6. Project Implementation Programme

The study result shows following implementation programme in order to start DeSOx system commercial operation on the first of January 1998.

(1)	Completion of the Feasibility Study	End of Dec. 1991
(2)	Preparation of Financial Source	End of Jan. 1993
(3)	Selection of Consultant	End of Apr. 1993
(4)	Detailed Design and Preparation of Tender Documents	End of Nov. 1993
(5)	Completion of Tender Evaluation	End of May 1994
(6)	Contract Award	End of May 1994
(7)	Commencement of Civil Work	Beginning of Oct. 1994
(8)	Erection Start	Beginning of Jun. 1995
(9)	Trial Operation Start	Beginning of Sep. 1996
(10)	Taking Over	End of Oct. 1997
(11)	Commercial Operation Start	1st of Jan. 1998

In Table 6-1, 6-2 (1) and (2), implementation schedule and construction schedule are shown.

Table 6-1 KOZIENICE POWER PLANT FGD SYSTEM IMPLEMENTATION SCHEDULE

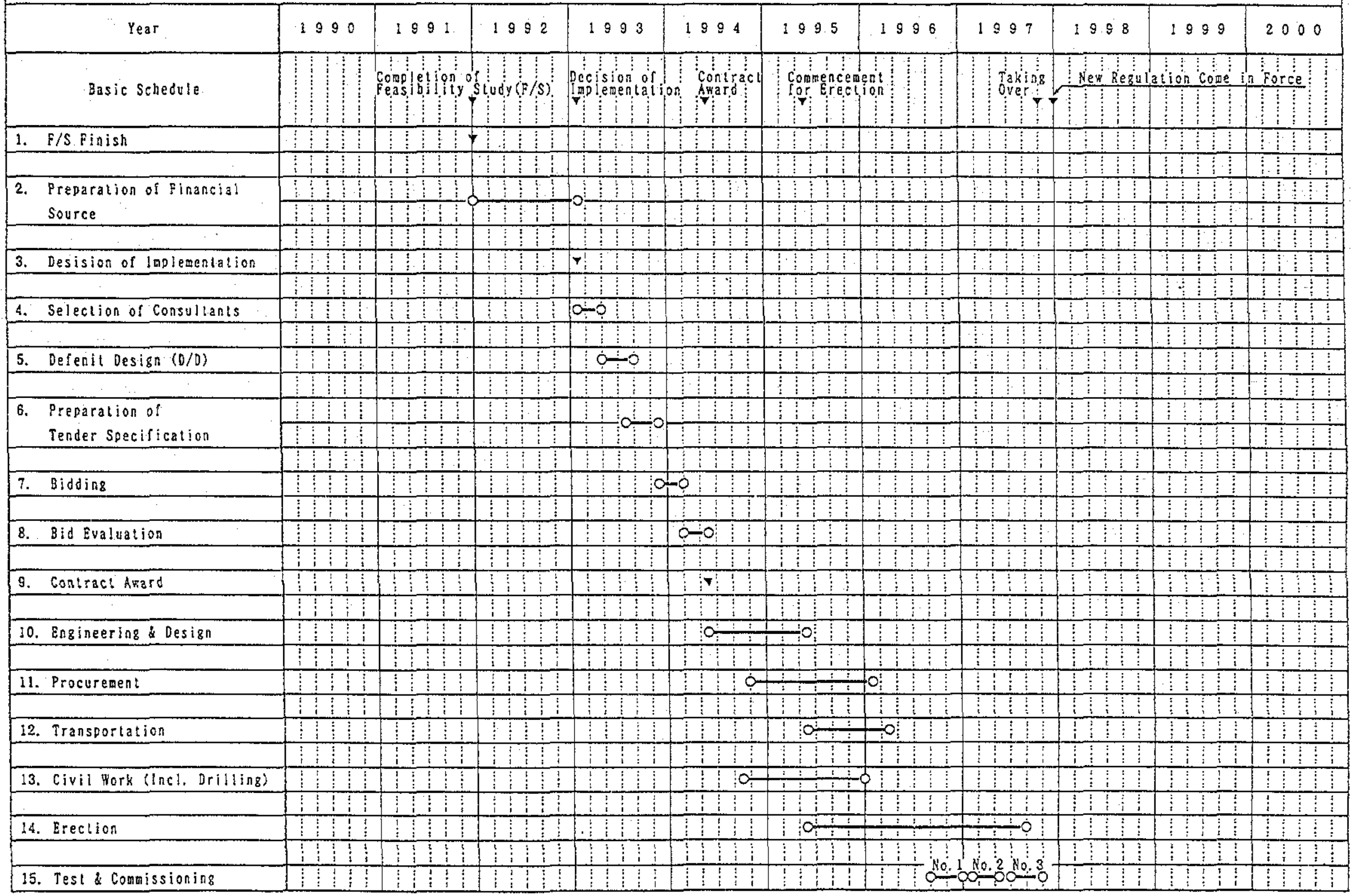
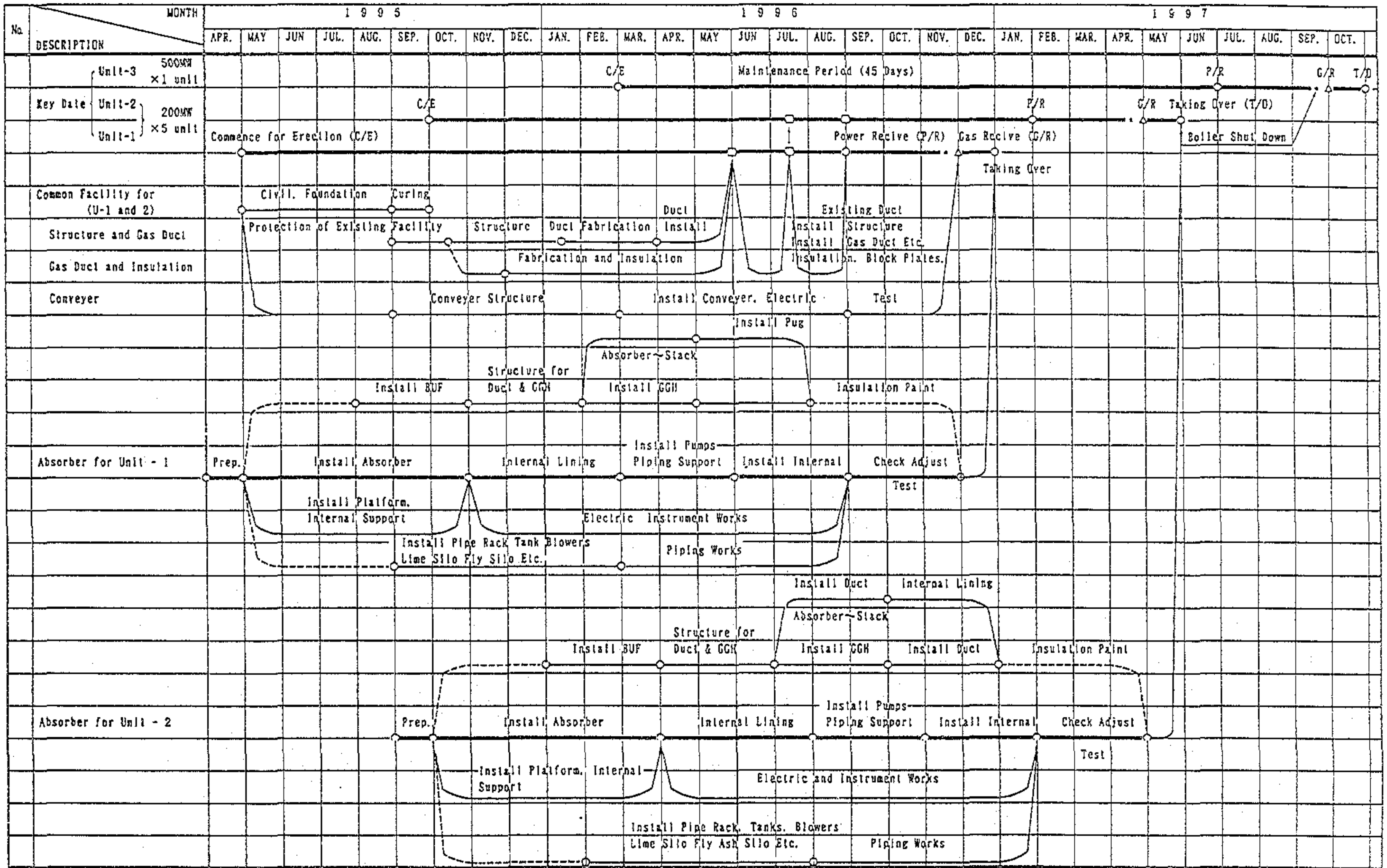
