

2-8 保守

発電所及び変電所の機器の保守点検は比較的行われている様であるが、負荷需要の大きい首都コロombo市内の132kVコロナワ変電所（現在31.5MVA x 2台増設中）等の一部基幹変電所では停電をとることが出来ない状況であり事故対応に精一杯で焼損のため取り替えたPT等の残骸がそのまま変電所構内に放置されたままとなっている状態であった。尚CEBとしての保守点検スタンダードマニュアルは現在のところまだ作成されていない。

2-9 基幹送電網拡張計画

各国コンサルタントにより作成されている電力開発計画に伴い1995年12月にCEBトランスミッションプランニングブランチが下記に示す1995年～2003年迄の基幹送電網拡張計画を作成している。

	<u>ルートマップ</u>	<u>系統図</u>
1995年～1996年	図5-9	図5-10
1997年～1998年	図5-11	図5-12
2002年～2003年	図5-13	図5-14

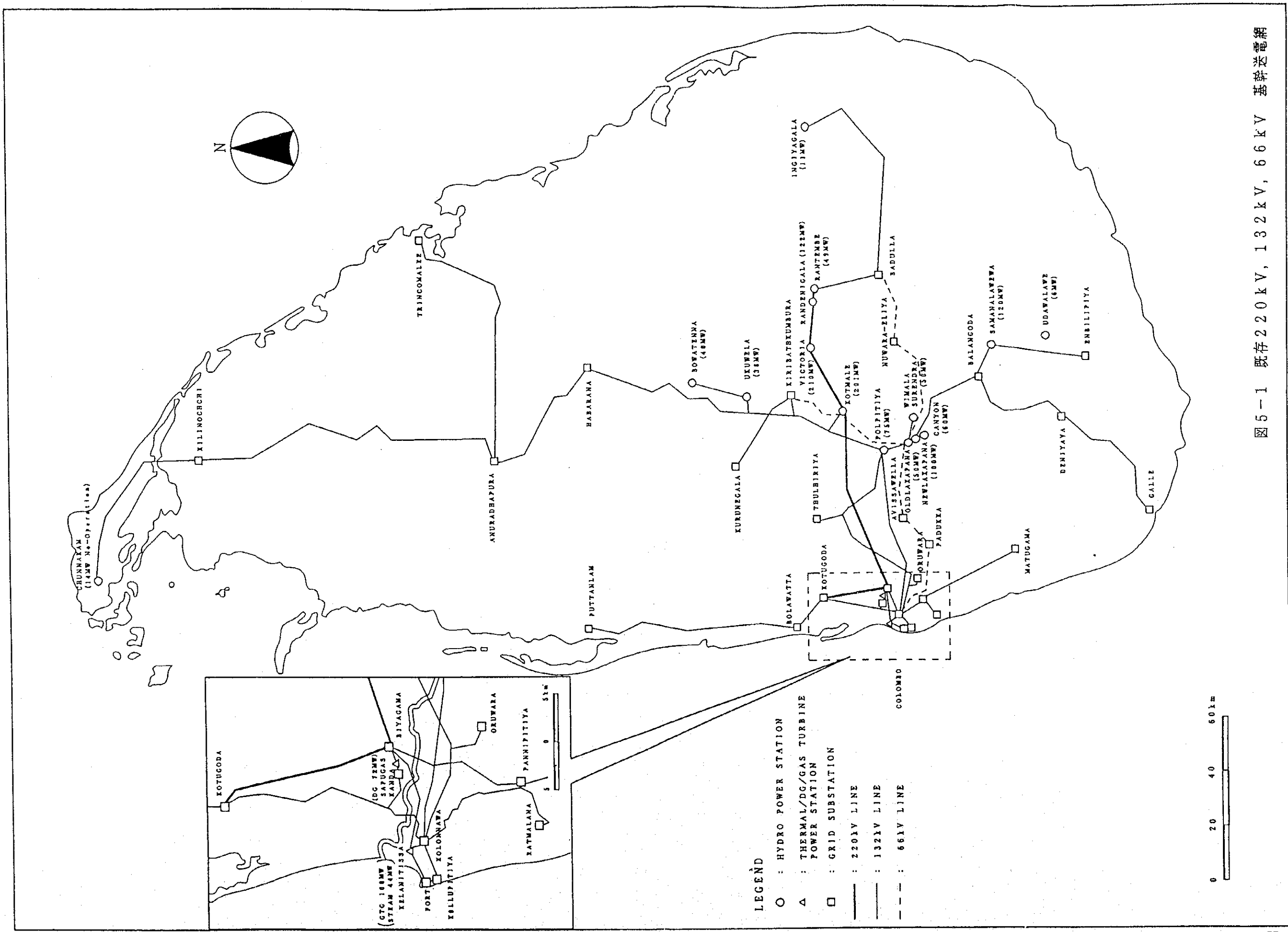


图 5-1 既存 220 kV, 132 kV, 66 kV 基幹送電網

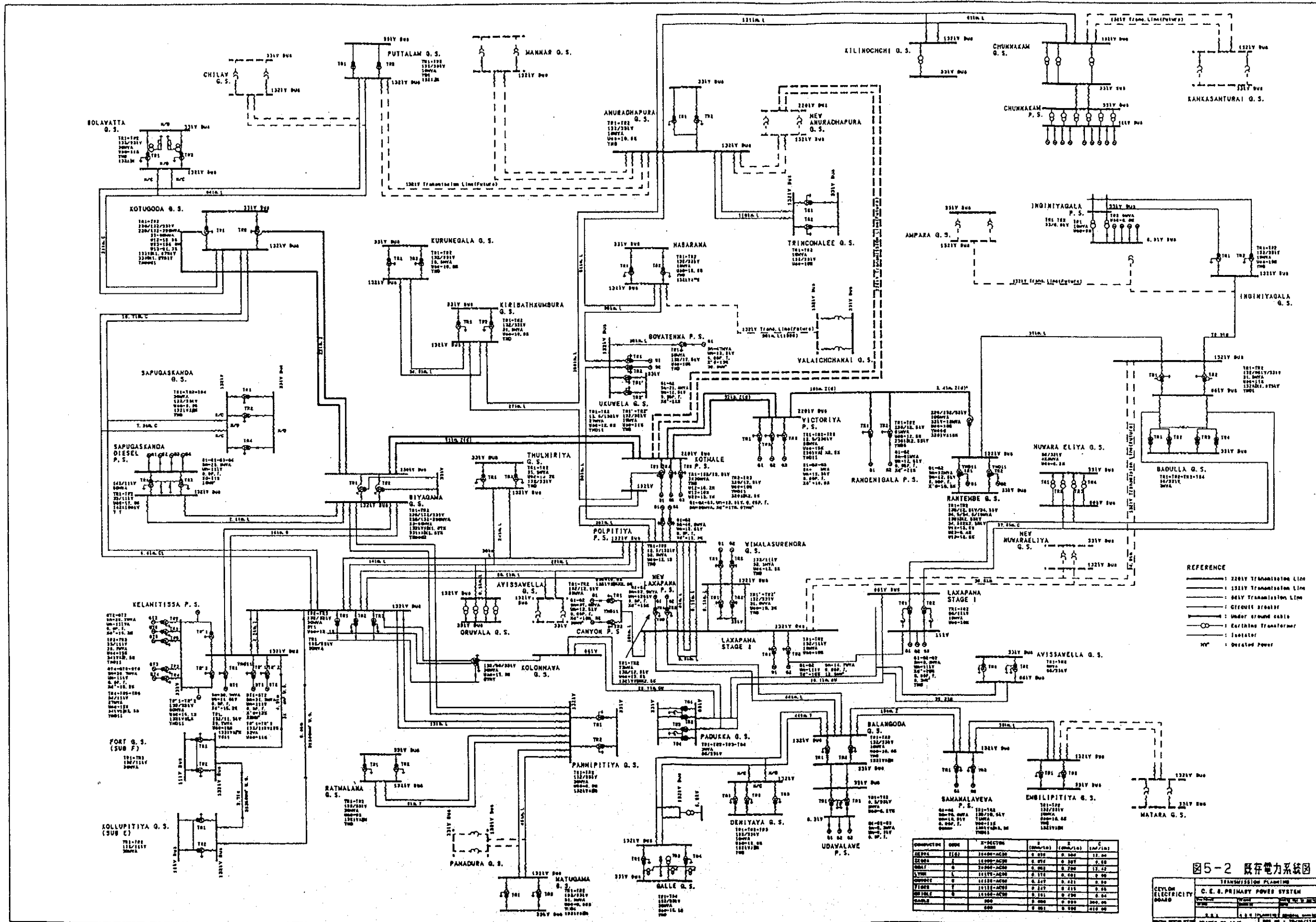
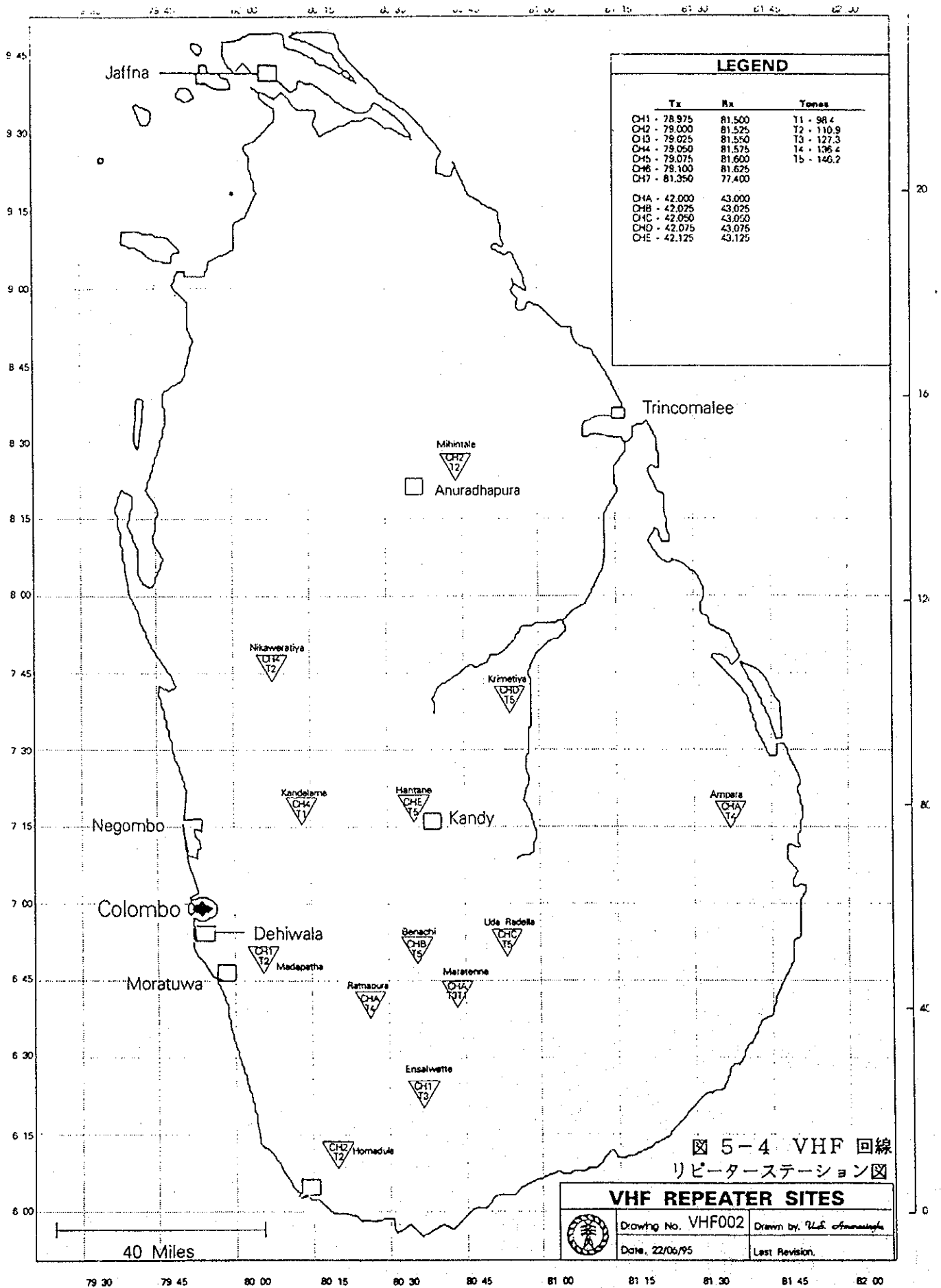


