Fig. 6-10 illustrates the total cost ($/kW - year) with yearly load factors as a variable.

6.4.4. Unit Costs for Evaluation of Power Benefits

The unit costs to be used for evaluation of the power benefits, attributable to the Lebir Hydro-Power Plant are considered from Fig. 6-10 as follows:

The plant factor of the Lebir Hydro Power Plant is relatively small and the power source which can be substituted at the lowest cost in that region, of the same plant factor, is the combined cycle CCYW.

Therefore, as unit costs for evaluation of the power benefits, the fixed and variable costs of the combined cycle CCYW should be applied.

Fixed costs and variable costs of the alternative combined cycle CCYW, based on the 1987 price, are sought in and around the year 2000, as follows:

Alternative	Combined Cycle (CCYW)	
Fixed Cost ($/kW-year)	209.09	
Variable Cost		
F.Y.	($/MWh)	($/MBTU)
1995	34.915	(3.3)
1999	37.289	(3.538)
2000	37.907	(3.60)
2001	39.373	(3.747)
2002	40.910	(3.901)

In calculating the variable costs, escalation of the fuel price estimated by NEB was applied.

The values sought above, apply the heat rate (efficiency) at the minimum load assuming the plant factor of the Lebir Hydro Power Plant to be small.

This section only outlines the calculation of costs. Further calculation of the amount of power benefits associated with the Lebir hydro power plant will be dealt with in Section 14. "Economic and Financial Analyses".

Table 6-1 Energy and Demand Forecast by NEB
~at Generating End ~

F.Y.	Generation (TWh)	(%)	System Peak Load (MW)	Load Factor (%)
1998	29.547	(6.27)	4,975	67.80
1999	31.440	(6.25)	5,286	67.90
2000	33.449	(6.24)	5,615	68.00
2001	35.486	(6.09)	5,957	68.00
2002	37.647	(6.09)	6,320	68.00
2003	39.940	(6.09)	6,705	68.00
2004	42.372	(6.09)	7,113	68.00
2005	44.952	(6.09)	7,546	68.00
2006	47.578	(5.84)	7,987	68.00
2007	50.357	(5.84)	8,454	68.00
2008	53.299	(5.84)	8,948	68.00
2009	56.413	(5.84)	9,470	68.00
2010	59.708	(5.84)	10,024	68.00

Note : ( ) shows Growth Rate of Generation

Table 6-2 Load Duration (P.U) (Based on NEB's Data)

Year	1985				1986		1985 – 1986		1986							
MW \ Month	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Subtotal	Mean	Mar.	Apr.	May	Jun.	July	Aug.	Subtotal	Mean
2300										0.000	0.000	0.000	0.000	0.000	0.000	0.000
2200						0.000	0.000	0.000	0.000	0.010	0.020	0.010	0.020	0.020	0.080	0.013
2100	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.003	0.020	0.030	0.084	0.054	0.099	0.094	0.381	0.064
2000	0.025	0.040	0.020	0.015	0.020	0.059	0.179	0.030	0.113	0.149	0.167	0.139	0.208	0.183	0.959	0.160
1900	0.154	0.153	0.105	0.094	0.108	0.118	0.732	0.122	0.222	0.238	0.241	0.212	0.297	0.252	1.462	0.244
1800	0.254	0.262	0.216	0.221	0.222	0.192	1.367	0.228	0.305	0.322	0.325	0.279	0.376	0.337	1.944	0.324
1700	0.333	0.370	0.295	0.324	0.296	0.266	1.884	0.314	0.384	0.396	0.414	0.360	0.470	0.419	2.443	0.407
1600	0.418	0.460	0.379	0.421	0.379	0.355	2.412	0.402	0.473	0.480	0.498	0.438	0.545	0.490	2.924	0.487
1500	0.498	0.530	0.454	0.505	0.473	0.433	2.893	0.482	0.542	0.545	0.557	0.508	0.604	0.561	3.317	0.553
1400	0.564	0.587	0.514	0.558	0.547	0.507	3.277	0.546	0.616	0.609	0.631	0.578	0.683	0.634	3.751	0.625
1300	0.649	0.658	0.582	0.621	0.621	0.576	3.707	0.618	0.690	0.678	0.754	0.690	0.777	0.738	4.327	0.721
1200	0.767	0.748	0.693	0.729	0.700	0.700	4.337	0.723	0.798	0.807	0.901	0.818	0.926	0.901	5.151	0.859
1100	0.931	0.911	0.835	0.885	0.867	0.837	5.266	0.878	0.946	0.931	0.980	0.901	0.990	0.978	5.726	0.954
1000	0.990	0.986	0.955	0.985	0.980	0.926	5.822	0.970	0.985	0.980	1.000	0.956	1.000	0.995	5.916	0.986
900	1.000	1.000	1.000	1.000	1.000	0.980	5.980	0.997	1.000	0.995	1.000	0.986	1.000	1.000	5.980	0.997
800						1.000	6.000	1.000		1.000		1.000			6.000	1.000

Max. : 2,168.9 (Feb.) Min. : 870.8 (Feb.) Max. : 2,278.0 (May) Min. : 854.6 (Jun.)

Table 6-3 Demand Forecast (Integrated System)

F.Y.	Generating End		Sending End		Yearly Load Factor (%)
	GWh *	MW *	GWh **	MW **	
1998	29,547	4,975	28,070	4,538 4,726	67.80
1999	31,440	5,286	29,868	4,836 5,021	67.90
2000	33,449	5,615	31,777	5,153 5,335	68.00
2001	35,486	5,957	33,712	5,467 5,659	68.00
2002	37,647	6,320	35,765	5,800 6,004	68.00
2003	39,940	6,705	37,943	6,153 6,370	68.00
2004	42,372	7,113	40,253	6,528 6,757	68.00
2005	44,952	7,546	42,704	6,925 7,169	68.00
2006	47,578	7,987	45,199	7,330 7,588	68.00
2007	50,357	8,454	47,839	7,758 8,031	68.00
2008	53,295	8,948	50,630	8,211 8,500	68.00
2009	56,413	9,470	53,592	8,691 8,997	68.00
2010	59,708	10,024	56,723	9,199 9,522	68.00

Note : (1) ＊: NEB's Date (2) $GWh^{**} = GWh^{*} \times 0.95$

(3) MW^{**} (Lower Figures) = GWh^{**} / (8.76 × Load Factor)

(4) [MW^{**} (Upper Figure) + MW^{**} (Lower Figure)] × 8.76/2 × 0.69175 = GWh^{**}

Table 6-4 Sent Out Energy by Period (GWh)

F.Y.	Sept. ~Feb.		Mar.~Aug.		Yearly
	Per Month	Semiannual	Per Month	Semiannual	Total
1998	2,291.6	13,750	2,387.0	14,320	28,070
1999	2,442.1	14,652	2,535.5	15,216	29,868
2000	2,602.1	15,613	2,694.1	16,164	31,777
2001	2,760.7	16,564	2,857.7	17,148	33,712
2002	2,928.9	17,573	3,031.9	18,192	35,765
2003	3,107.1	18,643	3,216.7	19,300	37,943
2004	3,296.5	19,779	3,412.1	20,474	40,253
2005	3,497.0	20,982	3,620.2	21,722	42,704
2006	3,701.5	22,209	3,831.8	22,990	45,199
2007	3,917.6	23,506	4,055.5	24,333	47,839
2008	4,146.4	24,878	4,292.3	25,752	50,630
2009	4,388.8	26,333	4,543.3	27,259	53,592
2010	4,645.3	27,872	4,808.4	28,851	56,723

Table 6-5 Installed Capacity and Period Inflow of Existing Reservoir Type Hydro Power Plants

Plants	Installed Capacity (MW)	Live Storage (GWh)	Period Inflow (GWh)							Plant Factor (%)
			Sept/Oct	Nov/Dec	Jan/Feb	Mar/Apr	May/Jun	Jul/Aug	Total	
Bersia	69	3.4	31	32	32	31	31	33	190	31.4
Kenering	114	24	56	57	57	57	56	57	340	34.0
Temenggor	348	278	91	92	92	92	91	92	550	18.0
Kenyir	400	1972	241	242	242	242	241	242	1450	41.1
Total	931 (923.6)	2,277.4	419	423	423	422	419	424	2,530 (2,509.8)	31.0
Mean Per Month	—	—	210.8 (209.1)			210.8 (209.1)			210.8 (209.1)	—

Note : ( ) shows Value at Sending End

Table 6-6 Required Peak Capacity and Energy (Per Month)
～at Sending End～

Period F.Y.	Sept／Feb		Mar／Aug	
	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)
1999	549.1	16.19	587.0	18.34
2000	614.1	19.93	651.5	22.17
2001	678.6	23.84	718.0	26.33
2002	747.0	28.20	788.8	30.95
2003	819.4	33.00	864.0	36.03
2004	896.4	38.27	943.4	41.57
2005	977.9	44.02	1,028.0	47.63
2006	1,061.1	50.04	1,114.0	53.93
2007	1,148.9	56.53	1,205.0	60.73
2008	1,241.9	63.52	1,301.3	68.04
2009	1,340.5	71.05	1,403.3	75.91
2010	1,444.8	79.14	1,511.1	84.34

Note : Considering Next Condition of Reservoir Type H.P.P.
Output Capacity at Sending End = 923.6 MW
Monthly Inflow at Sending End =209.1 GWh

Table 6-7 Percentage of Required Peak Capacity to System Peak Demand

Period F.Y.	Sept／Feb	Mar ／Aug
1999	549.1／4,836 (11.4)	587.0／5,021 (11.7)
2000	614.1／5,153 (11.9)	651.5／5,335 (12.2)
2001	678.6／5,467 (12.4)	718.0／5,659 (12.7)
2002	747.0／5,800 (12.9)	788.8／6,004 (13.1)
2003	819.4／6,153 (13.3)	864.0／6,370 (13.6)
2004	896.4／6,528 (13.7)	943.4／6,757 (14.0)
2005	977.9／6,925 (14.1)	1,028.0／7,169 (14.3)
2006	1,061.1／7,330 (14.5)	1,114.0／7,588 (14.7)
2007	1,148.9／7,758 (14.8)	1,205.0／8,031 (15.0)
2008	1,241.9／8,211 (15.1)	1,301.3／8,500 (15.3)
2009	1,340.5／8,691 (15.4)	1,403.3／8,997 (15.6)
2010	1,444.8／9,199 (15.7)	1,511.5／9,522 (15.9)

Table 6 - 8 Cases Studied With Various Parameters

Peak rate (α)	Qf / HWL	40m³/s	50m³/s	60m³/s	70m³/s	80m³/s	90m³/s	100m³/s	Remarks
2	EL. 65								
	60	㉟							
4	85		○	①	④	⑦	○	○	
	80		○	⑬	⑯	⑲	○	○	
	75		○	㉒	㉕	○	○	○	
	70		○	㉘	○	○	○	○	
	65		㉜						
5	85		○	②	⑤	⑧	○	○	
	80		○	⑭	⑰	⑳	○	○	
	75		○	㉓	㉖	○	○	○	
	70		○	㉙	○	○	○	○	
6	85		○	③	⑥	⑨	○	○	
	80		○	⑮	⑱	㉑	○	○	
	75		○	㉔	㉗	○	○	○	
	70		○	㉚	○	○	○	○	
	65		㉝						
8	85					Ⓐ			
	80					Ⓑ			
	75				Ⓒ				
	70			Ⓓ					
	65		㉞						

The cases with number are those selected for the economic consideration,
but those without number have been discarded during the study due to physical constraint.

Table 6-9 (1) Power Generation and Annual Energy Production

α	HWL (EL. m)	Qf	60 m³/s	70 m³/s	80 m³/s
4	85	MW	112.8	131.6	150.4
		GWh	377.4	390.6	392.2
		Pf	0.382	0.339	0.298
	80	MW	102.4	119.5	136.6
		GWh	347.1	357.3	359.2
		Pf	0.387	0.341	0.300
	75	MW	92.1	107.4	—
		GWh	314.6	321.8	—
		Pf	0.390	0.342	—
	70	MW	81.7	—	—
		GWh	279.8	—	—
		Pf	0.391	—	—
5	85	MW	141.0	164.5	188.0
		GWh	392.3	403.0	401.5
		Pf	0.318	0.280	0.244
	80	MW	128.0	149.4	170.7
		GWh	360.4	369.4	369.2
		Pf	0.321	0.282	0.247
	75	MW	115.1	134.3	—
		GWh	326.6	333.3	—
		Pf	0.324	0.283	—
	70	MW	102.2	—	—
		GWh	291.1	—	—
		Pf	0.325	—	—
6	85	MW	169.2	197.4	225.6
		GWh	403.8	410.9	407.3
		Pf	0.272	0.238	0.206
	80	MW	153.6	179.3	204.9
		GWh	370.3	377.2	375.0
		Pf	0.275	0.240	0.209
	75	MW	138.1	161.1	—
		GWh	335.6	342.1	—
		Pf	0.277	0.242	—
	70	MW	122.6	—	—
		GWh	299.6	—	—
		Pf	0.279	—	—

Pf＝E(GWh)／P(MW) ×8.760

Table 6-9 (2) Power Generation and Annual Energy Production

① Low Dam Scheme

α	HWL (EL. m)	Qf	40 m³/s	50 m³/s	60 m³/s
2	65	MW	23.8	29.7	35.7
		GWh	166.1	186.7	201.0
		Pf	0.797	0.718	0.643
4	65	MW	47.6	59.5	–
		GWh	221.9	236.7	–
		Pf	0.532	0.454	–
6	65	MW	71.4	89.2	–
		GWh	248.3	258.3	–
		Pf	0.397	0.331	–
8	65	MW	95.2	119.0	–
		GWh	262.1	270.5	–
		Pf	0.314	0.259	–
2	60	MW	20.3	–	–
		GWh	142.1	–	–
		Pf	0.799	–	–

② High Peak Rate

α	HWL (EL. m)	Qf	50 m³/s	60 m³/s	70 m³/s	80 m³/s
8	85	MW	–	–	–	300.8
		GWh	–	–	–	416.6
		Pf	–	–	–	0.158
	80	MW	–	–	–	273.2
		GWh	–	–	–	380.8
		Pf	–	–	–	0.159
	75	MW	–	183.4	214.0	–
		GWh	–	345.0	345.1	–
		Pf	–	0.215	0.184	–
	70	MW	–	163.5	–	–
		GWh	–	310.5	–	–
		Pf	–	0.217	–	–
	65	MW	119.0	–	–	–
		GWh	270.5	–	–	–
		Pf	0.259	–	–	–

Table 6-10 Caluculation on Costs and Benefits (Unit : 10^6 \$, 1987 Price)