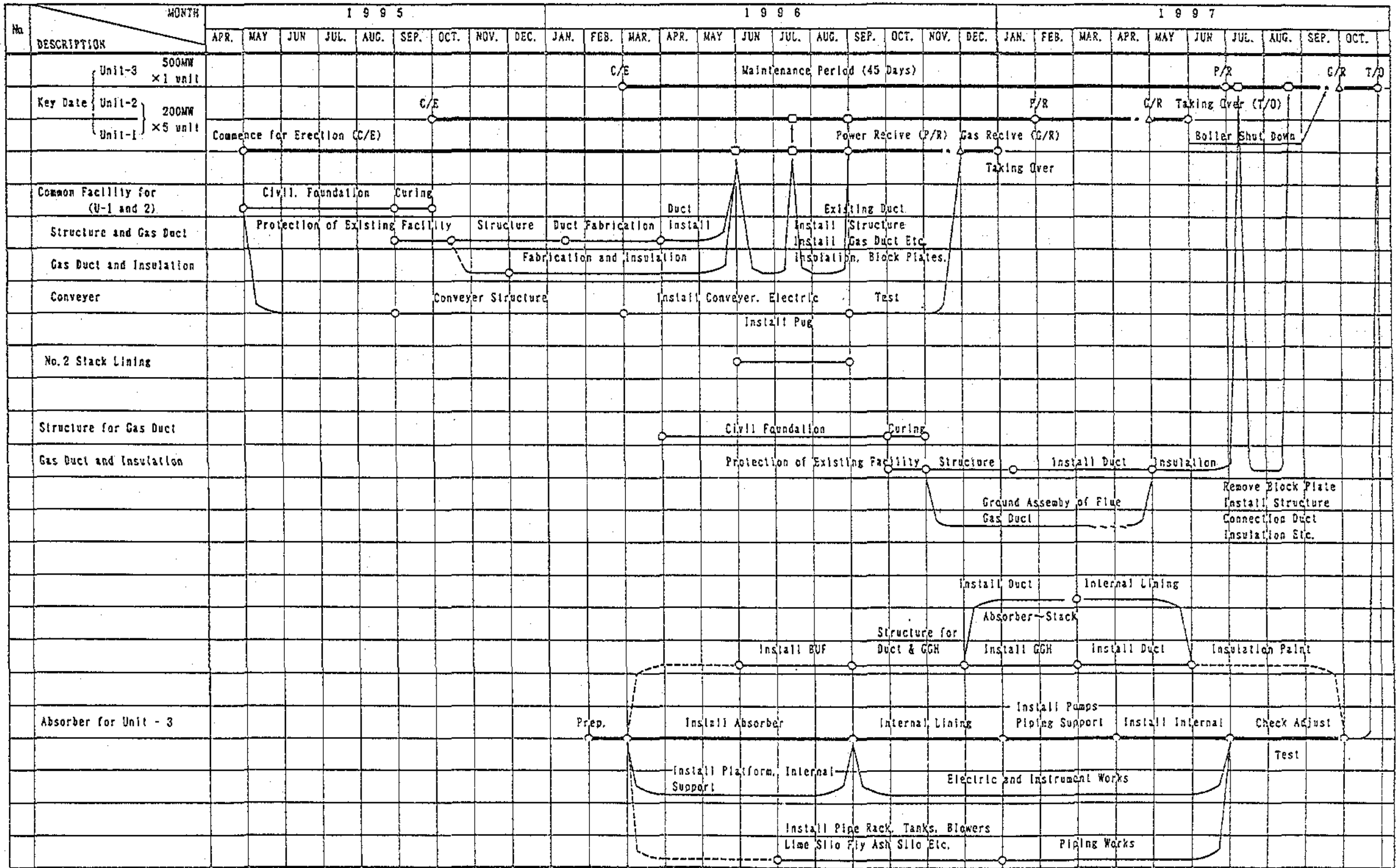


Table 6-2 (1) 500MW FGD Plant ×3 Units Construction Schedule



Remarks
(1) 3 days Boiler shut down work of each unit will be required before hot gas recive to remove block plates inside flue gas duct.
(2) connection change of the existing common duct and new one between IDF outlet and stack will be done during low load demand season.

Table 6-2 (2) 500MW FGD Plant × 3 Units Construction Schedule



Remarks
(1) 3 days Boiler shut down work of each unit will be required before hot gas recive to remove block plates inside flue gas duct.
(2) Connection change of the existing common duct and new one between IDF outlet and stack will be done during low load demand season.
(3) Approximately 3 months plant shut down of No.4 to No.8 will be required by No.2 stack lining.

7. Construction Cost and Operation and Maintenance Cost

Construction cost for 3 units of 500 MW class FGD system with 89% DeSOx efficiency are estimated at 185,404,000 U$.