图5-2 既存電力系統圖

TRANSMISSION PLANNING		C. E. S. PRIMARY POWER SYSTEM	
NO.	NAME	TYPE	STATUS
1
2
3
4
5
6
7
8
9
10



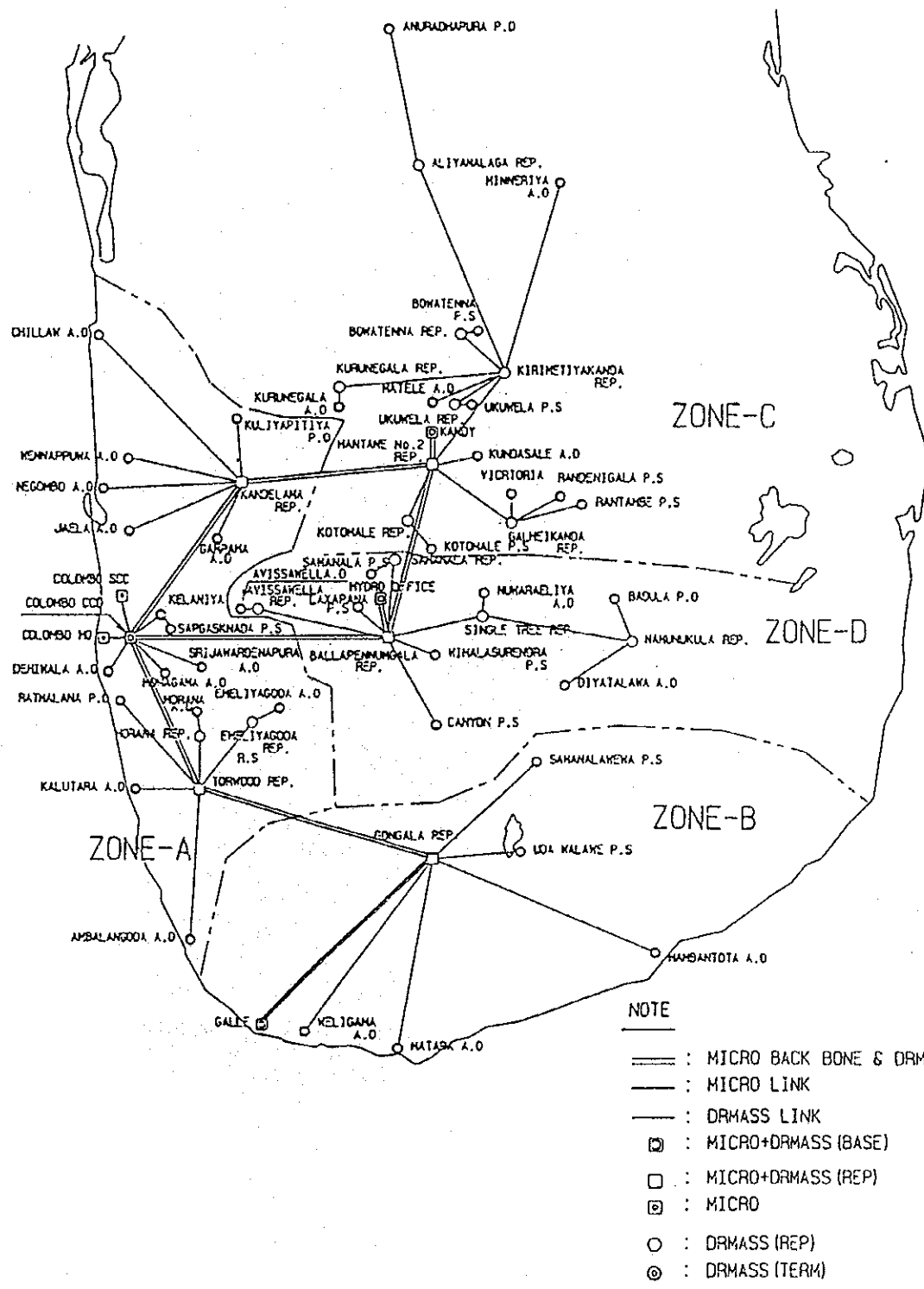


図 5-5 電力網通信回線図

HOURLY LOAD CURVE
 23RD OF NOVEMBER 1993

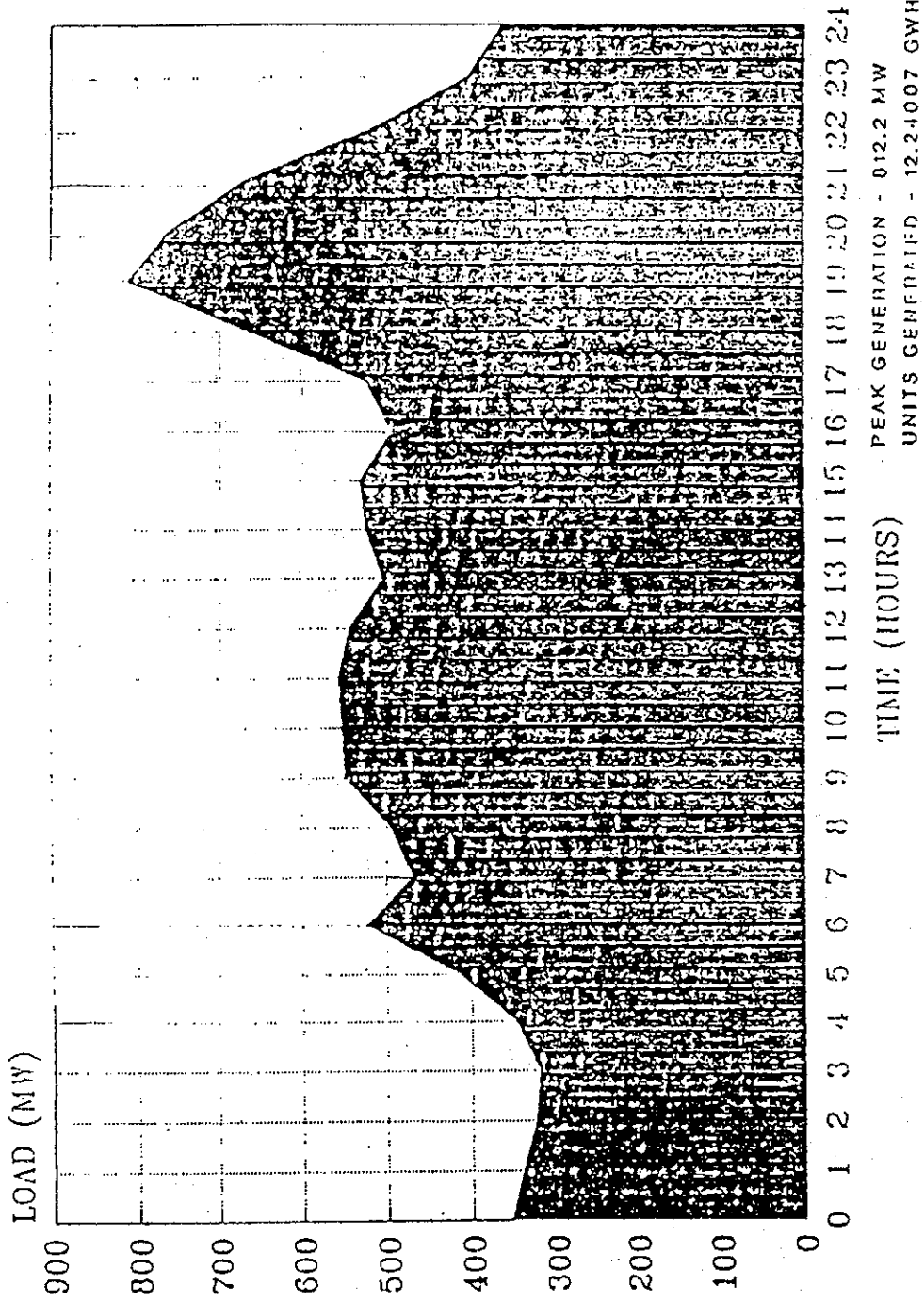


図 5-6 日負荷曲線 (1993年 11月 23日)

WEEKLY LOAD CURVE
FROM 23.11.93 TO 28.11.93
(From Monday To Sunday)

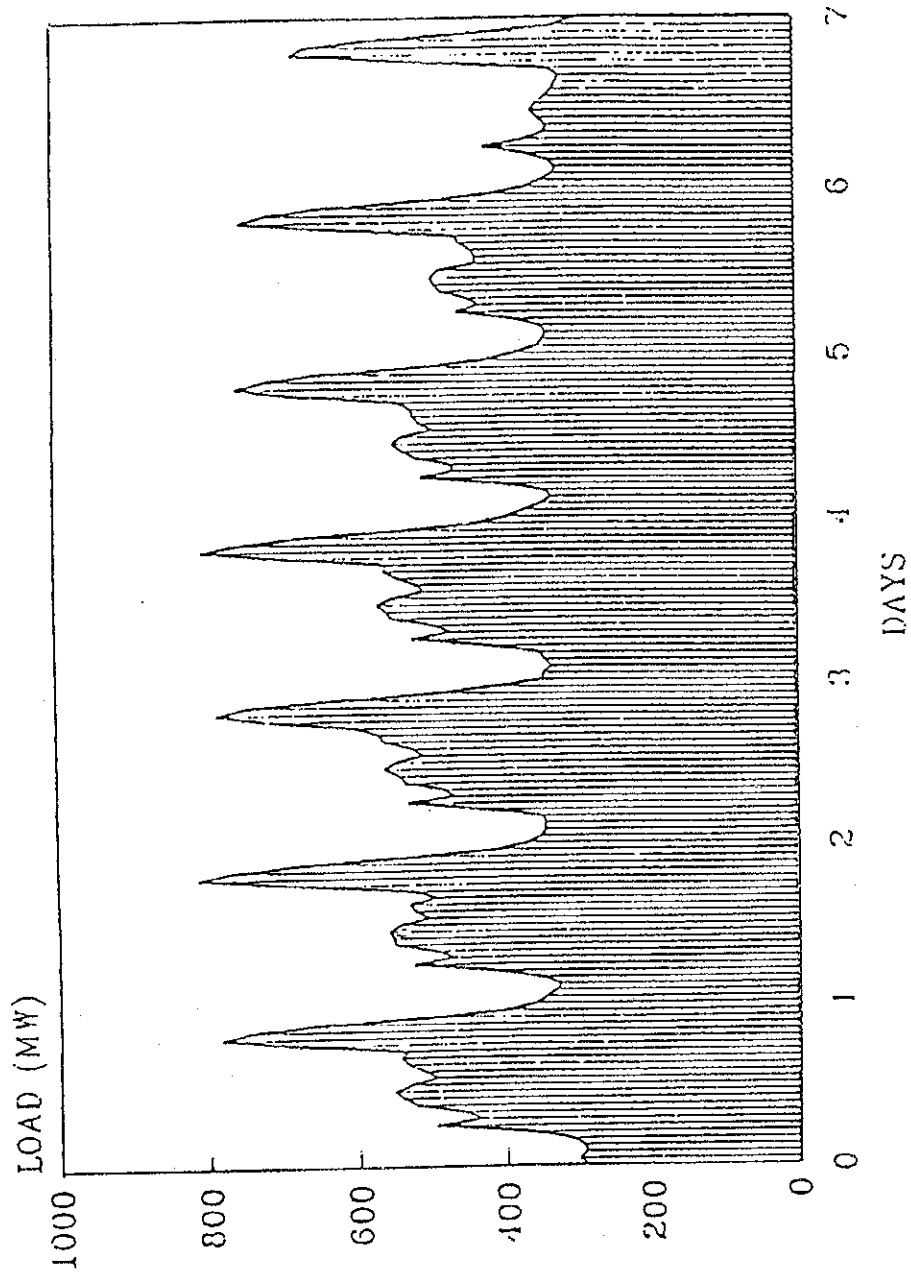
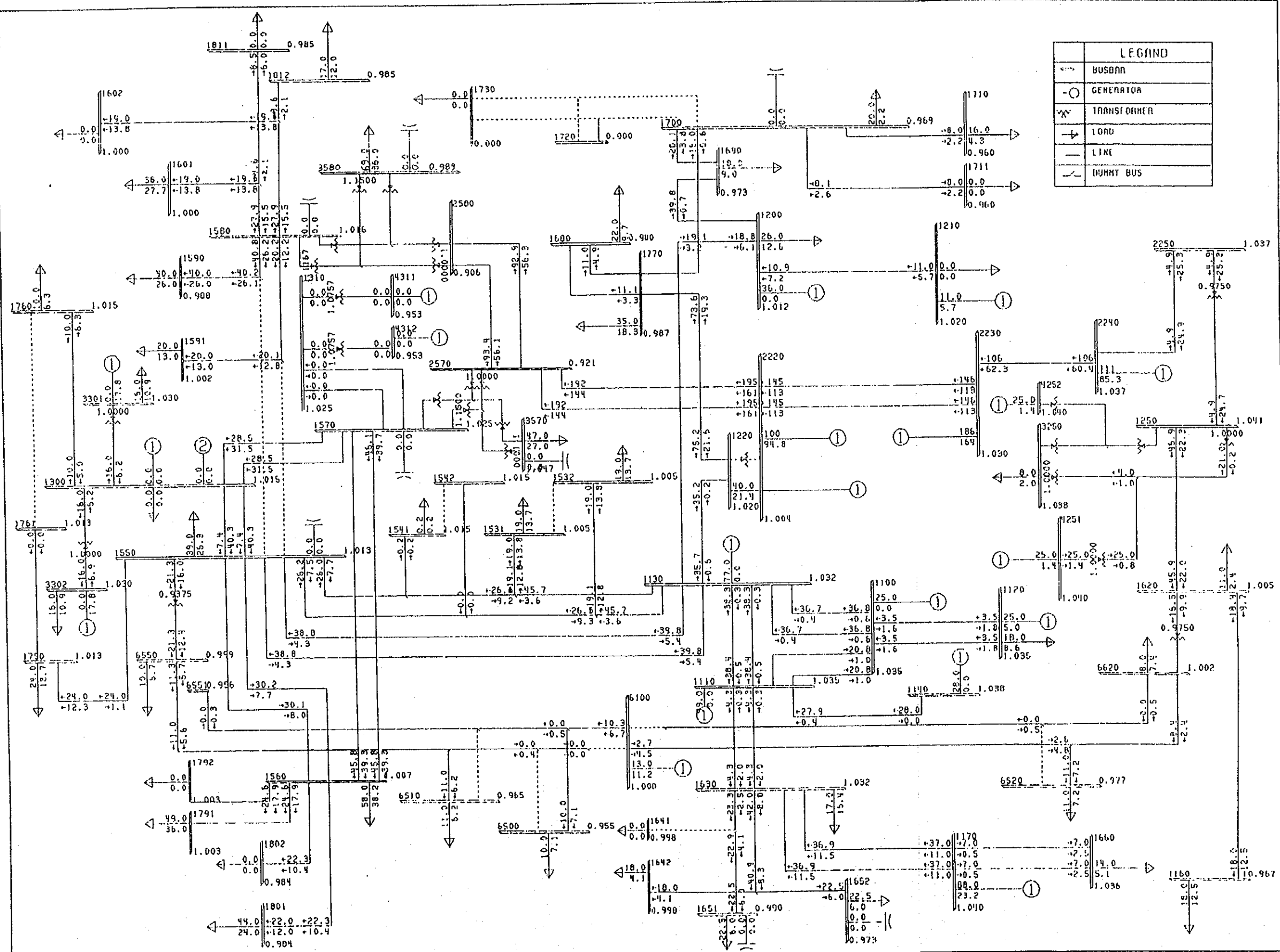


図 5-7 週負荷曲線 (1993年 11月 22日~28日)



LEGEND	
↔	BUSBAR
⊖	GENERATOR
⊕	TRANSFORMER
→	LOAD
—	LINE
⊖	DUMMY BUS

TRANSMISSION PLANNING BRANCH
 LOAD FLOW FOR PEAK LOAD (95/02/23, 19:30)
 BASE CASE : 95L12.SAV FRI, JUN 16 1995 09:55

100% RATED
 0.9500V 1.0500V BUS - VOLTAGE (PU)
 BRANCH - MW/MVAR EQUIPMENT - MW/MVAR

図 5-8 ロードフロー図 (1995年 2月 23日 19時30分)

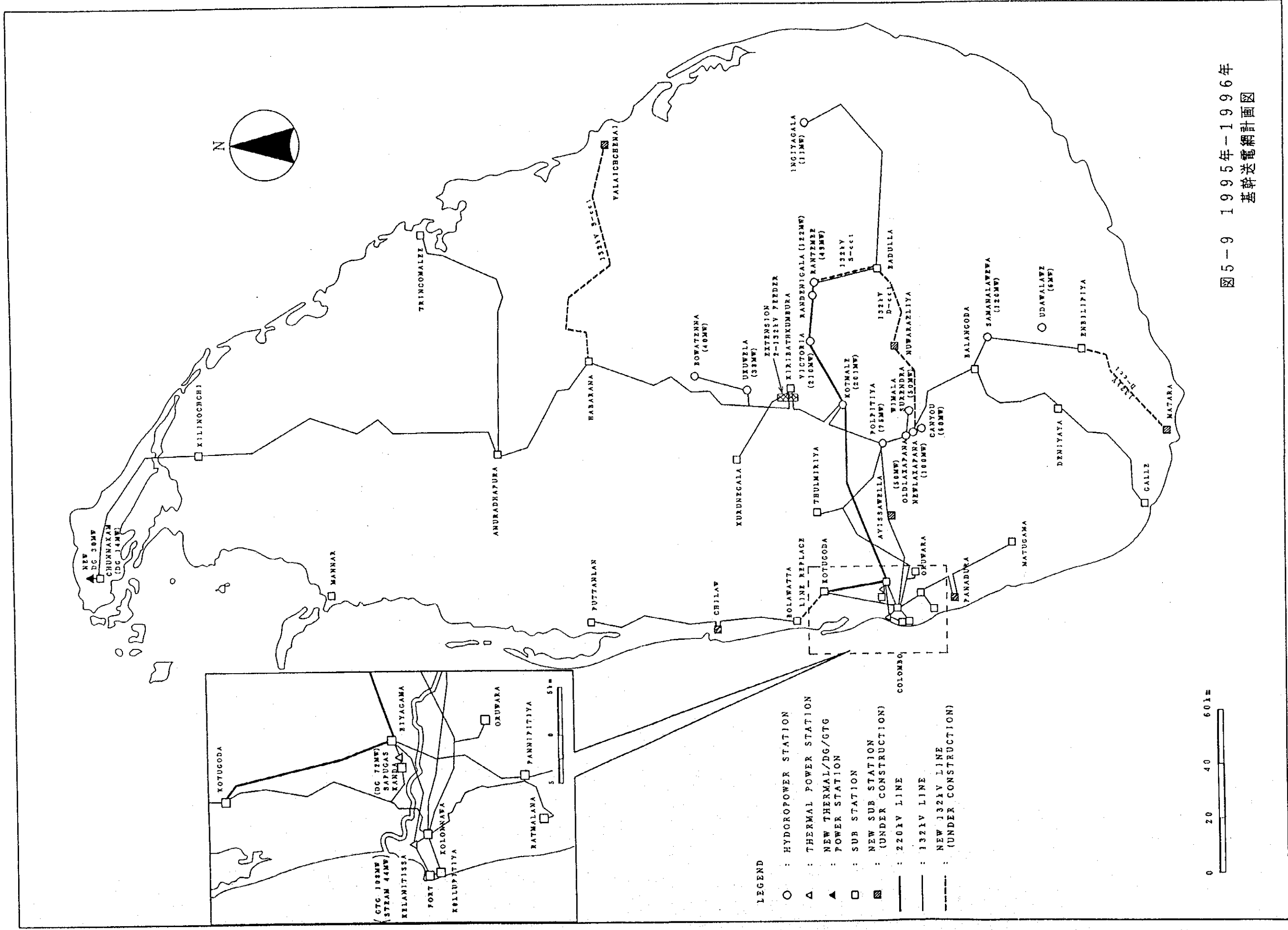


图5-9 1995年-1996年
基幹送電網計画図

LEGEND

- BUSBAR
- GENERATOR
- ⊗ TRANSFORMER
- 220kV LINE
- 132kV LINE
- 33kV LINE
- LOAD
- ⊥ CAPACITOR
- ▨ NEW P.S / G.S
- - - NEW T/L
- ⊗ EXPANSION OF 132kV FEEDER
- TG THERMAL GENERATOR
- DG DIESEL GENERATOR
- GTG GAS TURBINE GENERATOR
- COMB COMBINED CYCLE GENERATOR

