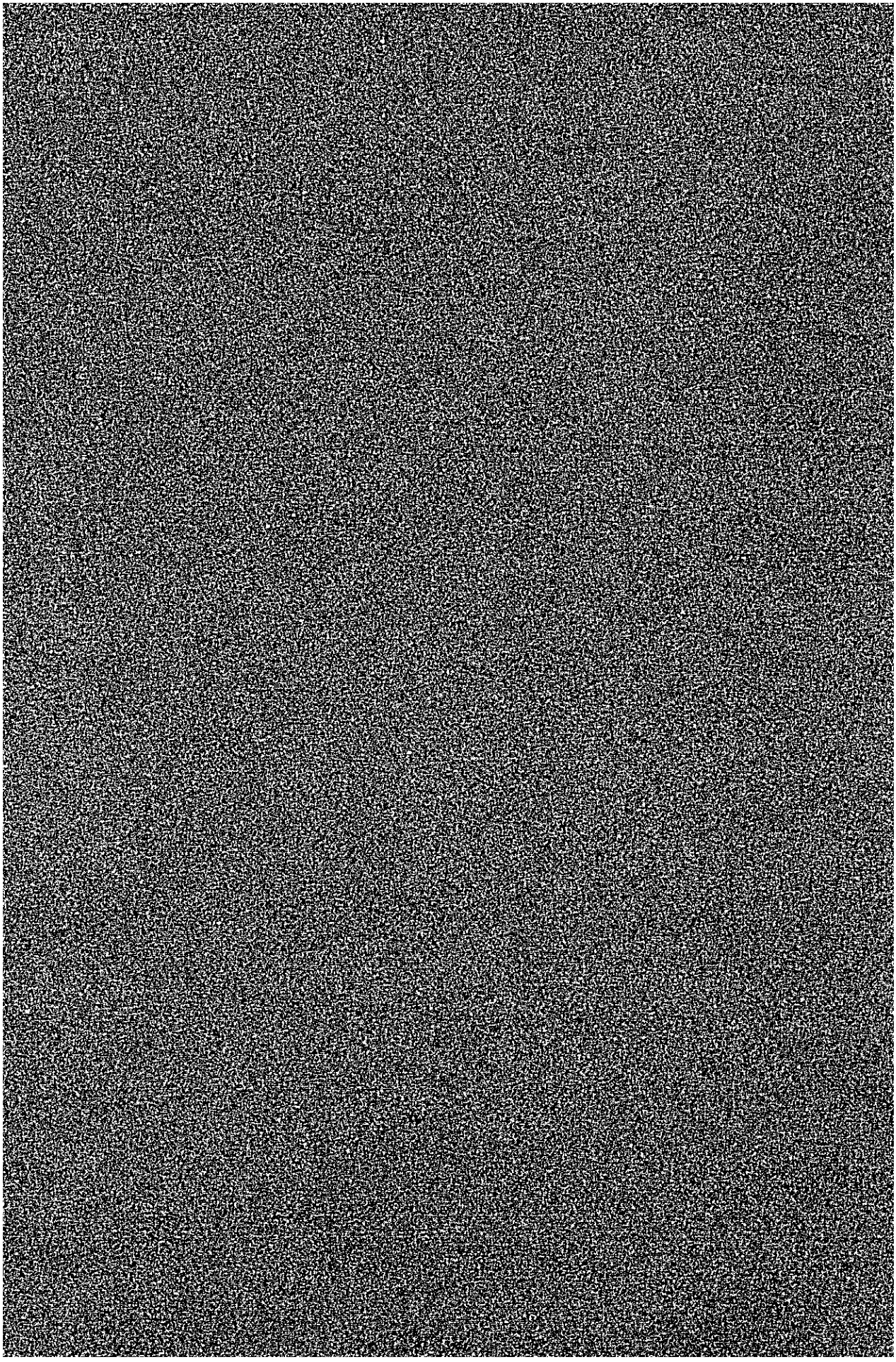
CHAPTER 11

ECONOMIC EVALUATION



CHAPTER 11 ECONOMIC EVALUATION

This transmission project aims at stabilizing electric supply in the Faridpur area by constructing a loop line connected to the main 132kV transmission line in the western grid, thus accelerating development in the area.

It is obvious that stable supply of electricity has considerable effect on the lives of people as well as various productive sectors in the region. This chapter tries to examine the viability of the project in quantitative terms.

11-1 Cost Comparison of Alternatives

The least-cost method will be applied for economic evaluation of the project. As an alternative plan, a thermal generation system within the Faridpur area will be considered.

11-1-1 Alternative Plan

(1) Outline

Three (3) thermal power stations would be constructed in Rajbari, Faridpur and Madaripur, the major demand centers in the Faridpur area. The generated power would be distributed through the existing 33kV and 11kV distribution lines.

(2) Scale and Commissioning Date for Power Stations

Based on the demand forecast for the Faridpur area as well as the following conditions, plant capacity and commissioning time are determined. The results are summarized in Table 11-1 and Figure 11-1.

Conditions:

a. A diesel plant would be constructed in Madaripur, where the demand is relatively small, while gas turbine plants would be installed in the other two (2) sites.

b. Commissioning time for the plants would coincide with that of the 132kV transmission line.

c. Plant capacity is designed to meet demand even if the largest unit fails or undergoes overhaul.

d. All demand in the area should be supplied by the above three (3) plants for two (2) reasons; (i) existing thermal plants are superannuated and nearly closed down, (ii) bulk supply from the 132kV grid system through the existing 33kV distribution lines is too little.

(3) Outline of Plant Facilities

Shown in Table 11-2 (as of year 2003/2004).

(4) Layout of generating equipment

Illustrated in Figure Annex IX.

(5) Land and Building Requirements

The alternative plan requires the following land and building space:

Land and Building Space

Station Name	Rajbari	Faridpur	Madaripur	Total
Building (m^2)	1,760	1,760	2,068	5,588
Land (m^2)	45,000 (150m x 300m)	45,000 (150m x 300m)	39,000 (130m x 300m)	129,000

11-1-2 Comparison Between This Project and the Alternative Plan

(1) Assumptions

a. Period of comparison: 1979/80-2008/09
b. Interest during construction: 0%
c. Discount rate: 15%
d. Maintenance costs: Transmission lines; 2% of investment cost
Power plants; 3.3% of investment cost
e. Load factor: 50%
f. Price escalation: Up to 1981/82; 7% for foreign currency, 9% for domestic currency
From 1981/82 onward; constant

(2) Cost Estimation for This Project

a. Construction costs:

i) Construction schedule

Major works of the project will be finished by 1985/86. After commissioning some extension work in substations and transmission facilities shall be carried out to meet increasing demand in the Faridpur area, as shown in Figure 11-2 and Table 11-3.

ii) Cost components

The investment costs for the project are shown in Table 10-8. These annual disbursements exclude interest during construction, training fee and price contingencies. The construction costs of the envisaged future extension work on the system is presented in Table 11-4.

b. Maintenance costs:

Maintenance cost for above item a. are shown in Table 11-6.

c. Electricity purchase cost

Results are shown in Table 11-5 and 11-6. The cost of electricity which this transmission project annually receives from the eastern grid through the east-west interconnector and from the power plants in the western grid is estimated to be a weighted average of both supplies.

i) Maximum annual energy transmitted through the east-west interconnector is derived as follows, assuming that the maximum current is 150% of the allowable transmitting capacity per one circuit:

Until 1990: 153MW x 1.5 x 0.5 x 24 x 365 = 1,005.3GWH

After 1990: 266MW x 1.5 x 0.5 x 24 x 365 ≒ 1,702.2GWH

ii) Possible transmitting energy from the east

Eastern grid transmits power only during off-peak hours (19.5 hours/day), that is, the energy transmitted from the east will be 70% of required energy in the west at maximum level.

iii) The unit price of electricity received from the west is calculated at 77.6 paisa/kWH as shown in Annex VIII.

iv) The unit price of electricity received from the east is 24.2 paisa/kWH as set forth in the "East-West Interconnector, 1978-4, BPDB" Report.

v) The results of unit price estimated on transmitting energy described in the same report, as a sensitive analysis, are given in Table 11-11 and this is almost equal to the figures described in Table 11-5.

(3) Cost Estimation for the Alternative Plan

a. Construction costs

Table 11-7 shows results of the cost estimation, being based on the implementation schedule of the alternative plan described in Section 11-1-1. The cost is estimated at 1981/82 prices.

b. Maintenance costs

Result based on the given conditions are shown in Table 11-9.

c. Fuel costs

Naphtha is used for the gas turbine generator power plants, whose consumption per unit power output is determined to be 307 gr/kWH. Diesel oil is used for the diesel generator power plants, whose consumption is determined to be 229gr/kWH. The cost is estimated at 1981/82 prices, which are converted from the price reported in "BPDB, Annual Report" and take into account price escalation of 9% per annum.

The results are as follows: Naphtha: 1,975 TK/ton
Diesel oil: 2,505 TK/ton

Fuel costs necessary for the alternative project are shown in Table 11-8. Table 11-9 shows all cost items of the alternative thermal project.

(4) Comparison of Two (2) Projects

The present values as of 1980/81, from 1980/81 to 2008/09 for both projects, are calculated at a 15% discount rate. Details are shown in Table 11-10. The summary is as below:

This project: TK 751,820 x 10^3
The alternative plan: TK 986,467 x 10^3

(5) Conclusion

The above considerations reveal that from the viewpoint of cost this project is superior to the alternative one. Furthermore, this project gives following advantages to the entire grid by forming a loop with the existing western main grid.

i) Even when a transmission trouble occurs, shutting-out of the affected area, it is possible to continue power supply.

ii) Voltage drops in the system is improved.

iii) Power flows in such a way to minimize line loss.

As mentioned above, it is definite that this project is much more advantageous than the best alternative one.

11-2 Project Benefits for the Region and Industry

This section deals with estimates of the benefits rendered by this transmission project for the people and for industry in the Faridpur area.

Benefits are considered by comparing consumer purchase costs for electricity with the cost of kerosine and diesel oil which would be substitute for electricity. Demand in the service area is classified into three categories, i.e., domestic service, industrial and agricultural demand. Growth in these demands implies increases in the consumption of kerosine and diesel oil if this project were not implemented.

11-2-1 Basic Data

(1) Growth of Power Demand

The demands for Rajbari, Faridpur and Madaripur are taken from Table 5-2. Classification is obtained from "Actual Load in KW, BPDB, 1978" Report. Future growth of demand is the same as described in Chapter 5 and is shown in Table 11-12.

(2) Fuel Equivalent Weight for kWH

i) Kerosine: 1WH = 1 gr

ii) Diesel oil: 1kWH = 0.27 kg

(3) Consumer Purchase Price

a. Price of electricity

The Calculated price is obtained from "Electric Power Service, BPDB, 1977/78" and is as follows:

The Calculated Price

Item	Consumer Category		
	Domestic Service	Industrial Demand	Agricultural Demand
Sales revenue - TK	46,415,317	276,043,515	4,279,748
Sold energy kWH	179,932,871	561,107,486	17,558,262
Average unit price TK	0.26	0.49	0.24

b. Price of fuel

Kerosine-white:

According to "Monthly Statistical Bulletin of Bangladesh, Dec., 1978," the price of kerosine-white in Khulna during July - October, 1978 was 2.69TK for a 22^{OZ} bottle. Therefore the retail price of kerosine-white per gram becomes 0.43 paisa/gr.

Diesel oil:

According to the above mentioned statistical bulletin, the exfactory price was 2,070 TK/ton, while the BPDB report indicates that power plants purchase it at 2,500 TK/ton. A field survey conducted by the team revealed that an appropriate price is approximately 2,800 TK/ton.

c. Fuel equivalent cost to kWH

The above considerations lead to fuel equivalent costs per kWH as follows:

Fuel Equivalent Cost to kWH

Item	Domestic Service	Industrial Demand	Agricultural Demand
1. Price of electricity (TK/kWH)	0.26	0.49	0.24
2. Fuel equivalent weight to kWH (kg)	1.0	0.27	0.27
3. Price of fuel (TK/kg)	4.3	2.8	2.8
4. Fuel equivalent cost to kWH (TK/kWH) 2. x 3.	4.3	0.76	0.76

d. Consumer profit per kWH

The consumer profit per kWH of consumption is the residual of 4. minus 1. in the above table.

11-2-2 Annual Consumer Profit

The results are shown in Table 11-13, which indicates that the consumer profit will become nearly 100 million TK in the year 1995. It appears that the relative price of fuel will increase more rapidly than electricity. Consumer profit will then be greater than the above estimate. Because the country does not produce crude oil, this considerable amount of consumer surplus means that the proposed project can save petroleum imports and reduced drain on foreign currency reserves. This transmission project is therefore strongly recommended.

11-3 Social Benefits

This project has two (2) major objectives: (i) stable supply of electricity with which improvement of the people's life and the promotion of industry, (ii) plentiful electric supply to pumping stations in the Faridpur irrigation area, in which a very large increase in rice production is planned. This section describes benefits for the latter objective.

(1) Although the Faridpur area is suitable for rice production, irrigation facilities are insufficient. The following table compares this area with the Kishoreganj area where irrigation systems are well established.

Comparison between Kishoreganj and Faridpur

(As of 1976/77)

	Total area 10^3 acre	Rice crop area 10^3 acre	Irrigated area 10^3 acre	Paddy yield 10^3 ton
Kishoreganj	1,372	1,119	365	676
Faridpur	1,724	1,396	62	407

As shown in the above table, paddy production in the Faridpur area in only 60% that of Kishoreganj in spite of its larger crop area. This is because irrigation facilities in the area are poor. The WDB has established an irrigation scheme to increase paddy production. The total power demand needed for pumping stations in this scheme amounts to about 32MW. This demand can be met by this transmission line project. Therefore, the project will play a key role in the irrigation scheme.

(2) This area has approximately 650 thousand acres of irrigable land, assuming 300 thousand acres are to be irrigated and increase of rice (paddy) production is 0.5 ton/acre in irrigated land, the additional production of 150 thousand tons of rice (paddy) can be expected, a considerable amount when compared with the country's total rice (paccy) production of 12 million tons.

