescribed by the related standards and in the boiler manuals (composition, combustibles, sulfur content, heat equivalent, etc.) as well as by delivery lots CFB.

2) Coal supplied by railway is weighed by railway weigh-bridges in the area of the wagon tippers, and coal delivered from the grading plant to the Power Plant is measured by conveyor scales. The details of measurements are recorded in the weighing-houses and control rooms.

3) Further conveyor scales are in place to prevent the overloading of conveyors, as well as to control the blending of different quality coals by heating value. These scales are in constant, mutual connection with the control room computer.

4) The scales incorporated in the coal reception and handling system fulfill all the measuring, controlling and checking functions related to coal quantity. The reliability of the legally effective measurements is insured by the plus-minus 0.5%-1.0% measuring accuracy of the conveyor scales, guaranteed in the informative

offers of suppliers. The data provided by the conveyor scales, which can be regularly verified against the calibrated railway scales, will be suitable for financial settlements between companies or divisions in the future, too.

(6) Environmental Protection

1) The dust emission of the coal handling system is prevented by local hose-filter exhausters, mounted directly on the cross-chutes at points of transfer. The automatic cleaning of the filters is done by compressed air blow-down. The removed dust falls back to the belt conveyor, therefore the hoses do not require any particular treatment or emptying.

2) At places of open air coal transfer (wagon discharging, delivery to coal stockyards) diffuse dust emission is limited by a fine sprinkle system. The dust source is surrounded by a hermetic, atomized water curtain produced by spraying heads that are automatically interlocked to the actual operational condition, preventing dust emission to the environment. The application of dust retention sprayers fed by heated pipelines is recommended at three places within the coal stockyards: at the 2 x 100 tons wagon tipper of the grading plant in the future; at the two belt scrapers and belt conveyor end in the hard coal stockyard; and at the belt conveyors which discharge coal from the middle of the grabbing crane and from the end of the crane bridge.

3) The dusting of the discharged coal in dry and windy weather can be effectively reduced by the wetting of the surface of coal piles with a rotary head sprayer. If necessary, both the hard coal stockyard and brown coal stockyard can be sprayed by high-pressure spraying heads positioned in even distribution.

4) The belt conveyors and forwarding equipment of the coal handling system operate indoors, except for the belt conveyors of the brown coal stockyard crane bridge. Consequently, noise sources are in closed rooms, therefore indoor noise level regulations are applicable. This level may not exceed 85 dBA at the transfer chutes and 80 dBA elsewhere, the enclosures are made accordingly.

5) The inflow to the ground-water of coal dust that is washed off by precipitation in the coal stockyards must be prevented by a drain ditch system around the stockyards and by a sedimentator. The water accumulating from time to time in the water collection sumps of the structures must be discharged to this sedimentator by slurry pumps.

4.5.2 Natural Gas and Fuel Oil Supply System

(1) Natural Gas Supply System

The boiler is provided with the necessary quantity of ignition- and supporting burners of necessary capacity each, as well as gas nozzles of total capacity according to the MCR. For the fuel supply to both the ignition- and supporting burners, natural gas and FA 60/80 fuel oil supplying the existing boilers in the Power Plant are available.

The rated capacity of the existing gas supply system amounts to 15,000 Nm^3/h. This is insufficient to cover the increased demand, therefore, two more new gas receiving stations - gas pressure reducers and meters - of unit capacity equal to that of the existing one will be established, accommodated in steel plate cabinets. Thus, the total capacity of the expanded system will be 45,000 Nm^3/h, sufficient to cover the heat demand without coal- and oil firing, or to operate the new unit at its rated power purely with natural gas firing. In this case, the gas demand will be about 41,000 Nm^3/h.

In addition to the boilers, the limestone drying equipment also requires a small quantity of natural gas.

Natural gas receiving station

Type: pressure reducer and meter, accommodated in a steel plate cabinet
Capacity: 15,000 Nm^3/h
Quantity: 2 units

Flow diagram of natural gas supply system is shown in Figure 4.5.3.

(2) Fuel Oil Supply System

For the purpose of supplying the ignition burners (unit capacity equal to 15% of MCR) and oil burners (unit capacity equal to 30% of MCR) of the new boiler during gas supply shortage periods as well as to ensure the fuel oil supply to the existing boilers, two fuel oil reservoirs of 2000 m^3 and 1000 m^3 capacity, respectively, sufficient to cover 5 days of operation will be established. The fuel oil type to be stored is FA 60/80 fuel oil with a low sulfur content, and a pour point at -20 C°. No heating for the reservoir shall be provided.