Case	HWL (m)	Qf (m^3/S)	α	MW	GWh	Capital Recovery Cost Discount Rate 8%	10%	12%	O/M cost	MW Value Discount Rate 8%	10%	12%	GWh Value	Subtotal Cost Discount Rate 8%	10%	12%	Benefit on Flood control	Benefit Agriculture Discount Rate 8%	10%	12%	Total Net Benefit Discount Rate 8%	10%	12%
1	85	60	4	112.8	377	72.40	95.61	122.18	1.96	20.19	23.40	26.87	13.95	40.22	60.22	83.32	25.72	5.97	3.98	2.09	△ 8.53	△30.52	△55.51
2	〃	〃	5	141.0	392	89.61	118.88	152.61	2.45	25.24	29.25	33.58	14.50	52.32	77.58	106.98	〃	〃	〃	〃	△20.63	△47.88	△79.17
3	〃	〃	6	169.2	403	76.26	100.62	128.46	2.94	30.29	35.10	40.30	14.91	34.00	53.55	76.19	〃	〃	〃	〃	△ 2.31	△23.85	△48.38
4	〃	70	4	131.6	391	73.87	97.51	124.56	2.29	23.56	27.30	31.34	14.46	38.14	58.04	81.05	〃	〃	〃	〃	△ 6.45	△28.34	△53.24
5	〃	〃	5	164.5	403	76.43	100.83	128.71	2.86	29.45	34.12	39.18	14.91	34.93	54.66	77.48	〃	〃	〃	〃	△ 3.24	△24.96	△49.67
6	〃	〃	6	197.4	411	79.50	104.80	133.67	3.43	35.34	40.94	47.01	15.20	32.39	52.09	74.89	〃	〃	〃	〃	△ 0.70	△22.39	△47.08
7	〃	80	4	150.4	392	75.74	99.94	127.60	2.62	26.93	31.20	35.82	14.50	36.93	56.86	79.90	〃	〃	〃	〃	△ 5.24	△27.16	△52.09
8	〃	〃	5	188.0	402	78.28	103.23	131.73	3.27	33.66	39.00	44.78	14.87	33.02	52.63	75.35	〃	〃	〃	〃	△ 1.33	△22.93	△47.54
9	〃	〃	6	225.6	407	82.76	109.01	138.94	3.93	40.39	46.79	53.73	15.06	31.24	51.09	74.08	〃	〃	〃	〃	0.45	△21.39	△46.27
(A)	〃	〃	8	300.8	416	93.56	123.02	156.52	5.23	53.85	62.39	71.64	15.39	29.55	50.47	74.72	〃	〃	〃	〃	2.14	△20.77	△46.91
13	80	60	4	102.4	347	63.53	83.79	106.92	1.78	18.33	21.24	24.39	12.84	34.14	51.49	71.47	21.64	〃	〃	〃	△ 6.53	△25.87	△47.74
14	〃	〃	5	128.0	360	65.65	86.54	110.37	2.23	22.92	26.55	30.49	13.32	31.64	48.90	68.79	〃	〃	〃	〃	△ 4.03	△23.28	△45.06
15	〃	〃	6	153.6	370	67.50	88.93	113.37	2.67	27.50	31.86	36.58	13.69	28.98	46.05	65.77	〃	〃	〃	〃	△ 1.37	△20.43	△42.04
16	〃	70	4	119.5	357	65.01	85.70	109.32	2.08	21.39	24.79	28.46	13.21	32.49	49.78	69.73	〃	〃	〃	〃	△ 4.88	△24.16	△46.00
17	〃	〃	5	149.4	369	67.30	88.67	113.04	2.60	26.75	30.99	35.58	13.65	29.50	46.63	66.41	〃	〃	〃	〃	△ 1.89	△21.01	△42.68
18	〃	〃	6	179.3	377	70.36	92.62	117.97	3.12	32.10	37.19	42.70	13.95	27.43	44.60	64.44	〃	〃	〃	〃	0.18	△18.98	△40.71
19	〃	80	4	136.6	356	66.45	87.56	111.66	2.38	24.46	28.33	32.53	13.17	31.20	48.44	68.34	〃	〃	〃	〃	△ 3.59	△22.82	△44.61
20	〃	〃	5	170.7	365	68.67	90.45	115.27	2.97	30.56	35.41	40.66	13.50	27.58	44.51	64.08	〃	〃	〃	〃	0.03	△18.89	△40.35
21	〃	〃	6	204.9	370	72.74	95.69	121.82	3.57	36.68	42.50	48.80	13.69	25.94	43.07	62.90	〃	〃	〃	〃	1.67	△17.45	△39.17
(B)	〃	〃	8	273.2	380	83.98	110.27	140.11	4.75	48.91	56.67	65.07	14.06	25.76	44.29	65.73	〃	〃	〃	〃	1.85	△18.67	△42.00
22	75	60	4	92.1	314	57.57	75.79	96.57	1.60	16.49	19.10	21.94	11.62	31.06	46.67	64.61	17.99	〃	〃	〃	△ 7.10	△24.70	△44.53
23	〃	〃	5	115.1	327	59.57	78.39	99.82	2.00	20.61	23.87	27.41	12.10	28.86	44.42	62.31	〃	〃	〃	〃	△ 4.90	△22.45	△42.23
24	〃	〃	6	138.1	336	61.66	81.10	103.22	2.40	24.72	28.64	32.89	12.43	26.91	42.43	60.30	〃	〃	〃	〃	△ 2.95	△20.46	△40.22
25	〃	70	4	107.4	321	58.86	77.47	98.67	1.87	19.23	22.28	25.58	11.87	29.63	45.19	63.09	〃	〃	〃	〃	△ 5.67	△23.22	△43.01
26	〃	〃	5	134.3	332	60.98	80.22	102.11	2.34	24.04	27.86	31.99	12.28	27.00	42.42	60.18	〃	〃	〃	〃	△ 3.04	△20.45	△40.10
27	〃	〃	6	161.1	340	64.19	84.37	107.29	2.80	28.84	33.42	38.37	12.58	25.57	41.17	59.14	〃	〃	〃	〃	△ 1.61	△19.20	△39.06
(C)	〃	〃	8	214.0	345	74.74	98.04	124.43	3.72	38.31	44.39	50.97	12.76	27.39	44.61	64.42	〃	〃	〃	〃	△ 3.43	△22.64	△44.34
28	70	60	4	81.7	280	52.50	69.02	87.79	1.42	14.63	16.95	19.46	10.36	28.93	43.13	59.39	12.71	〃	〃	〃	△10.25	△26.44	△44.59
29	〃	〃	5	102.2	291	54.33	71.39	90.77	1.78	18.30	21.20	24.34	10.76	27.05	41.21	57.45	〃	〃	〃	〃	△ 8.37	△24.52	△42.65
30	〃	〃	6	122.6	299	55.89	73.42	93.31	2.13	21.95	25.43	29.20	11.06	25.01	39.06	55.18	〃	〃	〃	〃	△ 6.33	△22.37	△40.38
(D)	〃	〃	8	163.5	311	67.15	87.99	111.57	2.84	29.27	33.91	38.94	11.50	29.22	45.42	63.97	〃	〃	〃	〃	△10.54	△28.73	△49.17
31	65	〃	2	35.7	201	43.23	56.91	72.51	0.62	6.39	7.40	8.50	7.44	30.02	42.69	57.19	〃	〃	〃	〃	△11.34	△26.00	△42.39
32	〃	50	4	59.5	237	48.38	63.60	80.89	1.04	10.65	12.34	14.17	8.77	30.00	43.53	58.99	〃	〃	〃	〃	△11.32	△26.84	△44.19
33	〃	〃	6	89.2	258	51.54	67.69	86.01	1.55	15.97	18.50	21.24	9.54	27.58	41.20	56.78	〃	〃	〃	〃	△ 8.90	△24.51	△41.98
34	〃	〃	8	119.0	270	53.82	70.64	89.71	2.07	21.30	24.68	28.34	9.99	24.60	38.04	53.45	〃	〃	〃	〃	△ 5.92	△21.35	△38.65
35	60	40	2	19.9	142	40.78	53.68	68.37	0.35	3.56	4.13	4.74	5.25	32.32	44.65	58.73	〃	〃	〃	〃	△13.64	△27.96	△43.93

Note: o Capital Recovery Cost = Present Worth of Construction Cost (at 1998) ×Capital Recovery Factor (Life Time :50) o O/M Cost= MW × 1.45[\$/kW−month]× 12

o MW Value= 180.474 [\$/kW-year at i=8%], 209.091 [\$/kW-year at i=10%], 240.085 [\$/kW-year at i =12%] at Sending End

o GWh Value = 37.289 [\$/MWh] at Sending End o α= Q max/Qf

Table 6-11 Fixed Cost (Constant Price at 1987)

Plant Name		Fuel type	Capacity (MW)	Construction cost ($/kW)	Construction Period (k) (years)	Life time (n) (years)	Residual Value rate(z) (P.U)	Forced Outage rate (%)	Maintenance days/year (days)	Station use rate (P.U)	Fixed O/M Cost ($/kW-month)	Annual Fixed cost [Discount rate (i)=0.1] ($/kW-year)
Peaking Gas turbine	(G 90W)	GT	90	900	2.0	15	0	45	21	0.01	0.08	243.98
Port Klang-I type	(G 300)	O/NG	300	1527	4.5	25	0	7	38	0.04	0.06	251.21
Port Klang-II type	(C 299)	C	300	1805	4.5	25	0	11	44	0.085	1.92	362.62
Combined cycle	(CCYE)	C.C	291	1541	3.0	20	0	10	36	0.04	1.15	274.16
	(CCYW)	C.C	300	1150	3.0	20	0	10	36	0.04	1.15	209.09
Coal-fired	(C 500)	C	500	1736	5.0	25	0	15	50	0.085	1.53	375.27

Note:

$$\text{Annual Fixed cost} = \left\{ \text{Construction cost} \times \left(\frac{(1+i)^K - 1}{kj} \cdot \frac{i(1+i)^n}{(1+i)^n - 1} - Z \cdot \frac{i}{(1+i)^n - 1} \right) + \text{Fixed O/M cost} \times 12 \right\} \div \left\{ \left(1 - \frac{\text{Forced Outage rate}}{100}\right)\left(1 - \frac{\text{Maintenance days}}{365}\right)(1 - \text{Station use rate}) \right\}$$

Table 6-12 Fuel Price and Others (Constant Price at 1987)

Fuel type	Fuel Price					Thermal Content	Moisture Content	Minimum Load (%)
	(1987)	(1990)	Equivalent US$ Per unit	Escalation (%/year)	(1995)			
Gas-turbine oil	–	312 $/t	17.86 U$/bbl	3.86	377.0 $/t	9700 kcal/ℓ	0	44.4
Fuel Oil	–	300 $/t	17.17 U$/bbl	3.86	362.5 $/t	9700 kcal/ℓ	0	33.3
Natural Gas	–	2.5 $/MBTU	3.968 U$/Mkcal	0.00	2.5 $/MBTU	–	0	33.3
	–	3.3 $/MBTU	5.238 U$/Mkcal	0.00	3.3 $/MBTU	–	0	33.3
Coal	105 $/t	–	42.0 U$/t	1.00	113.7 $/t	6500 kcal/kg	0.07	40.0

Note:

Exchange Rate ≒ 2.5 M$/US$, 1 bbl ≒ 159ℓ, Specific Gravity of Oil = 0.9

Table 6-13 Variable Cost (Constant Price at 1987)

Plant Name	Load	Heat rate (Efficiency)	Fuel Price (1995)			Specific Gravity	Thermal content		Moisture Content	Station Use	Variable O/M Cost ($/MWh)	Variable cost ($/MWh) : 1995				Loading order
			Oil ($/t)	Gas ($/MBTU)	Coal ($/t)		Oil kcal/ℓ	Coal kcal/kg				Oil	Gas ($/MBTU) 2.5	Gas ($/MBTU) 3.3	Coal	
G90W	rated	2965 (29)	377.0	2.5 (3.3)	–	0.9	9700	–	–	0.01	3.00	107.761	32.712	42.220		3
	min.	3042 (28)										110.482	33.483	43.238		
G300	rated	2263 (38)	362.5	2.5 (3.3)	–	0.9	9700	–	–	0.04	2.00	81.285	25.386	32.869		2
	min.	2531 (34)										90.675	28.155	36.525		
C299	rated	2293 (37.5)	–	–	113.7	–	–	6500	0.07	0.085	1.00				48.135	5
	min.	2590 (33)													54.241	
CCYE	rated	2150 (40)	–	2.5	–	–	–	–	–	0.04	2.00		24.218			1
	min.	2413 (35.7)											26.936			
CCYW	rated	2150 (40)	–	3.3	–	–	–	–	–	0.04	2.00			31.328		
	min.	2413 (35.7)												34.915		
C500	rated	2263 (38)	–	–	113.7	–	–	6500	0.07	0.085	1.00				47.519	4
	min.	2470 (35)													51.774	

Note :

Oil : Variable cost $= \dfrac{\text{Heat rate [kcal/kWh]} \times \text{Fuel Price [\$/t]} \times \text{Specific gravity}}{\text{Thermal content [kcal/ℓ]} \times (1-\text{moisture content}) \times (1-\text{Station use})} + \text{Variable O/M cost}$ [$/MWh]

Gas : Variable cost $= \dfrac{\text{Heat rate [kcal/kWh]} \times \text{Fuel Price [\$/MBTU]}}{252 \times (1-\text{Station Use})} + \text{Variable O/M cost}$ [$/MWh]

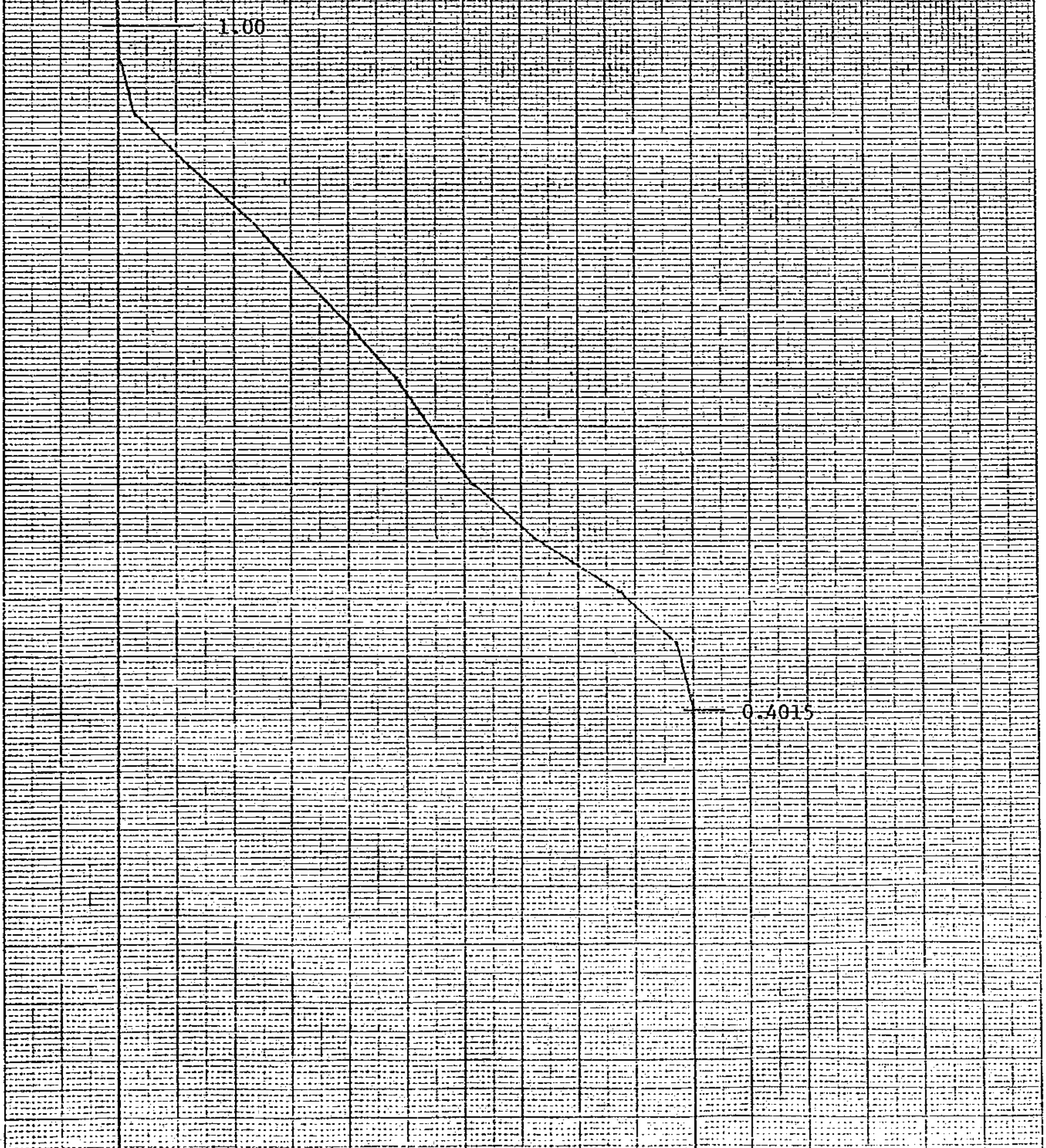
Coal : Variable cost $= \dfrac{\text{Heat rate [kcal/kWh]} \times \text{Fuel Price [\$/t]}}{\text{Thermal content [kcal/kg]} \times (1-\text{moisture content}) \times (1-\text{Station use})} + \text{Variable O/M cost}$ [$/MWh]

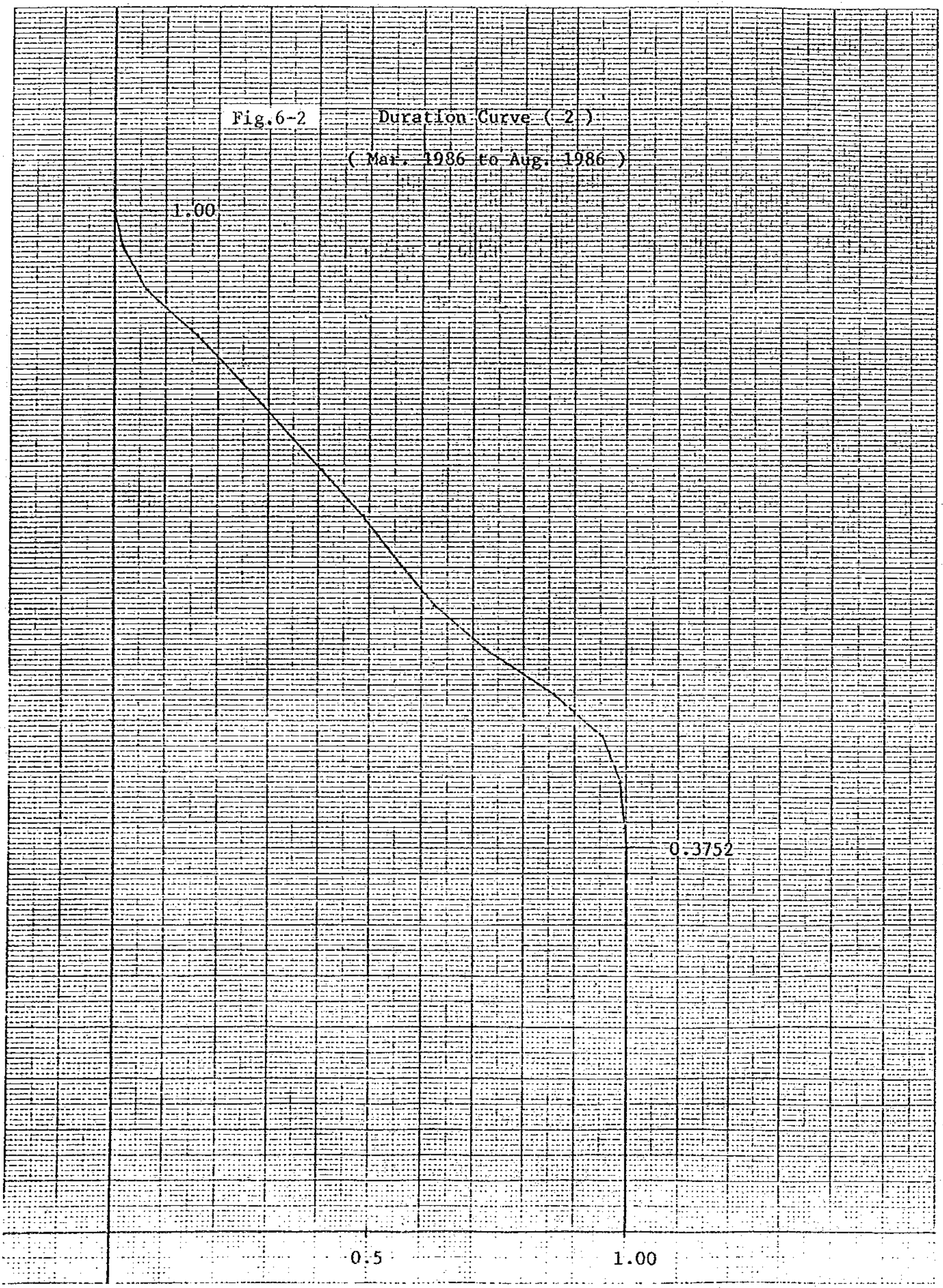
Table 6-14 Total Cost (Constant Price at 1987)