(3) People engaged in agriculture number is 20 million. Rice (paddy)

production is therefore 0.6 ton per person. Additional rice (paddy) production of 150 thousand tons can offer job opportunities to 250 thousand people, certainly a tangible social benefit.

(4) At present the country is obliged to import some of its foodstuffs. Additional rice production can reduce food imports worth 750 million TK or about 5% of total 1976/77 import expenditures (14 billion TK).

From the above considerations, it is obvious that this project produces considerable indirect social benefit through promoting of the irrigation scheme in the area.

Fig. 11-1 Alternative Plan

Plant Capacities and Commissioning Time

Firm capacity is designated as below

(1) Before 1997: total installed capacity minus largest unit.

(2) After 1997: total installed capacity minus 1st and 3rd units in large.

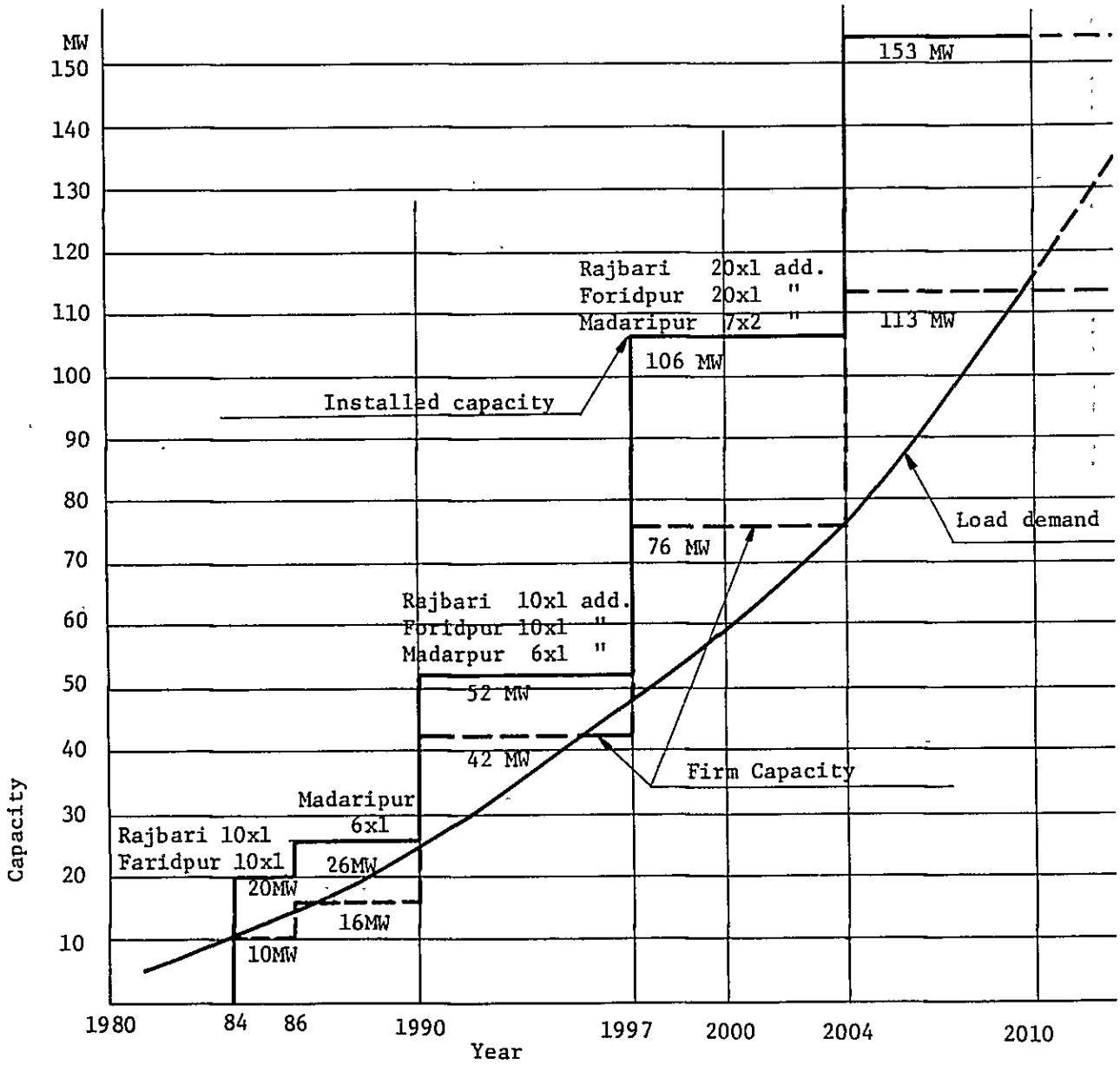


Table 11-1 Alternative Plan Demand Forecast and Plant Capacities, Commissioning Time

(1) Energies (GWH) are calculated assuming 50% of load factor.

Year	Rajbari (GTG)		Faridpur (GTG)		Madaripur (DEG)		Total	
	Max. Demand MW	P.S. Capacities MW	Max. Demand MW	P.S. Capacities MW	Max. Demand MW	P.S. Capacities MW	Max. Demand MW	Energy GWH
1980/81	2.3		2.8		1.5		6.8	29.0
81/82	2.7		3.2		1.7		7.6	33.3
82/83	3.1		3.8		2.0		8.9	39.0
83/84	3.6	10x1 new	4.4	10x1 new	2.4		10.4	45.6
84/85	4.2		5.1		2.7		12.0	52.5
85/86	4.9		5.9		3.2	6x1 new	14.0	61.3
86/87	5.7		6.8		3.7		16.2	71.0
87/88	6.6		7.9		4.3		18.8	82.3
88/89	7.6		9.2		4.9		21.7	95.1
89/90	8.9	10x1 add	10.6	10x1 add	5.7	6x1 add	25.2	110.4
90/91	9.9	(Total 20MW)	11.8	(Total 20MW)	6.3	(Total 12MW)	28.0	122.6
91/92	11.0		13.1		7.0		31.1	136.2
92/93	12.2		14.5		7.8		34.5	151.1
93/94	13.5		16.1		8.7		38.3	167.8
94/95	15.0		17.9		9.6		42.5	186.2
95/96	16.1		19.2		10.3		45.6	199.7
96/97	17.2	20x1 add	20.5	20x1 add	11.0	7x2 add	48.7	213.3
97/98	18.4	(Total 40MW)	21.9	(Total 40MW)	11.8	(Total 26MW)	52.1	228.2
98/99	19.7		23.4		12.6		55.7	244.0
99/2000	21.1		25.0		13.5		59.6	261.1
2000/01	22.6		26.8		14.4		63.8	279.4
01/02	24.2		28.7		15.0		67.9	297.4
02/03	25.9		30.7		16.1		72.7	318.4
03/04	27.7	20x1 add	32.8	20x1 add	17.2	7x1 add	77.7	340.3
04/05	29.6	(Total 60MW)	35.1	(Total 60MW)	18.4	(Total 33MW)	83.1	346.0
05/06	31.7		37.6		19.7		89.0	389.8
06/07	33.9		40.2		21.1		95.2	417.0
07/08	36.3		43.0		22.6		101.9	446.3
08/09	38.8		46.0		24.2		109.0	477.4

Fig. 11-2 Demand Forecast and Extention Schedule in this Project

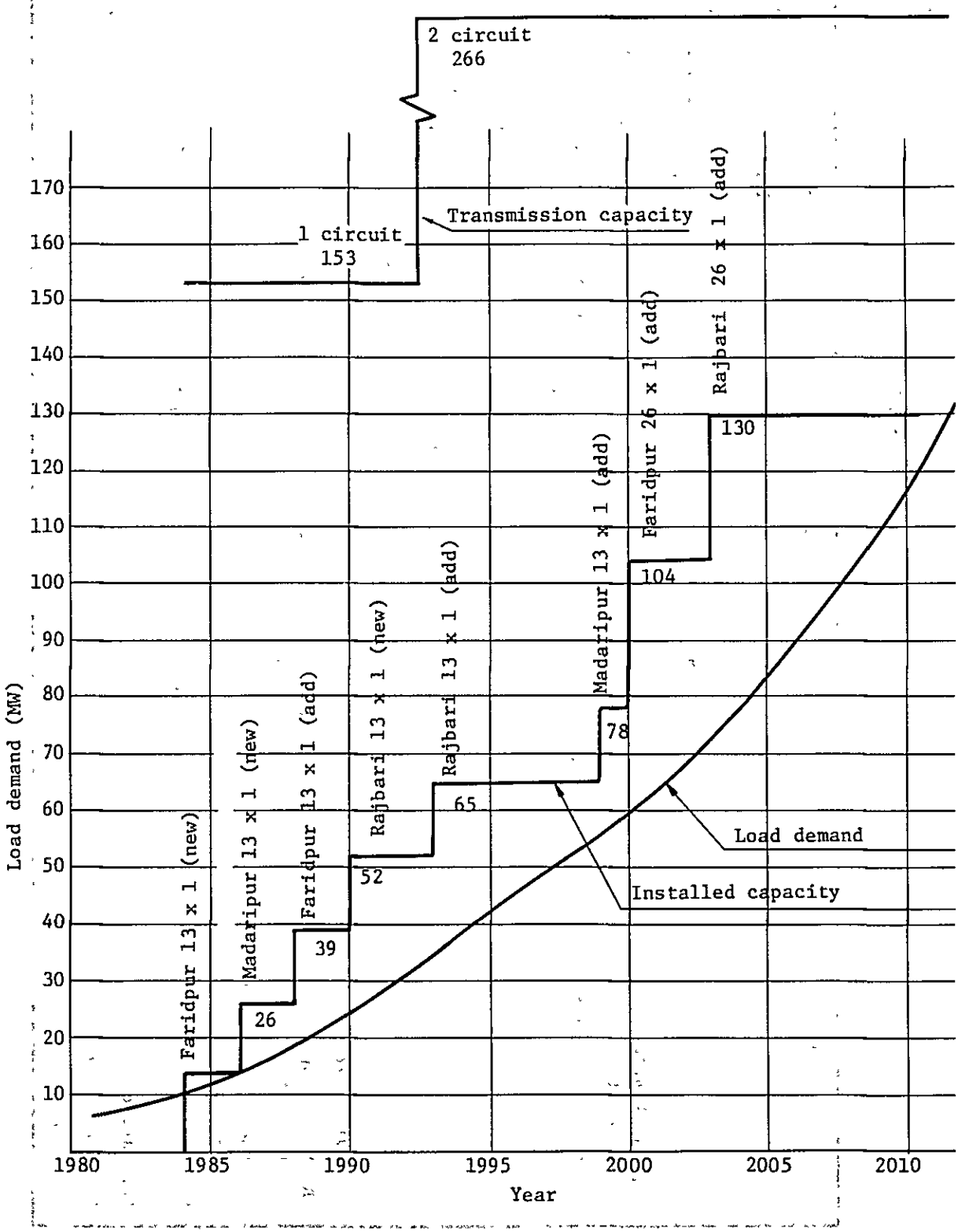


Table 11-2 Facilities in each Thermal Power Station

Facilities	Rajbari P.S.	Faridpur P.S.	Madaripur P.S.	Total
1. Generator	10 MW Gas-turbine Generators...2 units 20 MW Gas-turbine Generators...2 units Total 60 MW	10 MW Gas-turbine Generators...2 units 20 MW Gas-turbine Generators...2 units Total 60 MW	6 MW Diesel Engine Generators....2 units 7 MW Diesel Engine Generators....3 units Total 33 MW	153 MW
2. Auxiliaries to Generator	1 set	1 set	1 set	
3. Main Transformer	23 MVA ..... 1 bank 46 MVA ..... 1 bank	23 MVA ..... 1 bank 46 MVA ..... 1 bank	14 MVA ..... 1 bank 25 MVA ..... 1 bank	177 MVA
4. Transformer for Starting	1.1 MVA..... 1 bank	1.1 MVA..... 1 bank	1.2 MVA..... 1 bank	3.4 MVA
5. Transformer for Station Service	750 KVA..... 1 bank 1,500 KVA .. 1 bank	750 KVA..... 1 bank 1,500 KVA .. 1 bank	900 KVA..... 1 bank 1,500 KVA ... 1 bank	6,900 KVA
6. Ceiling Travelling Crane	30/5 ton ... 1 set	30/5 ton ... 1 set	20 ton ..... 1 set	3 sets
7. Switchyard	1 set	1 set	1 set	
8. Fuel Storage Facilities	6,000 Klx2 units 2 units	6,000 Klx2 units 2 units	2,500 Klx2 units 2 units	6 units
9. Fuel Processing Facility				
10. Cooler for Cooling Water	4 units	4 units	5 units	13 units
11. Warehouse				
12. Repair Shop				
13. Others				

Table 11-3 Demand Forecast and Extention in Substations after 1986/87

Year	Rajbari S.S.		Faridpur S.S.		Madaripur S.S.		Total	
	Max. demand MW	SS Capacity MW	Max. demand MW	SS Capacity MW	Max. demand MW	SS Capacity MW	Max. demand MW	Energy GWH
86/87	5.7		6.8		3.7		16.2	71.0
87/88	6.6		7.9	13x1 add	4.3		18.8	82.3
88/89	7.6		9.2		4.9		21.7	95.1
89/90	8.9	13x1 new	10.6		5.7		25.2	110.4
90/91	9.9	Installing Capacitor	11.8	Installing Capacitor	6.3	Installing Capacitor	28.0	122.6
91/92	11.0		13.1		7.0		31.1	136.2
92/93	12.2	13x1 add	14.5		7.8		34.5	151.1
93/94	13.5		16.1		8.7		38.3	167.8
94/95	15.0		17.9		9.6		42.5	186.2
95/96	16.1		19.2		10.3		45.6	199.7
96/97	17.2		20.5		11.0		48.7	213.3
97/98	18.4		21.9		11.8		52.1	228.2
98/99	19.7		23.4		12.6	13x1 add	55.7	244.0
99/2000	21.1		25.0	26x1 add	13.5		59.6	261.1
2000/01	22.6		26.8		14.4		63.8	279.4
01/02	24.2		28.7		15.0		67.9	297.4
02/03	25.9	26x1 add	30.7		16.1		72.7	318.4
03/04	27.7		32.8		17.2		77.7	340.3
04/05	29.6		35.1		18.4		83.1	346.0
05/06	31.7		37.6		19.7		89.0	389.8
06/07	33.9		40.2		21.1		95.2	417.0
07/08	36.3		43.0		22.6		101.9	446.3
08/09	38.8		46.0		24.2		109.0	477.4