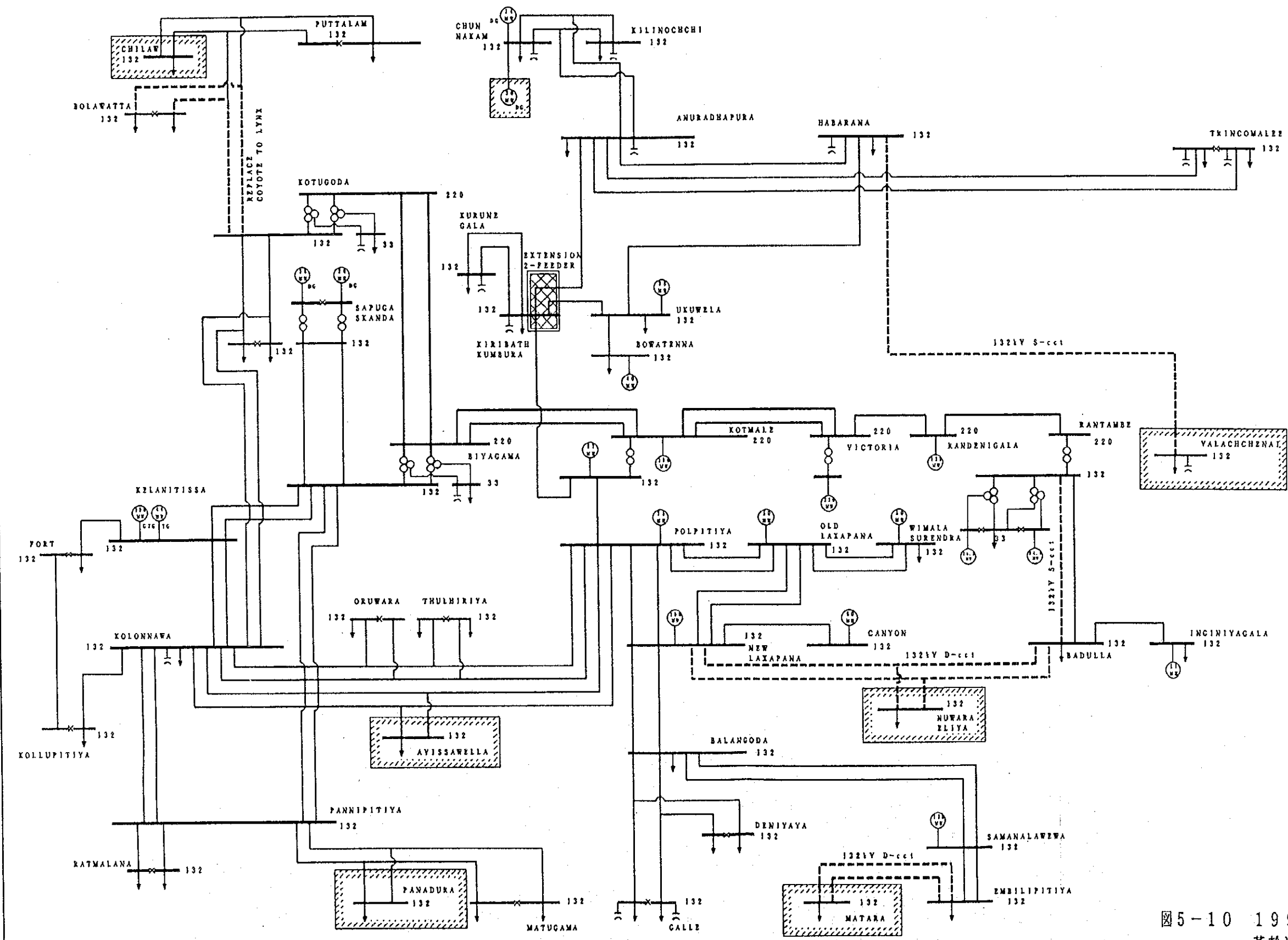


图5-10 1995年-1996年
基幹送電網計画系統图

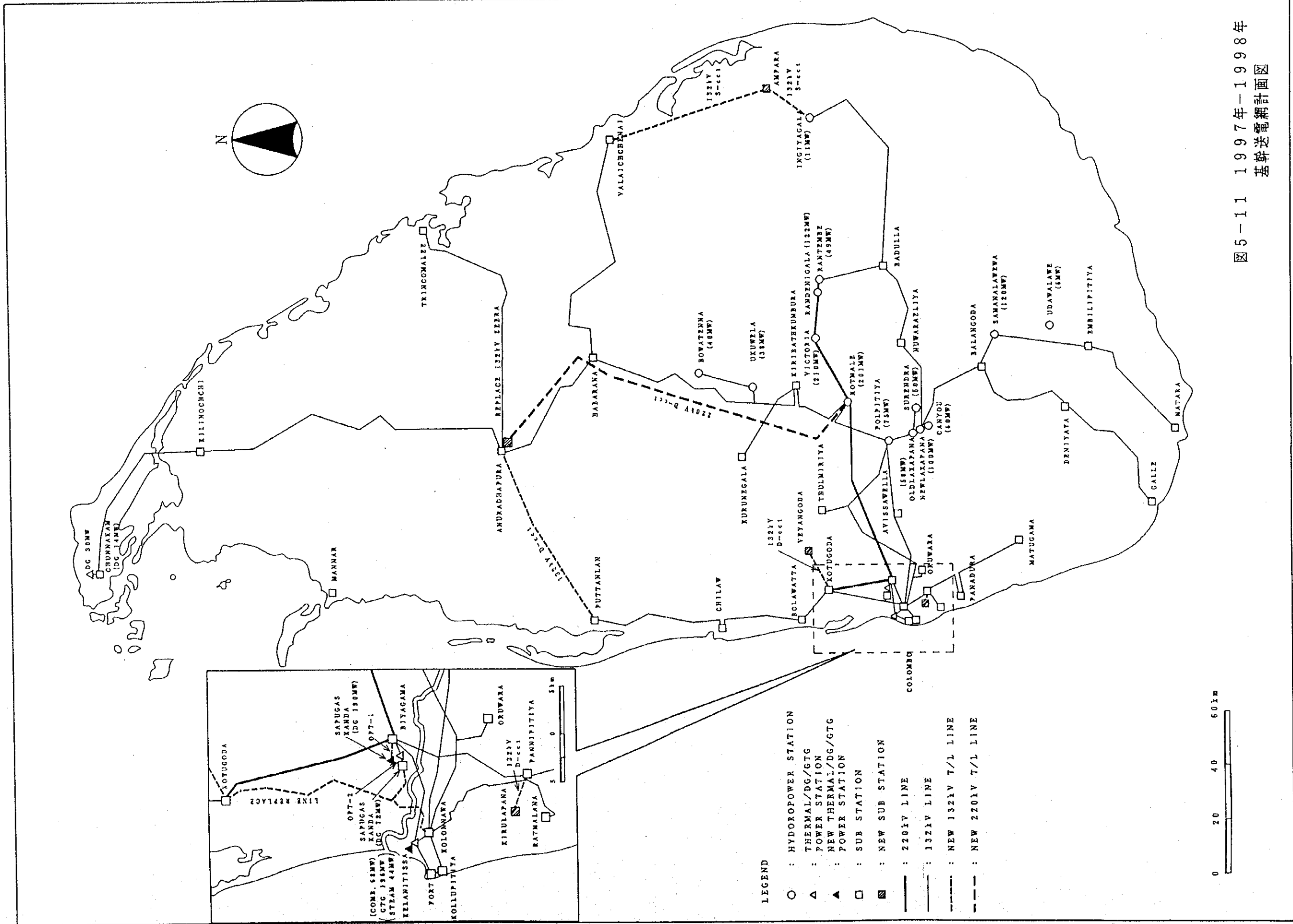


图 5-11 1997年-1998年 基幹送電網計画図

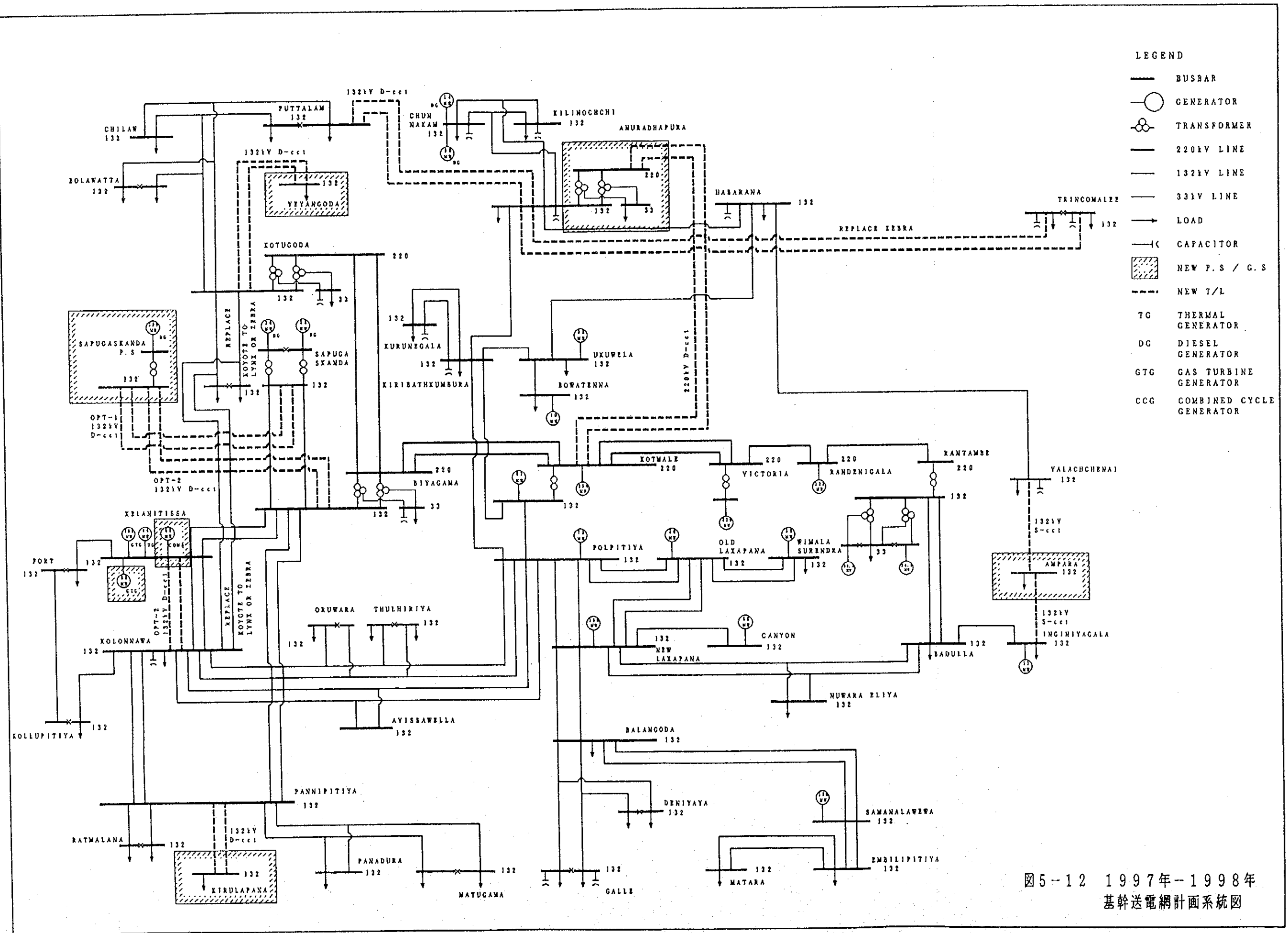
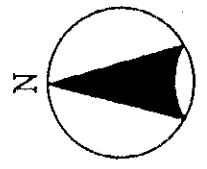
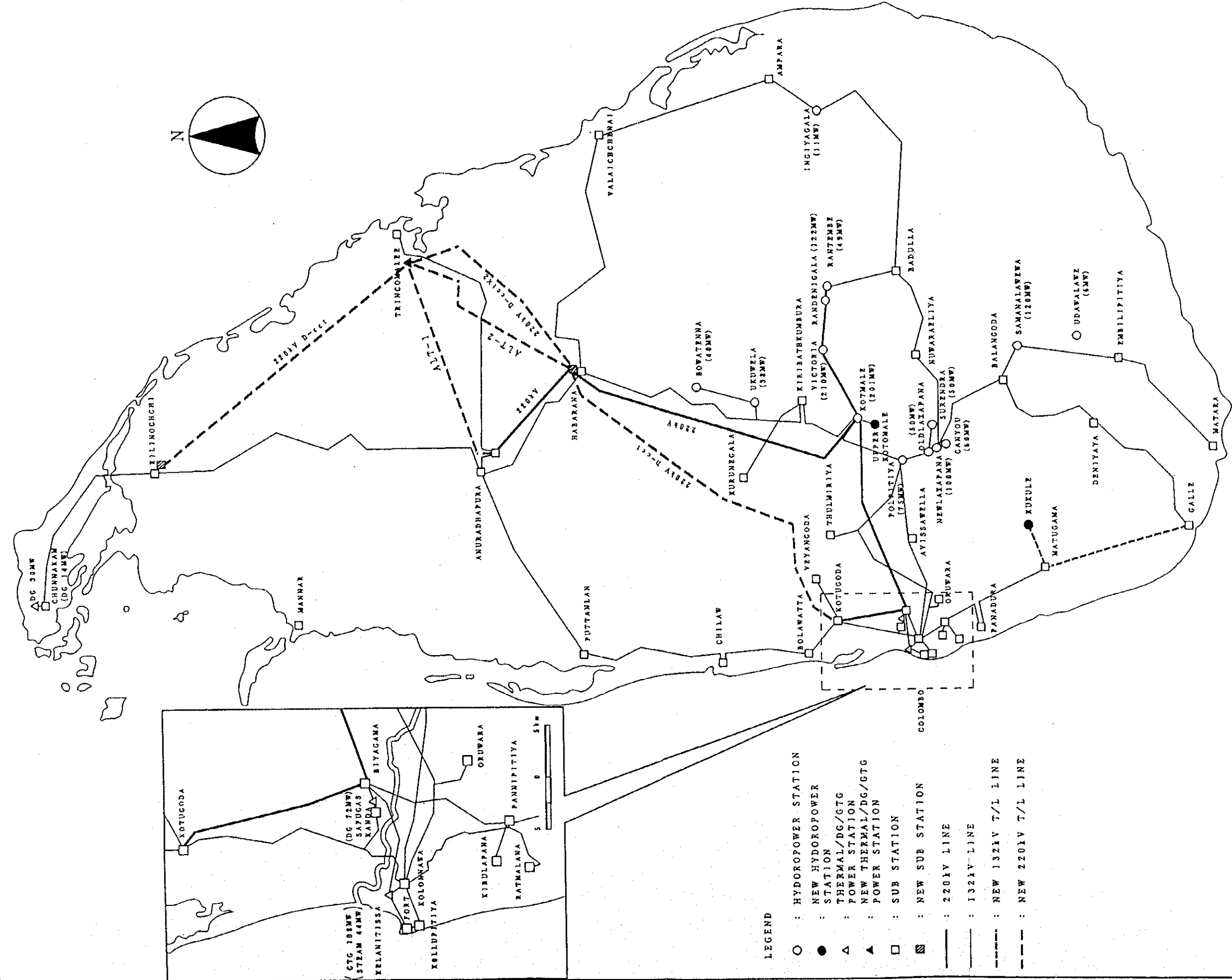