Plant Name	Fixed cost ($/kW-year)	Variable cost ($/kW-year) : 1995						Total cost ($/kW-year) : 1995					
		Minimum Load			Rated Load			Minimum Load			Rated Load		
		2.5 $/MBTU	3.3 $/MBTU	113.7$/t	2.5 $/MBTU	3.3 $/MBTU	113.7 $/t	2.5 $/MBTU	3.3 $/MBTU	113.7 $/t	2.5 $/MBTU	3.3 $/MBTU	113.7 $/t
G90W	243.98	130.36	168.34		286.56	369.85		374.34	412.32		530.54	613.83	
G300	251.21	82.21	106.65		222.38	287.93		333.42	357.86		473.59	539.14	
C299	362.62			190.06			421.66			552.68			784.28
CCYE	274.16	78.65			212.15			352.81			486.31		
CCYW	209.09		101.95			274.43			311.04			483.52	
C500	375.27			181.42			416.27			556.69			791.54

Fig. 6-1 Duration Curve (1)

(Sept. 1985 to Feb. 1986)





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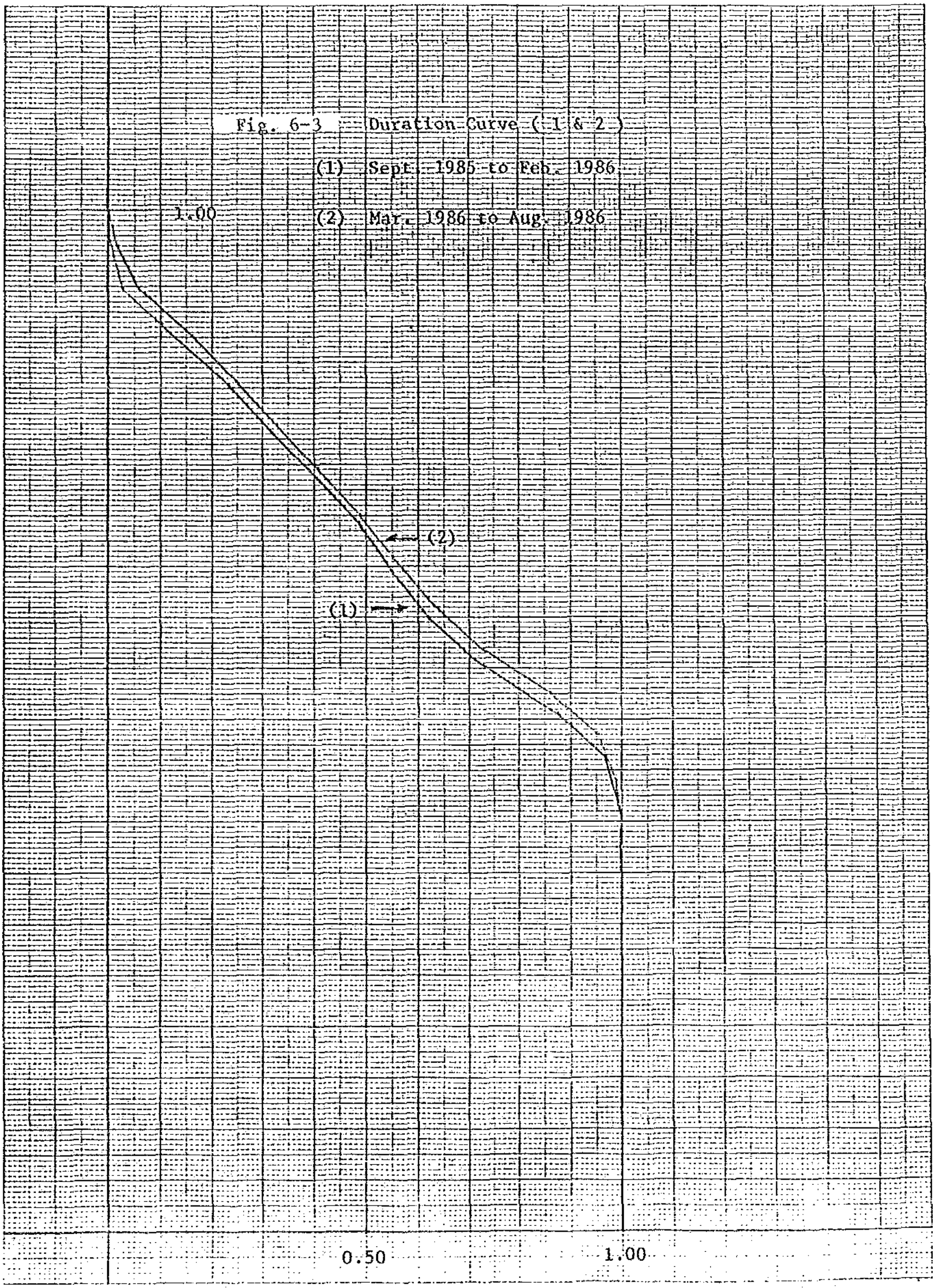


Fig. 6-3 Duration Curve (1 & 2)
(1) Sept. 1985 to Feb. 1986
(2) Mar. 1986 to Aug. 1986
1.00
(2)
(1)
0.50
1.00

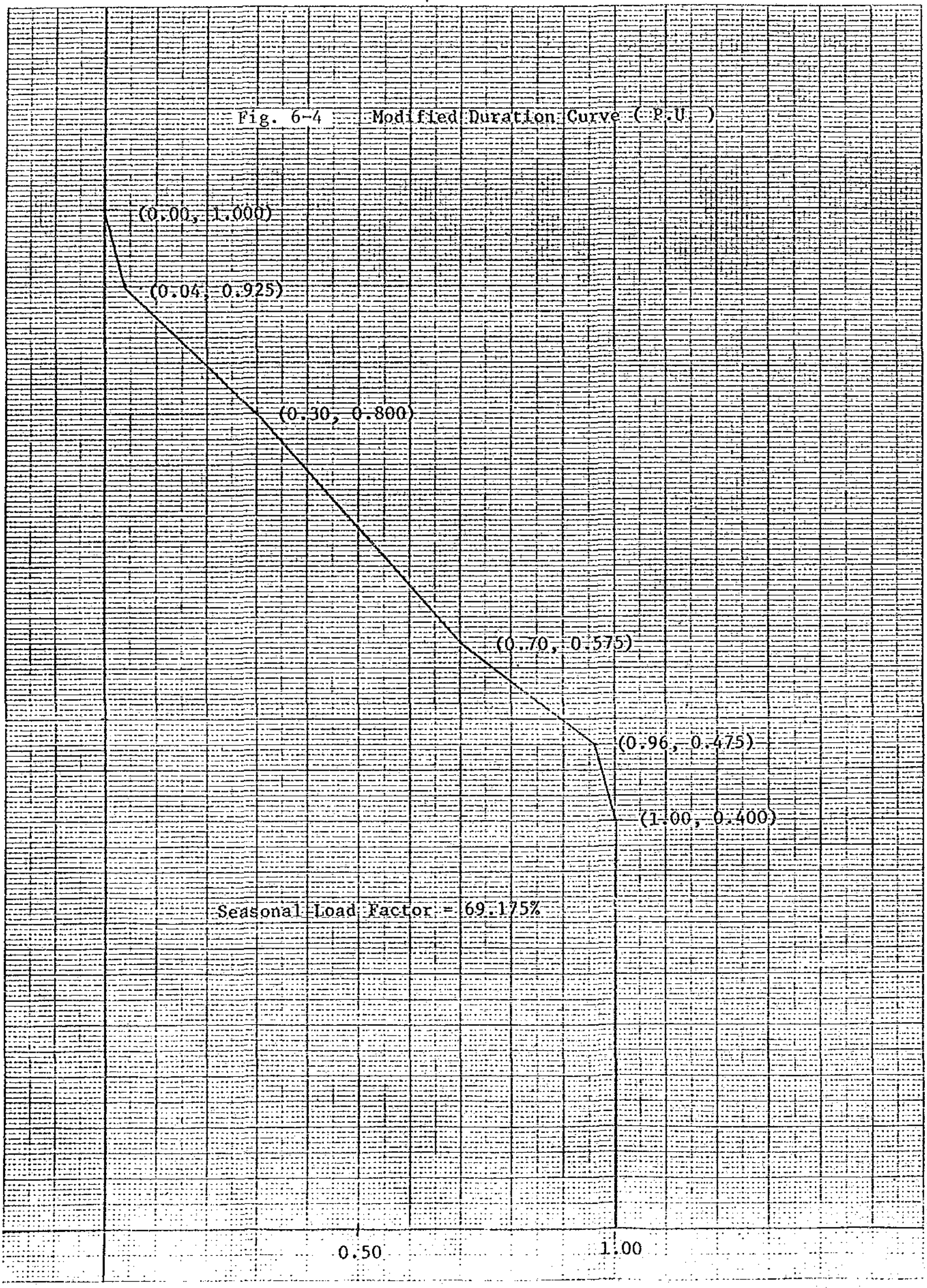


Fig. 6-4 Modified Duration Curve (P.U.)
(0.00, 1.000)
(0.04, 0.925)
(0.30, 0.800)
(0.70, 0.575)
(0.96, 0.475)
(1.00, 0.400)
Seasonal Load Factor = 69.175%
0.50
1.00

Fig. 6-5 Concept of Required Peak Capacity and Energy (1)

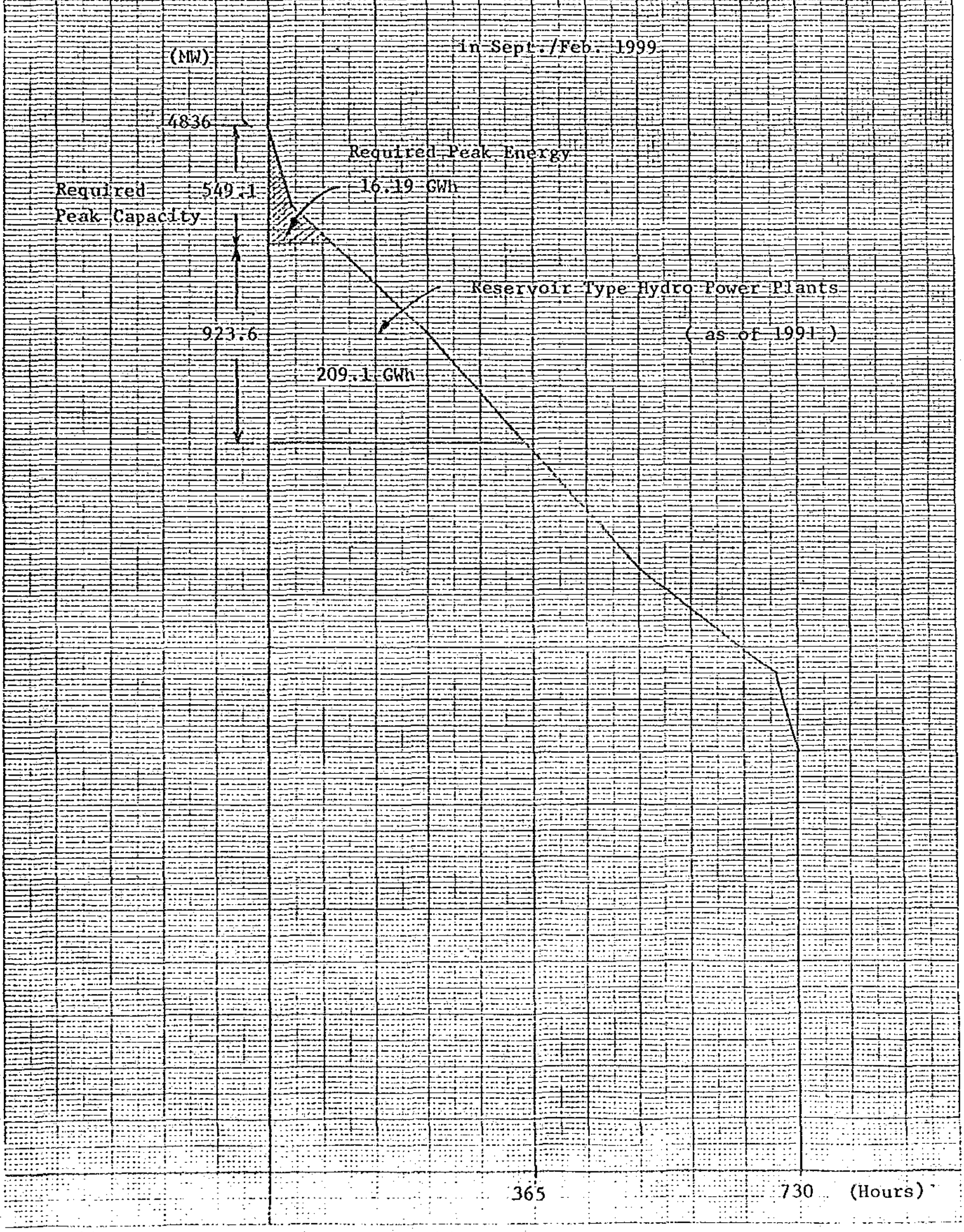


Fig. 6-6 Concept of Required Peak Capacity and Energy (2)