This is equivalent to 123.6 U$ per kW.

Costs are estimated as of March 1st 1991.

In Fig. 7-1, scope of the following cost estimation is shown.

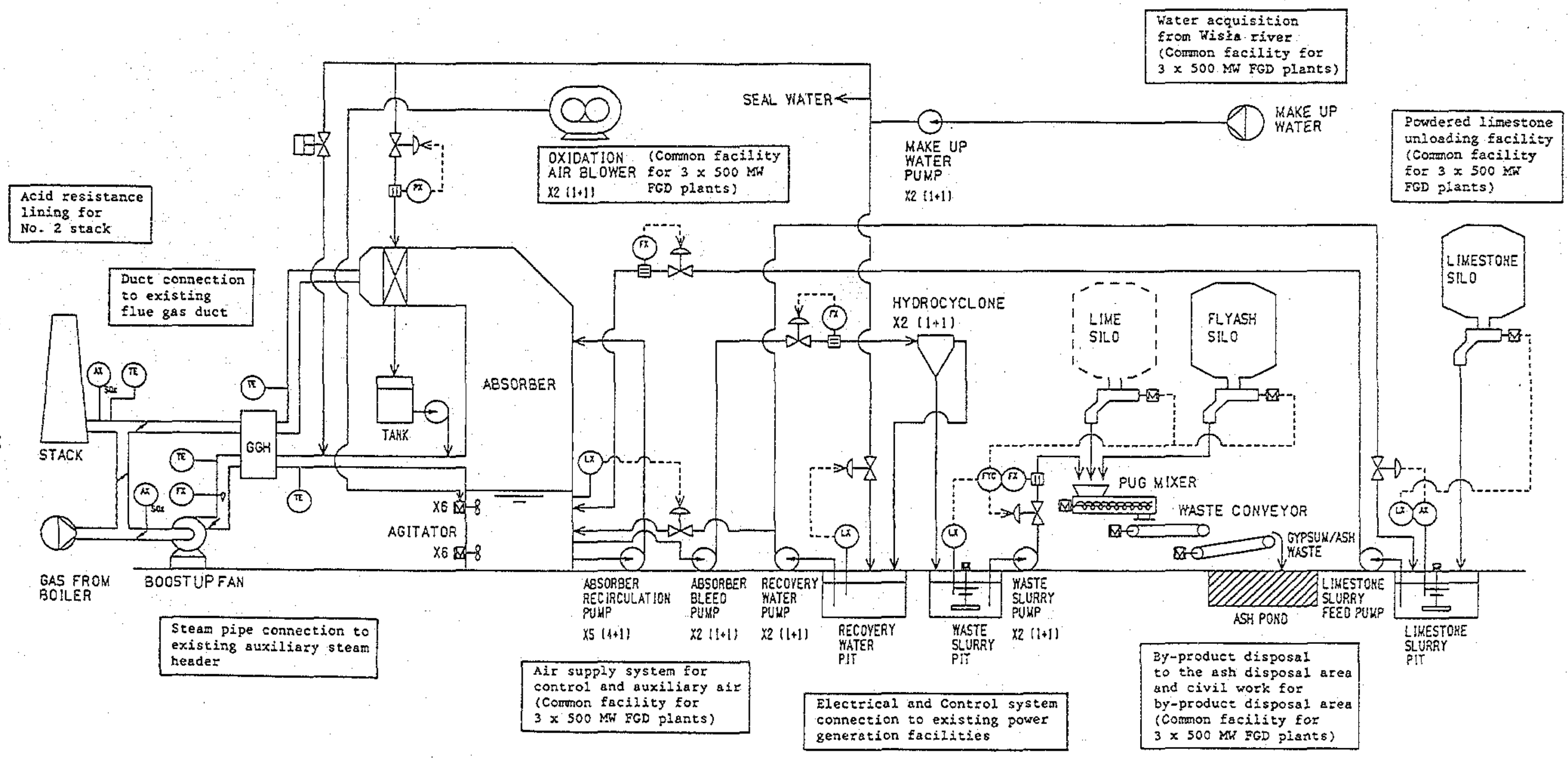


Fig. 7-1 Supply Limit of One 500 MW FGD Plant

(1) Estimated Construction Cost

		$\times 10^6$ ZL	$\times 10^3$ US\$
a.	DeSOx System and Associated Equipment	1,130,833	119,035
b.	Transportation	43,890	4,620
c.	Construction	92,369	9,723
d.	Civil Work	112,575	11,850
e.	Modification of Existing Facilities	12,350	1,300
f.	Spare Parts	22,686	2,388
g.	Start-up and Commissioning	22,686	2,388
h.	Import Tax	94,212	9,917
[Direct Construction Cost] a ~ h		[1,531,601]	[161,221]
i.	Engineering Fee [5% of Direct Const. Cost]	76,580	8,061
j.	Contingency [5% of Direct Const. Cost]	76,580	8,061
k.	Administration fee [5% of Direct Const. Cost]	76,580	8,061
[Total Construction Cost] a ~ k		[1,761,341]	[185,404]
[Construction Cost per kW]		[1,174 x 10^3ZL/kW]	[123.6 US\$/kW]

(2) Annual O&M Cost

		$\times 10^3$ ZL	US\$
a.	Utilities Cost	40,220,680	4,233,756
b.	Labor Cost	1,111,824	117,034
c.	Maintenance Cost	76,579,975	8,061,050
[Total]		[117,912,479]	[12,411,840]

8. Operation and Maintenance

(1) Methods of Operation

The FGD Units are started and stopped linked usually with start and stop of power generation plants.

The FGD Units are started in the sequence of the absorbing systems, the drafting systems and the gypsum processing systems. The FGD Units are stopped, on the other hand, in the sequence of the drafting systems, absorbing systems and the gypsum processing systems. Fig. 8-1 shows starting and stopping timings of the unit-to-unit FGD Unit.

As for stopping, regulations on volume of emission applies to the Kozienice Power Plant but no regulation on concentration applies. Thus, it is possible, at the Kozienice Power Plant, to stop FGD Units during low load operations.

The FGD Units are started remotely from the Control Room. The FGD Units are started system by system sequentially by operating on the CRT of the Control Desk. The starting flow chart is shown in Fig. 8-2.

The FGD Units are stopped system by system, from the Control Room, sequentially by operating on the CRT as in the case of starting. A stop mode is either a short-term stop mode or a long-term stop mode.

A flow chart of the short-term stop mode is shown in Fig. 8-3.

(2) Performance Management

It is desirable to practice performance management in routine operations. One way to do so is to prepare and keep operation log sheet having items necessary for judging operating conditions including performance items.