图 5-12 1997年-1998年
基幹送電網計畫系統圖

図 5-13 2002年-2003年 基幹送電網計画図



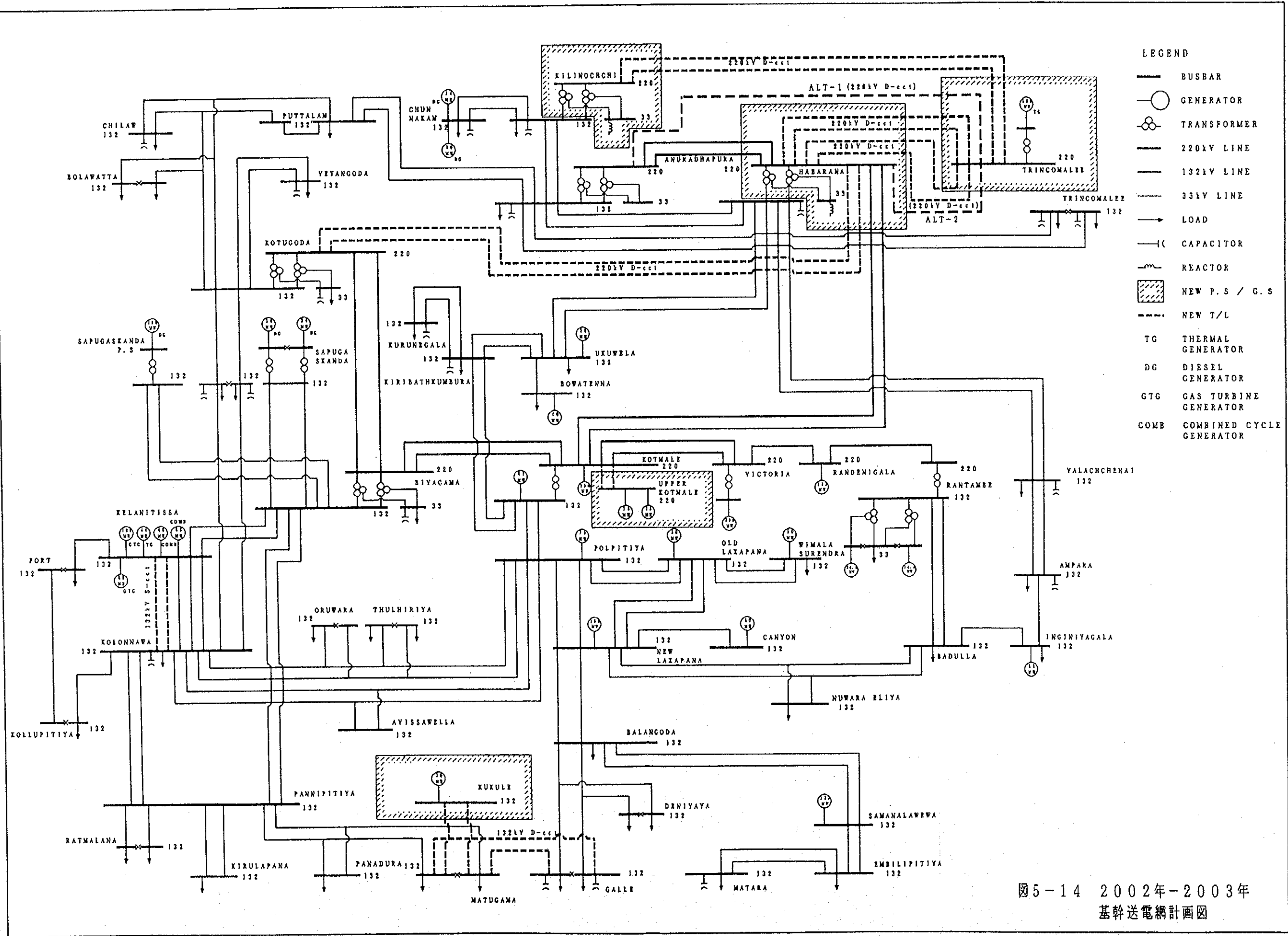


图5-14 2002年-2003年
基幹送電網計画図

項目	単位	1991	1992	1993	1991/1992の 増加率	1992/1993の 増加率
総電力販売量	GWh	2,742,410	2,916,308	3,270,103	6.34%	12.13%
需要者数	軒	882,373	1,075,791	1,266,250	21.92%	17.70%
総収入						
Without F.A.C.	百万ルピー-	6,570,760	6,899,189	8,636,895	5.00%	25.19%
With F.A.C.	百万ルピー-	-	8,059,875	10,220,976	-	26.81%
燃料調整費用	百万ルピー-	-	1,160,686	1,584,081	-	36.48%
平均販売単価						
Without F.A.C.	ルピー-/kWh	2.40	2.37	2.64	-1.25%	11.39%
With F.A.C.	ルピー-/kWh	-	2.76	3.13	-	13.41%
一人あたり売電量	kWh/人	159	168	186	5.66%	10.71%

注：1991年はF.A.C. (Fuel Adjustment Charge) 無し
資料：CEB LOAD FORECASTING & TARIFF BRANCH

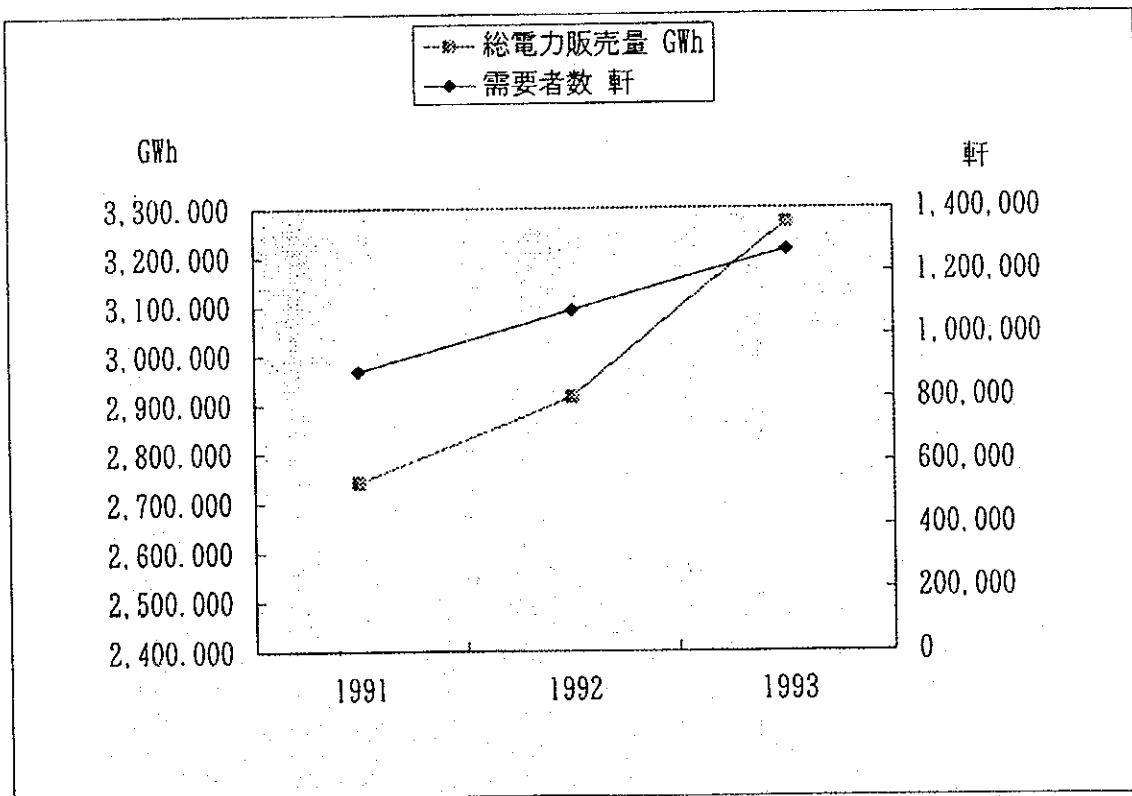


表 5-1 年負荷需要増加率

月	総発電量 (GWh)			発電所消費分 (GWh)			実発電量 (GWh)		
	水力	火力	合計	水力	火力	合計	水力	火力	合計
1月	305.125	11.318	316.443	1.440	0.508	1.948	303.685	10.810	314.495
2月	260.453	29.886	290.339	1.157	1.311	2.468	259.296	28.575	287.871
3月	285.824	52.294	338.118	1.223	2.558	3.781	284.601	49.736	334.337
4月	270.437	36.811	307.248	1.229	1.625	2.854	269.208	35.186	304.394
5月	272.101	51.726	323.827	1.372	2.031	3.403	270.729	49.695	320.424
6月	332.580	0.360	332.940	1.487	0.232	1.719	331.093	0.128	331.221
7月	343.462	0.107	343.569	1.522	0.142	1.664	341.940	-0.035	341.905
8月	338.286	0.026	338.312	1.431	0.216	1.647	336.855	-0.190	336.665
9月	336.412	0.085	336.497	1.330	0.210	1.540	335.082	-0.125	334.957
10月	349.833	0.046	349.879	1.440	0.170	1.610	348.393	-0.124	348.269
11月	347.108	0.000	347.108	1.410	0.200	1.610	345.698	-0.200	345.498
12月	354.282	0.036	354.318	1.460	0.210	1.670	352.822	-0.174	352.648
合計	3796	182.695	3978.598	16.501	9.413	25.914	3779	173.282	3952.684

資料：CEB LOAD FORECASTING & TARIFF BRANCH

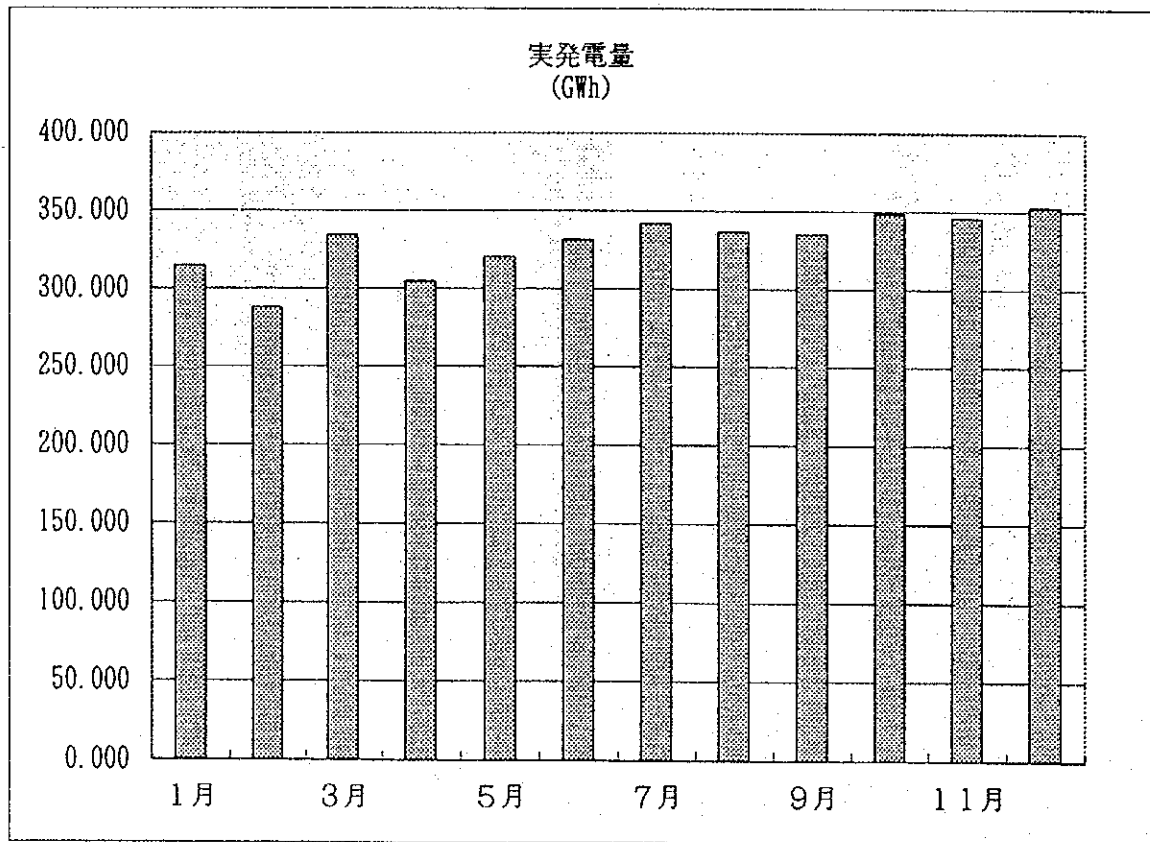


表5-2 1993年 月別発電電力量

月	ケラニ河水系 水力発電所				マハヴェリ河水系 水力発電所				小水力発電所				火力発電所				ピーク デマンド				
	CAN. PS 60MW	L. PS 50MW	N. L. PS 100MW	W. PS 50MW	S. PS 75MW	UK. PS 40MW	B. PS 40MW	V. PS 210MW	KT. PS 201MW	RD. PS 122MW	RT. PS 49MW	SW. PS 120MW	J. PS 11.25MW	UD. PS 6MW	NB. PS 3.2MW	C. PS 1.4MW		K. PS 50MW	GAS. PS 120MW	SP. PS 80MW	KKS. PS 8.2MW
1月	51.5	40.0	100.0	50.0	76.0	37.0	-	210.0	150.0	120.0	50.0	101.6	8.0	3.0	3.2	-	0.0	10.0	34.5	-	745.0
2月	50.5	40.0	100.0	50.0	75.0	37.6	-	140.0	145.0	120.0	50.0	61.0	6.7	1.6	3.2	-	22.7	0.0	33.0	-	752.0
3月	48.0	0.0	100.0	20.0	75.0	37.6	-	210.0	140.0	120.0	50.0	63.0	6.8	1.2	0.0	-	44.0	16.0	42.5	-	754.0
4月	44.0	0.0	97.0	25.0	37.5	37.8	-	210.0	115.0	120.0	50.0	122.0	6.7	1.2	3.2	-	44.0	50.0	42.0	-	755.0
5月	15.0	45.0	91.0	50.0	75.0	37.9	-	180.0	120.0	55.0	50.0	128.0	6.6	1.6	3.2	-	43.3	47.3	32.0	-	769.2
6月	50.0	43.0	92.0	50.0	75.0	38.1	-	176.0	140.0	96.0	50.0	130.1	6.6	3.3	3.2	-	0.0	16.0	16.5	-	782.0
7月	50.0	45.0	100.0	50.0	75.0	38.2	-	140.0	204.0	80.0	50.0	120.6	5.2	2.9	3.2	-	0.0	27.4	16.0	-	770.9
8月	50.0	45.0	100.0	50.0	75.0	38.0	-	210.0	195.0	76.0	48.0	122.5	3.3	2.5	3.2	-	0.0	16.8	0.0	-	770.4
9月	50.0	45.0	96.0	50.0	75.0	38.0	-	210.0	180.0	80.0	50.0	123.0	3.0	1.0	3.0	-	0.0	33.0	0.0	-	790.6
10月	50.0	45.0	100.0	50.0	75.0	38.0	-	210.0	195.0	90.0	50.0	123.0	5.0	0.0	3.0	-	0.0	20.0	0.0	-	804.9
11月	50.0	41.0	100.0	50.0	75.0	38.0	-	210.0	195.0	100.0	50.0	130.0	4.0	2.0	3.0	-	0.0	0.0	0.0	-	812.2
12月	50.0	41.0	100.0	50.0	75.0	38.0	-	210.0	150.0	120.0	50.0	129.0	4.0	2.0	3.0	-	10.0	0.0	0.0	-	808.2
最大値	51.5	45.0	100.0	50.0	76.0	38.2	-	210.0	204.0	120.0	50.0	130.1	8.0	3.3	3.2	-	44.0	50.0	42.5	-	812.2

資料：CEB LOAD FORECASTING & TARIFF BRANCH

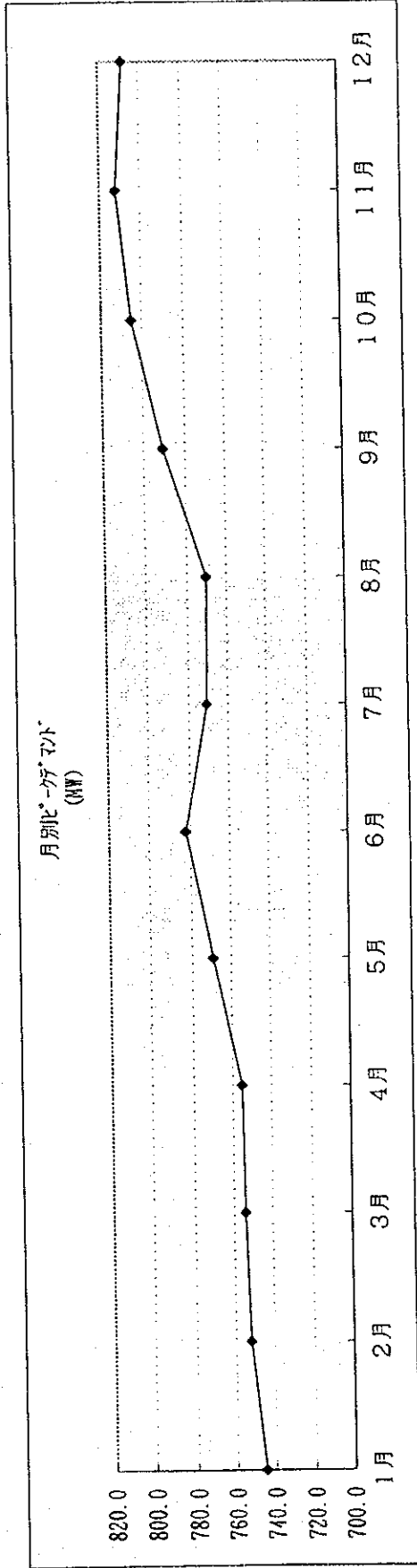


表5-3 1993年 月別ピークデマンド

SUMMARY OF TOTAL & PARTIAL FAILURES ON MAIN SYSTEM - 1991
(Exceeding 3 minutes)

Classification Date & Time	Reason	Supply Affected To	Duration
Due to disturbances in the system itself			
Partial 08.07.91 19.27 hrs.	Tripping of Biyagama transformer No. 01, while 2 on maintenance work.	Grid subs Matugama, Ratmalana, Sapugaskanda, Thulhiriya, Kotugoda and Colombo total subs.	19.27 hrs. to 19.43 hrs.
Partial 24.10.91 21.13 hrs.	Tripping of old Lax./Kol. 66kV line No. 01, tripping of Rantambe PS. (1&2) Old Laxapana (1 & 2) and Inginiyagala (2,3 & 4) machines	Badulla, N'Eliya, N'Bridge, Rantambe and Inginiyagala	21.13 hrs. to 21.36 hrs.
Partial 24.10.91 18.07 hrs.	Tripping of old Lax/Badulla 66kV line No. 01	Badulla, N'Eliya, N'Bridge, Rantambe and Inginiyagala	18.07 hrs. to 18.54 hrs.
Partial 30.10.91 18.55 hrs.	New Laxapana generator transformer earth fault and tripping of line New Laxapana, Canyon, Pol-New Lax. both lines, Old Lax. New Lax. line, Kiribathkumbura-Pol line, Habarana-A'pura & Old Lax. WPS both lines took place.	Ukuwela, Habarana, Kiribathkumbura & Kurunegala.	18.55 hrs. to 19.44 hrs.