Table 11-4 Construction Costs of the Envisaged Future Extention

	Foreign currency		Local currency	Total	Foreign currency		Local currency	Total
	¥('000)	Equivalent TK('000)	¥('000)	TK('000)	¥('000)	Equivalent TK('000)	¥('000)	TK('000)
Year/Site	87/88 Faridpur Substation extension				92/93 Rajbari substation extension			
Equipment	70,000	5,263			70,000	5,263		
Import duties and transportation cost to site			1,579				1,579	
Construction work			150				150	
Contingency		526	173			526	173	
Engineering fee		526	173			526	173	
Total	70,000	6,315	2,075	8,390		6,315	2,075	8,390
Year/Site	89/90 Rajbari new substation				98/99 Madaripur substation extension			
Equipment	229,100	17,227			70,000	5,263		
Import duties and transportation cost to site			5,168				1,579	
Construction work			1,601				150	
Contingency		1,723	677			526	173	
Engineering fee		1,723	677			526	173	
Total		20,673	8,123	28,796		6,315	2,075	8,390
Year/Site	90/91 Capacitor installation in 3 substations				99/2000 Faridpur substation extension			
Equipment	33,000	2,481			140,000	10,526		
Import duties and transportation cost to site			744				3,158	
Construction work			452				300	
Contingency		248	120			1,053	346	
Engineering fee		248	120			1,053	346	
Total		2,977	1,436	4,413		12,632	4,150	16,782
Year/Site	92/93 Duplicating of transmission line				02/03 Rajbari substation extension			
Equipment	704,862	52,997			140,000	10,526		
Import duties and transportation cost to site			15,899				3,158	
Construction work			4,503				300	
Contingency		5,300	1,907			1,053	346	
Engineering fee		3,459	865			1,053	346	
Total		61,756	23,174	84,930		12,632	4,150	16,782

Table 11-5 Unit Cost that the Transmission Line Purchase from the Sources

Assumptions:

Eastern grid transmits power during only off-peak hours (19.5 hours a day), that is the energy transmitted from the East will be 70% of required energy in West. The maximum transable power capacity of one circuit is fixed 150% of rating.

Item / Year	Eastern Grid		Western Grid			Unit Cost	% Supplyed from East
	Supply Energy GWH (a)	TK (a)x0.242 (b)x10^9	Total Demand GWH (c)	Supply Energy GWH (d),(c-a)	TK (d)x0.776 (e)	TK/kWh (b+e/c)	
1983/84	698.5	169.0	997.9	299.4	332.3	0.502	70
84/85	810.5	196.1	1,157.76	347.4	269.6	0.402	70
85/86	940.1	227.5	1,343.01	402.9	312.7	0.402	70
86/87	1,005.2	243.3	1,557.79	552.6	428.8	0.431	64.5
87/88	1,005.2	243.3	1,807.06	801.9	622.3	0.479	55.6
88/89	1,005.2	243.3	2,096.49	1,090.8	846.5	0.519	48
89/90	1,702.2	411.9	2,431.72	729.5	566.1	0.402	70
90/91	1,702.2	411.9	2,699.14	951.5	738.4	0.426	63
91/92	1,702.2	411.9	2,995.92	1,577.9	1,224.5	0.546	56.8
92/93	1,702.2	411.9	3,325.54	1,623.3	1,259.7	0.502	51.2
93/94	1,702.2	411.9	3,691.44	1,989.2	1,543.7	0.529	46.1
94/95	1,702.2	411.9	4,097.52	2,395.3	1,858.8	0.554	41.5
95/96	1,702.2	411.9	4,384.30	2,682.1	2,081.3	0.568	38.8
96/97	1,702.2	411.9	4,691.20	2,989.0	2,319.5	0.582	36.2
97/98	1,702.2	411.9	5,019.60	3,317.4	2,574.3	0.595	33.9
98/99	1,702.2	411.9	5,370.90	3,668.7	2,846.9	0.606	31.7
99/2000	1,702.2	411.9	5,746.90	4,044.7	3,138.7	0.618	29.6
2000/01	1,702.2	411.9	6,149.20	4,447.0	3,450.9	0.628	27.6
01/02	1,702.2	411.9	6,579.60	4,877.4	3,784.9	0.638	25.8
02/03	1,702.2	411.9	7,040.20	5,338.0	4,142.3	0.647	24.1
03/04	1,702.2	411.9	7,533.10	5,830.9	4,524.8	0.655	22.6
04/05	1,702.2	411.9	8,060.30	6,358.1	4,933.9	0.663	21.1
05/06	1,702.2	411.9	8,624.60	6,922.4	5,371.8	0.670	19.7
06/07	1,702.2	411.9	9,228.30	7,526.1	5,840.3	0.677	18.4
07/08	1,702.2	411.9	9,874.30	8,172.1	6,341.5	0.684	17.2
08/09	1,702.2	411.9	10,565.50	8,863.3	6,877.9	0.690	16.1

Table 11-6 Costs for this Project

10^3TK

Year	Construction Costs	Purchasing Energy Costs	Maintenance Costs	Total Costs
79/80	6,263			6,263
80/81	9,499			9,499
81/82	153,619			153,619
82/83	98,753			98,763
83/84	132,295	17,590	5,363	155,248
84/85	99,617	16,375	8,009	124,001
85/86		24,643	10,001	34,644
86/87		30,601	10,001	40,602
87/88	8,390	39,422	10,001	57,813
88/89		49,357	10,169	59,526
89/90	28,796	44,381	10,169	83,346
90/91	4,413	52,228	10,745	67,386
91/92		74,256	10,833	85,089
92/93	93,320	75,852	10,833	191,438
93/94		88,766	12,928	101,694
94/95		103,155	12,928	116,083
95/96		113,430	12,928	126,358
96/97		124,141	12,928	137,069
97/98		136,374	12,928	149,302
98/99	8,390	147,864	12,928	169,182
99/2000	16,782	161,360	13,096	191,238
2000/01		175,463	13,432	188,895
01/02		189,741	13,432	203,173
02/03	16,782	206,005	13,432	236,219
03/04		222,897	13,767	236,664
04/05		229,398	13,767	243,165
05/06		261,166	13,767	274,933
06/07		282,309	13,767	296,076
07/08		305,269	13,767	319,036
08/09		329,406	13,767	343,173

Table 11-7 Costs Estimation of Alternative Plan

Year		1981/82				1982/83				1983/84			
Currency		Foreign Currency		Local Currency	Total	Foreign Currency		Local Currency	Total	Foreign Currency		Local Currency	Total
Unit		Yen(1000)	TK(1000)	TK(1000)	TK(1000)	Yen(1000)	TK(1000)	TK(1000)	TK(1000)	Yen(1000)	TK(1000)	TK(1000)	TK(1000)
Rajbari Power Station	Land purchasing			758	758								
	Civil and building			11,241	11,241			5,631	5,631				
	Equipments (CIF)	194,031	14,589		14,589	776,128	58,355		58,355				
	Import duties and inland transportation							21,882	21,882				
	Installation of equipments					91,875	6,908	12,747	19,655				
	Contingency	19,403	1,459	2,000	3,459	86,800	6,526	4,026	10,552				
	Engineering fee and overhead	15,313	1,151	1,163	2,314	15,313	1,151	3,142	4,293				
	Total	228,747	17,199	15,162	32,361	970,116	72,940	47,428	120,368				
Faridpur Power Station	Land purchasing			758	758								
	Civil and building			11,241	11,241			5,631	5,631				
	Equipments (CIF)	194,031	14,589		14,589	776,128	58,355		58,355				
	Import duties and inland transportation							21,882	21,882				
	Installation of equipments					91,875	6,908	12,747	19,655				
	Contingency	19,403	1,459	2,000	3,459	86,800	6,526	4,026	10,552				
	Engineering fee and overhead	15,313	1,151	1,163	2,314	15,313	1,151	3,142	4,293				
	Total	228,747	17,199	15,162	32,361	970,116	72,940	47,428	120,368				
Madaripur Power Station	Land purchasing											657	657
	Civil and building											11,414	11,414
	Equipments (CIF)									128,192	9,638		9,638
	Import duties and inland transportation												
	Installation of equipments												
	Contingency									12,819	964	1,207	2,171
	Engineering fee and overhead									12,250	921	1,124	2,045
	Total									153,261	11,523	14,402	25,925
Grand Total		457,494	34,398	30,324	64,722	1,940,232	145,880	94,856	240,736	153,261	11,523	14,402	25,925

Table 11-7 (2)

Year		1984/85				1987/88				1988/89			
Currency		Foreign Currency		Local Currency	Total	Foreign Currency		Local Currency	Total	Foreign Currency		Local Currency	Local
Unit		Yen(1000)	TK(1000)	TK(1000)	TK(1000)	Yen(1000)	TK(1000)	TK(1000)	TK(1000)	Yen(1000)	TK(1000)	TK(1000)	TK(1000)
Rajbari Power Station	Land purchasing												
	Civil and building							8,028	8,028			4,745	4,745
	Equipments (CIF)					134,750	10,132		10,132	539,000	40,526		40,526
	Import duties and inland transportation											15,198	15,198
	Installation of equipments									91,875	6,908	7,303	14,211
	Contingency					13,475	1,013	803	1,816	63,088	4,743	2,725	7,468
	Engineering fee and overhead					15,313	1,151	886	2,037	15,313	1,151	2,231	3,382
	Total					163,538	12,296	9,717	22,013	709,276	53,328	32,202	85,530
Faridpur Power Station	Land purchasing												
	Civil and building							8,028	8,028			4,745	4,745
	Equipments (CIF)					134,750	10,132		10,132	539,000	40,526		40,526
	Import duties and inland transportation											15,198	15,198
	Installation of equipments									91,875	6,908	7,303	14,211
	Contingency					13,475	1,013	803	1,816	63,088	4,743	2,725	7,468
	Engineering fee and overhead					15,313	1,151	886	2,037	15,313	1,151	2,231	3,382
	Total					163,538	12,296	9,717	22,013	709,276	53,328	32,202	85,530
Madaripur Power Station	Land purchasing							758	758				
	Civil and building			4,604	4,604			8,559	8,559			3,840	3,840
	Equipments (CIF)	512,773	38,554		38,554	107,716	8,098		8,098	430,866	32,396		32,396
	Import duties and inland transportation			14,457	14,457							12,147	12,147
	Installation of equipments	55,125	4,145	8,654	12,799					55,125	4,145	6,936	11,081
	Contingency	56,790	4,270	2,772	7,042	10,772	810	932	1,742	48,601	3,654	2,292	5,946
	Engineering fee and overhead	12,250	921	2,171	3,092	12,250	921	924	1,845	12,250	921	1,877	2,798
	Total	636,938	47,890	32,658	80,548	130,738	9,829	11,173	21,002	546,842	41,116	27,092	68,208
Grand Total		636,938	47,890	32,658	80,548	457,814	34,421	30,607	65,028	1,965,394	147,772	91,496	239,268

Table 11-7 (3)

Year		1994/95				1995/96				2001/02			
Currency		Foreign Currency		Local Currency	Total	Foreign Currency		Local Currency	Total	Foreign Currency		Local Currency	Total
Unit		Yen(1000)	TK(1000)	TK(1000)	TK(1000)	Yen(1000)	TK(1000)	TK(1000)	TK(1000)	Yen(1000)	TK(1000)	TK(1000)	TK(1000)
Rajbari Power Station	Land purchasing							758	758				
	Civil and building			12,864	12,864			6,031	6,031				
	Equipments (CIF)	378,036	28,424		28,424	1,512,143	113,695		113,695	269,500	20,263		20,263
	Import duties and inland transportation							42,636	42,636				
	Installation of equipments					183,750	13,815	24,291	38,106				
	Contingency	37,804	2,842	1,286	4,128	169,590	12,751	7,372	20,123	26,950	2,026		2,026
	Engineering fee and overhead	15,313	1,151	1,224	2,375	15,313	1,151	5,484	6,635	9,188	691	190	881
	Total	431,153	32,417	15,374	47,791	1,880,796	141,412	86,572	227,984	305,638	22,980	190	23,170
Faridpur Power Station	Land purchasing							758	758				
	Civil and building			12,864	12,864			6,031	6,031				
	Equipments (CIF)	378,036	28,424		28,424	1,512,143	113,695		113,695	269,500	20,263		20,263
	Import duties and inland transportation							42,636	42,636				
	Installation of equipments					183,750	13,815	24,291	38,106				
	Contingency	37,804	2,842	1,286	4,128	169,590	12,751	7,372	20,123	26,950	2,026		2,026
	Engineering fee and overhead	15,313	1,151	1,224	2,375	15,313	1,151	5,484	6,635	9,188	691	190	881
	Total	431,153	32,417	15,374	47,791	1,880,796	141,412	86,572	227,984	305,638	22,980	190	23,170
Madaripur Power Station	Land purchasing												
	Civil and building			11,730	11,730			4,633	4,633				
	Equipments (CIF)	244,529	18,386		18,386	978,112	73,542		73,542	94,325	7,092		7,092
	Import duties and inland transportation							27,579	27,579				
	Installation of equipments					128,380	9,653	15,185	24,838				
	Contingency	24,453	1,839	1,173	3,012	110,649	8,320	4,740	13,060	9,433	709		709
	Engineering fee and overhead	12,250	921	1,175	2,096	12,250	921	3,589	4,510	9,188	691	220	911
	Total	281,232	21,146	14,078	35,224	1,229,391	92,436	55,726	148,162	112,946	8,492	220	8,712
Grand Total		1,143,538	85,980	44,826	130,806	4,990,983	375,260	228,870	604,130	724,222	54,452	600	55,052

Table 11-7 (4)