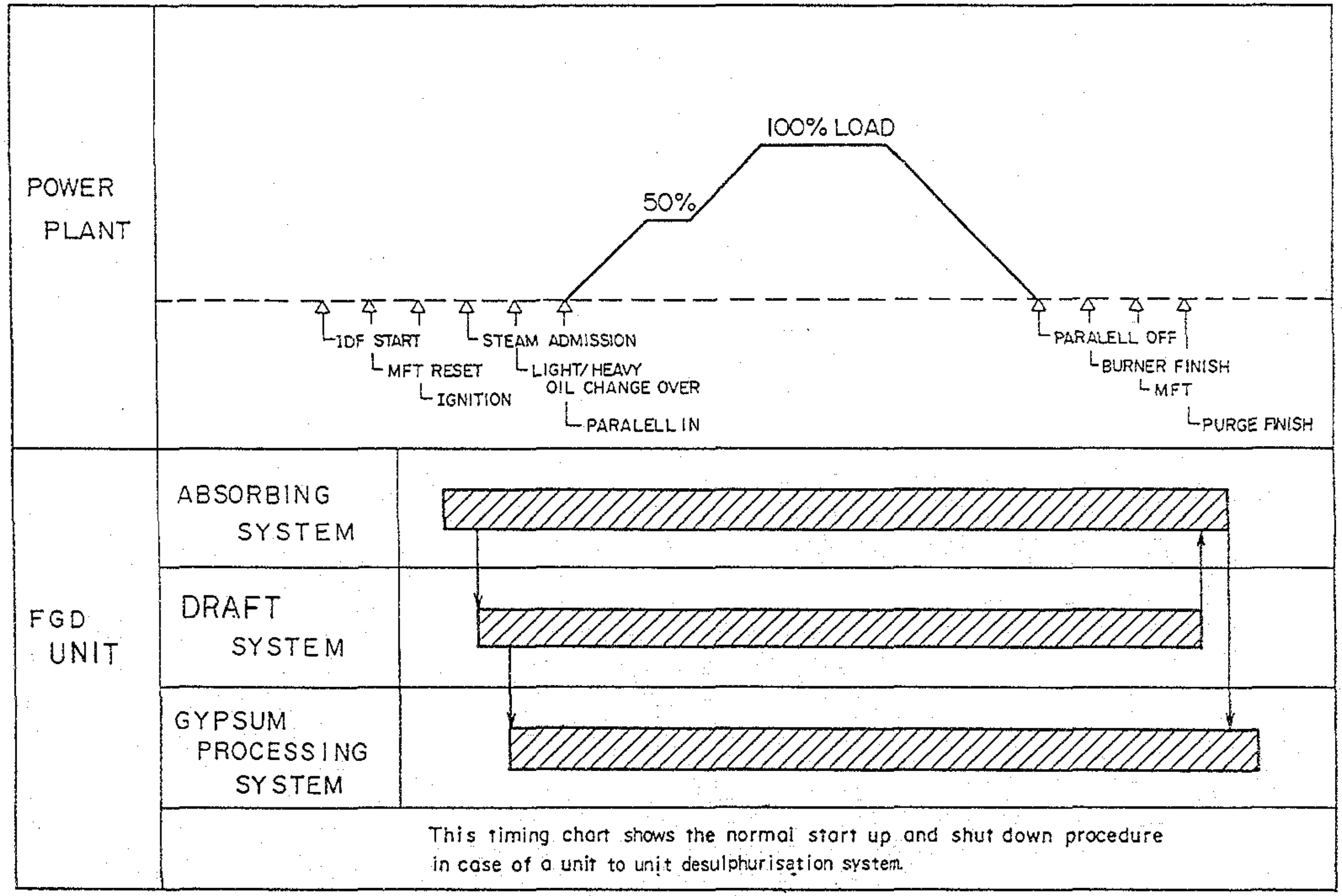


Fig. 8-1 FGD UNIT START UP SHUT DOWN TIMING CHART

Fig. 8−2 FLOW CHART OF START UP PROCEDURE (1/2)

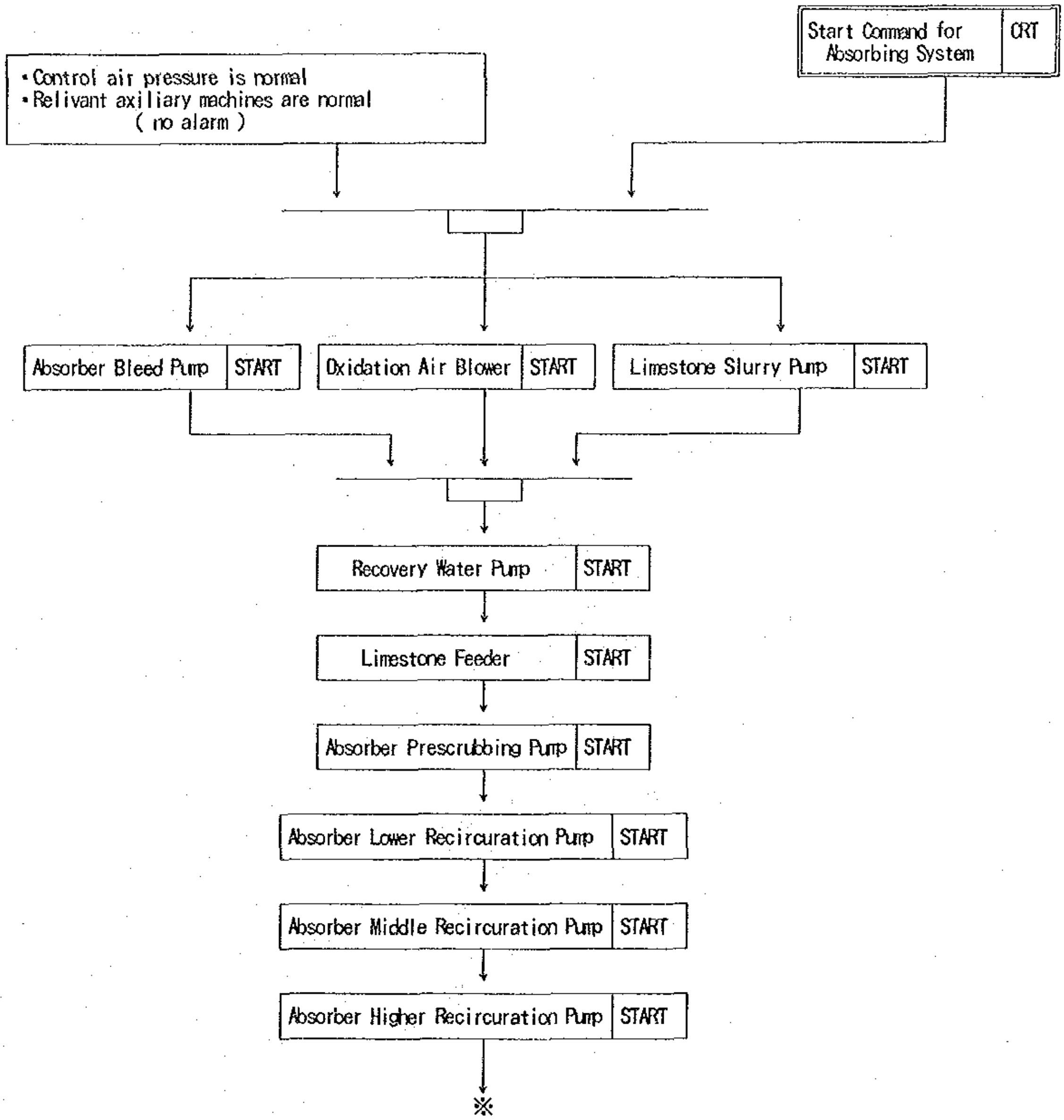


Fig. 8-2 FLOW CHART OF START UP PROCEDURE (2/2)

