2.Aggregate production

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Rock material		m3	1.20	4.62	5.54	
(2).Crushing plant 300t/hr						
(2)-1	Aggregate production equipment	hr.	1.00	194.58	194.58	
(2)-2	Allowance	(2)-1*2%			3.89	
(2)-3	Submergible pump (50kw , ϕ 150)	hr	1.00	1.97	1.97	
(2)-4	Turbine pump (55kw , ϕ 150)	hr	2.00	1.79	3.58	
(2)-5	Tractor shovel 988B	hr	0.50	137.31	68.66	
	Subtotal (2)				272.68	
(3).Fuel , Lubricant & Electricity						
(3)-1	Fuel	liter	37.50	0.40	15.00	
(3)-2	Lubricant	(3)-1*20%			3.00	
(3)-3	Electricity	kwh	400.00	0.20	80.00	
	Subtotal (3)				98.00	
(4).Labour						
(4)-1	Foreman	hr	0.25	10.04	2.51	
(4)-2	Ganger	hr	1.00	4.81	4.81	
(4)-3	Assistant	hr	3.00	3.44	10.32	
(4)-4	General labour	hr	5.00	2.48	12.40	
	Subtotal (4)				30.04	
(5).Allowance (2)to(4)*5%					20.04	
(6).Subtotal (2)to(5)					420.76	
(7).Aggregate production cost						
						for aggregate & filter
	(6)/270 t/hr	(per ton)			4.33	
						for rockfill
	(6)/135 m3/hr	(per m3)			8.66	

3.Cement - 1 (Bulk)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials						
(1)-1	Cement	ton	1.00	178.00	178.00	
(2).Transportation						
(2)-1	Tank lorry (18ton)	hr	2.00	47.73	95.46	
(2)-2	Allowance	(2)-1*2%			1.91	
	Subtotal (2)				97.37	
	(Subtotal (2)/18)				5.41	
(3).Labour						
(3)-1	Foreman	hr	0.25	10.01	2.50	
(3)-2	Tank lorry driver	hr	2.00	3.44	6.88	
(3)-3	Pump operator / attendant	hr	1.00	3.03	3.03	
(3)-4	General labour	hr	1.00	2.48	2.48	
	Subtotal (3)				14.89	
	(Subtotal (3)/18)				0.83	
(4).Allowance	((1)+(2)+(3))*10%				18.42	
	Total (1)to(4)				202.66	

4.Cement - 2 (Bag)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials						
(1)-1	Cement (40*25bags)	ton	1.00	227.50	227.50	
(2).Labour						
(2)-1	General labour	hr	1.00	2.48	2.48	
	Total				229.98	

5.Concrete - batching plant (per m3)						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials						
(1)-1	Cement 400kg/m3	ton	0.40	202.66	81.06	
(1)-2	Aggregate	ton	2.00	4.33	8.66	
(1)-3	Admixture	liter	1.00	1.00	1.00	
	Subtotal (1)				90.72	
(2).Equipment						
(2)-1	Batching plant 60m3/hr	hr	1.00	183.60	183.60	
(2)-2	Allowance	(2)-1*2%			3.67	
	Subtotal (2)				187.27	
	(Subtotal (2)/60)				3.12	
(3).Labour						
(3)-1	Foreman	hr	1.00	10.01	10.01	
(3)-2	Ganger	hr	2.00	4.81	9.62	
(3)-3	Pump operator / attendant	hr	4.00	3.03	12.12	
(3)-4	General labour	hr	4.00	2.48	9.92	
	Subtotal (3)				41.67	
	(Subtotal (3)/60)				0.69	
(4).Electricity						
(4)-1	Electricity		96.00	0.20	19.20	
(4)-2	Allowance	(4)-1*2%			0.38	
	Subtotal (4)				19.58	
	(Subtotal (4)/60)				0.33	
	Total (1)to(4)				94.86	

6.Formwork (steel form) (per m2)						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1). Equipment						
(1)-1	Truck crane	hr	0.05	18.68	0.93	
(2).Materials						
(2)-1	Steel form	m2	1.00	4.17	4.17	
(2)-2	Steel ties	kg/m2	1.30	0.76	0.99	
	Subtotal (2)				5.16	
(3).Labour						
(3)-1	Foreman	hr	0.10	10.01	1.00	
(3)-2	Ganger	hr	0.30	4.81	1.44	
(3)-3	Carpenter	hr	0.50	5.91	2.96	
(3)-4	Crane operator	hr	0.01	3.85	0.04	
(3)-5	General labour	hr	0.50	2.48	1.24	
	Subtotal (3)				6.68	
	Total				12.77	