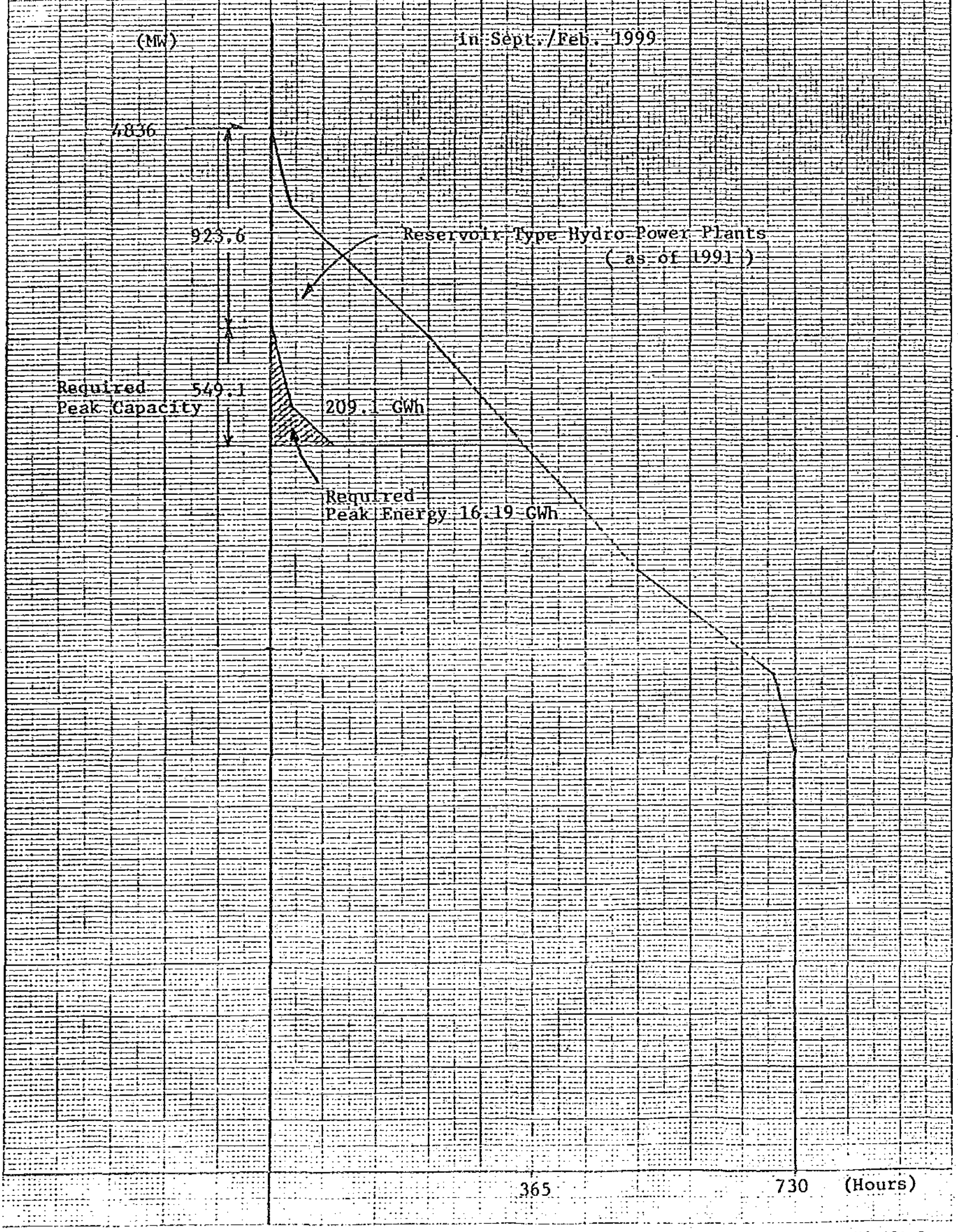


Fig.6-7 Monthly Inflow into Reservoir

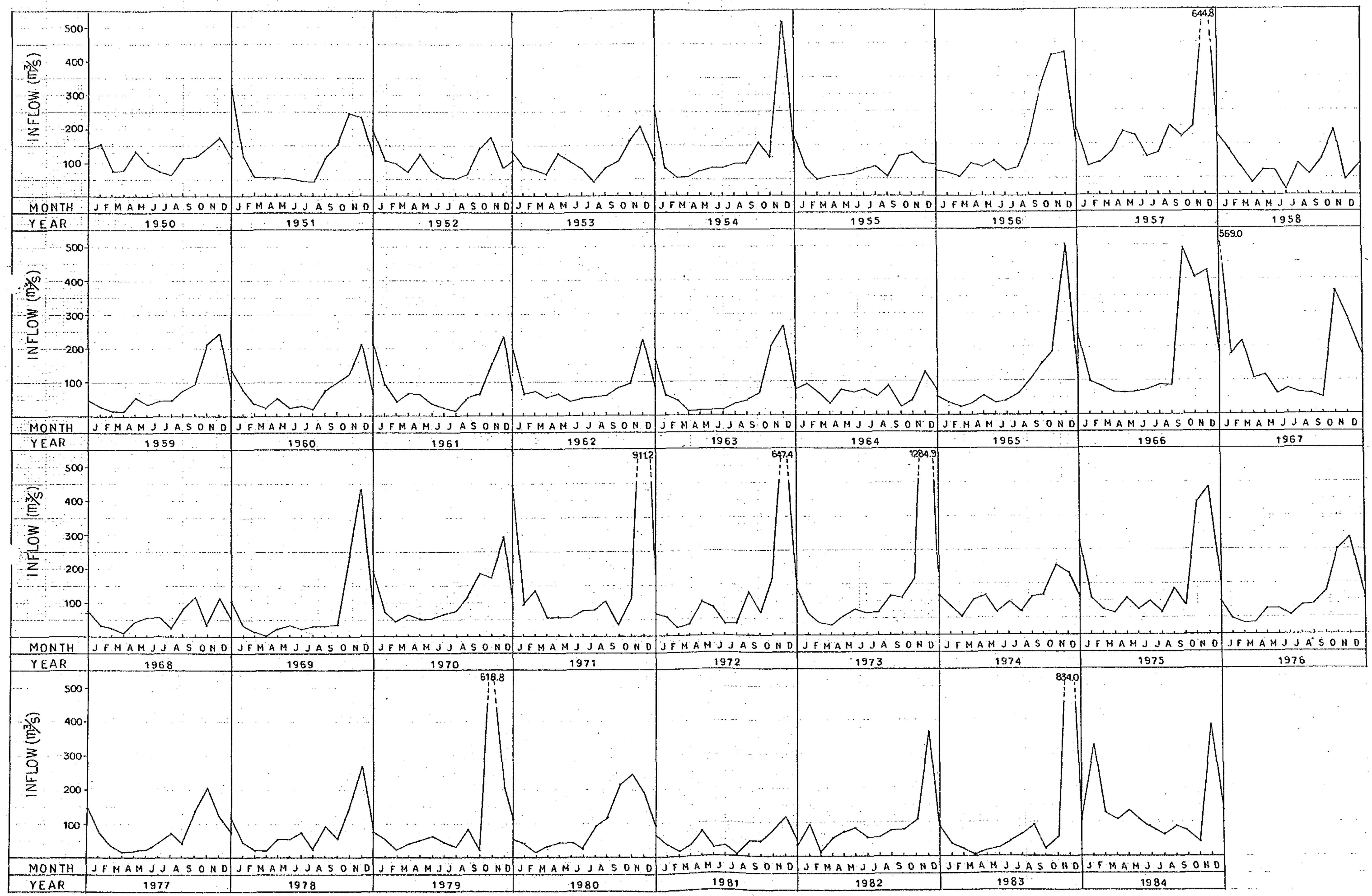


Fig.6-8 Reservoir Level due to Power Generation (by Simulation Model)

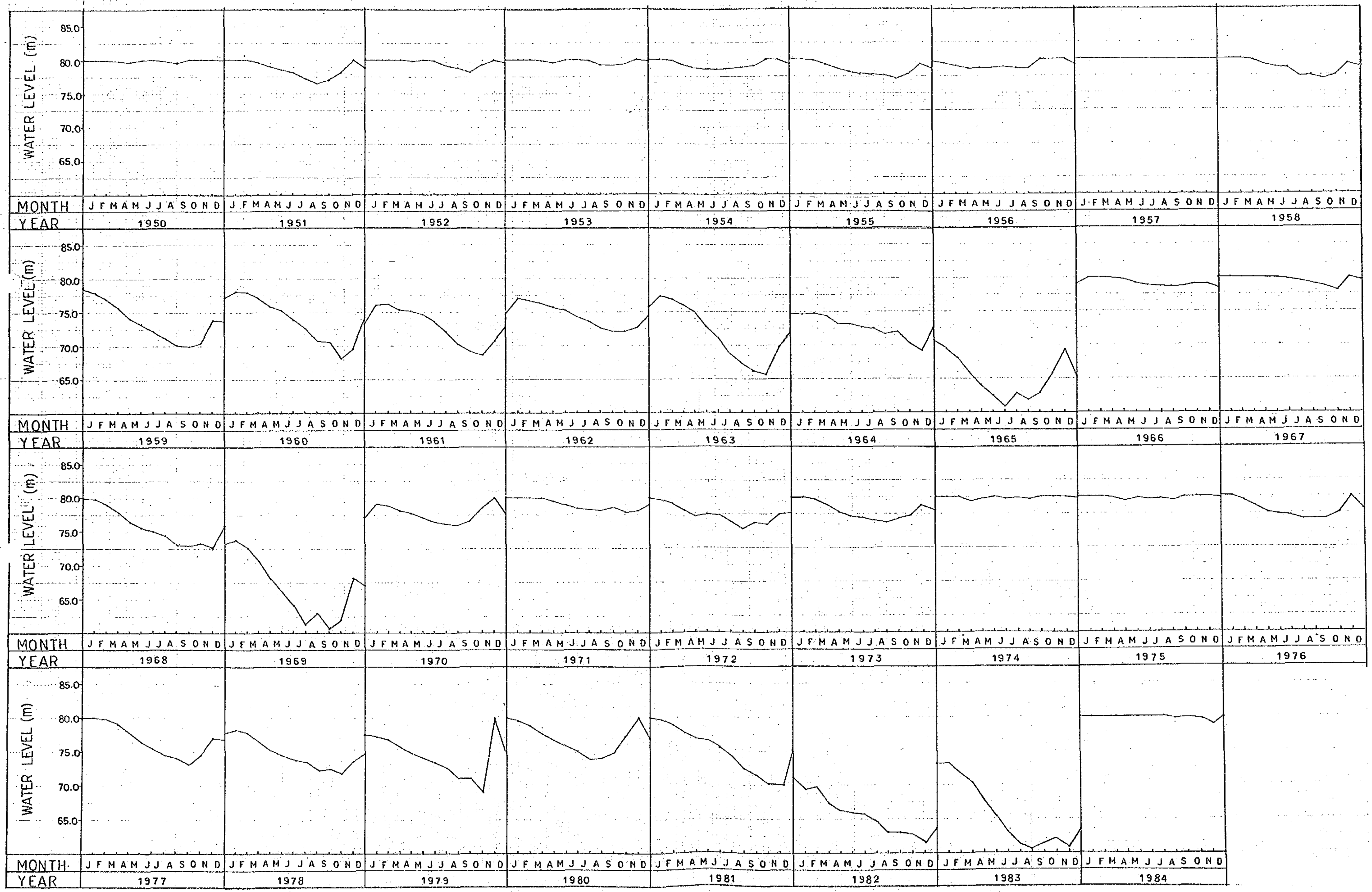
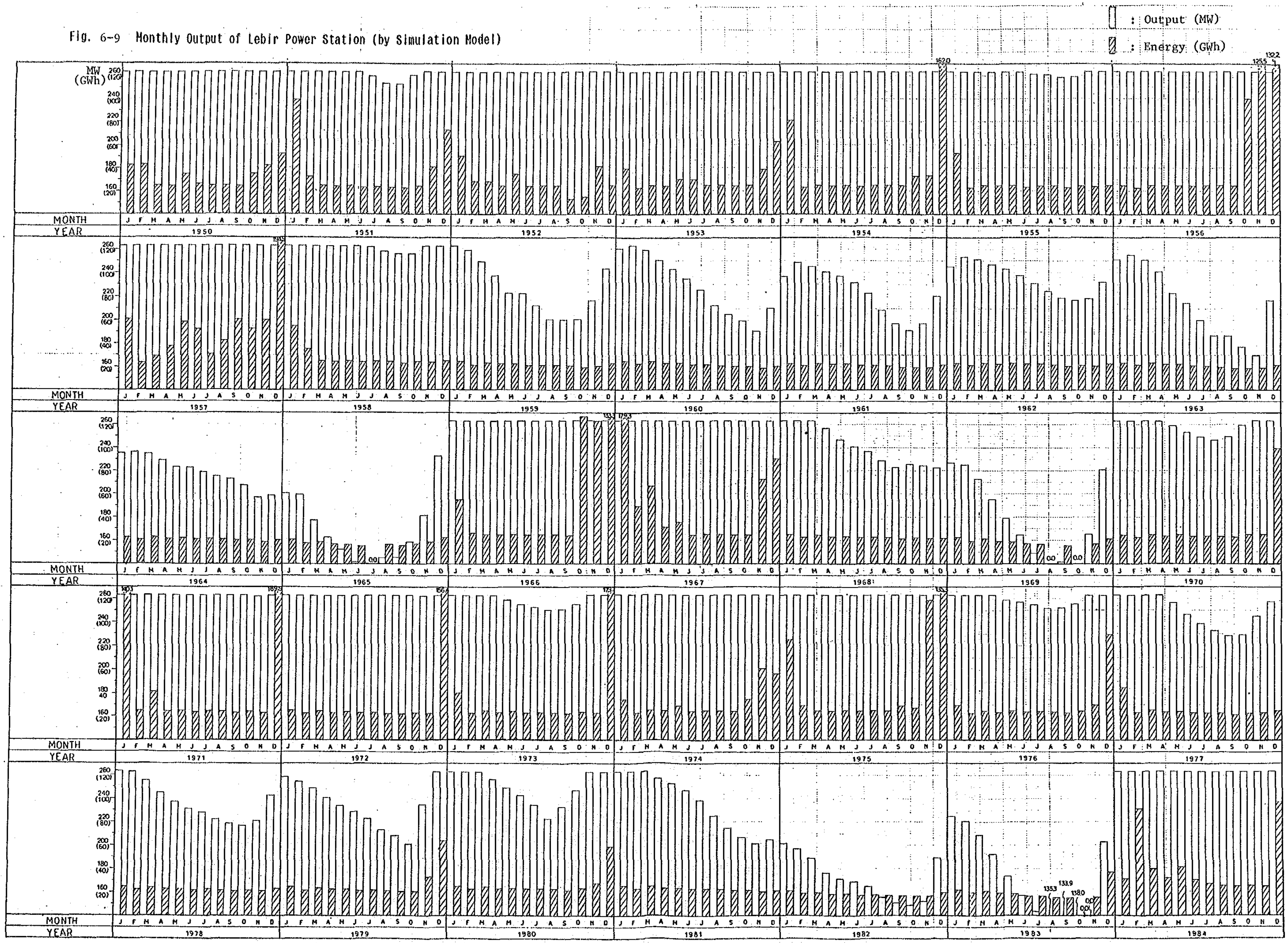


Fig. 6-9 Monthly Output of Lebir Power Station (by Simulation Model)



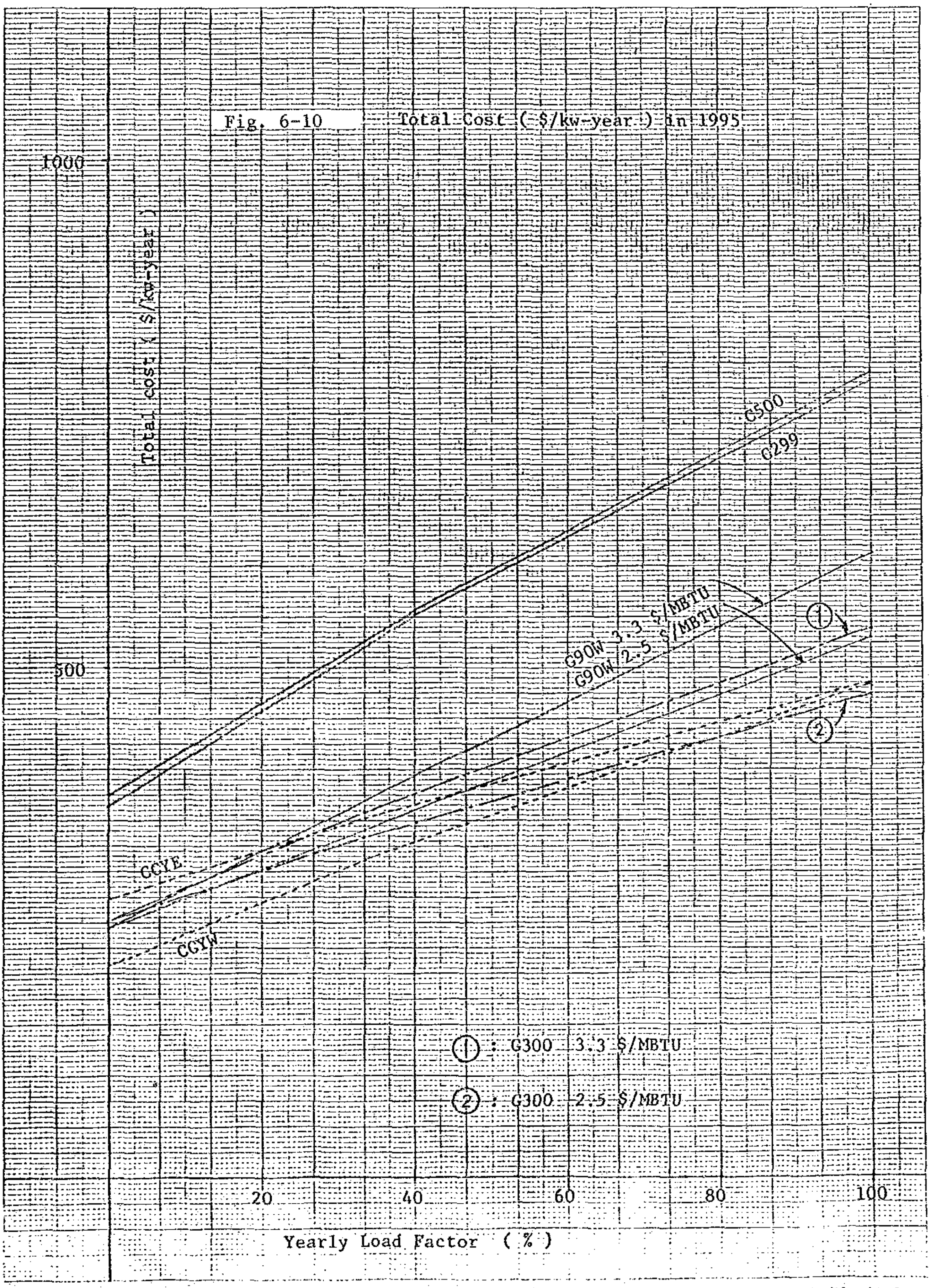


Fig. 6-10 Total Cost ($/kw-year) in 1995
1000
500
Total cost ($/kw-year)
C500
G299
G90W 3.3 $/MBTU
G90W 2.5 $/MBTU
①
②
CCYE
CCYW
① : G300 3.3 $/MBTU
② : G300 2.5 $/MBTU
20
40
60
80
100
Yearly Load Factor (%)

7. Flood Control

7. Flood Control Scheme

7.1. Relationship between Flood Control Scheme and Power Generation Scheme

The process of studying the flood control scheme is based on the "The Manual for River Work in Japan" provided for by the Ministry of Construction of Japan (hereinafter referred to as "the Criteria"), in addition, it shall suit the actual conditions in Malaysia, and also give due consideration to the features of the Kelantan River.

It is necessary to fix the flood control volume in determining the dam capacity for a multi-purpose dam project, which involves power generation and flood control in the framework of the flood control scheme. The general description of the Criteria explains the flood control scheme as follows:

In a flood control scheme, in order to prevent or diminish damage by flood of the river, a hydrograph of inflow flood which will form a basis of plan formulation should first be derived (hereinafter referred to as" the Base Flood"), and the scheme shall be elaborated to ensure the flood control effect against the Base Flood. Therefore, the flood control scheme should be formulated so that the facilities to be installed under the scheme against the Base Flood can be mutually consistent throughout the river system both technically and economically and can fully function as intended. In formulating the flood control scheme, it is also necessary to study various functions of the river, such as flood control, water utilization, environment, etc. synthetically, to note that this scheme is not intended to cope with the maximum possible flood in the river, and to consider any possible occurrence of floods exceeding the size under the scheme (hereinafter referred to as the "Excess Flood")".

At present, two JICA teams; the Lebir Dam Project Study and the Kelantan River Basin-Wide Flood Mitigation Study teams are undertaking their respective studies. According to the latest information of the Kelantan River Basin-Wide Flood Mitigation Study as of December 8, 1988, it was learnt that the basic flood for flood control of the Kelantan River Basin is determined by adopting a probable flood of 50-year return period, and the peak discharge of this flood, which is 16,369 m^3/s at Guillemard, can be reduced to 13,213 m^3/s by putting up a dam, namely the Lebir Dam.

On the other hand, in the Lebir Dam Project Study, the 50-year return flood at Guillemard is 16,851 m^3/s (Refer to Section 5.4.3). This flood discharge can be mitigated to 13,279 m^3/s by construction of the proposed Lebir Dam as mentioned in Section 7.2.1 hereunder. This is, however, for the case that the dam is designed to have an ungated spillway with the overflow length of 150 m, and crest elevation at EL.80 m).

The methods used by both JICA teams for the flood analysis are different to each other, but the respective values indicates a good agreement. It should therefore be remarked, that they never lack consistency nor involve any technical deficiency.

For hydro-power development, it is also necessary to design a spillway which should be able to release a volume of flood water even larger than the 50-year return period, in order to secure the safety of the Lebir Dam. The following section presents design studies on the spillway and discusses the mitigative effect on flood damage owing to the construction of the Lebir Dam.

7.2. Relationship between the Size of the Lebir Dam and the Flood Discharge at Guillemard Bridge

The design flood discharge for fill-type dams, according to the design criteria of Japan, is to be 1.2 times the flood discharge of a 200-year return period. This 1.2 times flood discharge of a 200-year return period is nearly equivalent to the flood discharge of a 1,000-year return period. For a comparison with the design flood discharge of the Kenyir Dam recently constructed in Malaysia near to the Lebir Dam (in the State of Terengganu facing the South China Sea) and the Temengor Dam facing the west coast (in the State of Perak) as well as the Creager curve in the Southeast Asia region, the peak flood discharge of the Lebir Dam applied with a 10,000-year return period is as shown in Fig.7-1 and in the Table below. The three dams are by comparison almost the same in specific run-off, and the Lebir Dam is placed almost in the middle in total flood discharge.