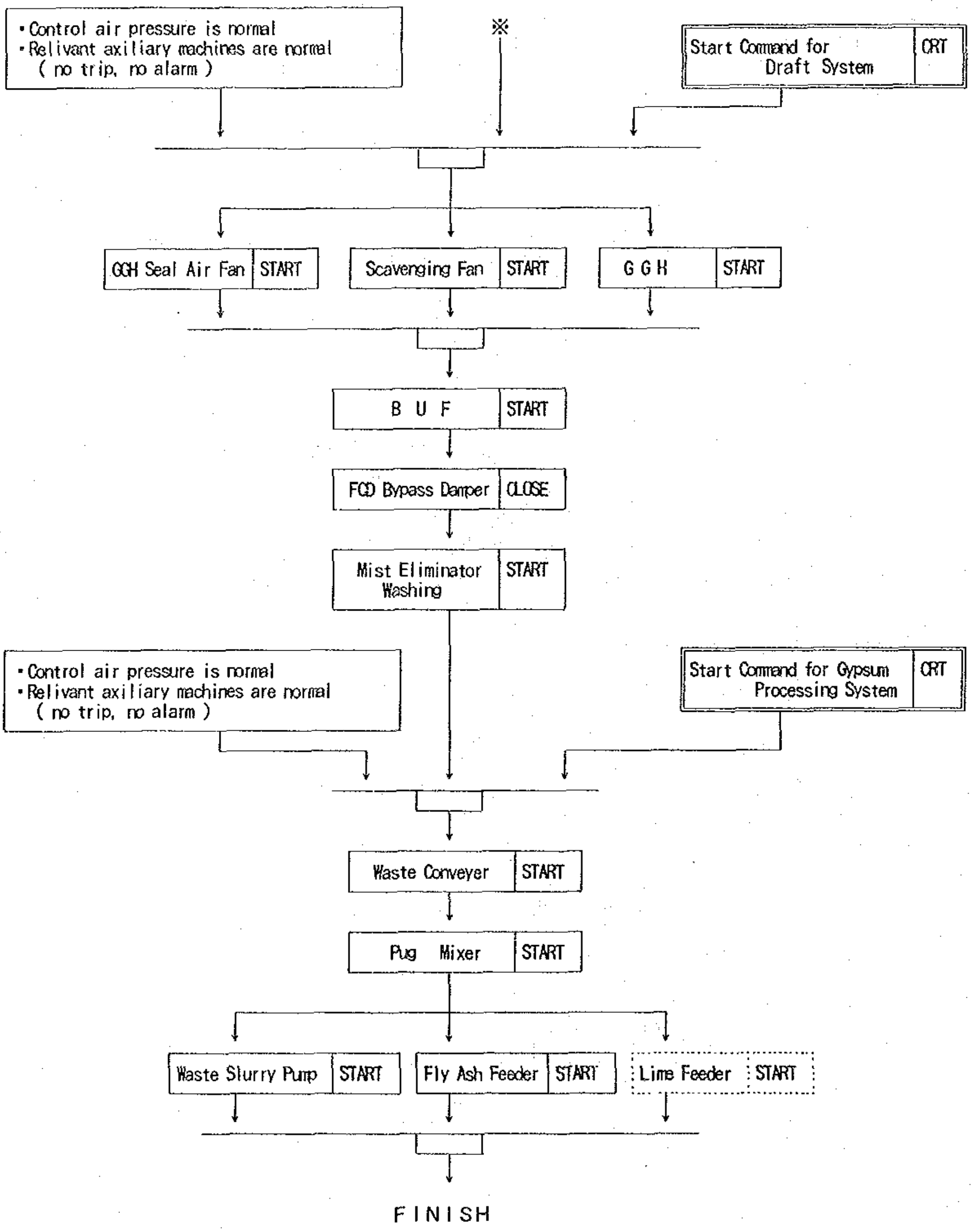
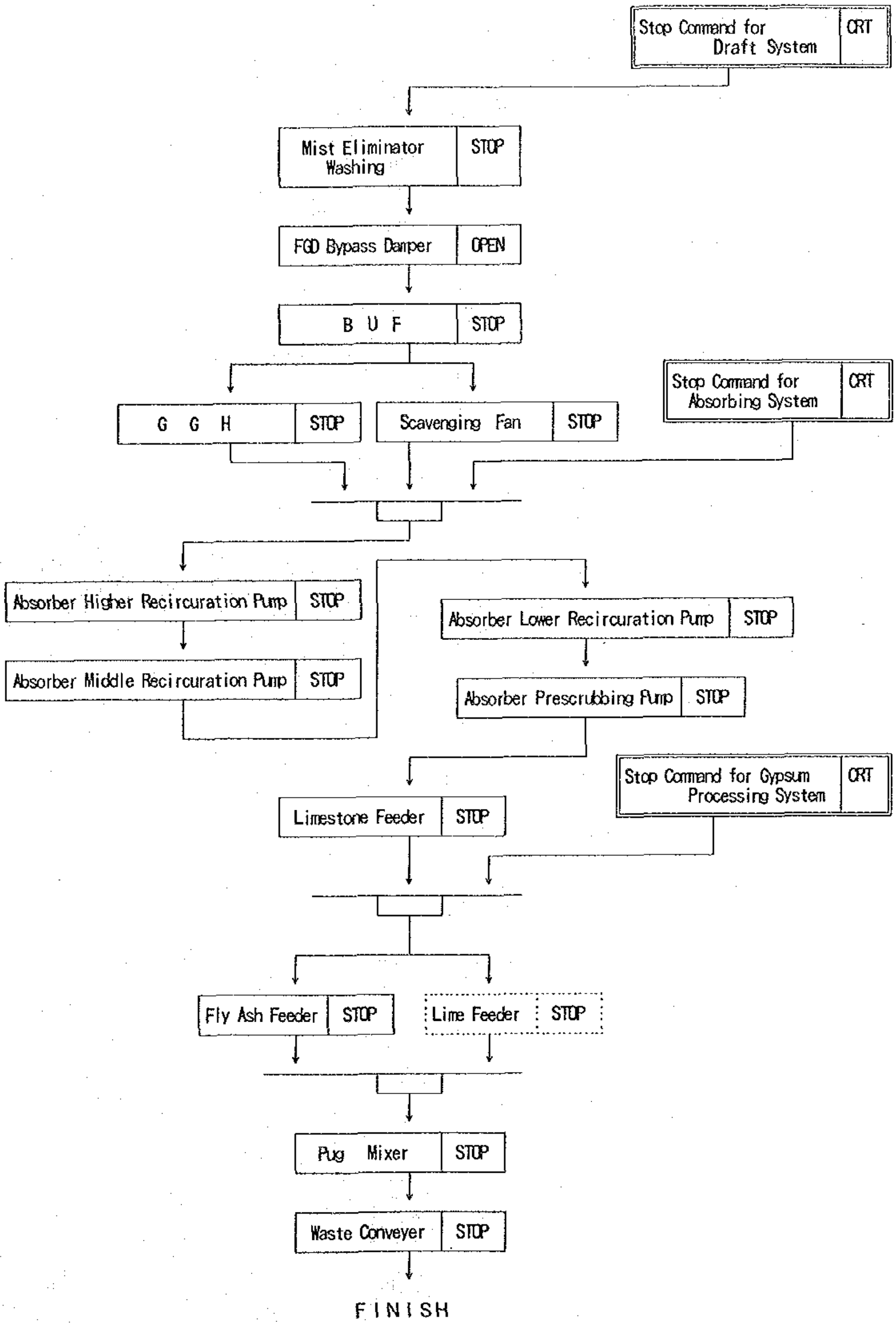