7.Excavation , common (Power Intake V=502,900m3)						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1). Equipment						
(1)-1	Tractor shovel 988B	hr	1,524.00	137.31	209,260.44	
(1)-2	Dump truck 769B	hr	7,288.00	108.02	787,249.76	
(1)-3	Bulldozer D8	hr	1,999.00	86.67	173,253.33	
	Subtotal (1)				1,169,763.53	
	(Subtotal (1)/502,900)				2.33	
(2).Fuel & Lubricant						
(2)-1	Fuel	liter	839,140.00	0.40	335,656.00	
(2)-2	Lubricant	(2)-1*20%			67131.2	
	Subtotal (2)				402,787.20	
	(Subtotal (2)/502,900)				0.80	
(3).Labour						
(3)-1	Foreman	hr	191.00	10.01	1,911.91	
(3)-2	Ganger	hr	762.00	4.81	3,665.22	
(3)-3	Operator (Equipment)	hr	10,811.00	4.81	52,000.91	
(3)-4	Ditto ,Assistant	hr	1,824.00	3.44	6,274.56	
(3)-5	General labour	hr	600.00	2.48	1,488.00	
	Subtotal (3)				65,340.60	
	(Subtotal (3)/502,900)				0.13	
(4).Allowance (1)to(3)*2%					0.07	
(5).General Overhead (1)to(4)*35%					1.17	
	Total				4.50	

8.Excavation , rock -1 (Power Intake V=539,200m3)						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Loading equipment						
(1)-1	Tractor shovel 988B	hr	1,541.00	137.31	211,594.71	
(1)-2	Dump truck 769B	hr	7,703.00	108.02	832,078.06	
(1)-3	Bulldozer D8	hr	1,704.00	86.67	147,685.68	
	Subtotal (1)				1,191,358.45	
	(Subtotal (1)/539,200)				2.21	
(2).Drilling equipment						
(2)-1	Crawlerdrill	hr	5,991.00	72.15	432,250.65	
(2)-2	Compressor	hr	5,991.00	21.87	131,023.17	
(2)-3	Allowance	(2)-1*3%			16,898.21	
	Subtotal (2)				580,172.03	
	(Subtotal (2)/539,200)				1.08	
(3).Fuel , Lubricaant & Electricity						
(3)-1	Fuel	liter	1,045,281.40	0.20	209,056.28	
(3)-2	Lubricant	(3)-1*20%			41,811.26	
	Subtotal (3)				250,867.54	
	(Subtotal (3)/539,200)				0.47	
(4).Blasting materials						
(4)-1	Dynamite	kg	37,700.00	14.08	530,816.00	
(4)-2	An-Fo	kg	501,500.00	0.96	481,440.00	
(4)-3	Detorator	No	15,400.00	1.70	26,180.00	
	Subtotal (3)				1,038,436.00	
	(Subtotal (3)/539,200)				1.93	

8.Excavation , rock -2 (Power Intake V=539,200m3)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(5).Labour						
(5)-1	Foreman	hr	193.00	10.01	1,931.93	
(5)-2	Ganger	hr	771.00	4.81	3,708.51	
(5)-3	Crawler operator	hr	5,991.00	5.23	31,332.93	
(5)-4	Operator (Equipment)	hr	10,948.00	4.81	52,659.88	
(5)-5	Ditto ,Assistant	hr	4,537.00	3.44	15,607.28	
(5)-6	General labour	hr	4,537.00	2.48	11,251.76	
	Subtotal (5)				116,492.29	
	(Subtotal (5)/539,200)				0.22	
(6).General	overhead (1)to(5)*35%				2.07	
	Total				7.98	

9.Embankment , rock (V=2,926,100 m3)						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Rock material						
(1)-1	Rock material	m3	1.05	4.62	4.85	
(2).Embankment (2,926,100 m3)						
(2)-1	Tractor shovel 988B	hr	4,046.00	137.31	555,556.26	
(2)-2	Dump truck 769B	hr	88,426.00	108.02	9,551,776.52	
(2)-3	Bulldozer D-8	hr	54,978.00	86.67	4,764,943.26	
(2)-4	Vibrating roller	hr	701.00	64.17	44,983.17	
	Subtotal (2)				14,917,259.21	
(3).Fuel & Lubricant						
(3)-1	Fuel (diesel)	liter	8,873,330.00	0.40	3,549,332.00	
(3)-2	Lubricant	L.S	(3)-1*20%		709,866.40	
	Subtotal (3)				4,259,198.40	
(4).Labour						
(4)-1	Foreman	hr	2,625.00	10.01	26,276.25	
(4)-2	Ganger	hr	10,500.00	4.81	50,505.00	
(4)-3	Operator (Equipment)	hr	148,151.00	4.81	712,606.31	
(4)-4	Ditto ,Assistant	hr	37,038.00	3.44	127,410.72	
(4)-5	General labour	hr	14,000.00	2.48	34,720.00	
	Subtotal (4)				951,518.28	
(5).Subtotal	(2)to(4)/2,926,100				6.88	
(6).Allowance	(5)*5%				0.34	
(7).General overhead	((1)+(5)+(6))*35%				4.22	
	Total (1)+(5)+(6)+(7)				16.29	