Items	Lebir Dam (Mean Curve)	Kenyir Dam	Temengor Dam
Drainage area (km^2)	2,474	2,600	2,700
Design flood discharge	(10,000 years return period)	P.M.F.	-
Peak flood discharge (m^3/s)	10,579	16,000	13,500
Total flood discharge (m^3)	3.36×10^9	4×10^9	1×10^9
Rainfall pattern	1 peak (5 days)	3 peaks (7 days)	1 peak (3 days)
Surcharge	-	7 m	-
Specific run-off ($m^3/s/km^2$)	4.28	6.15	5.0

On the other hand, the flood discharge at the Guillemard Bridge varies according to the reservoir capacity, size of spillway, flood discharge system, etc. In this Section, the flood discharges at the Guillemard Bridge, and the rise of the water level in the reservoir is calculated and studied against the flood discharges of each return period, where the system of regulating and discharging floods freely through the 150 m ungated spillway of the Lebir Dam is applied.

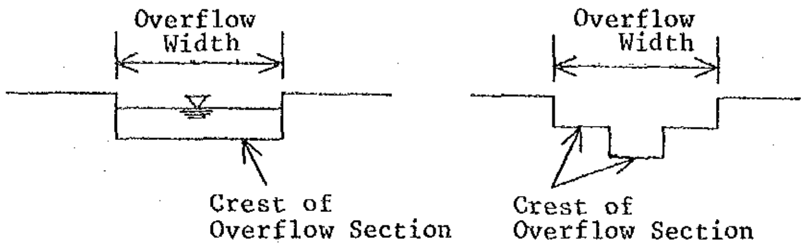
7.2.1. In the Case that the Lebir Dam Spillway is of the Ungated Type

The purpose of this Section is to discover the rise of the reservoir water level and the hydrograph when the elevation of the H.W.L. of the Lebir Dam is varied, and the hydrograph at the downstream Guillemard Bridge, if the spillway structure is of the ungated type.

(1) Hydraulic calculation at the time of floods

If an ungated spillway structure is adopted and the H.W.L. of the reservoir is designed to be equal in elevation to the spillway crest, a free overflow from the spillway will take place according to the rise of the water level due to flooding. The merits of this system are that flood control operation is not required. Besides, maintenance, inspection and rehabilitation work are easy, because the discharge structure is simple. Also, with this structure leakage from the dam does not occur frequently. Conversely, the demerits are that the flood control operation is not flexible and it takes time to lower the water level even if lowering the water level is urgently required.

The ungated free overflow spillway was studied by using principally two kinds of the overflow section shape as illustrated below, with variations in the overflow crest elevation and width. The shapes of overflow section of spillway applied for the study are depicted in Fig.7-7.



One Step Type

Two Steps Type

In the above shapes, the max. overflow width was taken at 150 m, and in the case of two step overflow section, the first overflow section was given three varied widths of 120 m, 70 m and 40 m. The crest of the overflow section, which corresponds to generation full water level, was changed in four different elevations of EL. 80 m, 79.3 m, 77.9 m and 76.3 m.

The simulation study down to the Guillemard Bridge was conducted with the input of probable flood inflows of 10,000-year, 1,000-year, 200-year, 100-year, 50-year, 20-year, 5-year, 2-year and 1.15-year recurrences. The results of simulation calculation of max. reservoir water rise, spilling discharge and peak flow at Guillemard Bridge were presented in Table 7-1.

In addition, reservoir water stage-duration curves, spillway discharge-duration curves and flood discharge-duration curves for the respective flood inflows of 10,000-year, 1,000-year and 50-year return periods in the case of spillway section with 150 m overflow width and crest elevation of the overflow section at EL.80 m, are given in Figs.7-2 to 7-4. Also, shown in Fig.7-5 and Fig.7-6 are probable peak discharges at Guillemard and the Lebir reservoir capacity curve respectively.

The rise of the water level of the Lebir reservoir is

$$dv/dt = Qin - Qout \quad \text{.............................} \quad (7.1)$$

where,

v : reservoir capacity, and water level capacity are indicated in Fig. 7-6. (m^3)

Qin : inflow to the reservoir, using the inflow of probable floods in Section 5.4.4. (m^3/s)

The discharge from the ungated spillway:

$$Qout = CBh^{3/2} \quad \text{..................................} \quad (7.2)$$

where,

C : Francis formula overflow coefficient
C = 1.84 is applied

B : overflow width (m)

h : overflow depth (m)

There is also a method to calculate the spread of the flow in the reservoir at the time of flooding by unsteady flow calculation. The necessity for applying the methods, according to Akimoto, depends on the following conditions:

(a) The conditions under which the unsteady flow has to be calculated, are as follows:

$$\{2L/(gh)^{1/2}\}/T \geqq 0.6 \quad \text{.....................} \quad (7.3)$$

where,

L : Length of reservoir (m)

h : Depth of reservoir (m)

g	:	Acceleration of gravity ($=9.8\ m/s^2$)
$2L/(gh)^{1/2}$	:	Period of wave motion in reservoir (sec)
T	:	Time from start of flood discharge till flood peak (sec)

(b) Taking the mean depth in the reservoir as h in the formula (7.3).

$$h = \{(HWL\ 90 - (Riverbed\ at\ the\ dam\ site\ EL\ 25)\}/2$$
$$= 65\ m/2$$
$$= 32.5\ m$$

while,

$$h = (Reservoir\ capacity\ 4{,}397 \times 10^6 m^3)/(Flooding\ area\ 247 \times 10^6 m^3 = 17.8\ m$$

The mean depth becomes 32.5 to 17.8 m. As the length of the reservoir L is equal to 45,000 m, the numeration of the formula (7.3) $2L/(gh)^{1/2}$ becomes 5.043 to 6.814 sec (= 1 hour 24 minutes to 1 hour 54 minutes).

$2L/(gh)^{1/2}$ is the period of the wave motion in the reservoir.

The time(T) till the peak of the flood discharge is about 60 hours, the left side term of the formula (7.3) is $\{2L/(gh)^{1/2}\}T = 0.023$ to 0.032, which is less than the critical value of 0.6. Therefore, the rise of the water level in the reservoir at the time of flooding does not require the unsteady flow calculation and can be fully satisfied with the horizontal storage system of the formula (7.1).

Waves in the reservoir due to the wind and earthquakes are described below:

(2) Waves caused by the wind

Data on the wind records for the period from 1948 to 1972 supplied by the Malaysia Meteorological Service shows that the wind force at Kota Bharu has exceeded 8. The wind force 8 is equivalent to a wind velocity of 17.2 m/s to 20.8 m/s. Hence, the maximum wind velocity of v = 20.8 m/s shall be applied to compute the wave of the Lebir Dam lake.

Assuming the storage water level is 90 m, the fetch length is $F \doteqdot 4.5$ km in the NNW-SSE direction.

The calculation of the wave shall be done according to the S.M.B. method.

$$Hw = 0.00086V^{1.1}F^{0.45}$$

Where,

Hw	:	Wave due to wind (Total wave-height) (m)
F	:	Fetch (m)
V	:	Average wind velocity for 10 minutes (m/s)

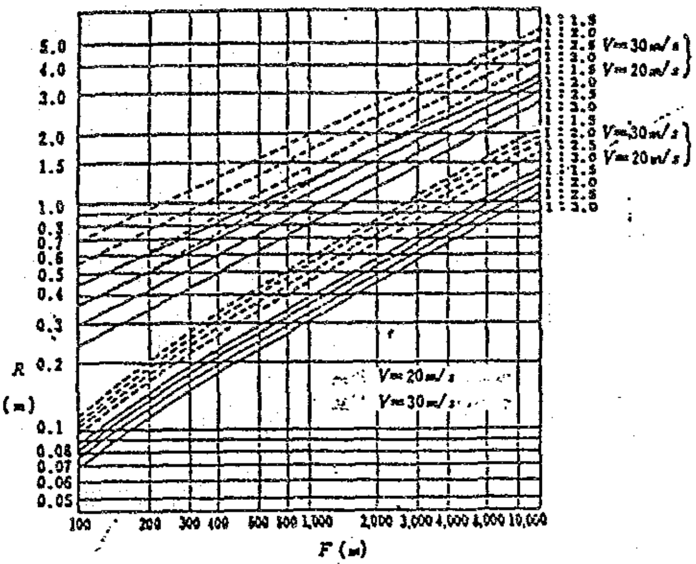
Therefore, the following is obtained:

$$Hw = 0.00086 \times 20.8^{1.1} \times 4,500^{0.45}$$
$$= 1.07 \text{ m}$$

Conversely, as the dam is of the fill-type, the grade of the upstream face of which is 1 : 1.85, the wave run-up shall also be assumed according to the Saville method.

As shown in the figure below, the fetch F is 4,500 m, the grade of the upstream face of the dam is 1 : 1.85 and the average wind velocity for 10 minutes (v) is 20 m/s. If the value R against the riprap slope is interpolated, R can be read as approximately 0.86 m.

As the result of the above study, the wave height at the dam site shall be calculated at 1.1 m.



(3) Wave height caused by earthquakes

The wave height due to earthquakes is calculated by the following formula:

$$he = \frac{1}{2} \cdot \frac{KT}{\pi} (gHo)^{1/2}$$

where,

K : Design seismic coefficient in a state of HWL
T : Earthquake period (s)
Ho : Depth of reservoir in a state of HWL (m)
g : Acceleration of gravity 9.8 m^2/s

Assuming K = 0.1, T = 1 sec, Ho = 90 - 35 = 55 m for the Lebir Dam, the following is obtained:

$$he = \frac{1}{2} \times \frac{0.1 \times 1}{\pi} \times (9.8 \times 55)^{1/2}$$

$$= 0.37 \text{ m}$$

7.3. Relationship between Other Dam Projects in the Kelantan River Basin and Flood Discharge at the Guillemard Bridge

Apart from the Lebir Dam, dam projects in the Kelantan River basin include the Nenggiri Dam on the Nenggiri River and the Dabong Dam on the Galas River. The catchment areas of those dams are as shown in the Table below:

Name of Dam	Name of River	Catchment Area
Nenggiri	Nenggiri	3,740 km^2
Dabong	Galas	7,480
Lebir	Lebir	2,474

The features of those dams can be extracted, as shown in the Table below, from Volume No. 7 Other Associated Aspects of the Nenggiri Dam Project Feasibility Study Report, prepared by Electroconsult, Milano, Italy in September 1986:

Feature \ Name of Dam	Nenggiri	Dabong
High water level HWL	EL 153	EL 57
Type of spillway	Ungated	Ungated
Overflow crest of spillway	EL 153	EL 57
Overflow length	75 m	145 m

The relationship between the reservoir water level and the capacity is as shown in Tables 7-5 and 7-6, which is used in the following analysis. In this Section, the run-off against the probable rainfall obtained in Section 5.4.3. was sought examining the existence of each dam both individually and separately. As a consequence, the run-off at the Guillemard Bridge is as shown in the Table below.

Flood Peak Discharge at
the Guillemard Bridge

(Using the mean curve)

Return Period (Years)	Without dam	Only with Lebir Dam*	Only with Nenggiri Dam	Only with Dabong Dam
	m^3/s	m^3/s	m^3/s	m^3/s
1.15	4,120	3,644	2,446	2,479
2	7,193	5,887	5,533	5,286
5	10,294	8,208	9,112	8,228
20	14,315	11,305	12,782	11,472
50	16,851	13,279	-	-
100	18,752	14,795	16,925	15,217
200	20,679	16,306	18,666	16,784
1,000	25,078	19,816	22,796	20,505
10,000	31,413	24,914	28,767	25,989

* HWL : Overflow crest elevation EL 80 m
Ungated : Overflow width 150 m

For the cases of "Nenggiri Dam" and "Dabong Dam", the values in the above Table are from the Interim Report submitted in February, 1988.

7.4. Case Study of a Hydrograph of the Flood Control Effect of the Lebir Dam forming the Basis of the Scheme

It is difficult to decide on a hydrograph forming the basis of the flood control scheme within the scope of this Study. However, in this Section, a basic hydrograph is fixed as a case study, and provided to describe the flood control effect of the Lebir Dam should the Lebir Dam be constructed. This Section deals with the Lebir Dam spillway if it is an ungated overflow type (overflow crest elevation EL. 80 m).

The Guillemard Bridge is one of the basic points where DID warns of flooding on the Kelantan River. The flood warning discharge levels at the Guillemard Bridge are converted from the water level as follows:

Discharge converted from the cautionary water level	1,500 m^3/s
Discharge converted from the warning water level	3,700 m^3/s
Discharge converted from the dangerous water level	6,400 m^3/s

As shown in Fig. 7-5, the peak flood discharge of 6,400 m^3/s corresponds to the dangerous water level. If this is converted to a return period without the Lebir Dam, the return period is 1.7 years. Fig. 7-5 also shows a return period (years) and a peak flood discharge with the Lebir Dam.

A case study in which a 50-year return period was selected for a basic hydrograph to control floods with the dam on the Kelantan River (hereinafter referred to as the "Base Flood"), is shown in Fig. 7-5.

The peak flood discharge 50-year return period without the dam at the Guillemard Bridge is 16,800 m^3/s. (Point A in the Fig.) It will be reduced to 13,300 m^3/s. (Point B in the Fig.) by constructing the Lebir Dam.

This peak discharge of 13,300 m^3/s corresponds to a 14-year return flood (Point C in the Fig.) if no dam is constructed.

With a discharge of 13,300 m^3/s at this point C, countermeasures against floods by providing flood control structures other than the Lebir Dam are required, and these are referred to as the design flood. Amounts of the reduction in flood discharge due to the dam construction, can be obtained from various hydrographs such as points A, B and C in Fig. 7-5.

Conceptually, point A is the Base Flood and points B and C correspond to the Design Flood.

The 50-year return flood without the dam is 5,260 m^3/s at the Tualang point near the Lebir Dam site. By constructing a dam, this discharge below the dam will be 2,947 m^3/s.

7.5. Relationship between Flood Discharges and the Amount of Damages

The amount of damages caused by eleven major floods during the period from 1967 to 1986 was calculated by the DID and SEPU survey organizations. The SEPU survey covers two floods in 1984 and 1986. The relationship between the peak flood discharges at the Guillemard Bridge and the amount of damage caused by those eleven floods is indicated in Fig. 7-8. Table 7-2 shows the survey results of the amount of damages classified according to the types of assets. The survey items are as follows:

Agriculture : Rice crops, short-term crops, vegetables, rubber, tobacco, fruits, oil palm, etc.

Public facilities : Roads, bridges, etc.

Public service facilities: Schools, hospitals, etc.

Private properties : House furniture, clothing, domestic animals, etc.

Private corporations : Factories, shops, etc.

As shown in Table 7-2, the contents of the survey items change each year.

Therefore, it is difficult to estimate the total damage amount. However, according to the DID survey report, the sum of the survey items of the 1967 flood damages amounts to 17.6 million Malaysian Dollars. The actual total damage amount is estimated, however, to be 30 million Malaysian Dollars. Likewise, the sum of the surveyed items of the 1968 flood damages reportedly amounted to 0.36 million Malaysian Dollars but the actual total damage amount is estimated to be 1 million Malaysian Dollars.

These survey results of the damages were converted to the prices prevailing in 1986. The consumer price index for the period of 1969 to 1986 is as shown in Fig. 7-9 and was calculated according to an average increase rate of 5%. The relationship between the peak flood discharges and the amount of damages on Fig. 7-8 shows the amount in 1986 price. The value of the total damages estimated by DID is used, especially for the 1967 and 1968 floods. In addition, taking into account that the discharge at the Guillemard Bridge for the flood warning water level is 3,700 m^3/s, the curve of the relationship between the peak flood discharges and the amount of damages is as shown in Fig. 7-8 designated as (A)-curve.

At the same time, the flood damages corresponding to various peak discharges which are assessed in the Interim Report on Study on Kelantan River Basin-Wide Flood Mitigation January 1989 (JICA) are plotted in Fig.7-8 (designated as (B)-curve) for reference.

7.6. Relationship between Each Dam Project and Annual Average Expected Amount of Damage Mitigation

The calculation method of the annual average expected amount of damage mitigation shall be based on the Criteria published by the Ministry of Construction of Japan.

The spillway of the dam is of the ungated type. The results are as shown in the following table. (The design shape of spillway are as shown on Fig.7-7.)

The benefits from the flood control by constructing the Lebir Dam are the balance between the annual average estimated damages without the dam and the annual average estimated damages with the Lebir Dam only.

Dam on the River	Spillway		Estimated Annual Flood Damage (10^6M$)	Benefit Accrued from Flood Control by Dam (10^6M$)			
	Ungated	Overflow width		1986 (1986 Price)	1986 (1987 Price)	1990 (1987 Price)	2000 (1987 Price)
			$x10^6$	$x10^6$	$x10^6$	$x10^6$	$x10^6$
None	EL. - m	m	26.961	-	-	-	-
With Lebir Dam only	No.1 Overflow Section 80	150	18.806	8.155	8.277	10.164	16.982
	No.2 Overflow Section		18.368	8.593	8.722	10.710	17.895
	No.3 Overflow Section		17.418	9.543	9.686	11.894	19.873
	No.4 Overflow Section		16.758	10.203	10.356	12.717	21.248

In the above table, 1986 prices were increased by about 1.5% for modification to 1987 prices. Since flood damages are considered to be proportional to the GDP of the region, the flood benefits increase year by year. The per capita GDP growth rate and the population growth rate in Kelantan State for the period of 1986 to 1990 are considered to be 2.5% and 2.7% respectively and the GDP growth rate is about 5.27%.

The GDP growth rate for the period of 1990 to 2000 was also assumed to be about 5.23%.

The calculation of the annual average damages employed above is indicated in Table 7-3.