Year		2002/03				Total			
Currency		Foreign Currency		Local Currency	Total	Foreign Currency		Local Currency	Total
Unit		Yen(1000)	TK(1000)	TK(1000)	TK(1000)	Yen(1000)	TK(1000)	TK(1000)	TK(1000)
Rajbari Power Station	Land purchasing							1,516	1,516
	Civil and building							48,540	48,540
	Equipments (CIF)	1,078,000	81,053		81,053	4,881,588	367,037		367,037
	Import duties and inland transportation			30,396	30,396			110,112	110,112
	Installation of equipments	183,750	13,815	14,606	28,421	551,250	41,446	58,947	100,393
	Contingency	126,175	9,487	4,500	13,987	480,197	40,847	22,712	63,559
	Engineering fee and overhead	9,188	691	3,340	4,031	110,254	8,288	17,660	25,948
	Total	1,397,118	105,046	52,842	157,888	6,086,382	457,618	259,487	717,105
Faridpur Power Station	Land purchasing							1,516	1,516
	Civil and building							48,540	48,540
	Equipments (CIF)	1,078,000	81,053		81,053	4,881,588	367,037		367,037
	Import duties and inland transportation			30,396	30,396			110,112	110,112
	Installation of equipments	183,750	13,815	14,606	28,421	551,250	41,446	58,947	100,393
	Contingency	126,175	9,487	4,500	13,987	480,197	40,847	22,712	63,559
	Engineering fee and overhead	9,188	691	3,340	4,031	110,254	8,288	17,660	25,948
	Total	1,397,118	105,046	52,842	157,888	6,086,382	457,618	259,487	717,105
Madaripur Power Station	Land purchasing							1,415	1,415
	Civil and building							44,780	44,780
	Equipments (CIF)	377,300	28,368		28,368	2,873,813	216,074		216,074
	Import duties and inland transportation			10,638	10,638			64,821	64,821
	Installation of equipments	52,500	3,947	5,111	9,058	291,130	21,890	35,886	57,776
	Contingency	42,980	3,232	1,575	4,807	316,497	23,798	14,691	38,489
	Engineering fee and overhead	9,188	691	1,292	1,983	91,876	6,908	12,372	19,280
	Total	481,968	36,238	18,616	54,854	3,573,316	268,670	173,965	442,635
Grand Total		3,276,204	246,330	124,300	370,630	15,746,080	1,183,906	692,939	1,876,845

Table 11-8 Consumption & Cost of Fuel for Three (3) Power Plants

Year	Diesel Engine Power Plant			Gas Turbine Power Plant			Total
	Output Energy (GWH)	Consumption (ton)	Cost (10^3TK)	Output Energy (GWH)	Consumption (ton)	Cost (10^3TK)	(10^3TK)
83/84				35.0	10,745	21,221	21,221
84/85				40.7	12,495	24,678	24,678
85/86	14.0	3,206	10,400	47.3	14,521	28,679	39,079
86/87	16.2	3,709	12,032	54.8	16,824	33,227	45,259
87/88	18.8	4,305	13,965	63.5	19,495	38,503	52,468
88/89	21.5	4,926	15,980	73.6	22,595	44,625	60,605
89/90	25.0	5,725	18,572	85.4	26,218	51,781	70,353
90/91	27.6	6,320	20,502	95.1	29,196	57,662	78,164
91/92	30.7	7,030	22,805	105.6	32,419	64,028	87,013
92/93	34.2	7,832	25,407	116.9	35,888	70,879	96,286
93/94	38.1	8,725	28,304	129.6	39,787	78,579	106,883
94/95	42.1	9,641	31,275	144.1	44,239	87,372	118,647
95/96	45.1	10,328	33,504	154.6	47,462	93,737	127,241
96/97	48.2	11,038	35,807	165.1	50,686	100,105	135,912
97/98	51.7	11,839	38,406	176.5	54,186	107,017	145,423
98/99	55.2	12,641	41,007	188.8	57,962	114,475	155,482
99/2000	59.1	13,534	43,904	201.9	61,983	122,416	166,320
2000/01	63.1	14,450	46,876	216.4	66,435	131,209	178,085
01/02	65.7	15,045	48,806	231.7	71,132	140,486	189,292
02/03	70.5	16,145	52,374	247.9	76,105	150,307	202,681
03/04	75.3	17,244	55,940	265.0	81,355	160,676	216,616
04/05	80.6	18,457	59,875	283.4	87,004	171,833	231,708
05/06	86.3	19,763	64,111	303.4	93,205	184,080	248,191
06/07	92.4	21,160	68,643	324.6	99,652	196,813	265,456
07/08	99.0	22,671	73,545	347.3	106,621	210,576	284,121
08/09	106.0	24,274	78,745	371.4	114,020	225,190	303,935

Assumption:

1. Diesel engine power plant: consumption per KWH = 229 gr./KWH
   Gas turbine power plant: consumption per KWH = 307 gr./KWH

2. Price of fuel

	1977/78	1981/82
Naphtha	TK 1,527/ton	TK 1,975/ton
Diesel Oil	TK 2,505/ton	TK 3,244/ton

Table 11-9 Cost Estimation for Alternative Plan
(Thermal Power Plants)

Year	Construction Cost	Maintenance Cost	Cost of Fuel	Total
80/81				
81/82	64,722			64,722
82/83	240,736			240,736
83/84	25,925	10,080	21,221	57,226
84/85	80,548	10,080	24,678	115,306
85/86		13,597	28,679	52,676
86/87		13,597	45,259	58,856
87/88	65,028	13,597	52,468	131,093
88/89	239,268	15,743	60,605	315,615
89/90		23,639	70,353	93,992
90/91		23,639	78,164	101,803
91/92		23,639	87,013	110,652
92/93		23,639	96,286	119,925
93/94		23,639	106,883	130,522
94/95	130,806	23,639	118,647	273,092
95/96	604,130	27,956	127,241	759,327
96/97		47,892	135,912	183,804
97/98		47,892	145,423	193,315
98/99		47,892	155,482	203,374
99/2000		47,892	166,320	214,212
2000/01		47,892	178,055	225,947
01/02	55,052	47,892	189,292	292,235
02/03	370,631	49,709	202,681	623,021
03/04		61,940	216,616	278,556
04/05		61,940	231,708	293,648
05/06		61,940	248,191	310,131
06/07		61,940	265,456	327,396
07/08		61,940	284,121	346,061
08/09		61,940	303,935	365,875

Table 11-10 Comparison between Alternative and the Project

Year	Alternative		The Project	
	Cost	Present Value at 15% Discount Rate as of 80/81	Cost	Present Value at 15% Discount Rate as of 80/81
79/80			6,263	7,202
80/81			9,499	9,499
81/82	64,722	56,282	153,619	133,582
82/83	240,736	182,020	98,763	74,679
83/84	60,794	39,972	155,248	102,078
84/85	120,166	68,711	124,001	70,898
85/86	42,276	21,020	34,644	17,224
86/87	58,856	25,449	40,602	17,553
87/88	131,093	49,281	57,813	21,734
88/89	315,615	103,175	59,526	19,459
89/90	93,992	26,715	83,346	23,692
90/91	101,803	25,162	67,386	16,657
91/92	110,652	23,784	85,089	18,289
92/93	119,925	22,412	179,641	33,574
93/94	130,522	21,214	101,694	16,528
94/95	273,092	38,597	116,083	16,406
95/96	759,327	93,314	126,358	15,529
96/97	183,804	19,643	137,069	14,648
97/98	193,315	17,966	149,302	13,874
98/99	203,374	16,432	169,182	13,671
99/2000	214,212	15,053	191,238	13,437
2000/01	225,947	13,803	188,895	11,541
01/02	292,235	15,531	203,173	10,795
02/03	623,021	28,788	236,219	10,913
03/04	278,556	11,883	236,664	9,508
04/05	293,648	10,260	243,165	8,495
05/06	310,131	9,419	274,933	8,352
06/07	327,396	8,648	296,076	7,821
07/08	346,061	7,947	319,036	7,328
08/09	365,875	7,306	343,173	6,854
Total		986,467		751,820

Table 11-11 Estimation of Unit Price on the Proforma
(For Reference)

Assumptions:

1. The energy (GWH) and unit price (24.2 paisa/KWH) transfered from East-West Interconnector are derived from "Project Proforma East-West Interconnector issued from Directorate of Project Planning PDB, April 1978".
2. The unit price received from the Western Grid is shown in Annex VIII.
3. Obtained unit price is calculated with the weighted average.

Item / Year	Eastern Grid		Western Grid			Unit Price
	Transfered Energy GWH (a)	TK (a)x0.242 (b)x10^9	Total Demanded Energy GWH (c)	Receiving Energy GWH (d),(c-a)	TK (d)x0.776 (e)	TK/KWH (b+e/c)
1983/84	405.0	98.01	997.9	592.7	460.10	0.559
84/85	491.27	118.89	1,157.76	666.49	517.19	0.549
85/86	687.64	166.41	1,343.01	655.97	509.03	0.503
86/87	873.86	211.47	1,557.79	683.93	530.73	0.476
87/88	859.32	207.96	1,807.06	947.74	735.45	0.522
88/89	962.47	232.92	2,096.49	1,134.02	879.99	0.531
89/90	1,109.59	268.52	2,431.72	1,322.13	1,025.97	0.532
90/91	1,201.04	290.65	2,699.14	1,498.10	1,162.52	0.538
91/92	1,190.25	288.04	2,995.92	1,805.67	1,401.20	0.564
92/93	1,347.13	326.01	3,325.54	1,978.41	1,535.24	0.559
93/94	1,410.64	341.37	3,691.44	2,280.80	1,769.90	0.572
94/95	1,546.08	374.15	4,097.52	2,551.40	1,979.90	0.550
95/96	1,691.01	409.22	4,384.30	2,693.30	2,090.00	0.570
96/97	1,822.43	441.03	4,691.20	2,868.80	2,226.20	0.568
97/98	1,870.09	452.56	5,019.60	3,149.60	2,444.10	0.577
98/99	2,047.64	495.53	5,370.90	3,323.90	2,579.30	0.572
99/2000	2,190.29	530.05	5,746.90	3,556.60	2,759.90	0.572
2000/01	2,190.29	530.05	6,149.20	3,958.90	3,072.10	0.586
01/02	2,190.29	530.05	6,579.60	4,389.30	3,406.10	0.598
02/03	2,190.29	530.05	7,040.20	4,849.90	3,763.50	0.609
03/04	2,190.29	530.05	7,533.10	5,342.80	4,146.00	0.621
04/05	2,190.29	530.05	8,060.30	5,870.00	4,555.10	0.631
05/06	2,190.29	530.05	8,624.60	6,434.30	4,993.00	0.640
06/07	2,190.29	530.05	9,228.30	7,038.00	5,461.40	0.649
07/08	2,190.29	530.05	9,874.30	7,684.00	5,962.80	0.657
08/09	2,190.29	530.05	10,565.50	8,375.20	6,499.10	0.665
09/10	2,190.29	530.05	11,305.10	9,114.80	7,073.10	0.672

Table 11-12 Power Demand Forecast in Faridpur District

Unit: MW

Year	Domestic Service				Industrial				Agricultural				Total
	R	F	M	Sub-total	R	F	M	Sub-total	R	F	M	Sub-total	
84/85	0.7	0.3	0.2	1.2	3.2	3.4	2.3	8.9	0.3	1.3	0.3	1.9	12.0
85/86	0.9	0.3	0.2	1.4	3.7	4.0	2.7	10.4	0.4	1.5	0.3	2.2	14.0
86/87	1.0	0.4	0.2	1.6	4.3	4.7	3.0	12.0	0.4	1.8	0.4	2.6	16.2
87/88	1.1	0.5	0.3	1.9	5.0	5.5	3.4	13.9	0.5	2.0	0.5	3.0	18.8
88/89	1.3	0.6	0.3	2.2	5.8	6.1	4.1	16.0	0.6	2.4	0.5	3.5	21.7
89/90	1.5	0.7	0.4	2.6	6.7	7.0	4.9	18.6	0.7	2.7	0.6	4.0	25.2
90/91	1.7	0.8	0.4	2.9	7.4	7.9	5.4	20.7	0.7	3.0	0.7	4.4	28.0
91/92	1.8	0.9	0.5	3.2	8.3	8.8	5.9	23.0	0.8	3.4	0.7	4.9	31.1
92/93	2.0	1.0	0.5	3.5	9.2	9.8	6.6	25.6	0.9	3.7	0.8	5.4	34.5
93/94	2.2	1.1	0.6	3.9	10.2	10.8	7.4	28.4	1.0	4.1	0.9	6.0	38.3
94/95	2.5	1.2	0.6	4.3	11.3	12.0	8.2	31.5	1.1	4.6	1.0	6.7	42.5
95/96	2.7	1.2	0.7	4.6	12.1	12.9	8.8	33.8	1.2	4.9	1.1	7.2	45.6
96/97	2.9	1.3	0.7	4.9	13.0	13.9	9.2	36.1	1.2	5.3	1.2	7.7	48.7
97/98	3.1	1.3	0.8	5.2	13.9	14.7	10.0	38.6	1.3	5.7	1.3	8.3	52.1
98/99	3.3	1.4	0.9	5.6	14.8	15.7	10.7	41.2	1.4	6.1	1.4	8.9	55.7
99/2000	3.5	1.5	1.0	6.0	15.9	16.8	11.4	44.1	1.5	6.5	1.5	9.5	59.6

Note: R : Rajbari
F : Faridpur
M : Madaripur

Table 11-13 Annual Consumer Profit rendered by this Project

Unit: Energy 10^3KWH Profit x10^3TK

Year	Domestic service		Industrial		Agricultural		Total Profit
	Energy	Profit	Energy	Profit	Energy	Profit	
84 - 85	3,500	14,100	38,900	10,500	8,300	4,300	28,900
85 - 86	4,100	16,500	45,400	12,300	9,600	5,000	33,800
86 - 87	4,700	18,900	52,400	14,100	11,400	5,900	38,900
87 - 88	5,500	22,200	60,700	16,400	13,100	6,800	45,400
88 - 89	6,400	25,800	70,000	18,900	15,300	8,000	52,700
89 - 90	7,400	29,800	81,200	21,900	17,500	9,100	60,800
90 - 91	8,400	33,900	90,500	24,400	19,300	10,000	68,300
91 - 92	9,300	37,400	100,500	27,100	21,400	11,100	75,600
92 - 93	10,300	41,500	111,900	30,200	23,600	12,300	84,000
93 - 94	11,400	45,900	124,200	33,500	26,200	13,600	93,000
94 - 95	12,400	50,000	137,700	37,200	29,300	15,200	102,400
95 - 96	13,400	54,000	147,700	39,900	31,400	16,300	110,200
96 - 97	14,300	57,600	157,800	42,600	33,600	17,400	117,600
97 - 98	15,300	61,700	168,700	45,500	36,300	18,900	126,100
98 - 99	16,400	66,100	180,000	48,600	38,900	20,200	134,700
99 - 2000	17,500	70,500	192,700	52,000	41,500	21,600	144,100

Note: Power factor of domestic service is assumed 33%.