資料：CEB 1991年 年次報告書

表 5-4 1991年 CEBシステム事故概要 (3分以上)

MAJOR TRANSMISSION LINE OUTAGES 1991

LINE	OUTAGE	TOWER NO.	DAMAGE	DATE OF COMMENCEMENT	DATE OF COMPLETION
A'pura/Trinco	132kV	201 to 238	Legs and bracings damaged. Replacement of bracing bolts & nuts etc.	01.01.91	31.01.91
A'pura/Trinco	132kV	163 & 164	Do.	26.09.91	05.10.91
Lax/Kolonnawa	66kV	167	Conductor fallen	22.04.91	25.04.91
Lax/Kolonnawa	66kV	171	Conductor fallen	25.04.91	25.04.91
Bolawatta/Putt.	132kV	Circuit 1 & 2	Insulator shattered	31.05.91	31.05.91
Badulla/Ingi.	132kV	175	Tree fallen on conductor	06.07.91	07.07.91
Laxapani/Galle	132kV	237	Jumpers conductor opened	12.06.91	12.06.91
Lax/Kolonnawa	66kV	268 TO 269	Conductor fallen	29.11.91	01.12.91

資料：CEB 1991年 年次報告書

表 5-5 1991年 CEB基幹送電線事故概要

POWER STATION MAINTENANCE & OUTAGES
(EXCEEDING 5 DAYS)

LAXAPANA COMPLEX

POWER STATION	GEN. SET NO.	TOTAL OUTAGE DURATION	NO. OF DAYS	BRIEF DESCRIPTION
Wimalasurendra	1	16.02.91 to 31.10.91	257	Planned outage for maintenance repair work and augmentation of sub station work
Canyon	2	21.02.91 to 12.04.91	51	Penstock repair and maintenance work
Laxapana	4	17.05.91 to 12.07.91	57	Overhaul maintenance
Laxapana	5	17.05.91 to 12.07.91	57	Overhaul maintenance work
Laxapana	1	03.10.91 to 10.10.91	8	Maintenance work
Laxapana	3	09.10.91 to 16.12.91	69	Repair & maintenance work
Laxapana	5	17.10.91 to 23.10.91	7	Repair & maintenance work

資料：CEB 1991年 年次報告書

表 5-6 (A) 1991年 CEB發電所 保守・停止概要

MAHA WELI COMPLEX				
POWER STATION	GEN. SET NO.	TOTAL OUTAGE DURATION	NO. OF DAYS	BRIEF DESCRIPTION
Victoria	1	22.01.91 to 27.01.91	6	Repair and maintenance
Ukuwela	1	17.01.91 to 23.01.91	7	Repair to coolers
Victoria	1	20.02.91 to 11.04.91	51	Annual maintenance
Rantambe	2	29.01.91 to 04.02.91	7	Repairs and maintenance
Rantambe	1	18.03.91 to 22.04.91	36	Planned overhaul
Kotmale	2	17.04.91 to 04.06.91	49	Planned outage
Kotmale	3	05.06.91 to 04.07.91	30	Planned outage
Randenigala	2	15.08.91 to 19.08.91	5	Repairs and maintenance
Bowatenna	1	25.09.91 to 04.10.91	10	Overhaul and maintenance work
Ukuwela	2	25.09.91 to 15.10.91	21	Overhaul and maintenance work
Rantambe	1	24.09.91 to 29.09.91	5	Overhaul and maintenance work
Bowatenna	1	10.10.91 to 22.10.91	13	Overhaul and maintenance work
Rantambe	1	03.10.91 to 10.10.91	8	Overhaul and maintenance work
Randenigala	1	04.10.91 to 05.11.91	33	Overhaul and maintenance work
Kotmale	1	27.10.91 to 15.11.91	20	Overhaul and maintenance work
Victoria	2	07.12.91 to 31.12.91	25	Overhaul and maintenance work
Bowatenna	1	13.12.91 to 31.12.91	19	Power station flooded almost all

資料：CEB 1991年 年次報告書

表 5-6 (B) 1991年 CEB發電所 保守・停止概要

THERMAL COMPLEX

POWER STATION	GEN. SET NO.	TOTAL OUTAGE DURATION	NO. OF DAYS	BRIEF DESCRIPTION	
Sapugaskanda	2	09.01.91 to 08.02.91	30	Electrical planned maintenance	
	1	15.05.91 to 14.06.91	30	Radiator repair done	
	2	18.06.91 to 01.07.91	13	Jacket water repair done	
	3	01.07.91 to 17.09.91	79	Planned maintenance	
	2	02.07.91 to 16.07.91	14	Chimney repair done	
	1	11.07.91 to 16.07.91	5	Exhaust leak through inlet valve cylinder B1	
	1	19.07.91 to 22.08.91	34	Chimney repair done	
	2	19.07.91 to 18.08.91	30	Repair to chimney and overheated water radiator	
	4	06.09.91 to 31.09.91	55	Planned maintenance	
	2	13.09.91 to 20.09.91	7	Attended to governor defect	
	1	08.10.91 to 31.12.91	84	Planned maintenance	
	2	30.10.91 to 31.12.91	62	Planned maintenance	
	4	13.11.91 to 05.12.91	22	Seizure of piston on B2 Cylinder	
	3	02.12.91 to 15.12.91	13	Inter cooler cleaning done	
	1	01.01.91 to 01.03.91	59	Routine maintenance	
	6	01.01.91 to 04.05.91	124	Roter inspection and maintenance	
	Gas Turbine	1	01.04.91 to 07.04.91	6	Repairs done on exhaust chimney
1		22.04.91 to 30.04.91	8	Repairs to exhaust chimney	
4		23.05.91 to 31.05.91	8	Repairs to silencer baffle	
3		01.06.91 to 30.09.91	120	Repairs done on exhaust chimney	
5		11.06.91 to 31.07.91	50	Routine maintenance	
4		30.07.91 to 21.09.91	52	Routine maintenance	
1		21.09.91 to 31.12.91	101	Overhaul due to turbine bearing failure	
1		18.11.91 to 05.12.91	17	Replaced FD Fan bearings	
Steam Turbine					

資料：CEB 1991年 年次報告書

表 5-6(C) 1991年 CEB發電所 保守・停止概要

1993年11月期 系統事故集計

事故系統	発電所/変電所/ライン名	電圧 (kV)	事故回数	事故継続時間(h:m)	損失 (MWH)	事故日数	事故原因
送電線	Anuradhapura-Trincomalee 2	132	18	88:57	24.7	14	E/F
送電線	Kotugoda-Sapugaskanda 1	132	1	0:02	-	1	リレー
送電線	Kotugoda-Bolawatta 2	132	1	0:57	1.2	1	O/C
送電線	Kotugoda-Kolonnawa 1	132	2	0:02	-	2	E/F
送電線	Kolonnawa-Laxapana 2	66	6	0:14	1.1	5	リレー
送電線	Old Laxapana-Kolonnawa 1	66	9	0:13	1.5	7	リレー
送電線	Sapugaskanda-Biyagama 1	132	1	22:19	-	1	E/F
送電線	Samanala-kolonnawa 4	132	1	0:00	-	1	リレー
送電線	Habarana-Ukuwela	132	1	2:57	-	1	過負荷リセット
送電線	KPS-Biyagama 2	132	1	0:04	-	1	保護動作
送電線	KPS-Kolonnawa 1	132	1	0:05	-	1	保護動作
変電所	Kolonnawa G.S TR No.1-4	-	1	0:03	0.2	1	O/C
変電所	Badulla 132/33kV G.S TR No.1	-	6	0:32	-	5	保護動作
変電所	Bolawatta G.S TR No.2	-	1	0:01	-	1	保護動作
変電所	Ukuwela G.S TR No.1	-	2	0:10	-	2	補助TR火災
変電所	Ukuwela G.S TR No.2	-	1	10:04	1.8	1	補助TR火災
発電所	Samanalawewa Unit1	-	1	0:30	1.7	1	ガイトベン故障
発電所	Rantambe Unit1	-	1	1:24	-	1	冷却水故障
発電所	Kotmale Unit1	-	2	6:06	1.1	2	逆相リレー
発電所	New Laxapana Unit1	-	1	1:59	1.4	1	E/F

資料：CEB 1993年11月期 月次報告

表5-7 1993年11月期 送電網・変電所・発電所事故概要

1995年 4月期 系統事故集計

事故系統	変電所/発電所	電圧 (kV)	事故 回数	事故継続 時間(h:m)	損失 (MWH)	事故 日数	事故原因
変電所	Anuradhapura 132/33 TR No.1	-	3	0:43	0.60	3	O/C
変電所	Kotugoda 132/33 TR No.1	-	1	0:06	6.67	1	O/C
変電所	Sapugaskanda TR No.1	-	1	1:20	-	1	他GS事故
変電所	KPS Inter Bus TR No.1	-	2	0:12	-	2	E/F
変電所	Ratmalana 33kV TR No.2	-	2	0:38	2.47	1	NutralO/C, E/F
変電所	Ratmalana 33kV BC	-	1	0:09	-	1	O/C
変電所	Badulla 132/66/33 kV	-	5	0:36	2.94	4	O/C
変電所	Deniyaya TR No.2	-	5	0:06	0.48	3	メテ・表示不良
変電所	Matugama BS 2	-	1	0:07	1.63	1	TR修理
変電所	Matugama TR No.2	-	1	3:15	-	1	DZ
変電所	Kolonnawa Inter TR	-	3	0:34	1.12	4	表示不良
変電所	Rantambe 33kV TR No.2	-	7	0:44	3.84	5	O/C
変電所	Pannipitiya TR No.1/2	-	2	0:04	0.93	1	NutralO/C, E/F
変電所	Embilipitiya TR No.1	-	1	0:02	-	1	バックアップ・リレー
変電所	Old Laxapana 11/66kV TR No.1	-	2	0:08	-	2	マニュアルオフ・ライン事故
変電所	Wimalasurendra TR No.2	-	1	1:27	-	1	マニュアルオフ・雷
変電所	Kotugoda TR No.1/2	-	2	0:26	22.45	1	O/C
変電所	Padukka BC	-	1	0:02	-	1	O/C
変電所	Bolawatta TR No.2	-	1	0:01	0.20	1	O/C
発電所	Old Laxapana Unit1,3,4,5	-	37	46:46	-	14	ライン, OV, スピート
発電所	Canyon Unit1,2	-	2	0:33	-	1	E/F
発電所	Bowatenna	-	1	2:15	-	1	インターゲート故障
発電所	Kotmale Unit1	-	1	64:42	0.43	3	負荷制限
発電所	Ukuwela Unit2	-	3	16:01	-	3	OCG, Temp. ライン
発電所	Inginiyagala Unit1,2,3	-	5	0:25	-	2	O/C
発電所	Samanalawewa Unit1,2	-	4	63:35	0.66	3	負荷制限, ライン
発電所	Kelanitissa GT 1,3	-	3	4:38	-	3	AVR故障
発電所	Kelanitissa Steam 1	-	3	8:34	-	3	AVR故障

資料：CEB 1995年 4月期 月次報告

表5-8 1995年 4月期 変電所・発電所事故概要

1995年 4月期 系統事故集計

事故系統	ライン名	電圧 (kV)	事故回数	事故継続時間(h:m)	損失 (MWH)	事故日数	事故原因
送電線	Samanala-Kononnawa 1	132	1	0:03	2.00	1	リレ-
送電線	Samanala-Kononnawa 2	132	5	0:11	1.30	4	リレ-
送電線	Kononnawa-Samanala 1	132	4	0:18	-	4	リレ-/表示不良
送電線	Kononnawa-Samanala 2	132	1	0:07	-	1	リレ-
送電線	Kotmale-Samanala	132	1	0:03	-	1	リレ-
送電線	Kiribathkumbura-Anuradhapura	132	4	3:00	2.23	4	過負荷マニュアルオフ
送電線	Anuradhapura-Kiribathkumbura	132	2	4:54	1.00	2	リレ-
送電線	Anuradhapura Main OCB	132	1	0:15	3.26	1	表示不良
送電線	Anuradhapura-Trincomalee 1	132	1	2:49	0.20	2	リレ-E/F
送電線	Anuradhapura-Trincomalee 2	132	4	0:07	0.22	3	リレ-
送電線	Habarana-Anuradhapura	132	1	0:06	0.90	1	リレ-
送電線	Anuradhapura-Habarana	132	1	0:04	1.07	1	リレ-
送電線	Avissawella Incoming OCB	66	2	0:08	0.54	2	リレ-O/C
送電線	Old Laxapana-Kolonnawa 1	66	17	4:21	3.89	13	リレ-
送電線	Kolonnawa-Old Laxapana 1	66	19	1:22	6.10	13	リレ-
送電線	Kolonnawa-Old Laxapana 2	66	11	1:05	0.28	9	リレ-
送電線	Old Laxapana-Badulla 1	66	2	0:15	-	2	他GS事故マニュアルオフ
送電線	Old Laxapana-WPS 2	132	1	0:03	-	1	リレ-Def
送電線	New Laxapana-Canyon	132	1	0:02	-	1	リレ-OCG/DZ
送電線	Biyagama-Kotugoda 1	220	2	0:13	-	2	TR トリップ°
送電線	Biyagama-Kotugoda 2	220	1	0:05	-	1	TR トリップ°
送電線	Kotugoda-Sapugaskanda 1	132	1	0:06	-	1	リレ-
送電線	Kotugoda-Sapugaskanda 2	132	1	0:06	-	1	リレ-
送電線	Kotugoda-Puttalam 1	132	1	0:03	2.07	1	リレ-E/F
送電線	Kotugoda-Puttalam 2	132	2	0:06	-	1	リレ-DZ
送電線	Kotugoda-Kolonnawa 1	132	1	0:10	-	1	TR トリップ°
送電線	Kotugoda-Kolonnawa 2	132	1	0:14	-	1	TR トリップ°
送電線	Smanalawewa-Embilipitiya 1	132	1	0:16	1.30	1	リレ-
送電線	Smanalawewa-Embilipitiya 2	132	1	0:19	-	1	リレ-
送電線	Smanalawewa-Balangoda 1	132	2	0:34	10.67	2	リレ-バックアップ°
送電線	Smanalawewa-Balangoda 2	132	2	0:34	-	2	リレ-バックアップ°
送電線	Ukuwela-Habarana	132	3	0:52	8.31	2	リレ-DZ
送電線	Habarana-Ukuwela	132	2	0:35	-	2	リレ-DZ
送電線	Habarana Coupler OCB	132	1	0:06	-	1	リレ-OCH
送電線	Habarana-Valachchenai	132	1	0:04	-	1	リレ-OC/DZ
送電線	Balangoda-Galle 1	132	1	0:02	0.26	1	プロテクション動作
送電線	Kolonnawa-Kelanitissa 1	132	1	0:25	-	2	表示不良
送電線	Badulla 66kV OCB	66	1	0:08	0.30	1	リレ-OC