The fuel oil is transported by railway. Two drain pumps installed at the four-post railway unloading station will discharge the oil through the filters into the vertical cylindric tanks.

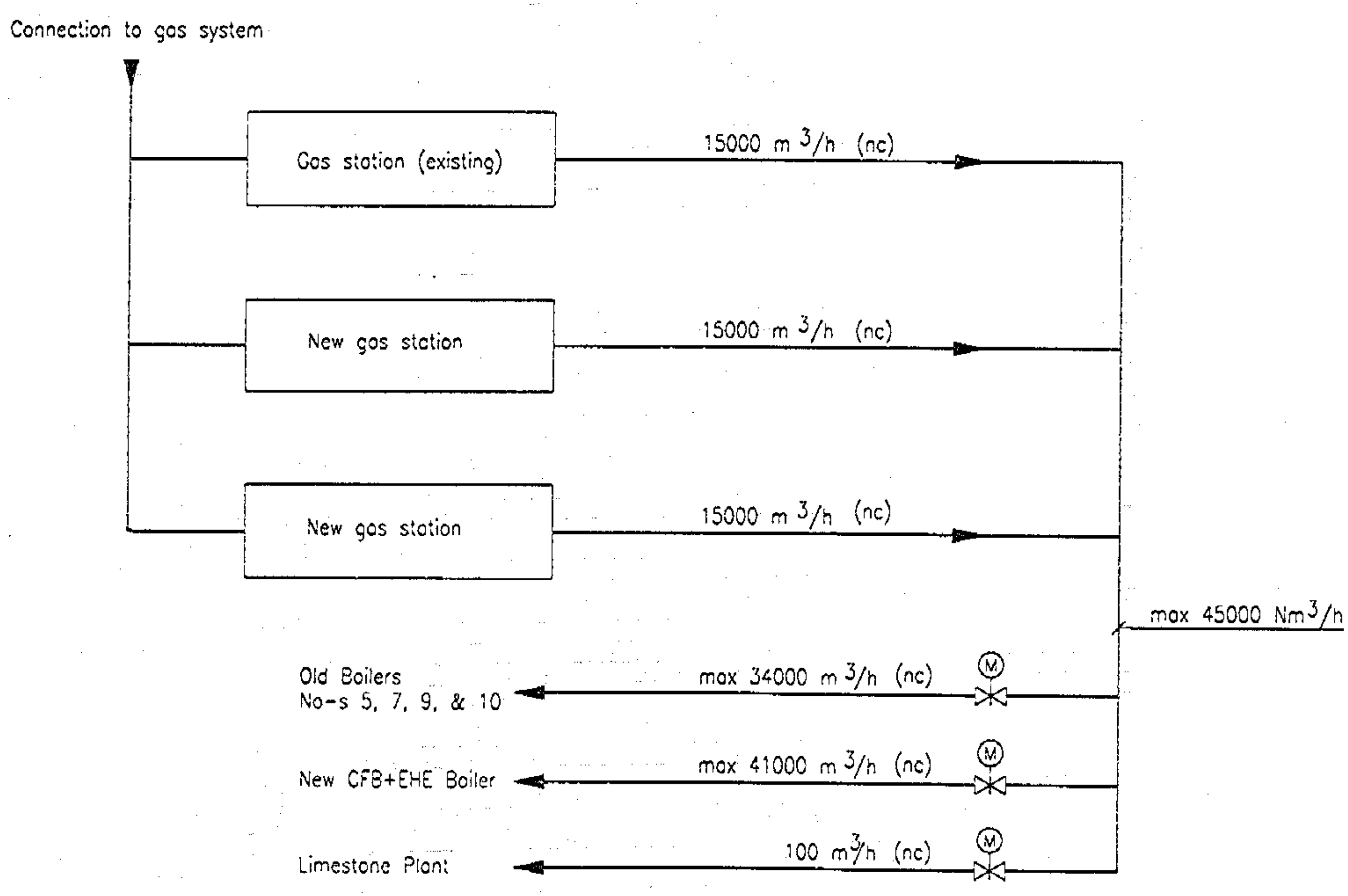


Figure 4.5.3 Natural gas supply system

From the tanks, two transfer pumps provided with inlet filters deliver the oil to both the existing boilers and the oil consumers of the new unit. One of the pumps is in a standby mode.