ANNEX I

METEOROLOGICAL DATA

- CLIMATOLOGICAL DATA
- ANNUAL RAIN FALL
- WIND ROSE
- OCCURENCES OF STORMS/CYCLONES THAT AFFECTED BANGLADESH

ГЛАВА 1

ANNEX I-1 CLIMATOLOGICAL DATA BASED ON 1961 - 76

AT : BARISAL STATION

Month	Temperature in °F				Relative Humidity in %			Total Rainfall in Inches
	Max.	Min.	Highest Max.	Lowest Min.	0000 G.M.T.	0300 G.M.T.	1200 G.M.T.	
Jan.	77.8	54.1	89	44	91	79	66	0.39
Feb.	32.9	60.0	93	45	91	72	61	0.61
Mar.	90.1	68.9	100	53	91	73	62	1.42
Apr.	91.9	74.5	100	61	92	77	72	2.82
May	91.8	76.9	100	65	92	78	76	7.57
June	88.7	78.2	97	71	94	86	85	16.38
July	86.4	78.4	97	72	95	88	86	14.97
Aug.	86.9	78.2	97	72	95	89	87	12.31
Sept.	88.3	78.2	95	70	95	86	85	11.35
Oct.	88.2	75.6	95	64	95	82	84	8.26
Nov.	83.7	65.8	91	51	94	80	77	1.64
Dec.	78.5	55.8	87	45	93	80	73	0.30

ANNEX I-2

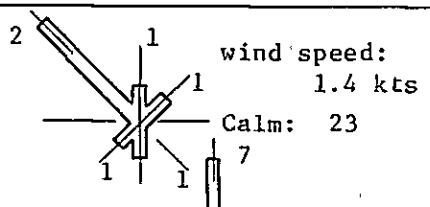
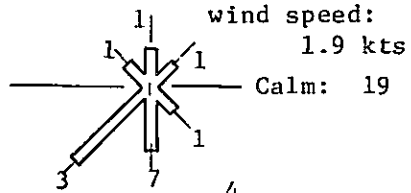
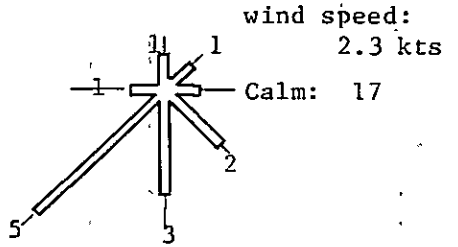
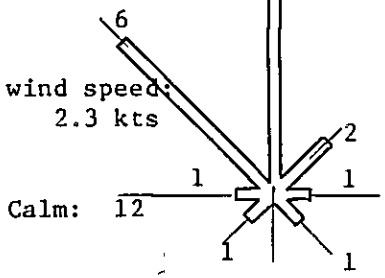
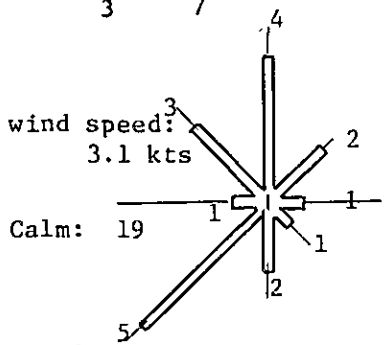
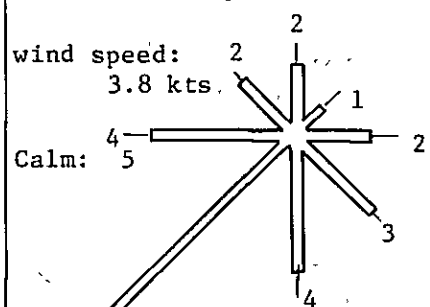
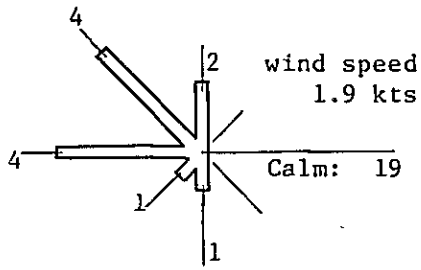
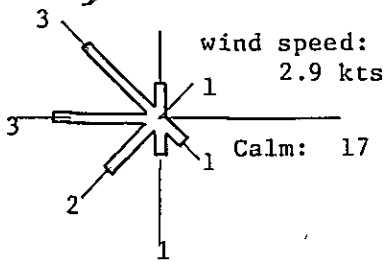
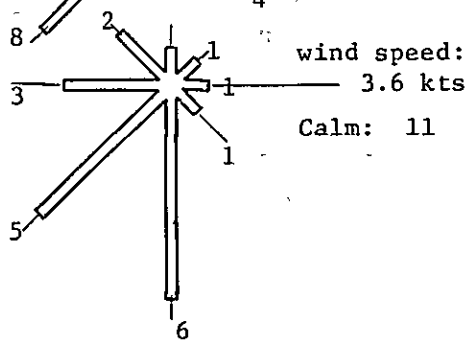
ANNUAL RAINFALL (IN INCHES)
(FROM 1948-77)

STATION	MEAN	MAXIMUM	MINIMUM
BARISAL	85.70	146.52	51.39
BOGRA	69.95	108.22	45.22
BRAHMANBARIA	77.34	100.46	51.49
CHITTAGONG	111.90	162.23	70.89
COMILLA	104.55	184.51	63.91
COX'S BAZAR	146.30	216.83	73.06
DACCA	79.44	107.23	52.19
DINAJPUR	68.03	101.83	41.22
FARIDPUR	71.53	116.50	52.66
ISHURDI	68.98	114.10	37.67
JESSORE	61.41	99.33	36.90
KHULNA	74.47	117.89	50.33
MYMENSINGH	125.96	157.63	95.93
NARAYANGANJ	79.21	110.02	53.70
RAJSHAHI	57.45	83.54	35.60
RANGPUR	83.53	120.61	48.40
RANGAMATI	100.72	143.04	55.67
SATHIRA	68.59	99.32	48.14
SIRAJGANJ	72.06	119.59	49.42
SRIMANGAL	101.34	123.98	77.21
SYLHET	172.28	221.34	142.39

STATION: DACCA

ANNEX I-3 WIND ROSE (BASED ON DATA 1961 - 1970)

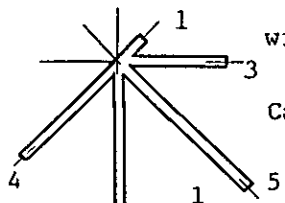
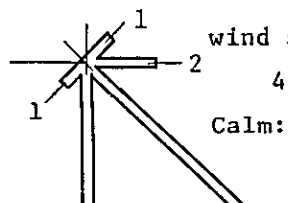
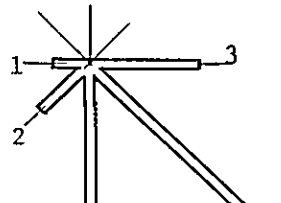
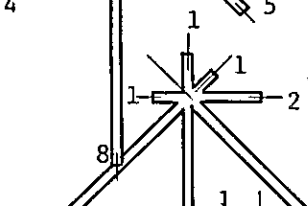
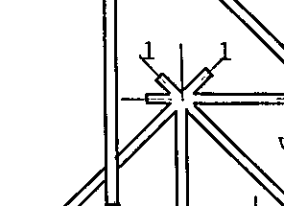
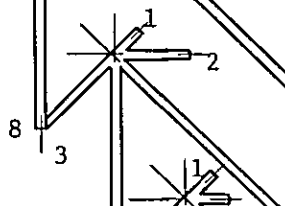
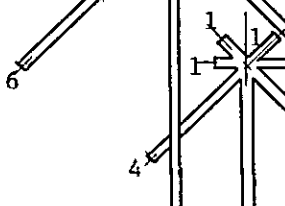
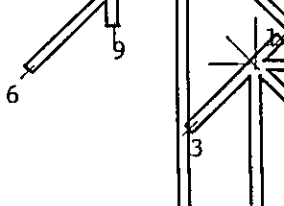
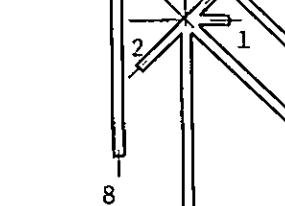
NO. OF DAYS OF WIND BLOWING FROM DIFFERENT DIRECTIONS: (1)

HOURS \ MONTH	January	February	March
06 AM (0000 GMT)			
09 AM (0300 GMT)			
06 PM (1200 GMT)			

STATION: DACCA

WIND ROSE (BASED ON DATA 1961 - 1970)

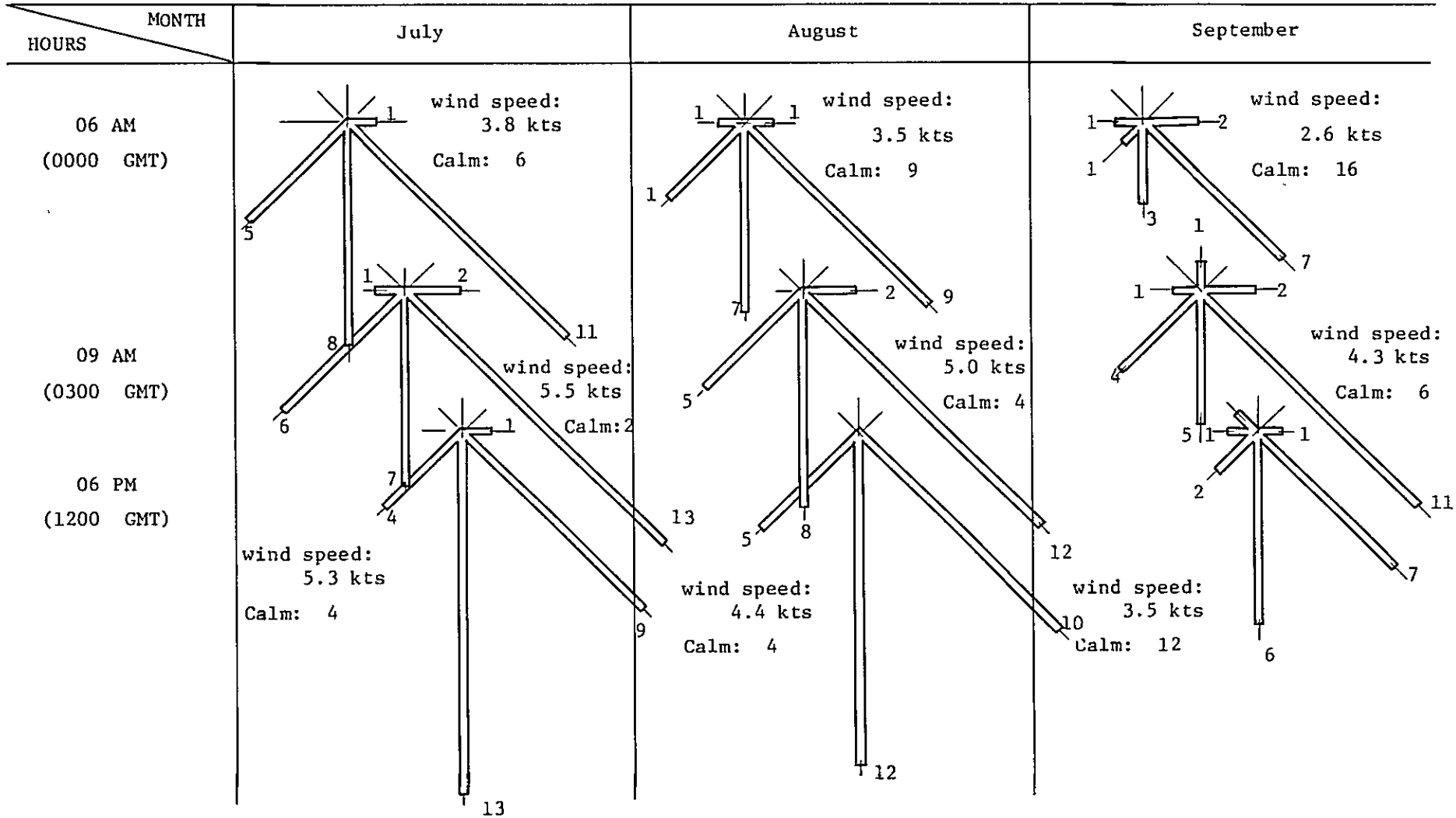
NO. OF DAYS OF WIND BLOWING FROM DIFFERENT DIRECTIONS: (2)

HOURS \ MONTH	April	May	June
06 AM (0000 GMT)	 wind speed: 3.5 kts Calm: 9	 wind speed: 4.4 kts Calm: 11	 wind speed: 3.8 kts Calm: 6
09 AM (0300 GMT)	 wind speed: 5.5 kts Calm: 2	 wind speed: 6.4 kts Calm: 2	 wind speed: 5.1 kts Calm: 2
09 PM (1200 GMT)	 wind speed: 6.2 kts Calm: 3	 wind speed: 5.6 kts Calm: 6	 wind speed: 4.6 kts Calm: 4

STATION: DACCA

WIND ROSE (BASED ON DATA 1961 - 1970)