資料：CEB 1995年 4月期 月次報告

表5-9 1995年 4月期 送電網事故概要

第6章 本格調査及び本格調査時に留意すべき点

1. 調査の目的

本調査の目的は2010年迄のスリ・ランカ国、全国送電網整備計画を行いそのマスタープランを作成する事にある。その要旨は既存送・変電設備、系統を調査し、電力需要予測に基づいて系統構成、系統安定度、供給信頼度の検討を行い、CEBの送電システム拡張計画を策定すると共に、CEBが独自に系統運用を行えるべく技術移転を行うものである。長期に渡る整備計画である事からCEBに対しては、単位年度毎の整備計画、プロジェクトの優先着工順位等に付き勧告すると共にプレリミナリー・デザイン及び建設コストの算出を行うものである。

2. 調査の範囲及び内容

基本的にはスリ・ランカ国全土を対象とする（但し、安全の確保上困難が伴うと想定される地域については、現地踏査は行わず、CEB等の保有する既存データ等の活用による分析調査に置き換えるものとする）。

対象とする電圧レベルは66kV以上とする。1995年現在、CEBは220kV系統総延長270km、132kV系統総延長2,517kmの合計2,787kmの送電線、34ヶ所のグリッド変電所を有しており、これらが調査対象となる。

2-1 調査の種類

マスタープラン調査

2-2 調査期間

本格調査は、スリ・ランカ国内での現地調査及び日本国内作業とで構成され、その調査期間はS/Wに示すとおり、全体で13ヶ月を予定している。

2-3 調査内容

1) 本目的に基づく関連資料・情報の収集

2) 電力事情調査

2)-1 既存送・変電設備の調査

- 2)-2 現在建設或は計画中の発電所、送電系統、変電所の新設、拡張及びリハビリテーションの調査
- 2)-3 系統運転、給電システム及び通信、制御システム等系統全体のシステム・コントロールの調査
- 2)-4 系統及び設備の事故により系統運転に与える影響度、及び事故復旧体制、保守・点検の調査
- 2)-5 システム・ロスの調査。33kV以下は今回の対象外であるが、CEBのシステム・ロスを系統電圧毎に調査、システム・ロスの発生別ウエイト付けを行い必要に応じCEBへの勧告を行う。
- 2)-6 電気料金体系のレビューと料金徴収実態等の調査

3) 電力需要予測

地域別、需要家別の電力需要予測を行い、本長期計画の基本資料を作成すると共に、需要変動に伴う系統解析に適応し得る需要予測パターンを作成する。

4) 電圧、周波数の維持

系統電圧、周波数の適正維持はサービスの基本であるが、CEBではこの基準が明確ではない。従って、CEBの現状を調査すると共に、電圧については、例えば送電用変電所二次母線、配電用変電所の送り出し電圧の基準、周波数については平常時、異常時の変動幅といった様に基準値を設定する必要がある。

5) 供給信頼度の確立

供給信頼度は系統構成、即ち送電網、変電設備計画等から構成され、通常予想される設備事故、或は重大事故の発生時供給支障を最少限にする対策が肝要であるが、これらの高レベルの維持は設備余力の増大を招く事にもなりスリ・ランカ国の経済等も考慮にいたした適正な基準に基づくものでなければならない。この点、大需要家地帯を考慮に入れてCEBとの協議の下に供給信頼度の検討を行い適正な系統構成を策定するものとし、今後CEBが独自に計画の見直しを行えるよう考慮するものとする。

6) 系統解析

5) 項と関連して、1995、2000、2005、2010年の各断面において長期計画に基づいた系統解析、即ち、潮流、短絡、地絡、安定度等の解析を行うものとする。但し、近5年の2000年に付いては具体的に、以降の断面に付いてはCEBとの協議の中で必要項目の選択を行うものとする。

7) 系統運用の調査、計画立案

現在コロombo市内デマタゴダにシステム・コントロールセンターがあり、潮流及び負荷状況に応じて基幹系統の運用を行っているが、今後の長期計画に対応する系統運用方式の策定、立案をおこなう。

8) 損失の低減対策

CEB集計資料の分析に基づき、損失の発生要因を突き止め、その対策を講ずる。

9) 最適送・変電設備拡張計画の策定と基本仕様の作成

以上に基づき

- 9)-1 送電電圧と送電容量
- 9)-2 基幹系統の回線方式（ループ化の検討）と回線数
- 9)-3 大消費地域或は大口径需要家への送電、給電方式
- 9)-4 上記に対応した変電所の規模と位置
- 9)-5 系統保護システム

等を考慮に入れた年度別拡張計画と基本仕様の作成を行う。

10) 年度別施工計画と建設費用の積算並びに経済・財務分析

上記設備拡張計画と基本仕様に基づいた年度別施工計画と建設費用の積算を行い、これに対応する経済性、建設費、運営費等の財務分析を行う。

3. 本格調査時に留意すべき点

3-1 安全対策

スリ・ランカの北東部では政府軍とLTTEとの戦闘状態が続いており、

またコロombo市内においても爆弾事件が起こっており、人の多く集まる場所及び政府要人の周辺は特に危険であるといわれている。現地当局等の情報収集に努め、現地大使館、JICA事務所の指示に従い、CEBと理解を同じくし、安全かつ円滑に調査を進めるよう留意する必要がある。

本調査はスリ、ランカ全土が対象となるが、国土の北東部を中心として、特に安全の確保に困難が伴うと想定される地域については、CEBと協議の上、現地踏査を行わず、CEBの所有するデータ等を活用し、これを解析することによって調査を行うものとする。

また既存の発電所、変電所、システムコントロールセンター等の現地調査を行う場合でも、カウンターパートの同行と助言が必要である。

3-2 現行プロジェクトの状況把握

CEBが現在実施中の電力プロジェクトについて、個々について詳細に状況を把握した上で、整合性のある計画を作る必要がある。

また、マスタープランの策定にあたっては、既存の国家計画等や各事業体との計画等と十分整合性を取るものとする。特にゴールを含む南部総合開発計画が、日本の資金援助により調査・策定される予定であり、本計画の策定にあたっては、この開発計画の内容を十分に把握し、整合性を取るよう留意すること。

3-3 OECFとの連携

新規送電線整備事業の主な資金ソースはそのほとんどが円借款である状況にあり、本マスタープラン終了後、スムーズにOECFのエンジニアリングサービス(E/S)に移行できるよう、調査内容、スケジュールについて、密かにOECF本部及び現地事務所と連絡を取合いながら調査を進める必要がある。

3-4 カウンターパートへの技術移転について

本件調査は電力需要予測と供給計画に基づく最適な送電網の整備計画を策

定するものであるが、15年間の長期計画であることから、調査終了後も事情の変更による調査結果の見直し - いわゆるローリングプランの策定がある程度避けられない。この点CEBとしても十分な問題意識をもっており、事前調査の協議の中でも、調査が日本側調査団によって一方的に行われるのではなく、CEBの技術者も参画し、調査手法を理解、吸収したいとの希望が表明された。

したがって調査実施にあたっては、可能な限りスリ・ランカ国内で作業を実施し、日本での系統構成、系統解析、電力運営の実際も併せて説明し、カウンターパートと共に技術移転の骨子を策定する必要がある。なお、調査終了後CEBが独自である程度の見直しを行うことが可能となるよう留意すること。

3-5 セミナーについて

技術移転の一環として、インテリムレポート、ドラフトファイナルレポート提出時にCEB及び関係機関に対し、セミナーを実施する。

セミナーの内容は、CEB系統の信頼度基準と系統解析について（第1回）、最適開発計画について（第2回）とするが、その詳細についてはCEBと協議の上、決定するものとする。

また、環境問題は今や国際問題化しており、スリ・ランカ国についても近年この問題により発、変電所の建設に支障が生じており、日本あるいは諸外国の例を主題に環境問題についてセミナーにおいて紹介するものとする。

3-6 資料の出典と整理

CEBには、CEBはじめ各国コンサルタント作成の資料等かなりの資料があるが、それらの統一性が無い為これら諸資料の総合整理が必要と考えられる。

3-7 供給予備力

ピーク・デマンドに対する発電設備の供給予備力は、日本の場合電力会社

相互間の電力融通があるが、スリ・ランカ国はCEB一社であり電力融通という考え方は成り立たない。従い、かかる状況下での適正予備力の設定が必要である。

3-8 系統運用

スリ・ランカ国全体の系統運用及び設備の現状を調査し、今後の拡張計画に対応したシステム及び運用方法を検討するものとする。

3-9 カウンターパートの配置、事務所、車輛、その他必要な機材等について

カウンタパートについて、技術移転が最も効果的に実施できるよう配慮のうえ、その担当分野、人数を決定する必要がある。

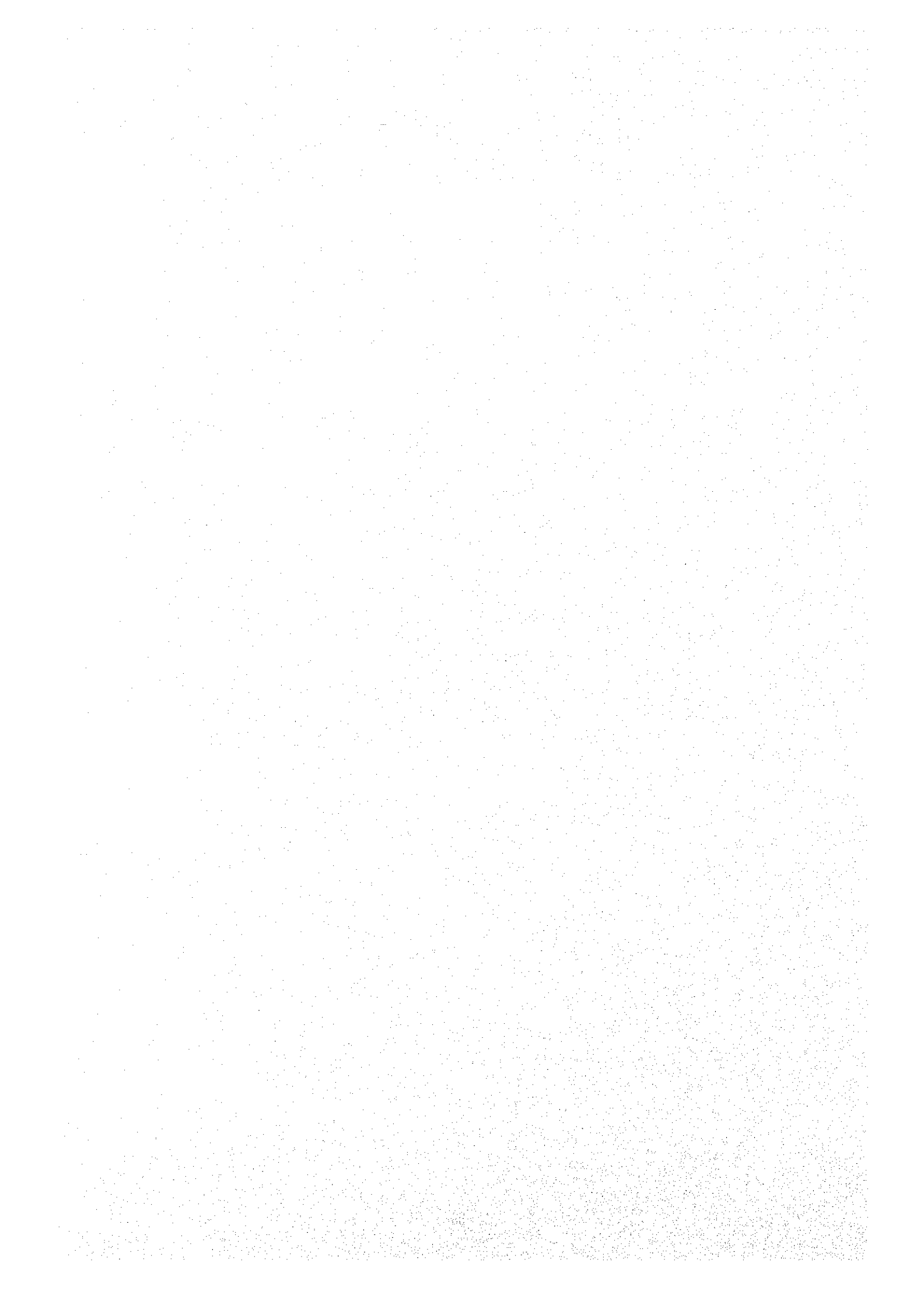
コロombo市内の作業事務所、必要な機材および車輛はCEBにて準備される。また、調査団員にはIDカードが交付されることになっている。従い現地到着後、速やかにIDカード交付のために必要な書類を提出し、交付を求める必要がある。

3-10 機材供与

系統解析等に必要データベースはCEB側にもあると思われるが、不足あるいは考え方の相違による補充データもかなり必要と考えられ、このためコンピューターを持参し、スタディー終了後にこれをCEB側に供与するものとする。コンピューターの型式については、スタディー・チームとCEB側との協議の下に決定する。

付 属 資 料

- 1 Terms of Reference
- 2 Scope of Work
- 3 Minutes of Meeting
- 4 Questionnaires
- 5 主要面会者リスト
- 6 収集資料リスト



付属資料 1 Terms of Reference

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පුද්ගල අමාත්‍යාංශය

බෙහෙවින්දු වහාත් ත්‍රිකුණාමල්ලා
රීථි කොට්ඨාසය

DEPARTMENT OF EXTERNAL RESOURCES
Ministry of Finance

මගේ අංකය }
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බණ්ඩාරය, (3 වැනි මහල)
The Secretariat, (3rd Floor)

නැ. අං. 277, කොළඹ 1
P. O. Box 277, Colombo 1.

19 31.10.1994

Mr K Doi
First Secretary
Embassy of Japan
Colombo 7

Dear Mr Doi

REQUEST FOR DEVELOPMENT SURVEY STUDIES
FINANCIAL YEAR 1995/96

I wish to draw your attention to my letter of even No. dated 28th October, 1994 regarding the above subject.

In addition to the Survey Studies included in our letter under the above reference, we would like to add Master Plan Study for development of the transmission system of the Ceylon Electricity Board as a High Priority Project for consideration by your Government.

The Note received from the CEB relating to the proposal is enclosed for your perusal.

Thanking you

Yours sincerely

S L Seneviratna
Director General

cc: Mr Y Nakamura
Resident Representative
JICA
Colombo 3

Application for the
Technical Cooperation (Development Study)
by the Government of Japan

1. Project Summary

- (1) Project Title -
Master Plan Study for development of the transmission system of the Ceylon Electricity Board.
- (2) Location - Sri Lanka (see map attached)
- (3) Implementing Agency -
Name : Ceylon Electricity Board
Number of the Staff : 15,000
Budget allocated : -
Organization Chart : attached
- (4) Justification of the Project -
The electricity demand in Sri Lanka is increasing at an annual average rate of about 8%. In order to meet this demand and to interconnect the future generating stations there is a need to develop a Long Term Optimum Transmission Expansion Plan. Presently the power transmission system has developed in a somewhat piece meal fashion. Therefore it is very essential to carry out a Master Plan Study for the development of the Power Transmission system of Sri Lanka (CEB). It is also necessary to upgrade CEB's in-house transmission planning capabilities. (The necessity of a Master Plan for the development of the transmission system was also recommended by the OECF Team when they visited Sri Lanka during February this year).