1) Fuel oil storage tanks

i) Type : Vertical, cylindric, double bottom, outdoor type
Capacity : 2,000 m^3
Quantity : 1

ii) Type : Vertical, cylindric, double bottom, outdoor type
Capacity : 1,000 m^3
Quantity : 1

2) Receiving oil pumps
Type: Screw pump
Capacity: 40 m^3/h
Quantity: 2

3) Oil feed pumps
Type: Screw pump
Capacity: 40 m^3/h
Quantity: 2

Pressure control is implemented by recirculation relief valves. The configuration allows fuel to be drawn from one tank to the other.

Flow diagram of the fuel oil supply system is shown in Figure 4.5.4.

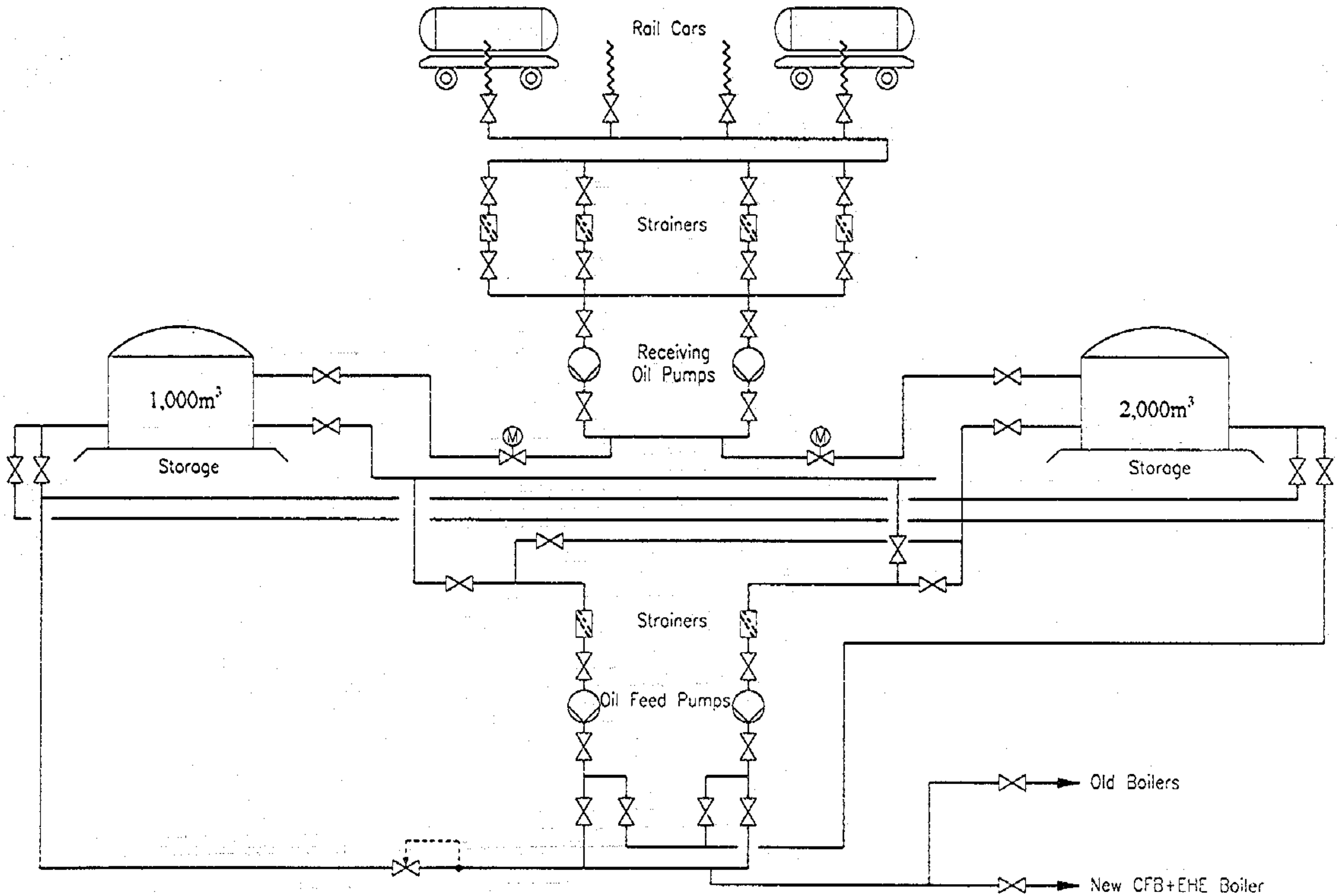


Figure 4.5.4 Oil supply system