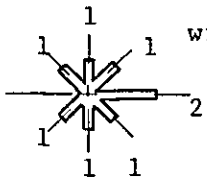
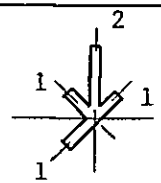
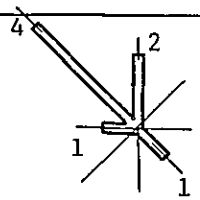
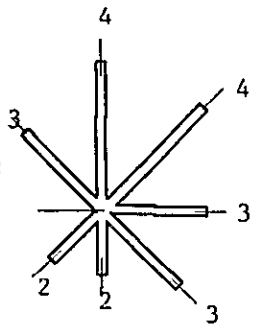
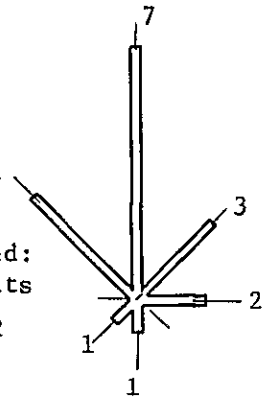
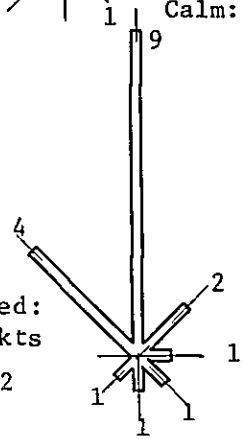
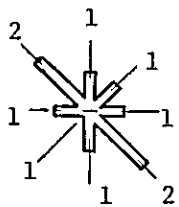
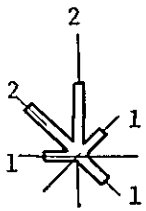
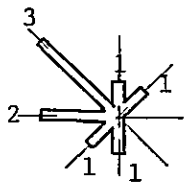
NO. OF DAYS OF WIND BLOWING FROM DIFFERENT DIRECTIONS: (3)



STATION: DACCA

WIND ROSE (BASED ON DATA 1961 - 1970)

NO. OF DAYS OF WIND BLOWING FROM DIFFERENT DIRECTIONS: (4)

HOURS \ MONTH	October	November	December
06 AM (0000 GMT)	 wind speed: 1.5 kts Calm: 23	 wind speed: 1.0 kts Calm: 25	 wind speed: 1.0 kts Calm: 23
09 AM (0300 GMT)	wind speed: 2.8 kts Calm: 10 	wind speed: 1.9 kts Calm: 12 	wind speed: 1.6 kts Calm: 12 
06 PM (1200 GMT)	 wind speed: 1.8 kts Calm: 22	 wind speed: 1.1 kts Calm: 23	 wind speed: 1.3 kts Calm: 22

ANNEX I-4 OCCURRENCES OF STORMS/CYCLONES THAT AFFECTED BANGLADESH

(1)

SL. No.	Date of occurrences	Type of storm	Maximum wind speed in the under noted station recorded in mill per hour	Storm surge with tidal wave
1.	25-29th May, 1960	Cyclonic storm (C.S)	Weakened	Monsoon become active in the Eastern district of B.D.
2	9-10th October, 1960	Severe cyclonic storm(S.C.S)	70-80 mph. (Estimated)	Storm surge plus astronomical tide of about 10 feet experienced in off shore island.
3	30-31th October, 1960	S.C.S.	Chittagong port 130 mph	Storm surge with tidal bore of about 20-30 at Chittagong.
4	9th May, 1961	S.C.S.	Comilla -92 mph. Dacca -90 mph.	10-22' (Storm surge with astronomical tide) recorded in different place of coastal area.
5	30th May, 1961	C.S.	Cox's Bazar 30 - 50 kts.	Tide of 21' at Ctg. port.
6	19-22nd September, 1962	C.S.	Cox's Bazar-20 kts. Akyab -30 kts. West Beng. -30 - 40 kts.	----------

... cont'd

OCCURRENCES OF STORMS/CYCLONES THAT AFFECTED BANGLADESH (cont'd) (2)

SL. No.	Date of occurrences	Type of storm	Maximum wind speed in the under noted station recorded in mill per hour	Storm surge with tidal wave
7	26-30th October, 1962	C.S.	Maijdee Court -30 kts	----------
8	28-29th May, 1963	S.C.S.	Patenga-125 mph Cox's Bazar -120 mph	8'-12' off-shore island and coastal area of Ctg. & N. khali District
9	5-8th June, 1963	C.S.	35-40 kts. in the coastal area, Cox's Bazar-40 kts. Pabna and Lamonirhat -45 kts.	----------
10	19-21st October, 1963	C.S.	Madras -40-50 kts	----------
11	11-12th May, 1965	S.C.S.	Dacca-100 mph.	7'-20' high tide wave
12	31st May, 1965	C.S.	Wind speed rain	----------
13	14-15th December, 1965	S.C.S.	Chittagong coastal left-130 mph.	7'-23' tide wave
14	Sept. 29-1st October, 1966	S.C.S.	Ctg. & Cox's Bazar -90 mph.	15'-32' tide wave
15	12th December, 1966	S.C.S.	Cox's Bazar -50mph. Ctg. -20-25 (Gusty wind)	---------- ... cont'd

OCCURRENCES OF STORMS/CYCLONES THAT AFFECTED BANGLADESH (cont'd)

(3)

SL. No.	Date of occurrences	Type of storm	Maximum wind speed in the under noted station recorded in mill per hour	Storm surge with tidal wave
16	10-11th October, 1967	C.S.	Sand Head - 60 kts.	----------
17	22-24th October, 1967	S.C.S.	Cox's Bazar N - 58 kts.	----------
18	10th May, 1968	S.C.S.	10 kts. at Ctg. Akyab - 120 mph.	----------
19	10th October, 1969	C.S.	35 mph N.E. of Patuakhali	----------
20	7th May, 1970	C.S.	Stormy weather	----------
21	23rd October, 1970	S.C.S.	Chittagong & Cox's Bazar -90 mph.	Moderate Storm surge
22	12th November, 1970	S.C.S.	Patenga reported 90 mph. and the broken ship at Chittagong port reported 138 mph.	10-20' surge with tide wave
23	7-8th May, 1971	C.S.	Petanga-50 mph. (estimated)	----------
24	28-30th September, 1971	S.C.S.	60-70 mph. in Khulna town	2' rise of seawater in Khulna town low lying areas inundated.

.... cont'd

OCCURRENCES OF STORMS/CYCLONES THAT AFFECTED BANGLADESH (cont'd)

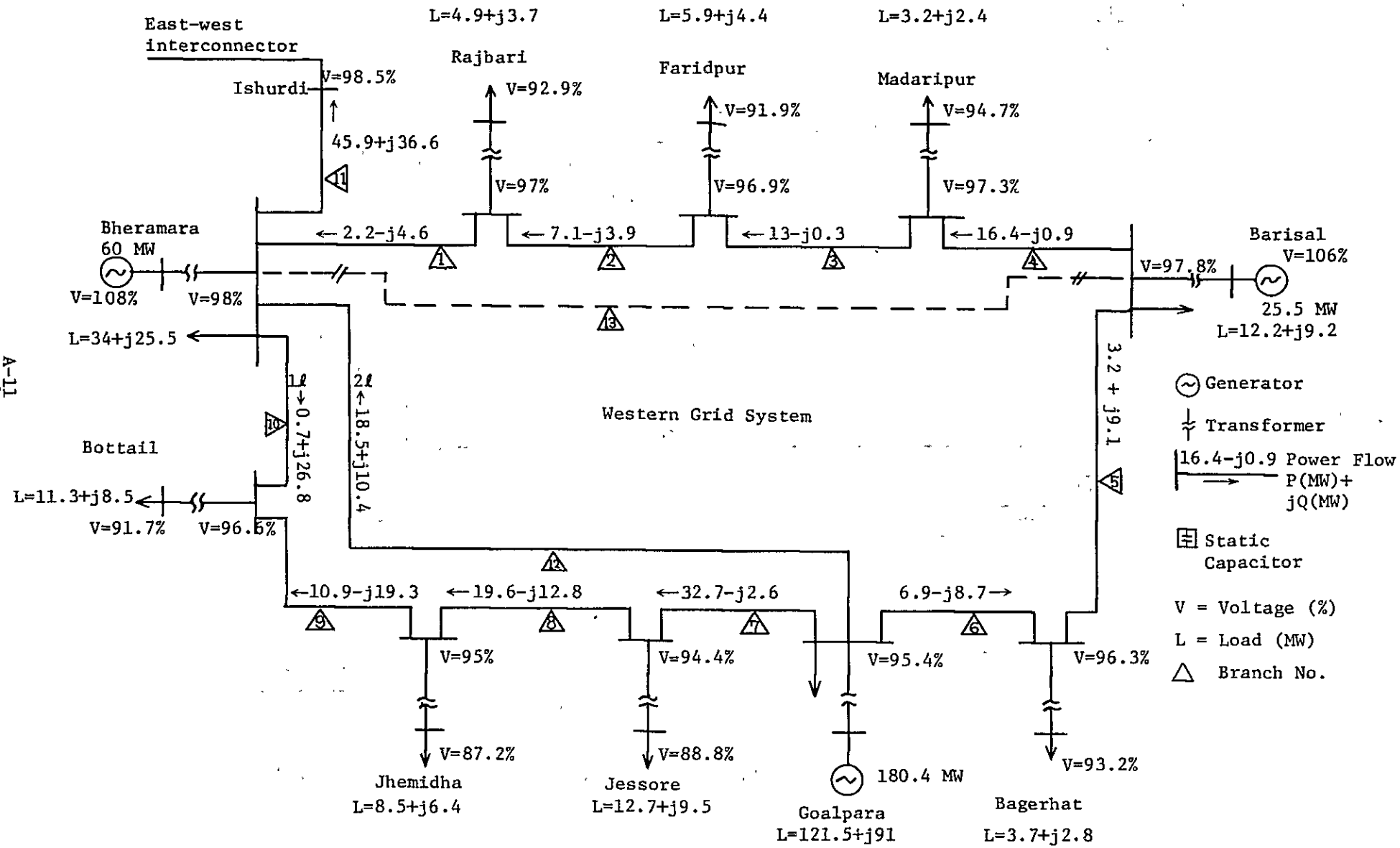
(4)

SL. No.	Date of occurrences	Type of storm	Maximum wind speed in the under noted station recorded in mill per hour	Storm surge with tidal wave
25	5-6th November, 1971	S.C.S.	----------	----------
26	16-18th November, 1971	C.S.	----------	----------
27	6-9th December, 1973	S.C.S.	----------	Storm surge of slight to moderate intensity inundated low lying areas of Paluakhali & offshore islands.
28	13-15th August, 1974	S.C.S.	Barisal and offshore island - 50 mph.	----------
29	24-28th November, 1974	S.C.S.	Coastal belt from Cox's Bazar to Chittagong & offshore island - 100 mph.	9-17' storm surge tide wave
30	5th January, 1975	C.S.	Ctg. - 60 mph.	Inundated low lying area of coastal & offshore island.
31	8th November, 1975	C.S.	----------	----------
32	9-12th May, 1975	S.C.S.	60-70 mph. experienced at Bhola. Wide spread rain max. at Chandpur-7'	----------