This Study would enable CEB to develop a transmission system that is consistent with the generation system, reduce system losses and increase the reliability and quality of the power supply. A reduction in the system losses is an effective increase in generation. Increasing the reliability and the quality of supply is important not only from the point of view of efficient expansion of the transmission system but is also one of the key factors in promotion of foreign investment and industrial development through out Sri Lanka. Therefore such a Master Plan Study will contribute to a increase in industrial development and employment opportunities. This will benefit Sri Lanka society as a whole.
- (5) Desirable time of the commencement of the Project -
As soon as possible (1995)
- (6) Expected funding source

- (7) Other relevant Project -
2. Terms of Reference of the proposed Study
(See appendix)
3. Facilities and information for the Study Team
- (1) Assignment of Counterpart Staff -
Will be provided by the CEB.
 - (2) Available data, information, documents, maps etc. related
to the Study -
Will be provided by the CEB.
 - (3) Information of the security conditions in the Study
Area -
There is no special security constraints outside the
North and East of Sri Lanka. Since it is a Master Plan
Study most of the work could be carried out in Colombo.
4. Global Issues - Not applicable.

5. Undertaking of the Government of Sri Lanka

In order to facilitate a smooth and efficient conduct of the Study, the Government of Sri Lanka shall take necessary measures:

- (1) to secure the safety of the Study Team.
- (2) to permit the members of the Study Team to enter, leave and sojourn in Sri Lanka in connection with their assignment therein, and exempt them from alien registration requirement and consular fees.
- (3) to exempt the Study Team from taxes, duties and any other charges on equipment, machinery and other materials brought into and out of Sri Lanka for the conduct of the Study.
- (4) to exempt the Study Team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Study Team for their services in connection with the implementation of the Study.
- (5) To provide necessary facilities to the Study Team for remittance as well as utilization of the funds introduced in Sri Lanka from Japan in connection with the

implementation of the Study.

- (6) to secure permission or entry into private properties or restricted areas for the conduct of the Study.
- (7) to secure permission for the Study to take all data, documents and necessary materials related to the Study out of Sri Lanka to Japan. (to be used for this study only)
- (8) to provide medical services as needed. Its expenses will be chargeable to members of the Study Team.

6. The Government of Sri Lanka shall bear claims, if any arises against member(s) of the Japanese Study Team resulting from, occurring in the course of or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the member of the Study Team.

7. The Ceylon Electricity Board shall act as counterpart agency to the Japanese Study Team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The Government of the Sri Lanka assured that the matters referred in this form will be ensured for a smooth conduct of the Development Study by the Japanese Study Team.

Signed:

Titled:

On behalf of the Government of

Date:

දුරකථන } 421251
 தொலைபேசி }
 Telephone }
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 Fax } 447633



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 DEPARTMENT OF EXTERNAL RESOURCES
 Ministry of Finance, Planning, Ethnic Affairs and
 National Integration

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 The Secretariat, (3rd Floor)
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 அ. பெ. இல. 277, கொழும்பு 1.
 P. O. Box 277, Colombo 1.
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Mr. K. Doi,
 First Secretary,
 Embassy of Japan,
 COLOMBO.

Dear Mr. Doi,

REQUEST FOR DEVELOPMENT SURVEY STUDIES FINANCIAL YEAR 1995/96
Master Plan Study for development of the transmission system
of the Ceylon Electricity Board

This has reference to our letter of even number dated 31st October, 1994 regarding the above matter.

I am enclosing herewith the Terms of Reference of the proposed study which we couldn't attached with the above mentioned letter.

Thanking you.

Yours sincerely,

D D J KUDALIGAMA
 Director
 for DG/ERD.

copy: Mr. Y. Nakamura
 Resident Representative, JICA Office, Colombo 3.

Attn: Mrs. Kudaliguma

(4)
Appendix 1

TERMS OF REFERENCE FOR THE PROPOSED MASTER PLAN STUDY
FOR DEVELOPMENT OF TRANSMISSION SYSTEM
OF THE CEYLON ELECTRICITY BOARD

[Handwritten initials/signature]

1. Objective of the Study

The principal objectives of the Study are :

- 1) to develop an optimum long-term power transmission system expansion program for CEB.
- 2) to upgrade CEB's in-house transmission planning capabilities.

2. Area - to be covered by study and planning period

Area :

Transmission system of the CEB excluding the 33kV distribution system.

Planning Period :

- . Short Term Plan (3 - 5 years)
- . Medium Term Plan ((5 - 10 years)
- . Long Term Plan (beyond 10 years)

3. Scope of the Study

- (1) Collection and review of existing data and information to formulate a suitable data base.
- (2) Transmission System Survey
 - (a) Review and study existing transmission lines and substations and identify existing/future problems.
 - (b) Review of existing transmission system expansion plans including load flow and short circuit studies.
- (3) Formulation of a planning criterion and reliability standard.

(4) Detail Studies

- (a) Dynamic simulation and stability studies of the present and future power system. (Should include collecting the necessary data and information to formulate a suitable data base for such studies).
- (b) Study of voltage and reactive power control methods.
- (c) Load flow & short circuit studies.

(5) Social environmental aspects study

Study of the social environmental aspects in relation to construction of transmission lines and substations.

(6) Formulation of optimum power system development plan.

(Various technical studies)

- (7) Cost estimation.
- (8) Economic and financial analysis.
- (9) Planning of implementation program.
- (10) Financial Plan.
- (11) Preliminary design and basic specification of the transmission lines and grid substations.
- (12) Training the counterpart staff i.e. the Transmission Planning Engineers in the above.

4. Expected major out put of the study

Enable CEB to

- (a) develop a transmission system that is consistent with the generation development.
- (b) reduce system losses.
- (c) increase reliability and quality of power supply.

Application for the
Technical Cooperation (Development Study)
by the Government of Japan

1. Project Summary

- (1) Project Title -
Master Plan Study for development of the transmission system of the Ceylon Electricity Board.
- (2) Location - Sri Lanka (see map attached)
- (3) Implementing Agency -
Name : Ceylon Electricity Board
Number of the Staff : 15,000
Budget allocated : -
Organization Chart : attached
- (4) Justification of the Project -
The electricity demand in Sri Lanka is increasing at an annual average rate of about 8%. In order to meet this demand and to interconnect the future generating stations there is a need to develop a Long Term Optimum Transmission Expansion Plan. Presently the power transmission system has developed in a somewhat piece meal fashion. Therefore it is very essential to carry out a Master Plan Study for the development of the Power Transmission system of Sri Lanka (CEB). It is also necessary to upgrade CEB's in-house transmission planning capabilities. (The necessity of a Master Plan for the development of the transmission system was also recommended by the OECF Team when they visited Sri Lanka during February this year).

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- (5) Desirable time of the commencement of the Project -
As soon as possible (1995)
- (6) Expected funding source -

- (7) Other relevant Project - -
2. Terms of Reference of the proposed Study
(See appendix)
3. Facilities and information for the Study Team
- (1) Assignment of Counterpart Staff -
Will be provided by the CEB.
 - (2) Available data, information, documents, maps etc. related to the Study -
Will be provided by the CEB.
 - (3) Information of the security conditions in the Study Area -
There is no special security constraints outside the North and East of Sri Lanka. Since it is a Master Plan Study most of the work could be carried out in Colombo.
4. Global Issues - Not applicable.

5. Undertaking of the Government of Sri Lanka

In order to facilitate a smooth and efficient conduct of the Study, the Government of Sri Lanka shall take necessary measures:

- (1) to secure the safety of the Study Team.
- (2) to permit the members of the Study Team to enter, leave and sojourn in Sri Lanka in connection with their assignment therein, and exempt them from alien registration requirement and consular fees.
- (3) to exempt the Study Team from taxes, duties and any other charges on equipment, machinery and other materials brought into and out of Sri Lanka for the conduct of the Study.
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implementation of the Study.

- (6) to secure permission or entry into private properties or restricted areas for the conduct of the Study.
- (7) to secure permission for the Study to take all data, documents and necessary materials related to the Study out of Sri Lanka to Japan. (to be used for this study only)
- (8) to provide medical services as needed. Its expenses will be chargeable to members of the Study Team.

6. The Government of Sri Lanka shall bear claims, if any arises against member(s) of the Japanese Study Team resulting from, occurring in the course of or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the member of the Study Team.

7. The Ceylon Electricity Board shall act as counterpart agency to the Japanese Study Team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The Government of the Sri Lanka assured that the matters referred in this form will be ensured for a smooth conduct of the Development Study by the Japanese Study Team.

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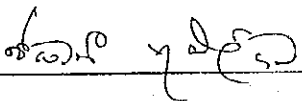
On behalf of the Government of

Date:


SCOPE OF WORK
FOR
MASTER PLAN STUDY
FOR
DEVELOPMENT OF THE TRANSMISSION SYSTEM
OF THE CEYLON ELECTRICITY BOARD
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF
SRI LANKA

AGREED UPON BETWEEN
CEYLON ELECTRICITY BOARD
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

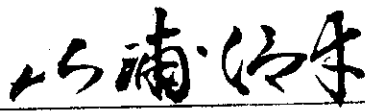
COLOMBO, JULY 11, 1995



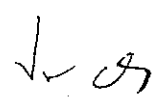
Ms. D. D. J. KUDALIGAMA
DIRECTOR
DEPT. OF EXTERNAL RESOURCES



Dr. LESLIE HERATH
CHAIRMAN
CEYLON ELECTRICITY BOARD



Mr. NOBUYUKI YAMAURA
LEADER OF THE PREPARATORY STUDY
TEAM, JICA



I. INTRODUCTION

In response to the request of the Government of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "the Government of Sri Lanka"), the Government of Japan has decided to conduct the Master Plan Study for Development of the Transmission System of the Ceylon Electricity Board in Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Sri Lanka.

The present document sets forth the scope of work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are as follows ;

- (1) to develop an optimum long-term transmission system expansion program for Ceylon Electricity Board (hereinafter referred to as "CEB"), up to the year 2010,
- (2) to upgrade CEB's in-house transmission planning capabilities.

III. STUDY AREA

The Study covers the transmission system of the CEB excluding the 33kv distribution system in the whole area of Sri Lanka.

IV. SCOPE OF THE STUDY

In order to achieve the above objective, the Study will cover the following items;

1. Collection and review of existing data and information related to the Study.

2. Review and study for the transmission system

(1) Review and study for existing transmission system

- Power station facilities
- Grid substation and transmission line facilities

Including review and study for actual fault results, system protection, system control, and maintenance and management for substation and transmission line system.

(2) Review and study of existing transmission expansion plan

- Power station facilities
- Grid substation and transmission line facilities
- Transmission line facilities

(3) Operation situation of transmission system
(frequency changes, voltage profile and so on)

- (4) Load dispatching and telecommunication system
 - (5) System losses
 - (6) Electricity tariff system
3. Electricity demand forecast
- (1) Actual demand past 20 years (per province area, sector and load curves for daily, monthly and yearly)
 - (2) Demand forecast next 15 years
4. Formulation of criteria and reliability standard for planning
5. Transmission system analysis

Following analysis will be conducted with selected years of existing(1995), short term(2000), medium term(2005) and long term(2010).

- (1) Power flow calculation
 - (2) Study of equipment capacity
 - (3) Study of transmission system stability
 - (4) Study of short circuit and grounding current
6. Analysis for supply reliability of transmission system

7. Formulation of optimum transmission system development plan

Formulation of optimum transmission system development plan will be conducted with most suitable power expansion program from 1996 to 2010.

8. Basic specifications

Basic specifications of power transmission and substation will be conducted on transmission voltages, circuit system, bus system and scale of grid substations, etc.

9. Cost estimation

The approximate cost plan needed for the Study will be estimated per each year.

10. Economic and financial analysis

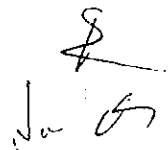
V. WORK SCHEDULE

The Study will be carried out in accordance with the attached Tentative Work Schedule shown in Appendix I.

VI. REPORTS

JICA shall prepare and submit the following reports in English to CEB.

1. Inception Report (20 copies)
2. Progress Report (20 copies)



3. Interim Report (20 copies)
4. Draft Final Report (20 copies)

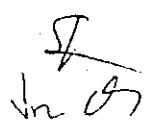
The Government of Sri Lanka shall provide its comments on the Draft Final Report within one (1) month after the submission of the Draft Final Report.

5. Final Report (30 copies)

Within two (2) months after receiving the comments of the Government of Sri Lanka on the Draft Final Report.

VII. UNDERTAKINGS OF THE GOVERNMENT OF SRI LANKA

1. To facilitate smooth conduct of the Study, the Government of Sri Lanka shall take necessary measures;
 - (1) to secure the safety of the Japanese study team,
 - (2) to permit the members of the Japanese study team to enter, leave and sojourn in Sri Lanka for duration of their assignment therein, and exempt them from foreign registration requirements and consular fees,
 - (3) to exempt the members of the Japanese study team from taxes, duties, fees and any other charges on equipment, machinery and other materials brought into Sri Lanka and out for the conduct of the Study,
 - (4) to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in



connection with the implementation of the Study,

- (5) to provide necessary facilities to the Japanese study team for remittance as well as utilization of the funds introduced into Sri Lanka from Japan in connection with the implementation of the Study,
 - (6) to secure permission for entry into private properties or restricted areas for the implementation of the Study,
 - (7) to secure permission for the Japanese study team to take all data and documents including maps and photographs related to the Study out of Sri Lanka to Japan,
 - (8) to provide medical services as needed. Its expenses will be chargeable on members of the Japanese study team.
2. The Government of Sri Lanka shall bear claims, if any arises, against the members of the Japanese study team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Japanese study team.
 3. CEB shall act as counterpart agency to the Japanese study team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.
 4. CEB shall, at its own expense, provide the Japanese study team with the following, in cooperation with other organizations concerned;
 - (1) available data and information related to the Study,



- (2) counterpart personnel,
- (3) suitable office space with necessary equipment and facilities in Colombo,
- (4) credentials or identification cards,
- (5) arrangement necessary for vehicles with drivers, fuel and spare parts.

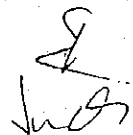
VIII. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures;

1. to dispatch, at its own expense, study teams to Sri Lanka,
2. to pursue technology transfer to Sri Lanka counterpart personnel.

IX. CONSULTATION

JICA and CEB shall consult with each other in respect of any matter that may arise from or in connection with the Study.



APPENDIX I TENTATIVE WORK SCHEDULE

Working Item	Year																
	1995						1996										
	Project Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Calendar Month	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1. Collection and review of existing data and information																	
2. Review and study for the transmission system																	
3. Electricity demand forecast																	
4. Formulation of criteria and reliability standard for planning																	
5. Transmission system analysis																	
6. Analysis for supply reliability of transmission system																	
7. Formulation of optimum transmission system development plan																	
8. Basic specifications																	
9. Cost estimation																	
10. Economic and financial analysis																	
Reports																	
Seminar																	

■ JICA work in Sri Lanka

□ JICA work in Japan

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MINUTES OF MEETING
ON
THE MASTER PLAN STUDY
FOR DEVELOPMENT OF THE TRANSMISSION SYSTEM
OF THE CEYLON ELECTRICITY BOARD
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Japan International Cooperation Agency(JICA) Preparatory Study Team (hereinafter referred to as "the Team"), headed by Mr.Nobuyuki Yamaura, and Ceylon Electricity Board (hereinafter referred to as "CEB"), represented by Dr.Leslie Herath, had meetings from July 4 to July 11, 1995 at the headquarters of CEB in Colombo.

A list of participants for the meetings is given in attachment to this minutes.

During the meetings, the document entitled "SCOPE OF WORK FOR MASTER PLAN STUDY FOR DEVELOPMENT OF THE TRANSMISSION SYSTEM OF THE CEYLON ELECTRICITY BOARD IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA" was discussed and both sides agreed on it, considering the followings in the series of discussions.

1. Both sides understood the need for the CEB to upgrade the transmission development plan and the need to improve capability of CEB to carry out such studies.
2. The Team explained that it would require thirteen (13) months to complete the Study and stated that the date of commencement of the Study was not formally decided, however, it would be commenced in around October 1995. Both sides confirmed the schedule.

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3. Both sides agreed that if there are any security and safety problems in certain areas the Study shall be carried out, without field surveys in those areas, by analyzing the existing information available in other ways.
4. CEB requested in the light of technology transfer that one(1) counterpart personnel from the related department would participate in the joint working in Japan next year. The Team stated that CEB's request would be conveyed to JICA headquarters.
Both sides understood the importance of the on-the-job training in Sri Lanka through the whole of the Study.
5. CEB requested to introduce the Japanese experiences with regard to the environment impact assessment for the construction of transmission line and substations. The Team mentioned it would be considered.
6. Number of counterpart personnel, vehicles and other facilities will be informed one month before the Study commencement.