Meanwhile, an amount of 42.57×10^6M$ (1988 level, 1988 price) is presented as the annual mean flood damage in the case of without Project in the foregoing Interim Report on Kelantan River Basin-Wide Flood Mitigation Study. When we use these data and the method in the Interim Report for the case with Lebir dam, an amount of 26.29×10^6 M$ is obtained as the annual mean flood damage, and a difference of 16.28×10^6 M$ between the two can be considered to be the benefit produced from the flood mitigation effect by Lebir dam. (refer to Table 7-4)

Table 7-1 Alternative of spillway shape and characteristics against each return period of floods

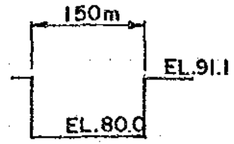
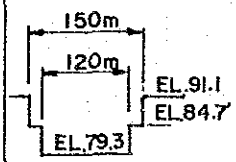
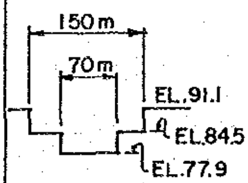
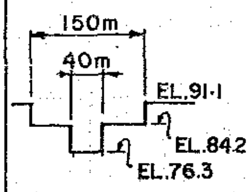
Lebir Dam			Probability in years	Lebir Dam			Peak Discharge at each site		
No.	Shape of overflow section	N.W.L		Peak inflow m³/S	Peak high water level EL. m	Peak discharge m³/S	Bertam m³/S	Dabong m³/S	Guillemard m³/S
1		EL. m 80.0	10000	10579	88.1	6405	6876	16081	24914
			1000	8263	86.8	4881	5600	12985	19816
			200	6648	85.8	3836	4730	10835	16306
			100	5938	85.3	3389	4339	9902	14795
			50	5248	84.9	2947	3944	8964	13279
			20	4314	84.2	2370	3439	7715	11305
			5	2840	83.1	1491	2635	5744	8208
			2	1698	82.1	855	2007	4234	5887
			1.15	619	81.2	343	1420	2669	3644
2		79.3	10000	10579	88.1	6091	6876	16081	24422
			1000	8263	86.7	4579	5600	12985	19396
			200	6648	85.6	3550	4730	10835	15982
			100	5938	85.1	3118	4339	9902	14510
			20	4314	83.9	2172	3439	7715	11113
			5	2840	82.7	1363	2635	5744	8094
			2	1698	81.6	782	2007	4234	5828
			1.15	619	80.6	319	1420	2669	3626
3		77.9	10000	10579	88.2	5319	6876	16081	23234
			1000	8263	86.7	3838	5600	12985	18512
			200	6648	85.5	2847	4730	10835	15305
			100	5938	84.9	2448	4339	9902	13920
			20	4314	83.4	1682	3439	7715	10718
			5	2840	82.0	1058	2635	5744	7861
			2	1698	80.7	609	2007	4234	5702
			1.15	619	79.4	254	1420	2669	3574
4		76.3	10000	10579	88.2	4637	6876	16081	22310
			1000	8263	86.6	3174	5600	12985	17883
			200	6648	85.3	2213	4730	10835	14829
			100	5938	84.7	1839	4339	9902	13507
			20	4314	82.9	1250	3439	7715	10445
			5	2840	81.2	789	2635	5744	7700
			2	1698	79.7	455	2007	4234	5613
			1.15	619	78.2	189	1420	2669	3535

Table 7-2 RELATIONSHIP BETWEEN FLOOD DAMAGES AND FLOOD DISCHARGE AT GUILLEMARD BRIDGE

Year	Guillemard bridge		Damage ($)								Remarks
	Max. Water Level	Max. Discharge	Agriculture	Public Facilities	Public Service	Commercial	Domestic Property	District Office	Total	Status of 1986	
	A.M.S.L. m	M³/S							$	$	
1965	17.19	6.170	6.361.032	442.598	8.000		21.450		6.833.080	19.036.705	
1967	22.30	18.000 (16,000)	14.342.360	2.707.533	250.631			314.723	17.615.247	44.512.852	$30,000,000 (75,808,506)
1969	17.49	6.650	24.150	333.700	1.680				359.530	824.049	$ 1,000,000 (2,292,018)
1973	20.02	11.180	6.000.000	243.921	78.000				6.321.921	11.920.925	( ) shows
1974	15.09	4.490	3.820.000						3.820.000	6.860.171	1986 shatus
1981	12.88	2.028	5.319.808	559.728			598.000		6.477.536	8.267.160	
1982	18.29	7.172	265.473	1.984.543					2.250.016	2.734.909	
1983	20.89	12.007	434.594	5.452.966	2.008	18.725	342.059		6.250.352	7.235.564	
1984	17.86	7.744	1.882.276*1 (8.717.671)	4.091.492*1 (8.265.010)	581.781*1 (772.324)				6.555.549*1 (17.755.005)	7.227.493*1 (19.574.893)	
1985	12.64	1.722							—	—	
1986	18.12	6.901	801.320*1 (378.394)	4.944.035*1 (3.638.623)	258.159*1 (725.050)		92.932	—*1 (6.575.200)	6.096.446*1 (11.317.267)	6.096.446*1 (11.317.267)	

Annual escalation rate is assumed 5%

*1) shows SEPU data

Table 7-3 (1) Calculation of the Annual Average Amount of Damages

(Using a mean curve)

Conditions: Without dam

Size of Flood Discharge	Annual Average Probability of Exceedance	Annual Average Probability of Return P	Estimated Amount of Damages Corresponding to Discharge Size	Average Estimated Amount of Damaged Section D	P x D Annual Average Amount of Damages	Aggregate of Annual Average Amount of Damages
m³/s			×106$	×106$	×106$	×106$
4,000	0.8850	—	—	—	—	—
5,320	0.7143	0.1707	12.474	6.237	1.065	1.065
6,380	0.5882	0.1261	20.542	16.508	2.082	3.146
7,193	0.5000	0.0882	26.025	23.283	2.054	5.200
8,180	0.4000	0.1000	32.093	29.059	2.906	8.106
10,294	0.2000	0.2000	43.553	37.823	7.565	15.671
12,340	0.1000	0.1000	53.258	48.405	4.841	20.511
14,315	0.0500	0.0500	61.718	57.488	2.874	23.385
18,752	0.0100	0.0400	78.472	70.095	2.804	26.189
20,679	0.0050	0.0050	85.030	81.751	0.409	26.598
23,180	0.0020	0.0030	93.046	89.038	0.267	26.865
25,078	0.0010	0.0010	98.812	95.929	0.096	26.961

Table 7-3 (2) Calculation of the Annual Average Amount of Damages
(Using a mean curve)

Conditions: Lebir Dam only
Spillway Alternative No.1

Size of Flood Discharge	Annual Average Probability of Exceedance	Annual Average Probability of Return P	Estimated Amount of Damages Corresponding to Discharge Size	Average Estimated Amount of Damaged Section D	P x D Annual Average Amount of Damages	Aggregate of Annual Average Amount of Damages
m³/s			×106$	×106$	×106$	×106$
4,000	0.8130	—	—	—	—	—
4,510	0.7143	0.0987	5.266	2.633	0.260	0.260
5,290	0.5882	0.1261	12.226	8.746	1.103	1.363
5,887	0.5000	0.0882	16.942	14.584	1.286	2.649
6,610	0.4000	0.1000	22.145	19.544	1.954	4.603
8,208	0.2000	0.2000	32.258	27.201	5.440	10.044
9,760	0.1000	0.1000	40.819	36.539	3.654	13.698
11,305	0.0500	0.0500	48.488	44.653	2.233	15.930
14,795	0.0100	0.0400	63.666	56.077	2.243	18.173
16,306	0.0050	0.0050	69.565	66.616	0.333	18.506
18,300	0.0020	0.0030	76.879	73.222	0.220	18.726
19,816	0.0010	0.0010	82.138	79.508	0.080	18.806

Table 7-3 (3) Calculation of the Annual Average Amount of Damage (Using a mean curve)

Conditions: Lebir Dam only
Spillway Alternative No. 2

Size of Flood Discharge	Annual Average Probability of Exceedance	Annual Average Probability of Return P	Estimated Amount of Damages Corresponding to Discharge Size	Average Estimated Amount of Damaged Section D	P x D Annual Average Amount of Damages	Aggregate of Annual Average Amount of Damages
m³/s			×106$	×106$	×106$	×106$
4,000	0.8065	—	—	—	—	
4,480	0.7143	0.0922	4.975	2.488	0.229	0.229
5,250	0.5882	0.1261	11.894	8.435	1.064	1.293
5,828	0.5000	0.0882	16.495	14.194	1.252	2.545
6,540	0.4000	0.1000	21.662	19.078	1.908	4.453
8,094	0.2000	0.2000	31.586	26.624	5.325	9.778
9,600	0.1000	0.1000	39.981	35.784	3.578	13.356
11,113	0.0500	0.0500	47.573	43.777	2.189	15.545
14,510	0.0100	0.0400	62.514	55.044	2.202	17.746
15,982	0.0050	0.0050	68.328	65.421	0.327	18.074
17,930	0.0020	0.0030	75.558	71.943	0.216	18.289
19,396	0.0010	0.0010	80.705	78.131	0.078	18.368

Table 7-3 (4) Calculation of the Annual Average Amount of Damages (Using a mean curve)

Conditions : Lebir Dam only
Spillway Alternative No.3

Size of Flood Discharge	Annual Average Probability of Exceedance	Annual Average Probability of Return P	Estimated Amount of Damages Corresponding to Discharge Size	Average Estimated Amount of Damaged Section D	P x D Annual Average Amount of Damages	Aggregate of Annual Average Amount of Damages
m^3/s			×106$	×106$	×106$	×106$
4,000	0.8000	—	—	—	—	—
4,400	0.7143	0.0857	4.188	2.094	0.179	0.179
5,140	0.5882	0.1261	10.968	7.578	0.956	1.135
5,702	0.5000	0.0882	15.527	13.247	1.168	2.303
6,380	0.4000	0.1000	20.542	18.034	1.803	4.107
7,861	0.2000	0.2000	30.193	25.367	5.073	9.180
9,290	0.1000	0.1000	38.330	34.262	3.426	12.606
10,718	0.0500	0.0500	45.659	41.995	2.100	14.706
13,920	0.0100	0.0400	60.086	52.872	2.115	16.821
15,305	0.0050	0.0050	65.695	62.890	0.314	17.136
17,130	0.0020	0.0030	72.647	69.171	0.208	17.343
18,512	0.0010	0.0010	77.629	75.138	0.075	17.418

Table 7-3 (5) Calculation of the Annual Average Amount of Damages (Using a mean curve)

Conditions : Lebir Dam only
Spillway Alternative No.4

Size of Flood Discharge	Annual Average Probability of Exceedance	Annual Average Probability of Return P	Estimated Amount of Damages Corresponding to Discharge Size	Average Estimated Amount of Damaged Section D	P x D Annual Average Amount of Damages	Aggregate of Annual Average Amount of Damages
m³/s			×106$	×106$	×106$	X106$
4,000	0.7937	—	—	—	—	—
4,340	0.7143	0.0794	3.588	1.794	0.142	0.142
5,070	0.5882	0.1261	10.369	6.978	0.880	1.022
5,613	0.5000	0.0882	14.832	12.600	1.111	2.134
6,280	0.4000	0.1000	19.830	17.331	1.733	3.867
7,700	0.2000	0.2000	29.213	24.521	4.904	8.771
9,070	0.1000	0.1000	37.136	33.174	3.317	12.089
10,445	0.0500	0.0500	44.309	40.723	2.036	14.125
13,507	0.0100	0.0400	58.348	51.329	2.053	16.178
14,829	0.0050	0.0050	63.803	61.076	0.305	16.483
16,570	0.0020	0.0030	70.562	67.182	0.202	16.685
17,883	0.0010	0.0010	75.389	72.975	0.073	16.758

Table 7-4 Probable Flood Damage (W/O Project and W. Lebir Dam)

	Return Period	Peak Discharge at Guillemard Bridge (m^3/s)	Annual Mean Probability Exceedance	Annual Mean Probability of Return	Probable Flood Damage (million M$)	Mean Flood Damage (million M$)	Annual Mean Flood Damage (million M$)	Accumulative Annual Mean Flood Damage (million M$)
W/O Project	2	5,100	0.500	-	0	-	-	-
	3	6,800	0.333	0.167	58.27	29.14	4.86	4.86
	5	8,700	0.200	0.133	100.50	79.39	10.58	15.44
	10	11,000	0.100	0.100	148.00	124.25	12.43	27.87
	13	12,100	0.077	0.023	159.98	153.99	3.55	31.42
	20	13,400	0.050	0.027	188.00	173.99	4.68	36.10
	50	16,300	0.020	0.030	242.91	215.46	6.46	42.57
W. Lebir Dam	2	4,300	0.500	-	0	-	-	-
	3	5,600	0.333	0.167	20	10	1.67	1.67
	5	7,000	0.200	0.133	63	41.5	5.52	7.19
	10	8,700	0.100	0.100	101	82	8.20	15.39
	13	9,600	0.077	0.023	120	110.5	2.54	17.93
	20	10,600	0.050	0.027	140	130	3.51	21.44
	50	13,300	0.020	0.030	183	161.5	4.85	26.29

Difference between W/O project and W. Lebir dam amounts to 16.28 million M$

W/O project cited from Table V.5.7 on page V-71 in Basin-Wide F/M Study Supporting Report

W. Lebir dam computed by JICA Lebir dam F/S Survey Team based on W/O project data

Table 7-5 RESERVOIR LEVEL V.S. STORAGE CURVE OF NENGGIRI DAM

Reservoir Level EL.m	Reservoir Storage $\times 10^6$ m³
150	2220
153	2520
154	2620
156	2830
160	3230

Table 7-6 RESERVOIR LEVEL V.S. STORAGE CURVE OF DABONG DAM

Reservoir Level EL.m	Reservoir Storage $\times 10^6$ m³
57	1170
58	1300
60	1580
64	2280
68	3020