10.Embankment -reused rock (V=400,000)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1). Equipment						
(1)-1	Tractor shovel 988B	hr	871.00	137.31	119,597.01	
(1)-2	Bulldozer D8	hr	3,428.00	86.67	297,104.76	
(1)-3	Dump truck 769B	hr	5,714.00	108.02	617,226.28	
(1)-4	Vibrating roller	hr	25.00	64.17	1,604.25	
	Subtotal (1)				1,035,532.30	
	(Subtotal (1)/400,000)				2.59	
(2).Fuel & Lubricant						
(2)-1	Fuel	liter	746,092.00	0.40	298,436.80	
(2)-2	Lubricant	(2)-1*20%			59687.36	
	Subtotal (2)				358,124.16	
	(Subtotal (2)/400,000)				0.90	
(3).Labour						
(3)-1	Foreman	hr	123.00	10.01	1,231.23	
(3)-2	Ganger	hr	490.00	4.81	2,356.90	
(3)-3	Operator (Equipment)	hr	10,038.00	4.81	48,282.78	
(3)-4	Ditto ,Assistant	hr	6,694.00	3.44	23,027.36	
(3)-5	General labour	hr	6,700.00	2.48	16,616.00	
	Subtotal (3)				91,514.27	
	(Subtotal (3)/400,000)				0.23	
(4).Allowance	(1)to(3)*5%				0.19	
(5).General Overhead	(1)to(4)*35%				1.37	
	Total				5.28	

11.Embankment, filter (V=321,200m3 - for maindam only)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1) Aggregate		m3	1.00	8.66	8.66	
(2).Equipment						
(2)-1	Tractor shovel 988B	hr	656.00	137.31	90,075.36	
(2)-2	Bulldozer D8	hr	2,415.00	86.67	209,308.05	
(2)-3	Dump Truck 769B	hr	3,278.00	108.02	354,089.56	
(2)-4	Tamping roller	hr	1,108.00	17.79	19,711.32	
	Subtotal (2)				673,184.29	
	(Subtotal (2)/321,200)				2.10	
(3).Fuel & Lubricant						
(3)-1	Fuel	liter	298,666.00	0.40	119,466.40	
(3)-2	Lubricant	(3)-1*20%			23,893.28	
	Subtotal (3)				143,359.68	
	(Subtotal (3)/321,200)				0.45	
(4).Labour						
(4)-1	Foreman	hr	1,208.00	10.01	12,092.08	
(4)-2	Ganger	hr	2,415.00	4.81	11,616.15	
(4)-3	Operator (Equipment)	hr	7,457.00	4.81	35,868.17	
(4)-4	Ditto ,Assistant	hr	4,386.00	3.44	15,087.84	
(4)-5	General labour	hr	3,278.00	2.48	8,129.44	
	Subtotal (4)				82,793.68	
	(Subtotal (4)/321,200)				0.26	
(5).General overhead	(1)to(4)*35%				4.01	
	Total				15.48	

12.Embankment , outer shell (Rock embankment + Backhoe)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Rock material		m3	1.05	4.62	4.85	
(2).Embankment						
(3).Fuel & Lubricant		m3	1.00	6.88	6.88	
(4).Labour						
(5).Allowance		m3	1.00	0.34	0.34	
(6).Equipment						
(6)-1	Backhoe	hr	304.00	83.03	25,241.12	
	Subtotal (6)				25,241.12	
	(Subtotal (6)/161,100)				0.16	
(7).Fuel & Lubricant						
(7)-1	Fuel	liter	6,202.00	0.40	2,480.80	
(7)-2	Lubricant	(7)-1*20%			496.16	
	Subtotal (7)				2,976.96	
	(Subtotal (7)/161,100)				0.02	
(8).Labour						
(8)-1	Foreman	hr	30.00	10.01	300.30	
(8)-2	Operator (Equipment)	hr	304.00	4.81	1,462.24	
(8)-3	Ditto ,Assistant	hr	304.00	2.48	753.92	
	Subtotal (7)				2,516.46	
	(Subtotal (7)/161,100)				0.02	
(9).General overhead (1)to(8)*35%					4.29	
	Total				16.56	