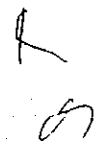
Colombo, July 11, 1995



Dr. Leslie Herath
Chairman
Ceylon Electricity Board



Mr. Nobuyuki Yamaura
Leader of the Preparatory Study
Team, JICA



LIST OF PARTICIPANTS

1. Ceylon Electricity Board

- 1) DR.LESLIE HERATH CHAIRMAN
- 2) MR.K.A.RANAWEERA GENERAL MANAGER
- 3) MR.D.G.D.C.WIJERATNE ADDITIONAL GENERAL MANAGER (PLANNING)
- 4) MR.RANIL LOKUBALASOORIA DEPUTY GENERAL MANAGER (TRANSMISSION
PLANNING)

2. JICA Preparatory Study Team

- 1) MR.NOBUYUKI YAMAURA LEADER
- 2) MR.ISAO YOSHIDA POLICY OF POWER PLANNING
- 3) MR.HIDEO KOIZUMI POWER SYSTEM PLANNING
- 4) MR.HIROSHI KITAICHI TRANSMISSION LINE AND SUBSTATION
EQUIPMENT
- 5) MR.TSUNYUKI UTAMARU PLANNING AND COORDINATION

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QUESTIONNAIRE
ON
MASTER PLAN STUDY
FOR
DEVELOPMENT OF THE TRANSMISSION SYSTEM
OF THE CEYLON ELECTRICITY BOARD
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF
SRI LANKA

JULY, 1995

PREPARATORY STUDY TEAM OF JICA

LEGEND OF AVAILABILITY:

- A: Collected by the Preparatory Study Team
- B: To be collected by the Master Plan Study Team
- C: No Data

1. GENERAL INFORMATION		DESCRIPTION	AVAILABILITY	REMARKS
ITEM				
1. The Authorities Concerned to This Project		<ul style="list-style-type: none"> - Name : CEB, Ministry of Irrigation, Power & Energy, LECO, Local Administration - Organization - Annual Report 	<ul style="list-style-type: none">)} A (CEB & LECO) 	<ul style="list-style-type: none"> } B (Except CEB & LECO)
2. Statistics (1985 to 1994)	*	<ul style="list-style-type: none"> - GDP Growth - Population Growth - Distribution of Population by Province Area - Economic Indices (National Income, National Finance, etc.) 	<ul style="list-style-type: none">)} A 	
3. Meteorological Data (at Kandy, Colombo and Trincomalee)		<ul style="list-style-type: none"> - Rainfall per Each Month - Temperature(Maximum and Minimum) and Relative Humidity per Each Month - Wind Velocity - Earthquake 	<ul style="list-style-type: none"> A A A B or C 	
4. Electrified Factor		<ul style="list-style-type: none"> - Electrified Factors of Each Province Area 	<ul style="list-style-type: none"> A 	

* This data was collected by the Project Identification Team (visited on 7 th to 16 th of February, 1995) for Mining, Industry and Power Development, but latest and additional data /informations are requested.

2. ELECTRIC POWER SITUATIONS IN THE POWER TRANSMISSION SYSTEM

ITEM	DESCRIPTION	AVAILABILITY	REMARKS
<p>1. Existing Supply Facilities</p> <p>* ** **</p>	<ul style="list-style-type: none"> - Installed Capacities of Power Generation Plants and Substations - Power Transmission Network Diagrams (with Conductor Size and Transmission Distance) - Route Maps for Power Transmission Network 	<p>A</p>	
<p>2. Demand and Power Supply Records</p>	<ul style="list-style-type: none"> - Records of Peak kW, kWh from 1985 to 1994 including Load Curves (Annual, Monthly, Daily) in whole Sri Lanka 	<p>A</p>	
<p>3. Power Consumption</p>	<ul style="list-style-type: none"> - Following Power Demands (kW) and Annual Power Consumptions (kWh) in whole Sri Lanka from 1985 to 1994 <ul style="list-style-type: none"> a. Domestic (Household) b. Industries c. Agricultures d. Commercials e. Others 	<p>A A A A</p>	
<p>4. Demand Forecast</p>	<ul style="list-style-type: none"> - Short Term(2000), Medium Term(2005) and Long Term(2010) Demand Forecasts in whole Sri Lanka 	<p>A</p>	
<p>5. Future Expansion</p>	<ul style="list-style-type: none"> - Future Expansion Program of Power System (Power Plant, Substation and Transmission Line) 	<p>A</p>	
<p>6. Communication System Diagram and Outline</p>	<ul style="list-style-type: none"> - Micro-wave, Power Line Carrier (PLC), VHF, etc. 	<p>A</p>	

* This data was collected by the Project Identification Team (visited on 7th to 16th of February, 1995) for Mining, Industry and Power Development, but latest and additional data /informations are requested.

** This data was collected by the above Team, but Network Diagrams and Route Maps are unclear.

3. POWER SYSTEM RELIABILITY (2/2)

ITEM	DESCRIPTION	AVAILABILITY	REMARKS
8. One Line Diagrams	- Typical One Line Diagrams for 220/132 kV Grid Substation	A	
9. Operation and Maintenance Manual	- Manual for Frequent Maintenance and Recovery Method of Faulted Equipment, etc.	B or C	
10. Salt Contamination	- Salt Contamination Data for Insulators and Equipment Bushings	B or C	
11. IKL	- IKL (Isokeraunic Level) Data in whole Sri Lanka	B or C	
12. Applicable Standards	- Designing Standard. - Equipment Standards	A (Below 33 kV) IEC Standard	B (Up to 66 kV)

3. POWER SYSTEM RELIABILITY (1/2)

ITEM	DESCRIPTION	AVAILABILITY	REMARKS
1. Power Flow and Impedance Map	<ul style="list-style-type: none"> - Existing Load, Power Flow and Impedance (with Conductor Size and Transmission Distance) - Future Expansion Load, Power Flow and Impedance (with Conductor Size and Transmission Distance) 	A	
2. Fault Records	<ul style="list-style-type: none"> - Outage Durations and Fault Causes of Power Facilities For Transmission Line - For Substation - For Power Station - Generator Step Out Experience and Causes 	A (April, 1995)	
3. Protective Relay System	<ul style="list-style-type: none"> - Transmission Line Protection - Bus Protection - Transformer Protection 	A	
4. SCADA and/or LDC System	<ul style="list-style-type: none"> - System Diagram and Outline including Telecommunication System For Central Station - For Each Branch Station 	B (Except SCADA)	
5. Generator Constant	<ul style="list-style-type: none"> - For Hydro, Steam, Gas Turbine, Diesel, etc. 	A	
6. Hydrological Data for Hydro Power Station	<ul style="list-style-type: none"> - Water Inflow and Discharge from 1985 to 1994 	A (Annual Record)	
7. Record of Generation (Normal)	<ul style="list-style-type: none"> - Warming-up Hours and Service Hours (Steam Turbine) - Load Curve (Yearly, Monthly, Daily) 	A	
		A (Monthly of 1993)	

4. ENVIRONMENTAL ASPECT ITEM	DESCRIPTION	AVAILABILITY	REMARKS
1. Laws, Regulations, Codes for Environmental Protection	<ul style="list-style-type: none"> - Electrical Shock - Noise and Vibration - Impact on Ecology - Impact on Scenery - Impacts on Historical and Cultural Assets - Impact on Existing Infrastructure - Impact on Land User 	B of C	

5. COST ESTIMATION DATA

ITEM	DESCRIPTION	AVAILABILITY	REMARKS
<p>1. Construction Cost for Civil and Electrical Works</p>	<ul style="list-style-type: none"> - Labours - Materials - Construction Machinery - Unit(km) Cost of Transmission Line (with Each System Voltage) - Unit(kVA) Cost of Substation (with Each System Voltage) 	<p>A B or C B or C A A</p>	
<p>2. Operation and Maintenance Yearly Costs</p>	<ul style="list-style-type: none"> - Transmission Lines - Substations - Power Stations 	<p>B or C</p>	
<p>3. Administration and Engineering Costs</p>	<ul style="list-style-type: none"> - Construction Office - Office Facilities - Engineers and etc. 	<p>B or C</p>	
<p>4. Escalation Rate</p>	<ul style="list-style-type: none"> - Latest 5 Years 	<p>A</p>	
<p>5. Exchange Rate</p>	<ul style="list-style-type: none"> - Between US \$ and Rupee 	<p>A</p>	
<p>6. Import Duties</p>	<ul style="list-style-type: none"> - Machinery and Materials for Construction 	<p>A</p>	
<p>7. Tax and Other Duties</p>	<ul style="list-style-type: none"> - Seles Tax, Corporate Tax and Other Duties 	<p>A</p>	

6. OTHERS ITEM	DESCRIPTION	AVAILABILITY	REMARKS
1. Service Life, Period of Replacement	- Service Life, Periods of Replacement of Transmission Lines and Substations	B or C	
2. Delivery Cost	- Delivery Cost for Transmission Line Materials - Delivery Cost for Substation Equipment - Delivery Cost for Administration Materials	A A B or C	
3. Tariff	- Tariff System - Provided Status to All Users of Tariff (Wh) Meter	A B or C	
4. Operation and Maintenance	- Operation and Maintenance Organization - Manpower of Operation - Manpower of Maintenance - Maintenance Tools and Facilities	} B or C	

* This data was collected by the Project Identification Team (visited on 7th to 16th of February, 1995) for Mining, Industry and Power Development, but latest and additional data/informations are requested.

主要面会者リスト

1. 在スリ・ランカ日本国大使館
 - 野口 晏男 特命全権大使
 - 神谷 武 公使
 - 土居 邦弘 一等書記官
 - 古川 茂樹 二等書記官
2. JICAスリ・ランカ事務所
 - 鈴木 晃 次長
 - 飯田 次郎 担当
3. OECFスリ・ランカ事務所
 - Mr.Hachiro Ida Representative
4. セイロン電力庁
 - Dr.Leslie Herath Chairman
 - Mr.K.A.Ranaweera General Manager
 - Mr.D.G.D.C.Wijeratne Additional General Manager (Planning)
 - Mr.Ranil Lokubalasooria Deputy General Manager (Transmission Planning)
 - Mr.D.G.Rienze Fernando Chief Engineer (Transmission Design)
 - Mr.M.A.W.Ranasinghe Chief Engineer (Transmission Planning)
 - Mr.Jas Perera Chief Engineer (Kelanitissa Power Station)
 - Mr.G.N.K.Samaranayake Chief Engineer (Samanalawewa Power Station)
 - Mr.T.S.M.K. Tilakaratna Chief Engineer (Victoria Power Station)
 - Mr.A.A. Sirisena Deputy General Manager (System Control Center)
5. 対外援助局
 - Ms.D.D.J.Kudaligama Director
 - Ms.Dharshana Senanayake Assistant Director
6. 国家計画局
 - Mr.Faiz Mohideen Additional Director General
 - Ms.C.Kulatunga Deputy Director
7. 灌漑・電力・エネルギー省
 - Mr.Jaliya Medagama Secretary

収集資料リスト

番号	資料名称	ページ数	資料の種類・区別	発行機関
1	ANNUAL REPORT 1994 [CENTRAL BANK OF SRI LANKA]	470	資料	スリランカ中央銀行/1994
2	ANNUAL REPORT 1991 [CEYLON ELECTRICITY BOARD]	93	資料	CEB/1991
3	ANNUAL REPORT 1992 [LANKA ELECTRICITY CO., LTD.]	18	資料	LECO/1992
4	POWER SYSTEM STUDY FOR 220KV TRANSMISSION LINK TO TRINCOMALEE POWER STATION	96	資料	CEB送電計画課/1994
5	TRANSMISSION NETWORK MAP	1	資料	CEB/1990
6	CEB PRIMARY POWER SYSTEM [DWG. No. TD/95/7706]	1	図	CEB送電計画部門/1995
7	CEB PRIMARY POWER SYSTEM [DWG. No. TP/95/7686]	1	図	CEB送電計画部門/1995
8	ORGANIZATION CHART OF CEB	1	図	CEB
9	ORGANIZATION CHART OF SRI LANKA GOVERNMENT IN REGARD OF POWER AND ENERGY	1	図	スリランカ政府 電力セクター
10	STATUS OF ELECTRIFICATION - 1994	1	図	CEB/1994. Dec
11	DATA ON SALES AND GENERATION 1993	100	図	CEB/1993
12	DEMAND FORECAST [BASE/LOW/HIGH CASE (1995-2015)]	3	図	CEB/1995
13	VHF REPEATER SITE MAP [DWG. No. VHF002]	1	図	CEB通信部門
14	PLC CHANNELS DIAGRAM [DWG. No. CEB/CMN/PLC/001b]	2	図	CEB通信部門
15	DATA OF LOAD DURATION CURVES	51	図	CEB/発電計画部門
16	LOAN SUMMARY [SL-P17, SL-P34 (1995/MARCH)]	5	図	CEB/1995. Mar
17	ANNUAL GENERATION [VICTORIA PS]	3	図	CEB/Victoria水力
18	DISTRIBUTION SYSTEM EFFICIENCY IMPROVEMENT PROGRAMME [SBARAGAMUWA]	24	図	CEB/1995
19	POWER SYSTEM DATA BASE	17	図	CEB/1994
20	MONTHLY REVIEW REPORT/ APRIL 1995	28	図	CEB/1995. April
21	PTI INTRACTIVE POWER SYSTEM SIMULATION [TRANSMISSION/THERMAL/LAXAPANA/MAHAVELI]	21	図	CEB
22	RESERVOIR OPERATION [K-M COMPLEX 1994]	14	図	CEB/1994
23	STANDARD CONSTRUCTION COSTS-1995	8	図	CEB/1995
24	CEB ELECTRICITY TARIFF 1994	1	図	CEB/1994
25	MINIMUM CLEARANCES OF DISTRIBUTION LINE [33kV/11kV/650V]	1	図	CEB

収集資料リスト

番号	資料名称	ページ数	オリジナル・コピーの区別	発行機関
26	CEB DISTRIBUTION CONSTRUCTION STANDARD DRAWINGS	27	コピー	CEB
27	PSS/E POWER SYSTEM SIMULATOR [CONTENTS OF APPLICATION GUIDE]	14	コピー	CEB
28	PSS/E POWER SYSTEM SIMULATOR [CONTENTS OF OPERATION MANUAL]	18	コピー	CEB
29	SECOND POWER DISTRIBUTION AND TRANSMISSION PROJECT	2	コピー	CEB
30	MASTERPLAN FOR THE ELECTRICITY SUPPLY [CANDIDATE HYDRO PROJECT BEL1015 1988]	78	コピー	CEB/1988
31	AVISSAWELLA G.S. [SINGLE LINE & LAYOUT]	2	コピー	CEB
32	TRANSMISSION SYSTEM AUGMENTATION & DEVELOPMENT PROJECT [PRICE SCHEDULE]	29	コピー	CEB
33	LOAN SUMMARY [SL-P17, SL-P34 (1995/MARCH)]	5	コピー	CEB/1995. Mar
34	SAMANALAWEWA HYDROELECTRIC PROJECT LOT II [SAMANALAWEWA DAM]	9	オリジナル	CEB
35	MAHAWELI PROGRAMME	3	オリジナル	CEB MAHAWELI AUTHORITY
36	THE POLITICS OF SRI LANKA (VOLUME I)		オリジナル	サーベイ部門
37	THE POLITICS OF SRI LANKA (VOLUME II)		オリジナル	サーベイ部門
38	PUBLIC INVESTMENT PROGRAM 1995-1999		オリジナル	ナショナルプランニング部門
39	PROJECT PIPELINE [PRIVATE AND SECTOR FINANCING]		オリジナル	ナショナルプランニング部門
40	スリランカ地勢図よりの抜粋	141	オリジナル	サーベイ部門
	40-1 気圧・風速			
	40-2 降雨量			
	40-3 人口分布			
	40-4 人口密度			
	40-5 人種区分			
	40-6 言語・通信ネットワーク			
	40-7 職業区分			
	40-8 MAHAWELI開発計画			
	40-9 公営企業分布			
	40-10 私企業分布			
	40-11 地方小企業分布			
	40-12 電力供給			
	40-13 電力消費			
	40-14 行政管理区分			
41	LONG TERM GENERATION EXPANSION PLANNING STUDIES 1995-2009	158	コピー	CEB
42	TRANSMISSION PLANNING STUDY 1994-2002	16	コピー	CEB

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