Fig. 8-3 FLOW CHART OF SHUT DOWN PROCEDURE
(SHORT TERM STOP MODE)



(3) Maintenance Procedures

In addition to keeping monitoring the operating condition in the Control Room, it is desirable to patrol, at each shift, the field to check for equipment troubles. For patrolling, it is desirable to prepare a check sheet considering the route of equipment inspection, inspection frequency, points of inspection, points of special observation, etc., and patrol the field according to the check sheet.

The FGD must be stopped once a year for scheduled inspection. In the FGD, especially, gypsum sedimentation and clogging possibly occur in the tower, tanks, pumps and pipings, and it is necessary to remove and clear such sedimentation and clogging in addition to overhauling of each equipment.

9. Analysis and Evaluation on Socioeconomic Impact

9.1 Analysis on Socioeconomic Impact

(1) Annual cost in each year was calculated from the total construction cost including interest during construction based on the construction cost in Chapter 7.

Total construction cost is shown in Table 9-1. In addition total construction cost of which financing for local portion is partly covered with foreign loan is shown in Table 9-2.

Tariff is calculated based on the annual cost. As a result of this calculation, 33 to 41ZL/kWh (0.35¢ to 0.43 ¢/kWh) additional burden in tariff is estimated. Increase in tariff enabling to recover this burden is strongly recommended. Tariff trend in each year are shown in Table 9-3 and 9-4. (With 1991 February cost ... Inflation is disregarded)

(2) For the economic evaluation, reconstruction of boilers into natural gas firing which has the same reduction of SO_2 effect as this project was chosen.

Flow of benefit and cost of the evaluation is shown in Table 9-5 EIRR. Excess benefit (B-C) and Benefit-Cost ratio (B/C) are as follows.

EIRR	37.69%
B-C	3,560.3 x 10^9 ZL
B/C	2.832

Judging from the study results of the above, this project is much superior to the partial reconstruction of the boilers into natural gas firing which has the same SO_2 reduction effect in terms of cost.

This superiority is maintained until social discount rate which reflects opportunity cost of capital reaches 37.69%.

Table 9-1 Total Construction Cost

(1,000 US$)

Interest for Foreign Loan / Interest for Local Loan		3.5%			5%			8.5%		
		Local Portion	Foreign Portion	Total	Local Portion	Foreign Portion	Total	Local Portion	Foreign Portion	Total
10%	C.C.	109,621	75,783	185,404	109,621	75,783	185,404	109,621	75,783	185,404
	I.D.C.	29,784.03	12,551.36	42,335.39	29,784.03	18,226.14	48,010.17	29,784.03	32,205.47	61,989.5
	Total	139,405.03	88,334.36	227,739.39	139,405.03	94,009.14	233,414.17	139,405.03	107,988.47	247,393.5
15%	C.C.	109,621	75,783	185,404	109,621	75,783	185,404	109,621	75,783	185,404
	I.D.C.	45,662.63	12,551.36	58,213.99	45,662.63	18,226.14	63,888.77	45,662.63	32,205.47	77,868
	Total	155,283.63	88,334.36	243,617.99	155,283.63	94,009.14	249,292.77	155,283.63	107,988.47	263,272.1

Note: C.C.: Construction Cost

I.D.C.: Interest during Construction

Table 9-2 Total Construction Cost

(1,000 US$)

Interest for Foreign Loan / Interest for Local Loan		3.5%			5%			8.5%		
		Local Portion	Foreign Portion	Total	Local Portion	Foreign Portion	Total	Local Portion	Foreign Portion	Total
10%	C.C.	74,162	111,242	185,404	74,162	111,242	185,404	74,162	111,242	185,404
	I.D.C.	20,149.82	15,828.39	35,978.21	20,149.82	22,938.64	43,088.46	20,149.82	40,340.89	60,490.71
	Total	94,311.82	127,070.39	221,382.21	94,311.82	134,180.64	228,492.46	94,311.82	151,582.89	245,894.71
15%	C.C.	74,162	111,242	185,404	74,162	111,242	185,404	74,162	111,242	185,404
	I.D.C.	30,892.18	15,828.39	46,720.57	30,892.18	22,938.64	53,830.82	30,892.18	40,340.89	71,233.07
	Total	105,054.18	127,070.39	232,124.57	105,054.18	134,180.64	239,234.82	105,054.18	151,582.89	256,637.07

Note: C.C.: Construction Cost

I.D.C.: Interest during Construction

Table 9-3 Calculation of Tariff

Calculation of Tariff

(USD 1000)