13.Embankment , core - 1						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1). Equipment -(1)						
(1)-1	Tractor shovel 988B 375HP	hr	2,003.00	137.31	275,031.93	Including disposal of overburden V=53,100m3
(1)-2	Dump truck 769B 415HP	hr	16,506.00	108.02	1,782,978.12	
(1)-3	Bulldozer D8 300HP	hr	5,178.00	86.67	448,777.26	
	Subtotal (1)				2,506,787.31	
	(Subtotal (1)/702,900)				3.57	
(2).Fuel & Lubricant -(1)						
(2)-1	Fuel	liter	1,830,903.00	0.40	732,361.20	
(2)-2	Lubricant	(2)-1*20%			146,472.24	
	Subtotal (2)				878,833.44	
	(Subtotal (2)/702,900)				1.25	
(3).Labour -(1)						
(3)-1	Foreman	hr	268.00	10.01	2,682.68	
(3)-2	Ganger	hr	1,071.00	4.81	5,151.51	
(3)-3	Operator (Equipment)	hr	23,687.00	4.81	113,934.47	
(3)-4	Ditto ,Assistant	hr	5,108.00	3.44	17,571.52	
(3)-5	General labour	hr	417.00	2.48	1,034.16	
	Subtotal (3)				140,374.34	
	(Subtotal (3)/702,900)				0.20	
(4).Equipment -(2)						
(4)-1	Bulldozer	hr	2,405.00	86.67	208,441.35	
(4)-2	Tamping roller	hr	194.00	17.79	3,451.26	
	Subtotal (4)				211,892.61	
	(Subtotal (4)/391,600)				0.54	
(5).Fuel & Lubricant						
(5)-1	Fuel	liter	104,269.20	0.40	41,707.68	
(5)-2	Lubricant	(5)-1*20%			8,341.54	
	Subtotal (5)				50,049.22	
	(Subtotal (5)/391,600)				0.13	

13.Embankment , core - 2						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(6).Labour -(2)						
(6)-1	Foreman	hr	349.00	10.01	3,493.49	
(6)-2	Ganger	hr	1,397.00	4.81	6,719.57	
(6)-3	Operator (Equipment)	hr	2,599.00	4.81	12,501.19	
(6)-4	Ditto ,Assistant	hr	2,599.00	3.44	8,940.56	
(6)-5	General labour	hr	2,405.00	2.48	5,964.40	
	Subtotal (6)				37,619.21	
	(Subtotal (6)/391,600)				0.10	
(7).Allowance	(1)to(6)*2%				0.12	
(8).General	Overhead (1)to(7)*35%				2.07	
	Total				7.98	

14.Protection dyke (V=17,200m3)						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Equipment						
(1)-1	Tractor shovel 988B	hr	35.00	137.31	4,805.85	
(1)-2	Bulldozer D8	hr	62.00	86.67	5,373.54	
(1)-3	Dump truck 769B	hr	99.00	108.02	10,693.98	
	Subtotal (1)				20,873.37	
	(Subtotal (1)/17,200)				1.21	
(2).Fuel & Lubricant						
(2)-1	Fuel	liter	14,562.00	0.40	5,824.80	
(2)-2	Lubricant	(2)-1*20%			1,164.96	
	Subtotal (2)				6,989.76	
	(Subtotal (2)/17,200)				0.41	
(3).Labour						
(3)-1	Foreman	hr	5.00	10.01	50.05	
(3)-2	Ganger	hr	18.00	4.81	86.58	
(3)-3	Operator (Equipment)	hr	196.00	4.81	942.76	
(3)-4	Ditto ,Assistant	hr	124.00	3.44	426.56	
(3)-5	General labour	hr	124.00	2.48	307.52	
	Subtotal (3)				1,813.47	
	(Subtotal (3)/17,200)				0.11	
(5).General overhead (1)to(3)*35%					0.61	
	Total				2.34	