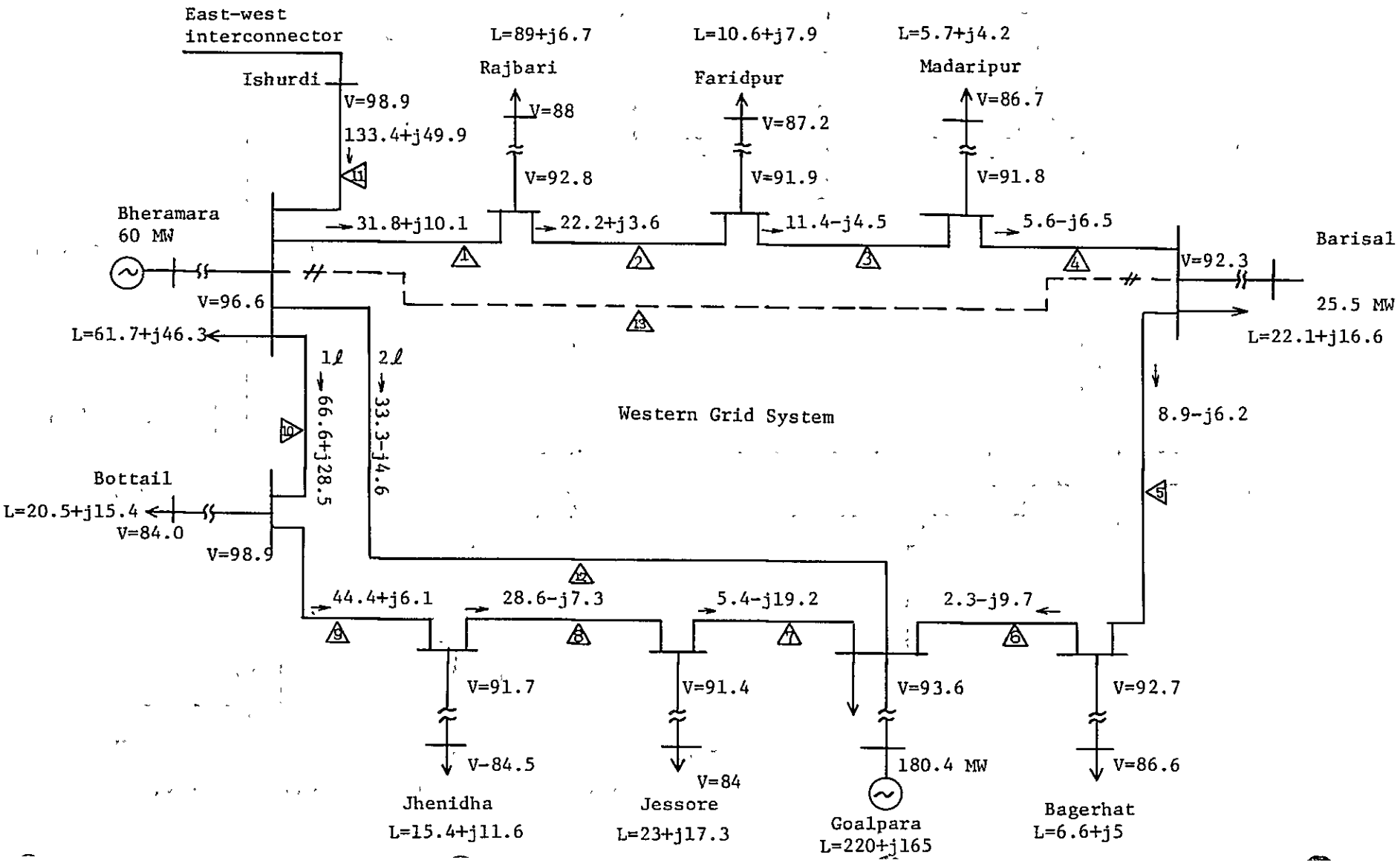
ANNEX II

DATA FOR SYSTEM POWER FLOW ANALYSIS

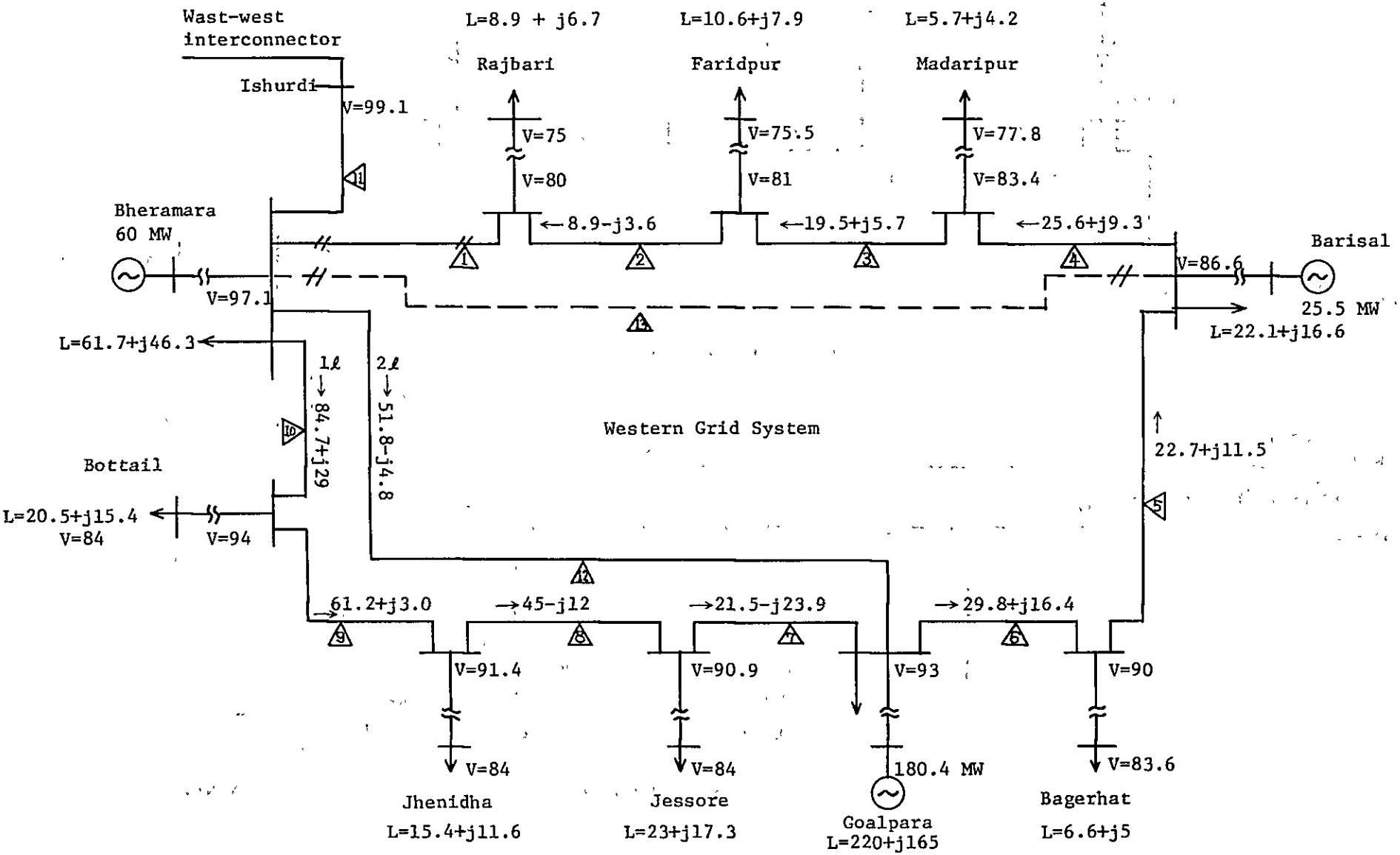
ANNEX II-1 POWER FLOW AT NORMAL CONDITION IN 1986



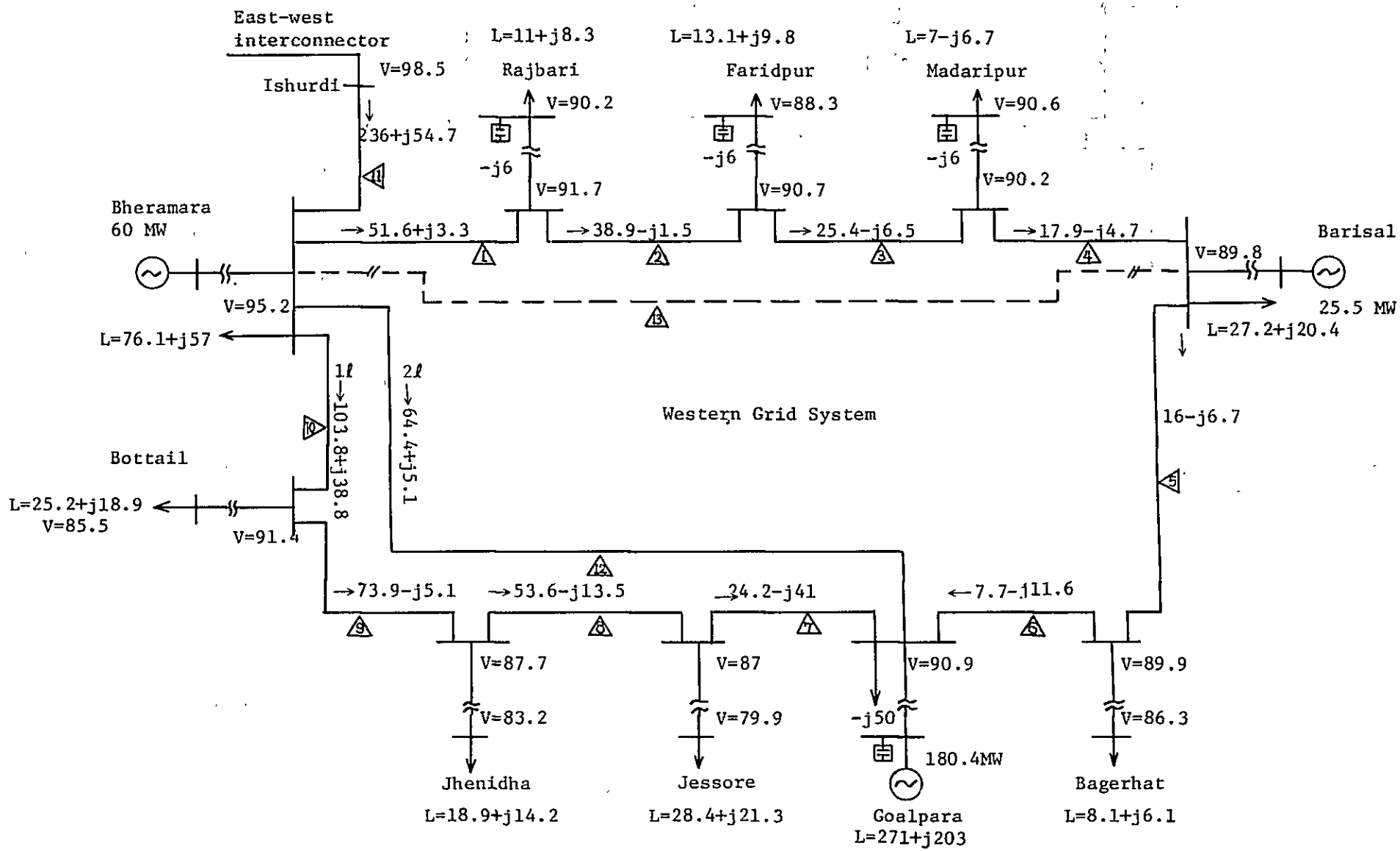
ANNEX II-2 POWER FLOW AT NORMAL CONDITION IN 1990



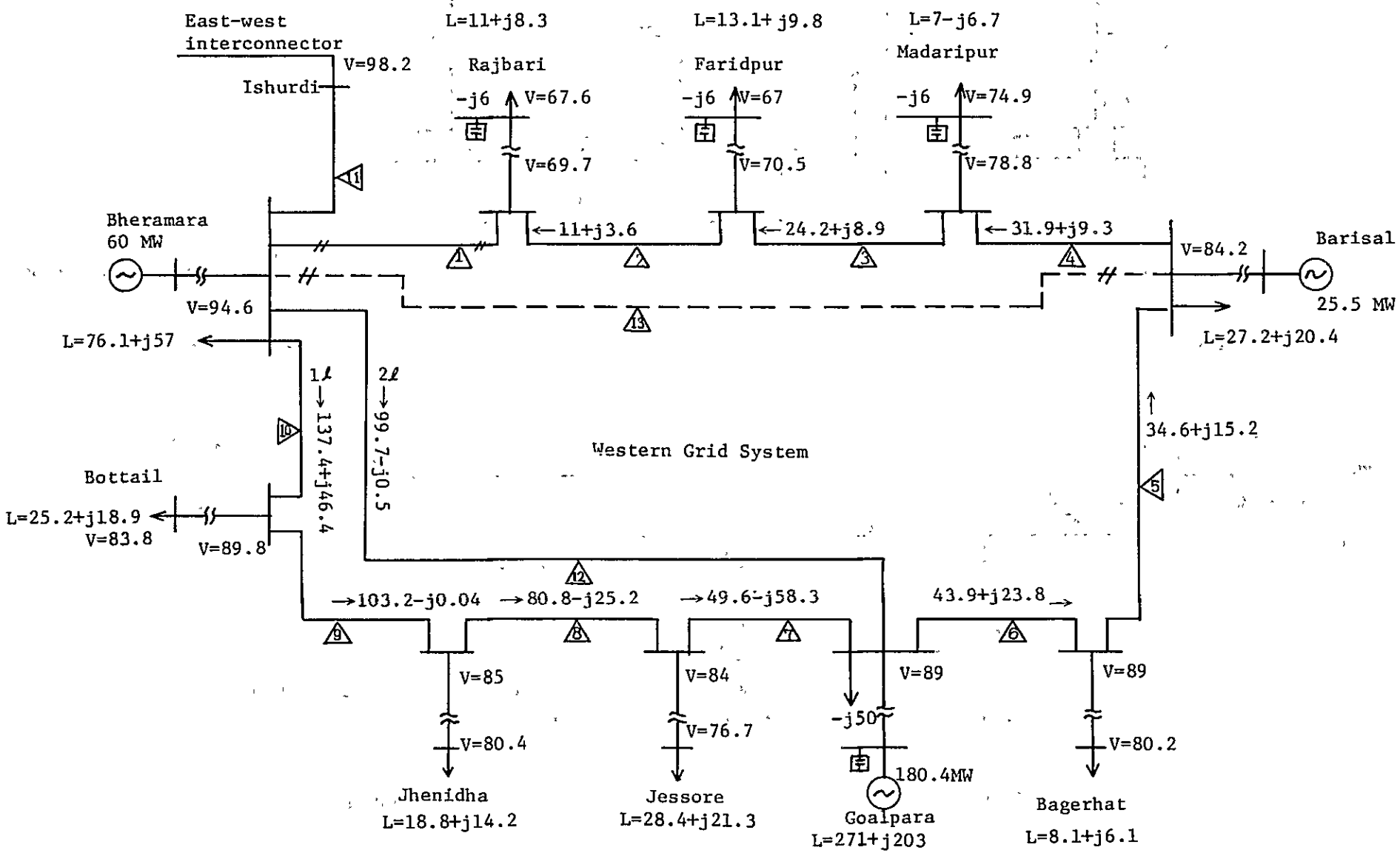
ANNEX II-3 POWER FLOW AT INTERRUPTION IN 1990 (BRANCH NO. ① OFF)