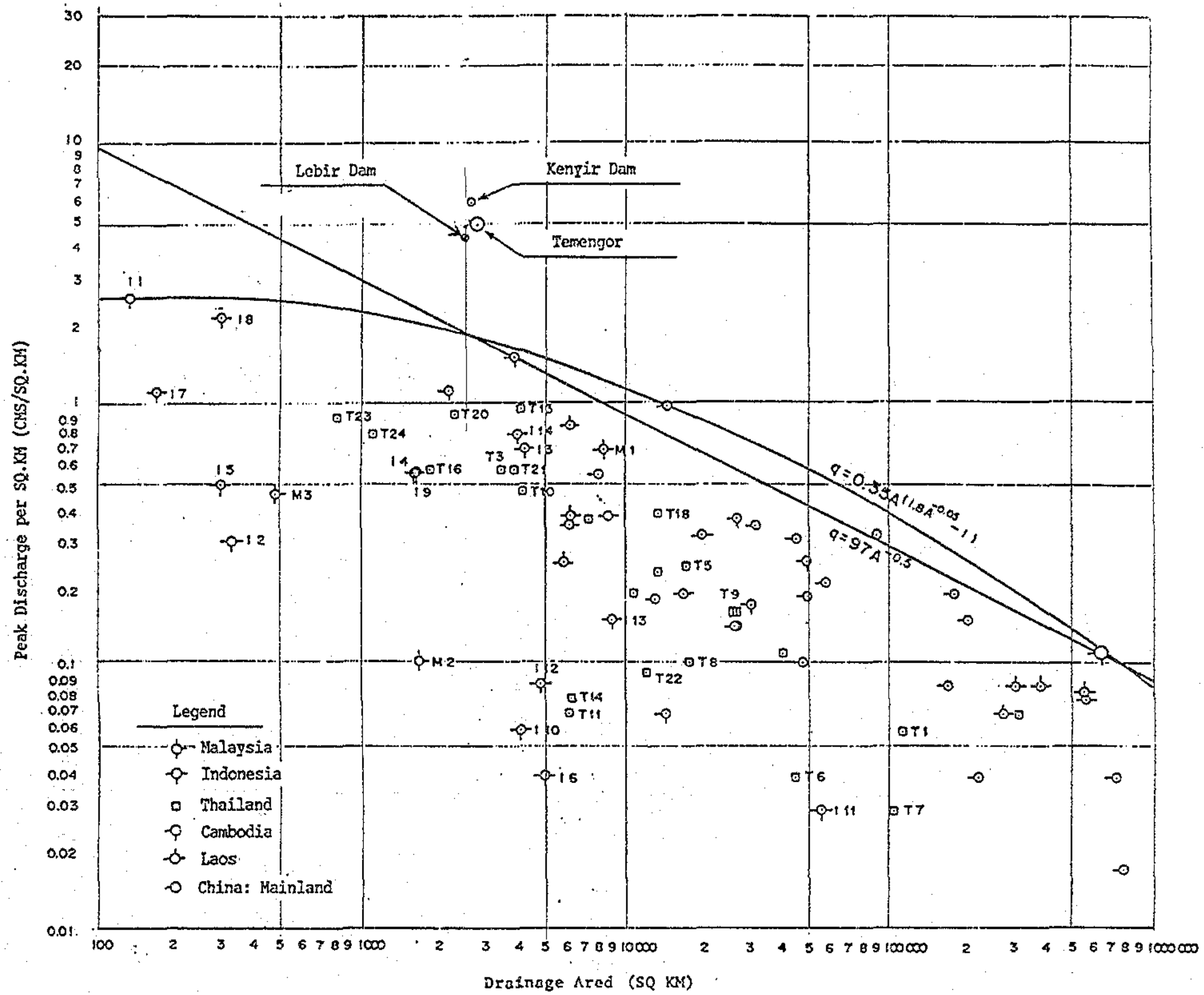


Fig. 7-1 CREAGER CURVE IN SOUTHEAST ASIA REGION MEAN CURVE

Fig. 7-2 FLOOD DISCHARGE-DURATION CURVES FOR A FLOOD OF 10,000 YEAR RETURN PERIOD

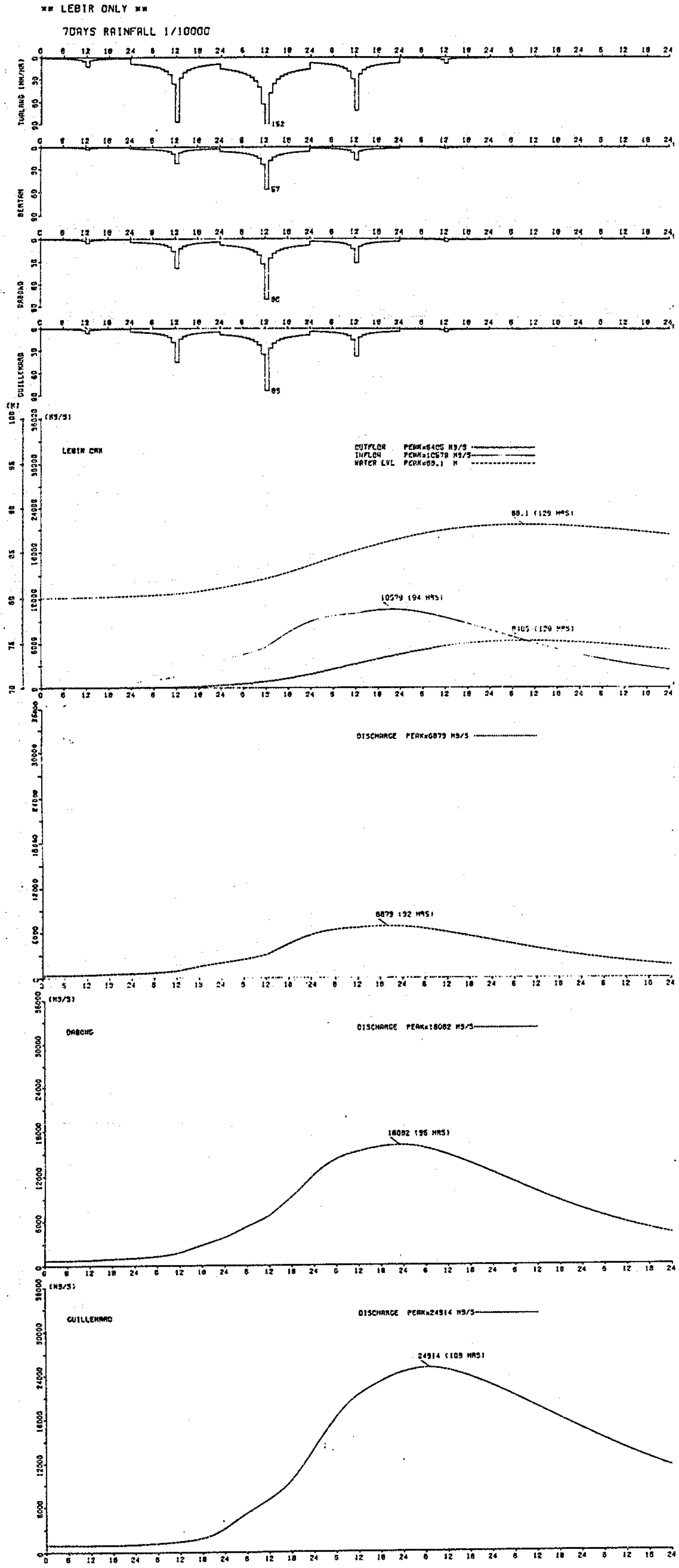


Fig. 7-3 FLOOD DISCHARGE-DURATION CURVES FOR A FLOOD OF 1,000 YEAR RETURN PERIOD

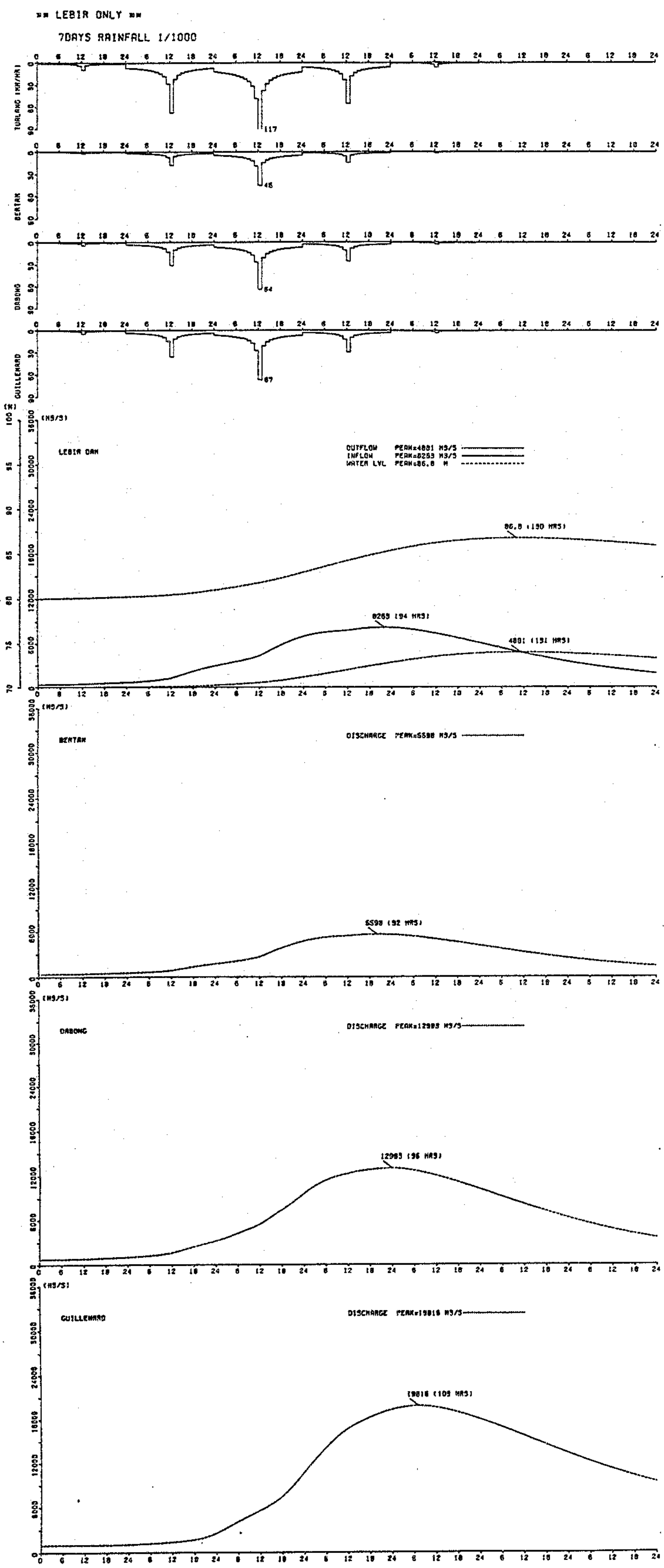
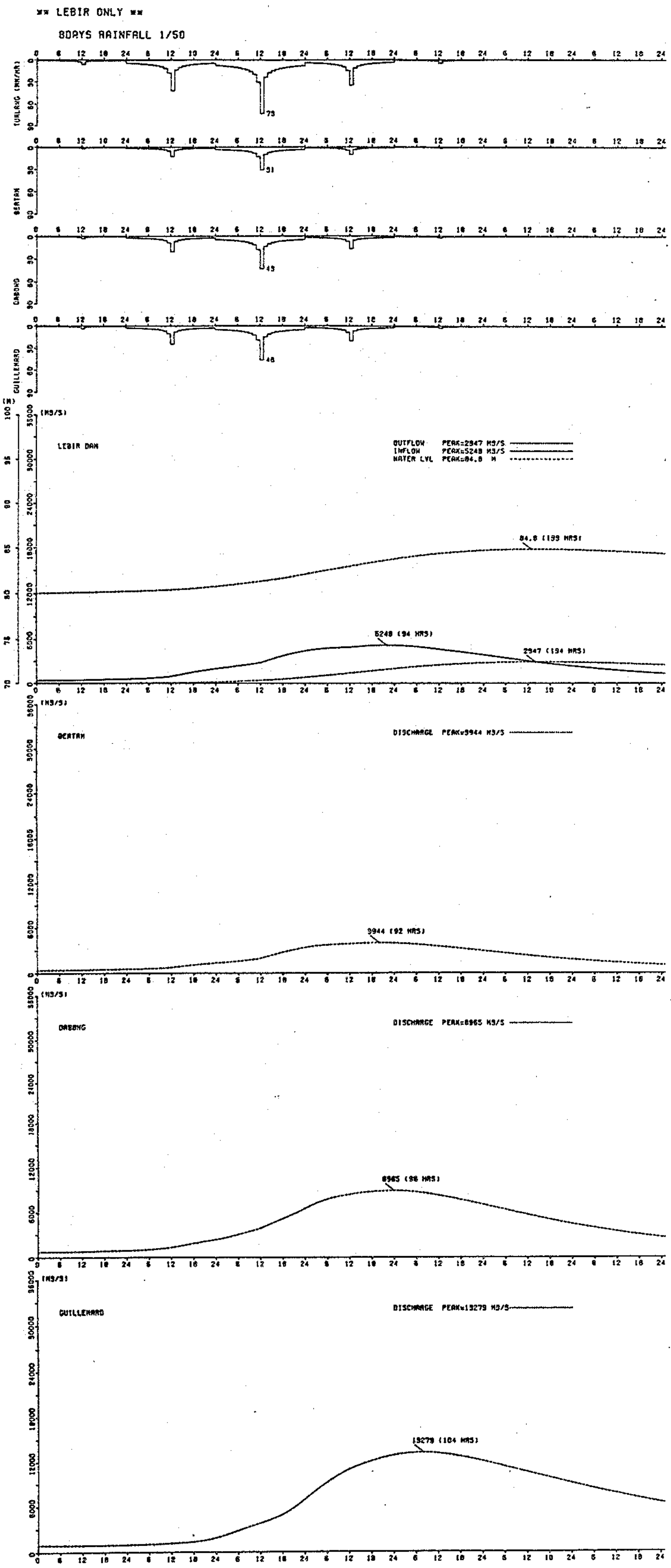


Fig. 7-4 FLOOD DISCHARGE-DURATION CURVES FOR A FLOOD OF 50 YEAR RETURN PERIOD



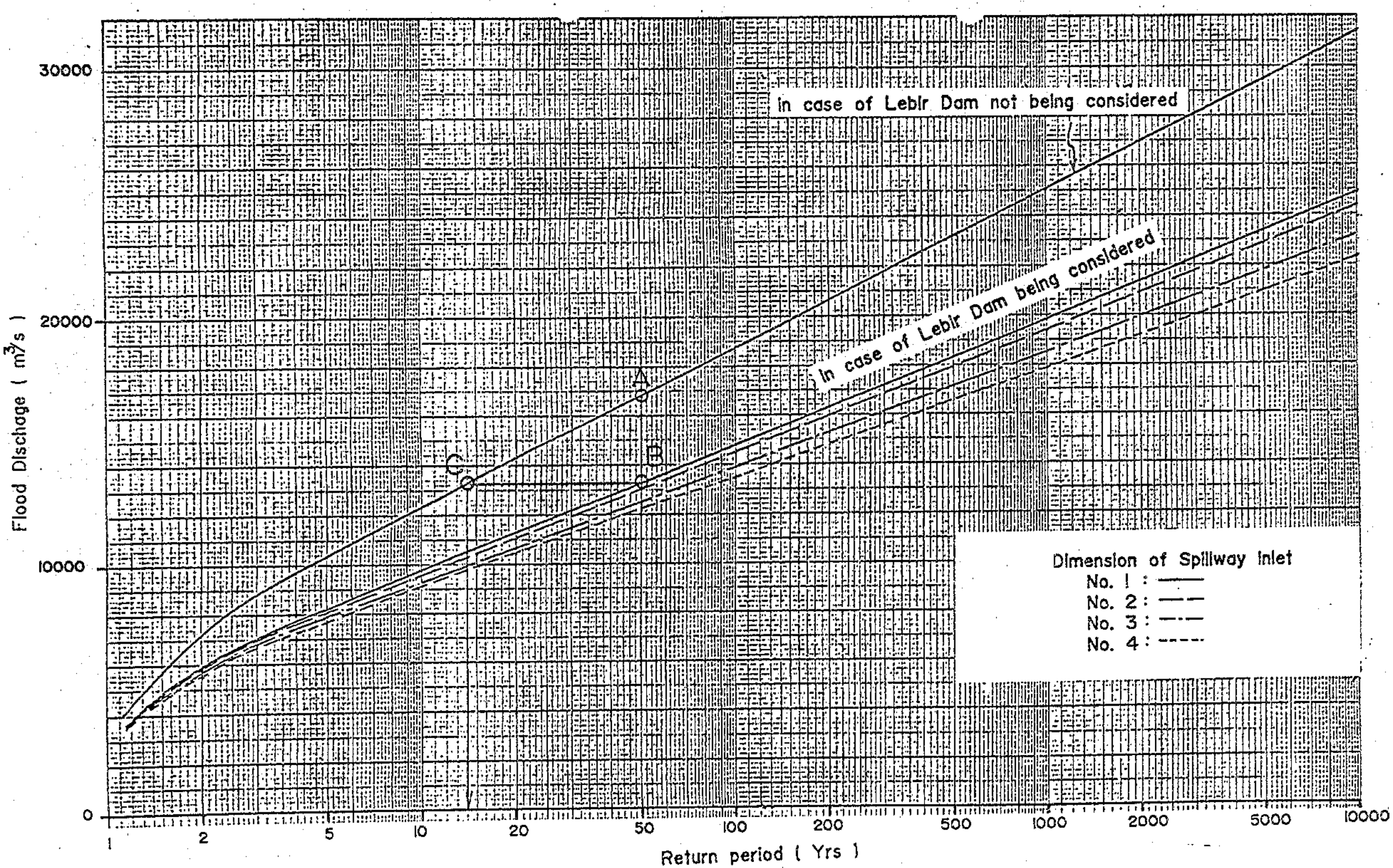


Fig.7-5 Probable peak flood dischage at Guillemard Bridge with / without Lebir Dam (Lebir Dam , ungated spillway)

Fig. 7-6 LEBIR DAM (JERAM PANJANG SITE) RESERVOIR VOLUME AND AREA V.S. RESERVOIR LEVEL

H (EL.m)	A (km²)	V ($10^9 m^3$)	H (EL.m)	A (km²)	V ($10^9 m^3$)
90	247	4.397	50	21	0.167
80	154	2.392	40	6	0.032
70	89	1.177	30	0.6	0.002
60	46	0.502			

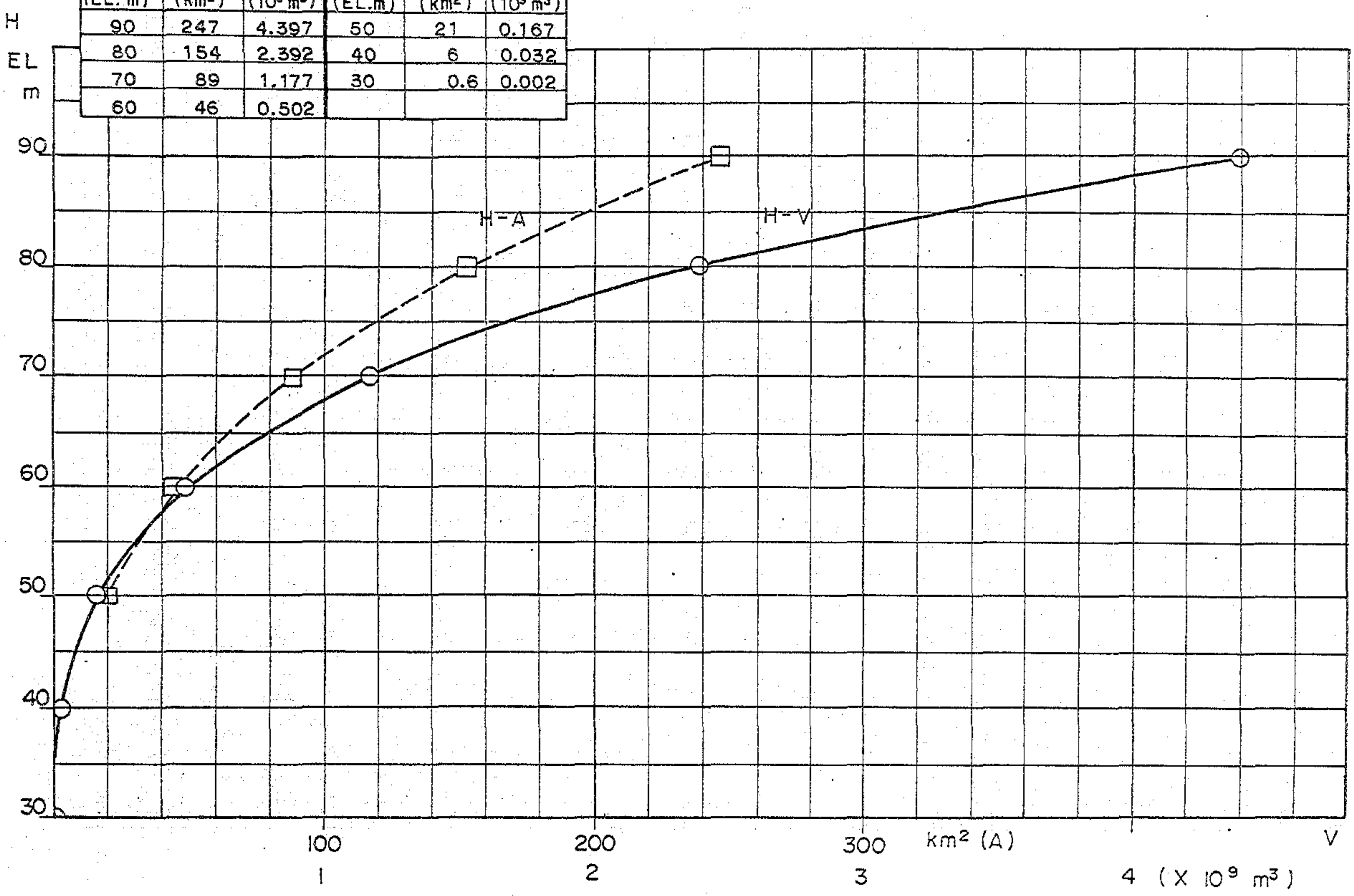
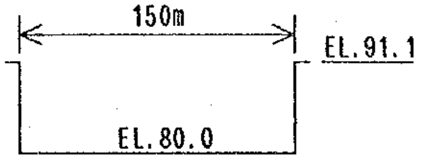
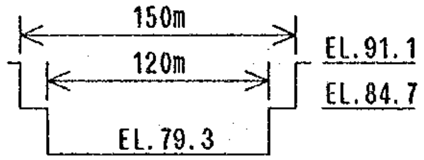
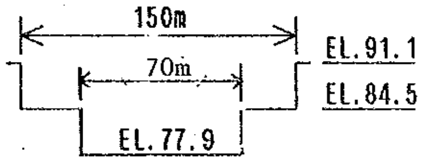
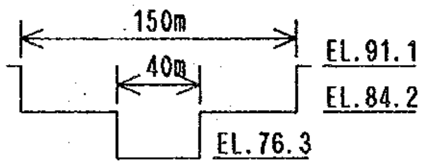