Year after Completion	Depreciation	Interest	Utility Cost	Personnel Cost	Repair Cost	Total	Tariff (Yen/KWh)	Tariff (Zl/KWh)	Tariff (c/KWh)
1	21939.342	20963.290	4233.756	943.541	8061.05	56140.978	0.58	41.03	0.43
2	21939.342	18634.035	4233.756	943.541	8061.05	53811.724	0.56	39.32	0.41
3	21939.342	20639.318	4233.756	943.541	8061.05	55817.007	0.58	40.79	0.43
4	21939.342	22389.628	4233.756	943.541	8061.05	57567.317	0.60	42.07	0.44
5	21939.342	19550.428	4233.756	943.541	8061.05	54728.117	0.57	39.99	0.42
6	21939.342	16711.228	4233.756	943.541	8061.05	51888.917	0.54	37.92	0.40
7	21939.342	13872.028	4233.756	943.541	8061.05	49049.717	0.51	35.84	0.38
8	21939.342	11032.828	4233.756	943.541	8061.05	46210.517	0.48	33.77	0.36
9	21939.342	8193.628	4233.756	943.541	8061.05	43371.317	0.45	31.69	0.33
10	21939.342	5354.428	4233.756	943.541	8061.05	40532.117	0.42	29.62	0.31
11	21939.342	4844.483	4233.756	943.541	8061.05	40022.172	0.42	29.25	0.31
12	21939.342	4079.565	4233.756	943.541	8061.05	39257.253	0.41	28.69	0.30
13	0.000	3314.646	4233.756	943.541	8061.05	16552.993	0.17	12.10	0.13
14	0.000	2804.701	4233.756	943.541	8061.05	16043.048	0.17	11.72	0.12
15	0.000	2294.755	4233.756	943.541	8061.05	15533.102	0.16	11.35	0.12
16	0.000	1784.809	4233.756	943.541	8061.05	15023.156	0.16	10.98	0.12
17	0.000	1274.864	4233.756	943.541	8061.05	14513.211	0.15	10.61	0.11
18	0.000	764.918	4233.756	943.541	8061.05	14003.265	0.15	10.23	0.11
19	0.000	254.973	4233.756	943.541	8061.05	13493.320	0.14	9.86	0.10
20	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
21	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
22	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
23	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
24	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
25	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
26	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
27	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
28	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
29	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
30	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10

Annual Operation Hour	5000
Annual Load Factor	57
Auxirialy Loss	
Annual Net Generation(KWh)	13000000000

Amount of Coal in 1990	526.9 Billion Zl
Construction Cost	161221

Depreciation	Straight Method
Residual Value	0
Term (Year)	12
Total Value	283272.100

Table 9-4 Calculation of Tariff

Calculation of Tariff

(USD 1000)

Year after Completion	Depreciation	Interest	Utility Cost	Personnel Cost	Repair Cost	Total	Tariff (Yen/KWh)	Tariff (Zl/KWh)	Tariff (c/KWh)
1	18978.283	12546.452	4233.756	943.541	8061.05	44763.082	0.46	32.71	0.34
2	18978.283	11152.402	4233.756	943.541	8061.05	43369.032	0.45	31.69	0.33
3	18978.283	11218.323	4233.756	943.541	8061.05	43434.952	0.45	31.74	0.33
4	18978.283	11198.362	4233.756	943.541	8061.05	43414.992	0.45	31.73	0.33
5	18978.283	9632.551	4233.756	943.541	8061.05	41849.180	0.43	30.58	0.32
6	18978.283	8066.739	4233.756	943.541	8061.05	40283.369	0.42	29.44	0.31
7	18978.283	6500.928	4233.756	943.541	8061.05	38717.557	0.40	28.29	0.30
8	18978.283	4935.116	4233.756	943.541	8061.05	37151.746	0.39	27.15	0.29
9	18978.283	3369.305	4233.756	943.541	8061.05	35585.934	0.37	26.01	0.27
10	18978.283	1803.493	4233.756	943.541	8061.05	34020.123	0.35	24.86	0.26
11	18978.283	1631.732	4233.756	943.541	8061.05	33848.362	0.35	24.74	0.26
12	18978.283	1374.090	4233.756	943.541	8061.05	33590.720	0.35	24.55	0.26
13	0.000	1116.448	4233.756	943.541	8061.05	14354.795	0.15	10.49	0.11
14	0.000	944.687	4233.756	943.541	8061.05	14183.034	0.15	10.36	0.11
15	0.000	772.926	4233.758	943.541	8061.05	14011.273	0.15	10.24	0.11
16	0.000	601.164	4233.756	943.541	8061.05	13839.511	0.14	10.11	0.11
17	0.000	429.403	4233.755	943.541	8061.05	13667.750	0.14	9.99	0.11
18	0.000	257.642	4233.756	943.541	8061.05	13495.989	0.14	9.86	0.10
19	0.000	85.881	4233.756	943.541	8061.05	13324.228	0.14	9.74	0.10
20	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
21	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
22	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
23	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
24	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
25	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
26	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
27	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
28	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
29	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10
30	0.000	0.000	4233.756	943.541	8061.05	13238.347	0.14	9.67	0.10

Annual Operation Hour	5000
Annual Load Factor	57
Auxirialy Loss	
Annual Net Generation(KWh)	13000000000

Depreciation	Straight Method
Residual Value	0
Term (Year)	12
Total Value	227739.390

Amount of Coal in 1990	526.9 Billion Zl
Construction Cost	161221

Table 9-5 Economic Evaluation

Econmic Evaluation

(Milliard Zl)