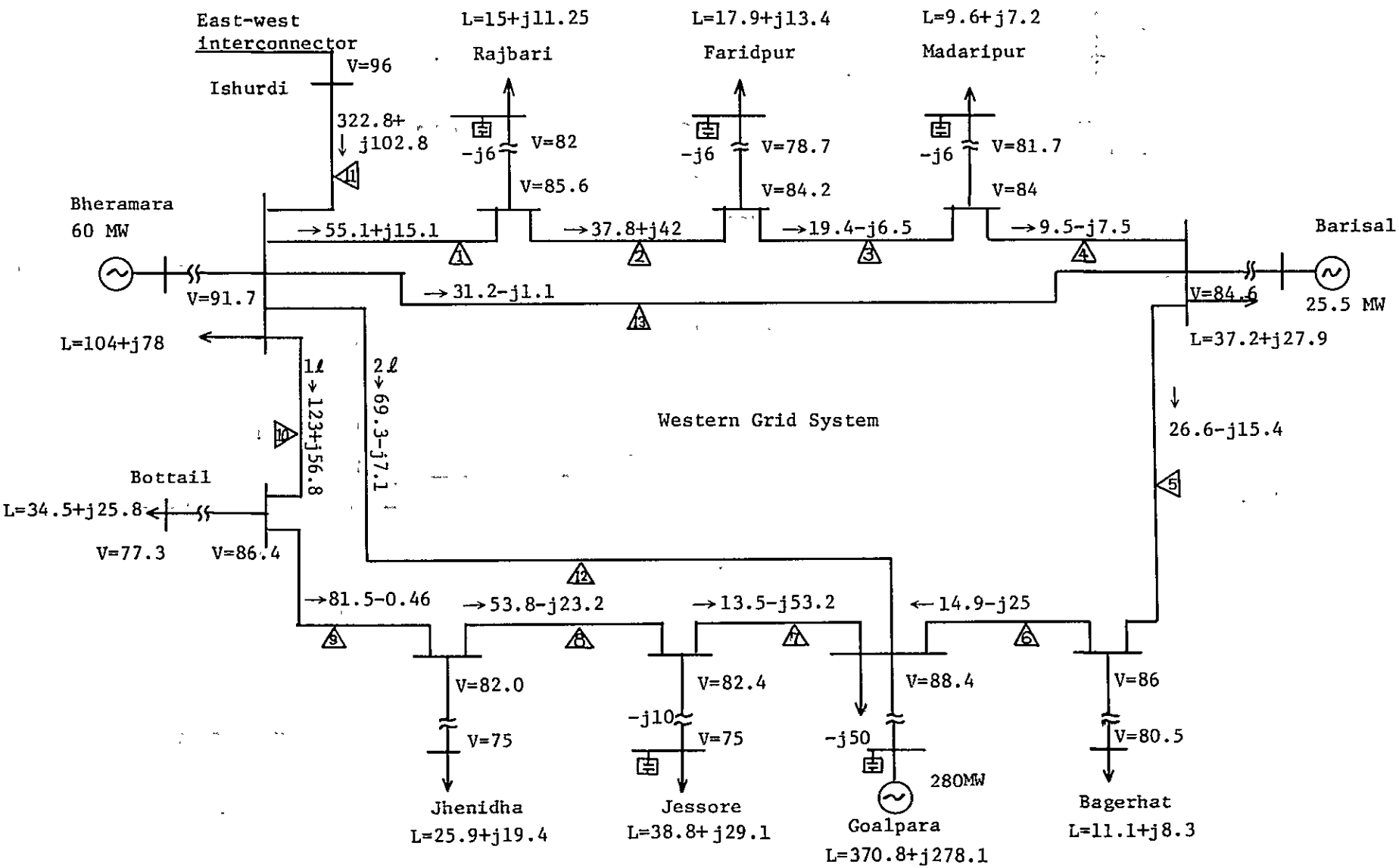
ANNEX II-4 POWER FLOW AT NORMAL CONDITION IN 1992



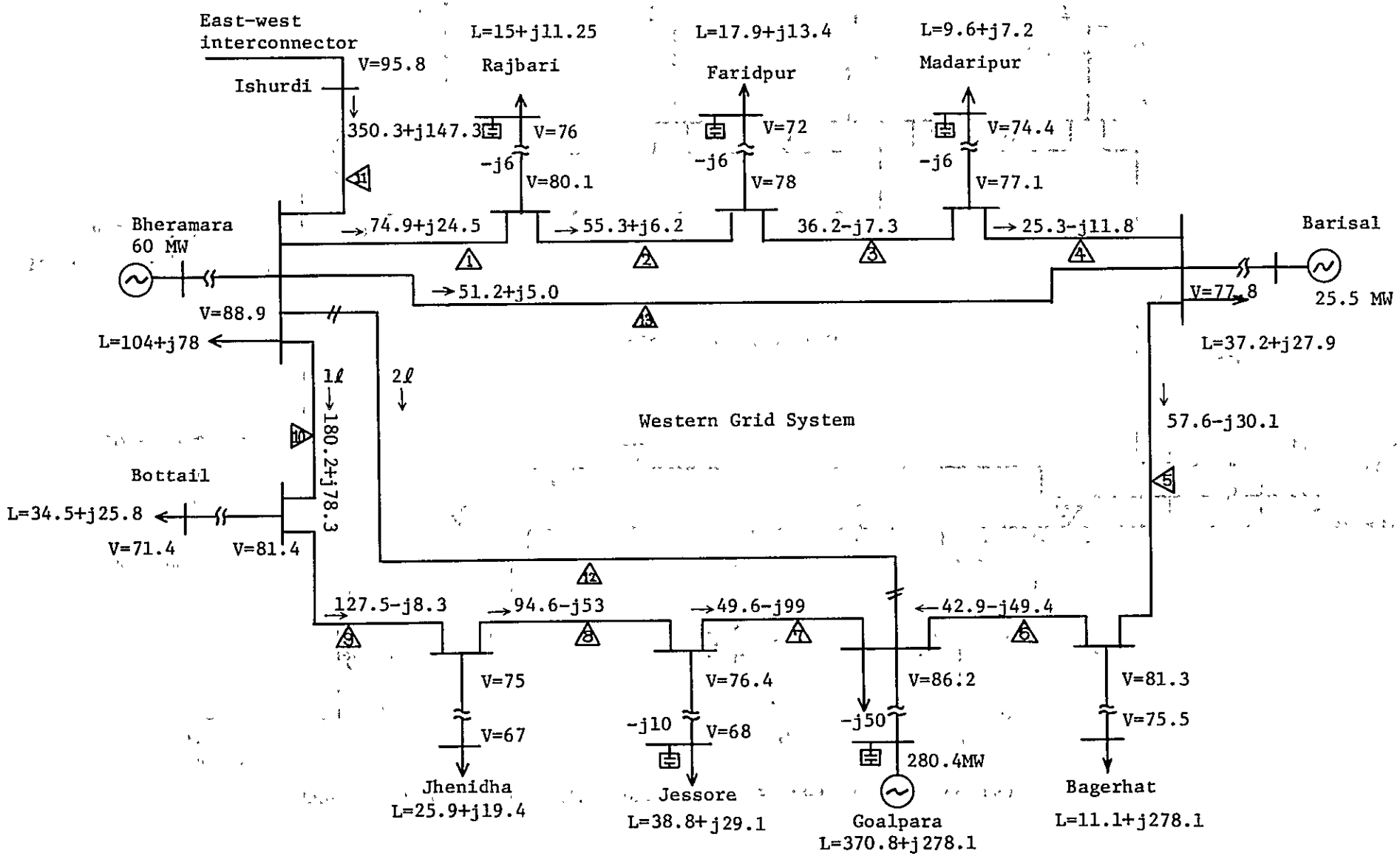
ANNEX II-5 POWER FLOW AT INTERRUPTION IN 1992 (Branch No. ① off)



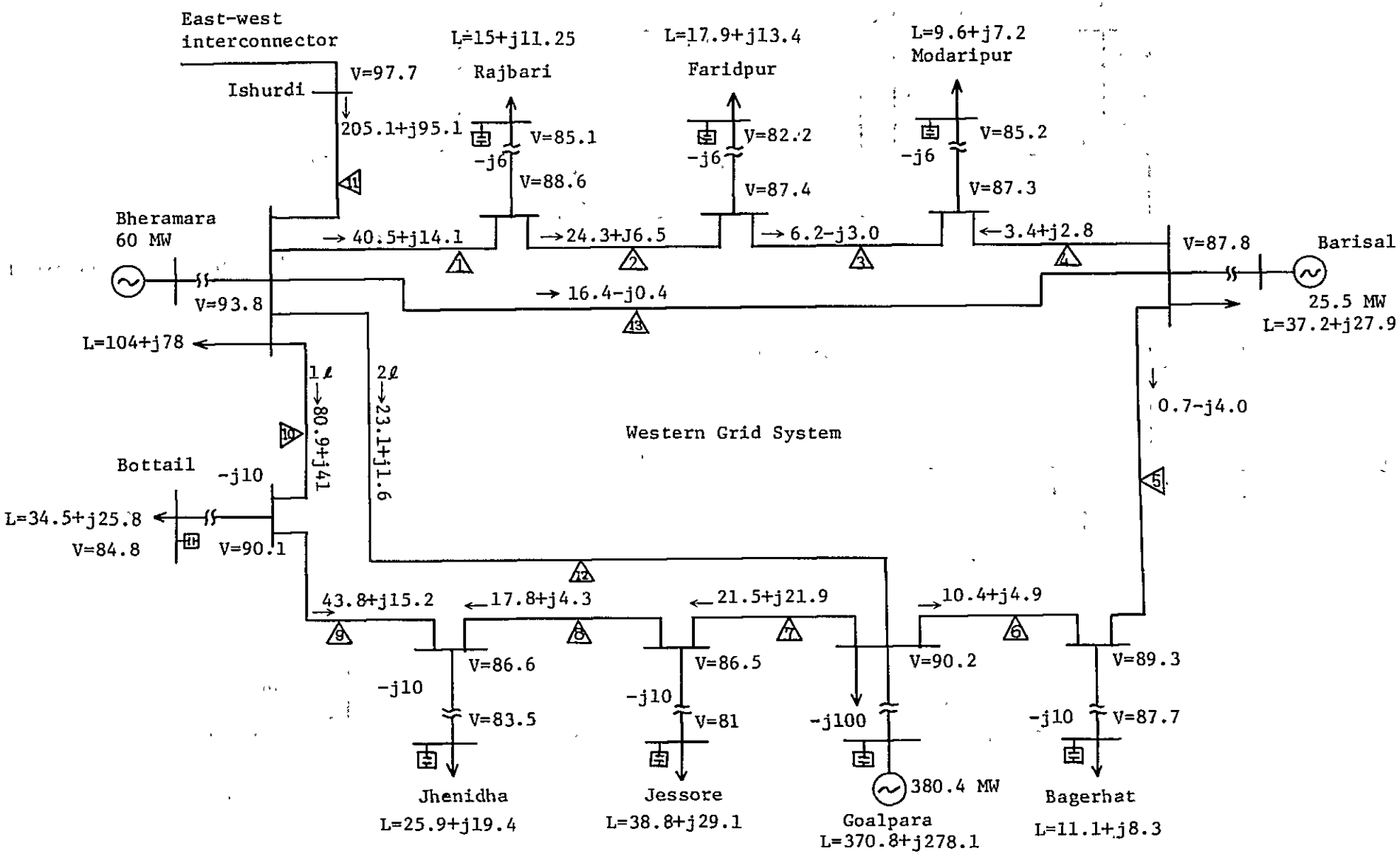
ANNEX II-6 POWER FLOW AT NORMAL CONDITION IN 1995 (Goalpara P/S 280 mw)



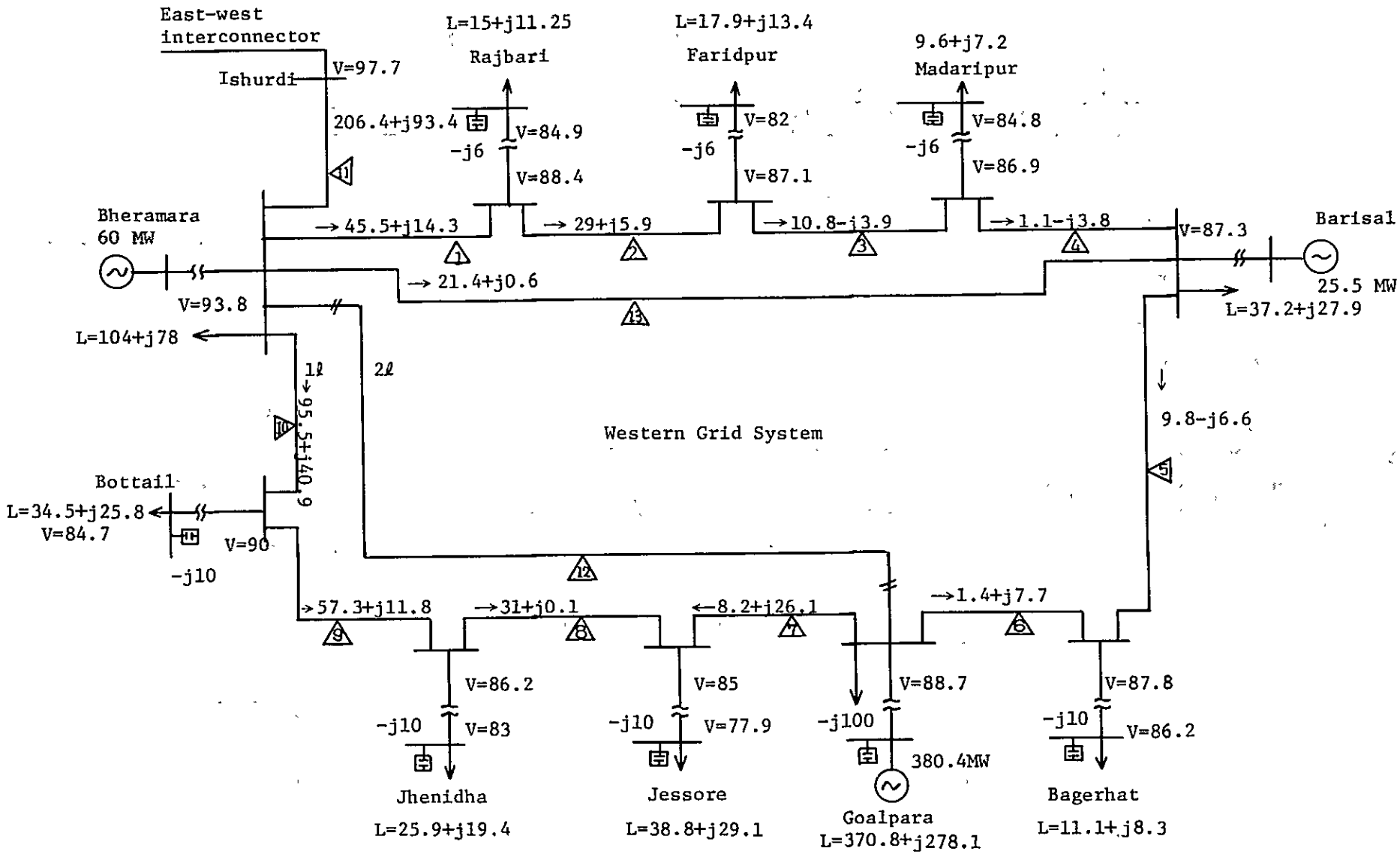
ANNEX II-7 POWER FLOW AT INTERRUPTION IN 1995 (Branch No. 12 off)



ANNEX II-8 POWER FLOW AFTER COUNTERMEASURE (Goalpara P/S 380 MW)



ANNEX II-9 POWER FLOW AT INTERRUPTION IN 1995 (Branch No. 12 Off)



ANNEX II-10 POWER FLOW AT INTERRUPTION IN 1995 (Branch No. 13 off)