Fig. 7-7 Spillway Alternative for Lebir Dam

Case No.	Shape of overflow section	N.W.L (EL. m)
1		80.0
2		79.3
3		77.9
4		76.3

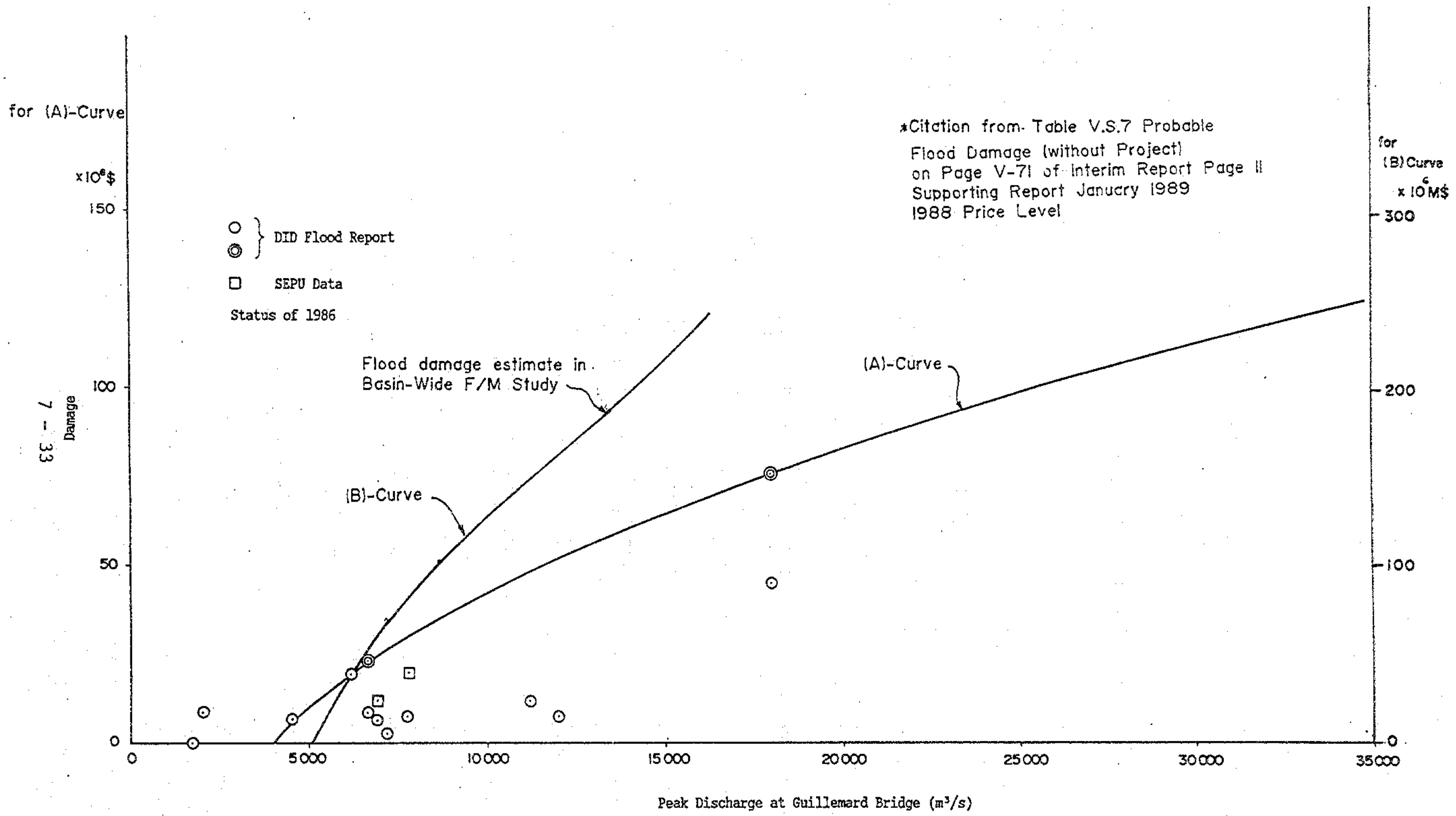


Fig.7-8 RELATIONSHIP BETWEEN DAMAGES AND FLOOD DISCHARGES AT GUILLEMARD BRIDGE

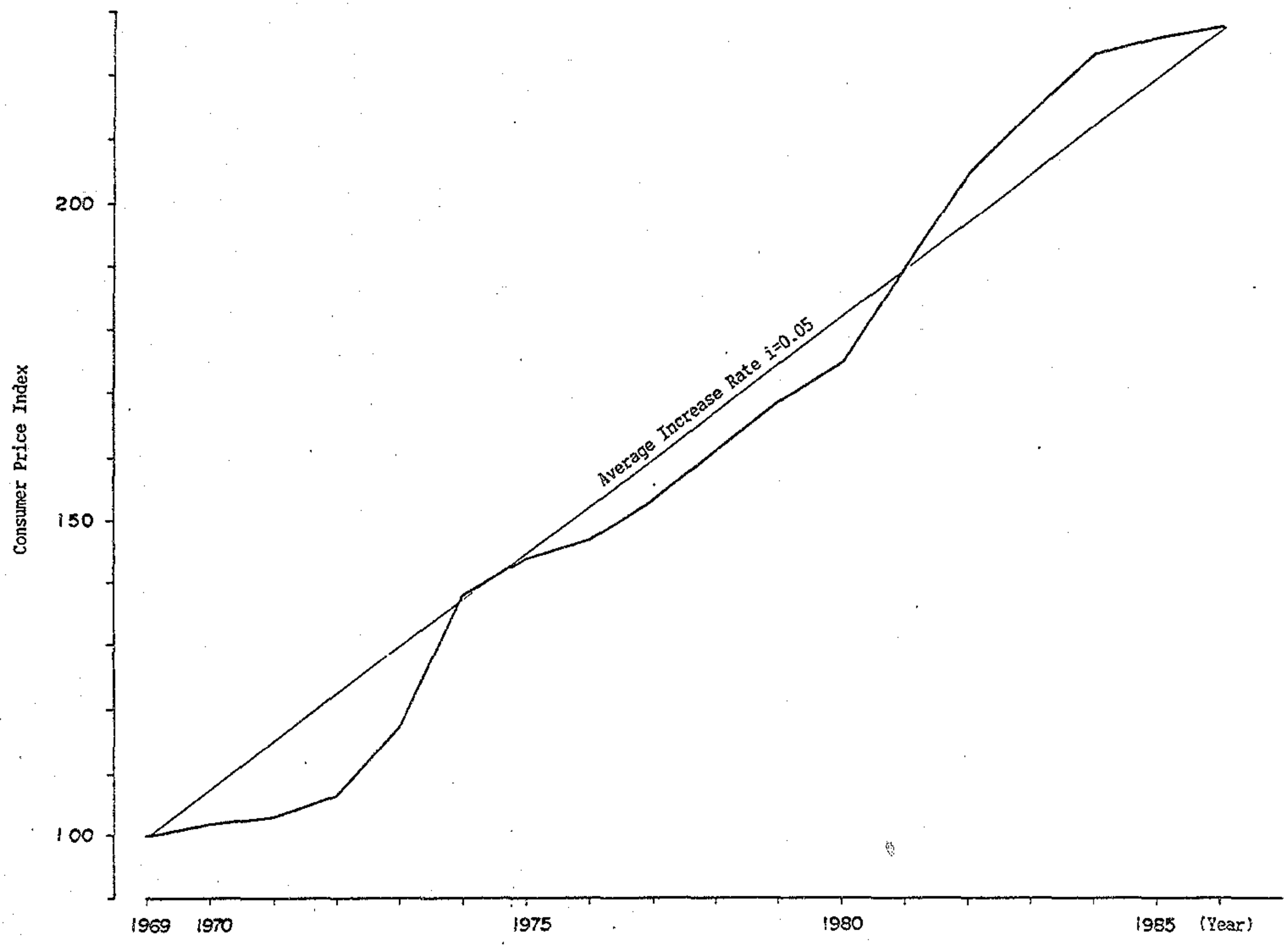


Fig. 7-9 CONSUMER PRICE INDEX (1969-1986)

8. Agricultural Irrigation

8. Agricultural Irrigation

8.1. Trend of Agricultural Production in Recent Years

During the Fourth Malaysia Plan period from 1981 to 1985, the area planted with oil palm and cocoa increased markedly, while that with rubber declined slightly. The acreage planted with paddy increased slightly, while those with coconut and pepper declined. With regard to other crops, the area planted with fruits remained fairly constant, while those of vegetables, pineapple and tobacco declined.

According to the Fifth Malaysia Plan, paddy production decreased from 2,040,200 tonnes in 1980 to 1,931,200 tonnes in 1985. This volume corresponds to 76.5 percent of domestic requirement, while the self-sufficiency target in the National Agricultural Policy (NAP) is 80 to 85 percent. This decrease in production was due largely to unfavorable weather conditions, damage from pest and disease, instability in yields or cropping intensities and increase in abandoned paddy land.

The trend of agricultural production in Kelantan State is similar to the national trend. The following table shows the acreage planted with each crop for five years from 1981 to 1985. The areas planted with oil palm, rubber, coconut, vegetable, pineapple and tobacco show the same trend. However, the acreage planted with paddy declined markedly, while that of fruits much increased.

- Trend of Area Planted by Crop in Kelantan - (unit: ha)

Year	Oil Palm	Rubber	Coconut	Fruits	Paddy	Pineapple	Vegetable	Virginia Tobacco
1981	21,250	117,169	18,516	6,920	60,768	782	1,820	11,232
1982	23,520	121,849	18,370	7,005	44,422	764	1,946	8,036
1983	34,720	129,417	17,242	7,311	25,538	542	1,457	8,871
1984	37,140	116,148	17,690	8,644	21,005	635	1,861	6,846
1985	27,593	104,766	17,638	8,608	13,137	602	1,545	6,891

Note : Redution in area planted with oil palm in 1985 is due to that in Ulu Kelantan District, though reason is not clear.

Source : SEPU, Kelantan

8.2. Present State and Forecast on Supply and Demand of Rice

8.2.1. Present State on Supply and Demand of Rice

A rough estimation of the national level of rice consumption is studied by use of the limited data. The following table shows that the rice production to satisfy the total apparent consumption has fallen from 89 percent in 1980 to 75 percent in 1985. The latter is less than the NAP's target of rice self-sufficiency of 80 - 85 percent.

A rough estimation of the rice consumption in Kelantan State using the calculated apparent consumption volume per head was carried out in the following table. The annual rice self-sufficiency in the State of 100 percent was attained in 1980, 1981, 1983 and 1985, 86 percent in 1982 and 84 percent in 1984 among six (6) years from 1980 to 1985. Rice produced in Kelantan State is primarily consumed in the State and the expected surplus rice is shipped to other States. The surplus rice from 1980 to 1984 is estimated at 27 percent of the production in 1980 and 26 percent of that in 1983. In other words, it is considered that rice supply in 1982 and 1984 was short in amount due to low production in the State, and hence, the consumers had to purchase imported rice from other States or countries. From the study of supply and demand of rice in Kelantan State in the recent 6 years, it is understood that its balance is remarkably unstable.

- Crude Estimation of Consumption of Rice in Malaysia, 1980 - 1985[4/]

Items	Unit	1980	1981	1982	1983	1984	1985
1. Rice Production	1,000 tonnes	1,818	1,303	1,213	1,117	1,010	1,269[5/]
2. Net Import	1,000 tonnes	167	317	393	358	426	429[6/]
3. Total Apparent Consumption[1/]	1,000 tonnes	1,485	1,620	1,606	1,475	1,436	1,698
4. Percentage of Production to Total Apparent Consumption	%	89	80	76	76	70	75
5. Population[2/]	million	13.764	14.128	14.506	14.888	15.262	15.791
6. Apparent Consumption per Head[3/]	kg	308	115	111	99	94	108

Note: 1/ Quantities stocked are not accounted due to lack of information.

2/ Figures 1980 to 1984 are the estimated mid-year population of Malaysia as at 30th June. Population in 1985 is based on the Fifth Malaysia Plan, 1986 - 1990.

3/ Rice consumption per head is estimated as total apparent consumption divided by population.

4/ The data from 1980 to 1984 was obtained from the Paddy Statistics, 1984.

5/ Paddy 1,952,900 tonnes x 0.65 = Rice 1,269,000 tonnes (Economic Report 1986/1987).

6/ Economic Report 1986/1987.

- Crude Estimation of Consumption of Rice in Kelantan, 1980 - 1985

Items	Unit	1980	1981	1982	1983	1984	1985
1. Rice Production							
Paddy 1/	1,000 tonnes	203.2	200.4	147.1	202.1	120.8	178.4
Rice 2/	1,000 tonnes	132.1	130.3	95.6	131.4	78.5	116.0
2. Population 3/	million	0.898	0.923	0.949	0.976	1.003	1.026
3. Apparent Consumption per Head 4/	kg	108	115	111	99	94	108
4. Total Apparent Consumption in Kelantan 5/	1,000 tonnes	97.0	106.1	105.3	96.6	94.3	110.8
5. Surplus to be Transported Outside Kelantan 6/	1,000 tonnes	35.1	24.2	-9.7	34.8	-15.8	5.2
6. Surplus/Production	%	27	19		26		4

Note: 1/ Production of paddy is obtained from the development statistics of KADA, Department of Agriculture and SEPU, Kelantan.

2/ Conversion factor is 65 percent.

3/ Population in 1980 and 1985 is based on the Fifth Malaysia Plan. Population in 1981 to 1984 is estimated using annual growth rate of 2.8 percent.

4/ Rice consumption per head is based on the crude estimation of consumption of rice in Malaysia.

5/ 3/ x 4/ = 5/

6/ 2/ - 5/ = 6/

8.2.2. Prospect on Demand and Supply of Rice in the Fifth Malaysia Plan

The Fifth Malaysia Plan directs the future production of rice as follows:

"In case of padi, future production efforts will be concentrated in the granary area of Muda, Kemubu, Besut, North-West Selangor, Krian-Sungai Manik, Tarans Perak, Kemasin-Semerak, and Seberang Prai. The production of padi in the existing padi land outside these granary areas will be gradually phased out and replaced by other more remunerative crops. Consequently, the self-sufficiency level will mainly depend on the future output from the granary areas. The production from these granary areas is currently estimated to meet 55 to 60 percent of domestic requirements."

Balance of demand and supply of rice in the nation is estimated by rough projection of consumption from 1985 to 2010 and shown in the following table. The prospect is based on the rice production policy in the Fifth Malaysia Plan mentioned above.

It is assumed that the population in Malaysia will increase by 2.3 percent to 2.5 percent annually in future and apparent rice consumption per head will decrease to 108 kg to 90 kg. The self-sufficiency level will be secured at 80 percent. With these factors, the domestic production could be estimated at 1,269,000 tonnes of rice or 1,952,000 tonnes of paddy in 1985 and 2,009,000 tonnes of rice or 3,091,000 tonnes of paddy in 2010. Import of rice is expected to be about 400,000 tonnes to 500,000 tonnes per year.

The production from the granary areas can be estimated at 1,074,000 tonnes of paddy in 1985 and 1,700,000 tonnes in 2010 in consideration of 55 percent of domestic requirements.

- Crude Projection of Demand and Supply on Rice Consumption in Malaysia -

Items	Unit	1985	1990	1995	2000	2005	2010
1. Population 1/	million	15.791	17.877	20.128	22.552	25.144	27.897
2. Apparent Rice Consumption per Head 2/	kg	108	100	95	95	90	90
3. Total Apparent Consumption (requirement)	1,000 t	1,698	1,788	1,912	2,142	2,263	2,511
4. Percentage of Domestic Production to Total Apparent Consumption 3/	%	75	80	80	80	80	80
5. Domestic Rice Production	1,000 t	1,269	1,430	1,530	1,714	1,810	2,009
6. Import	1,000 t	429	358	382	428	453	502
7. Domestic Paddy Production 4/	1,000 t	1,952	2,200	2,354	2,637	2,785	3,091
8. Domestic Paddy Requirement 4/	1,000 t	2,612	2,751	2,942	3,295	3,482	3,863
9. Paddy Production in Granary Area 5/	1,000 t	1,074	1,210	1,295	1,450	1,532	1,700
10. Paddy production in Area Outside Granary Area 6/	1,000 t	878	990	1,059	1,187	1,253	1,391

Note:
1/ Annual growth rate of population is assumed as follows.
1985 to 1900 ... 2.5%, 1990 to 1995 ... 2.4%, 1995 to 2000 ... 2.3%
2/ Apparent rice consumption per head is assumed to decrease, because the national standard of living will be expected to rise in future.
3/ The domestic rice production level is aimed at 80% of the domestic requirement according to NAP.
4/ Milling rate is 65%.
5/ Paddy production in granary area = total apparent consumption x 0.55.
6/ Paddy production in area outside granary area = Domestic paddy production - paddy production in granary area.