No. Year	Costs: Investmnet	Costs: Coal Cost	Costs: O&M Cost	Total Cost	Total Cost (N.P.V.)	Benefits: Investment	Benefits: O&M Cost	Benefits: Fuel Cost	Total Benefit	Total Benefit (N.P.V.)	Benefits-Costs
1	95.640			95.640	86.946	27.100			27.100	24.636	-68.540
2	0.000			0.000	0.000	0.000			0.000	0.000	0.000
3	363.434			363.434	273.053	102.980			102.980	77.370	-260.454
4	636.009			636.009	434.403	180.215			180.215	123.089	-455.794
5	636.009			636.009	394.911	180.215			180.215	111.899	-455.794
6	181.717	0.000	60.806	242.522	136.898	51.480	-34.736	514.500	531.254	299.879	288.732
7		0.000	121.611	121.611	62.406		-69.472	1029.000	959.528	492.390	837.917
8		0.000	121.611	121.611	56.732		-69.472	1029.000	959.528	447.627	837.917
9		0.000	121.611	121.611	51.575		-69.472	1029.000	959.528	406.934	837.917
10		0.000	121.611	121.611	46.886		-69.472	1029.000	959.528	369.940	837.917
11		0.000	121.611	121.611	42.624		-69.472	1029.000	959.528	336.309	837.917
12		0.000	121.611	121.611	38.749		-69.472	1029.000	959.528	305.735	837.917
13		0.000	121.611	121.611	35.226		-69.472	1029.000	959.528	277.941	837.917
14		0.000	121.611	121.611	32.024		-69.472	1029.000	959.528	252.674	837.917
15		0.000	121.611	121.611	29.113		-69.472	1029.000	959.528	229.703	837.917
16		0.000	121.611	121.611	26.466		-69.472	1029.000	959.528	208.821	837.917
17		0.000	121.611	121.611	24.060		-69.472	1029.000	959.528	189.837	837.917
18		0.000	121.611	121.611	21.873		-69.472	1029.000	959.528	172.580	837.917
19		0.000	121.611	121.611	19.884		-69.472	1029.000	959.528	156.890	837.917
20		0.000	121.611	121.611	18.077		-69.472	1029.000	959.528	142.628	837.917
21		0.000	121.611	121.611	16.433		-69.472	1029.000	959.528	129.662	837.917
22		0.000	121.611	121.611	14.939		-69.472	1029.000	959.528	117.874	837.917
23		0.000	121.611	121.611	13.581		-69.472	1029.000	959.528	107.158	837.917
24		0.000	121.611	121.611	12.347		-69.472	1029.000	959.528	97.417	837.917
25		0.000	121.611	121.611	11.224		-69.472	1029.000	959.528	88.561	837.917
26		0.000	121.611	121.611	10.204		-69.472	1029.000	959.528	80.510	837.917
27		0.000	121.611	121.611	9.276		-69.472	1029.000	959.528	73.191	837.917
28		0.000	121.611	121.611	8.433		-69.472	1029.000	959.528	66.537	837.917
29		0.000	121.611	121.611	7.666		-69.472	1029.000	959.528	60.488	837.917
30		0.000	121.611	121.611	6.969		-69.472	1029.000	959.528	54.989	837.917
Total	1912.808	0.000	2979.471	4892.280	1942.980	542.000	-1702.064	25210.500	24050.436	5503.268	19158.156

Discount Rate 10.00%

O&M Cost(USD) 3095929
Repair Cost(MJY) 1088.24

Benefit 542

EDR 37.69%
B-C(Discount Rate=10%) 3560.289
B/C(Discount Rate=10%) 2.832

9.2 Evaluation on Socio-economic Impact

(1) During reconstruction of Japanese economy after World War II, investment for environmental protection accounted for 3% of total investment of private companies. At that time the position of environmental protection was not clearly specified in the legislation for environmental protection and no governmental agency in charge of environmental issue did not exist.

In the prime of economic high rate growth, around 1970, environmental issue became the national-wide problem. Many environmental acts were enacted and the Environmental Agency was established in 1971. Environmental administration was strengthened in this way.

As in the field of electric utility legistrations were systematized, technology on flue gas treatment was introduced. Flue gas desulphuriser for coal fired thermal power stations was started at the Takasago Thermal Power Station as a pioneer and at the almost all coal fired thermal power stations and high sulphur oil fired thermal power stations, total 68 units 23,450 kW so far, flue gas desulphuriser were installed.

(2) Macro economic method for socio-economical evaluation on introduction of environmental protection has not been fully developed. However,

1) At the Tokyo Conference of Roma Club in 1982, Prof. Dr. Yoichi Kaya, University of Tokyo, presented a estimation, based on rough assumptions, that damage amounted to 6,000 x 10^9 Yen (45 x 10^9 US dollars) in comparison with that the cost for SOx removal amounted 480 x 10^9 Yen (3.7 x 10^9 Milliard US dollars) and

2) Environmental white paper for FY 1977 stipulated that there was hardly no adversal effect on macro economies although countermeasures for environmental protection were carried out from 1965 to 1975.

Those had affirmative effect that real rate of economic growth was raised by 0.9%.

(3) Following are analysis on introduction of DeSOx equipment in Polish power stations based on above analyses.

1) Economic extension and increase in employment attributable to increase in investment.

2) Absorbable effect on energy tariff

3) Increase in export

Poland is already industrialized. In this project, local procurement shall be extended as much as possible so that technology can be absorbed aggressively. As a consequence, Poland will be able to export DeSOx equipments to neighbor countries by taking advantage of its comparatively cheap labor cost and such technology.

10. Recommendation for the Implementation of the Project

(1) Arrangement of Scheme for Local Portion Investment : Improvement of Domestic Financial Market etc.

It has been studied that the Project be implemented as much as possible inside Poland for the least cost and giving good influence on Polish economy as well as taking into account current level of Polish technology. Consequently, although our Study has satisfied this requirement, there remains some problems in connection with the financing on the local portion of the Project.

As the present scheme loans on the basis of the Official Development Assistance in every countries as well as loans from organization for international aid such as the World Bank have limitation for credit line for local portion of projects. Therefore, a certain part of investment for local portion shall be funded from domestic financial market. However, since Polish private financial market is still unmatured, it is difficult to fund from the market at this stage. Therefore, the following schemes for financing on the local portion will be thought necessary to make the Project implement as scheduled.

a. Application of the Polish Environmental Fund

b. Application of a governmental financing entity

If expansion of the activity of private banking system, which is operated on the basis of saving of the national, will not be expected soon, application of a governmental financing entity (if no such an organization, urgent establishment is necessary) shall be studied. Since environmental project is expected to generate effective demand of Polish national economy, application of the governmental financing entity will be thought very useful.

c. Application of Debt for Nature Swap

To a certain extent, Debt for Nature Swap will be applicable to the implementation of the Project, upon agreement with a private bank which has credit to Polish government. (This scheme was materialized in Philippine.)

(2) Arrangement of the Electricity Tariff System

Unless credit incurred from this Project is duly borne by consumers in electricity tariff, it will increase national financial deficit and make inflation worse. Rise of electricity tariff by the implementation of the Project will be estimated at about 20 percent point (40ZL) on the basis of wholesaling price from the Kozienice Power Plant even in the first year from the completion of FGD Units. This will be equivalent to only 4ZL/kWh rise if the cost increase caused from the FGD Units installation of Kozienice Power Plant can be distributed in total electricity consumption all over the country.

Therefore, it shall be materialized that environmental cost including the investment cost be duly included in a new electricity tariff system, revision of which is under way from the basis of the subsidized by the government to the basis of actual cost.

(3) Consideration to High Chlorine Content of Coals

Coals used at the Kozienice Power Plant are high in chlorine content. At present, there is no commercially proven technology to lower chlorine content of waste water from the wet limestone-gypsum DeSOx system to a level at which the waste water can be discharged to river water.

In this Feasibility Study, it is planned that the waste water and gypsum from FGD system are to be mixed with flyash and are to be discarded to a disposal area to be built adjacent to the ash disposal area.

High chlorine content in coal affects to a design of FGD system to a great extent, therefore a study to lower chlorine content as much as possible is necessary.

At a detailed design stage, it is preferable to make a study to reduce chlorine content in coal by purchasing low chlorine coal and/or making optimum blending of coals, etc.