15.Backfill (powerhouse , V=19,600m3)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Equipment						
(1)-1	Bulldozer D8	hr	121.00	86.67	10,487.07	
(1)-2	Tractor shovel 988B	hr	40.00	137.31	5,492.40	
(1)-3	Dump truck 769B	hr	113.00	108.02	12,206.26	
	Subtotal (1)				28,185.73	
	(Subtotal (1)/19,600)				1.44	
(2).Fuel & Lubricant						
(2)-1	Fuel	liter	19,639.00	0.40	7,855.60	
(2)-2	Lubricant	(2)-1*20%			1,571.12	
	Subtotal (2)				9,426.72	
	(Subtotal (2)/19,600)				0.48	
(3).Labour						
(3)-1	Foreman	hr	22.00	10.01	220.22	
(3)-2	Ganger	hr	86.00	4.81	413.66	
(3)-3	Operator (Equipment)	hr	274.00	4.81	1,317.94	
(3)-4	Ditto ,Assistant	hr	121.00	3.44	416.24	
(3)-5	General labour	hr	242.00	2.48	600.16	
	Subtotal (3)				2,968.22	
	(Subtotal (3)/19,600)				0.15	
(4).General Overhead (1)to(3)*35%					0.72	
	Total				2.79	

15.Foundation Treatment (per m2)						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Material						
(1)-1	Concrete	m3	4.50	94.86	426.87	
(2).Equipment						
(2)-1	Truck mixer	hr	1.00	21.15	21.15	
(2)-2	Allowance	(2)-1*5%			1.06	
	Subtotal (2)				22.21	
(3).Labour						
(3)-1	Foreman	hr	0.10	10.01	1.00	
(3)-2	Ganger	hr	0.50	4.81	2.41	
(3)-3	Concretor	hr	0.20	3.58	0.72	
(3)-4	General labour	hr	2.00	2.48	4.96	
	Subtotal (3)				9.09	
(4).Subtotal	(1)+(2)+(3)				458.17	
(5).Subtotal	(4)/4.5 m3 * 5 %				5.09	
(6).General	Overhead (5)* 35 %				1.78	
	Total				6.87	

17.Tunnel excavation -1						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
1. Upper half						
(1). Equipment (V=94,600m3)						
(1)-1	Tractor shovel 915H 185HP	hr	415.00	81.62	33,872.30	
(1)-2	Bulldozor D8 300HP	hr	415.00	86.67	35,968.05	
(1)-3	Dump truck 769B 415HP	hr	2,956.00	108.02	319,307.12	
	Subtotal (1)				389,147.47	
	(Subtotal (1)/94,600)				4.11	
(2).Fuel & Lubricant						
(2)-1	Fuel	liter	285,603.00	0.40	114,241.20	
(2)-2	Lubricant	(4)-1*20%			22,848.24	
	Subtotal (2)				137,089.44	
	(Subtotal (2)/94,600)				1.45	
(3).Drilling equipment (V=468m3)						
(3)-1	Jumbo drill	hr	6.77	990.99	6,709.00	
(3)-2	Allowance	((3)-1+(3)-2)*5%			335.45	
	Subtotal (3)				7,044.45	
	(Subtotal (3)/468)				15.05	
(4).Other equipment (1 day)						
(4)-1	Blower	day	1.00	167.72	167.72	
(4)-2	Water pump	day	1.00	10.01	10.01	
	Subtotal (4)				177.73	
	(Subtotal (4)/468)				0.38	
(5).Electricity						
(5)-1	Pump , Blower & Lighting	day	4,479.25	0.20	895.85	
	Subtotal (5)				895.85	
	(Subtotal (5)/468)				1.91	

17.Tunnel excavation -2						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(6).Labour						
(6)-1	Foreman	hr	208.00	10.01	2,082.08	
(6)-2	Ganger	hr	830.00	4.81	3,992.30	
(6)-3	Crawler operator	hr	1,395.00	5.23	7,295.85	
(6)-4	Ditto ,Assistant	hr	697.00	3.03	2,111.91	
(6)-5	Operator (Equipment)	hr	3,786.00	4.81	18,210.66	
(6)-6	Ditto ,Assistant	hr	1,245.00	3.44	4,282.80	
(6)-7	General labour	hr	830.00	2.48	2,058.40	
	Subtotal (6)				40,034.00	
	(Subtotal (6)/94,600)				0.42	
	Upper half total				23.32	
2. Lower half (V=94,600m3)						
(1). Equipment						
(1)-1	Tractor shovel 915H	hr	415.00	81.62	33,872.30	
(1)-2	Bulldozor D8	hr	415.00	86.67	35,968.05	
(1)-3	Dump truck 769B	hr	2,956.00	108.02	319,307.12	
	Subtotal (1)				389,147.47	
	(Subtotal (1)/94,600)				4.11	
(2).Fuel & Lubricant						
(2)-1	Fuel	liter	285,603.00	0.40	114,241.20	
(2)-2	Lubricant	(4)-1*20%			22,848.24	
	Subtotal (2)				137,089.44	
	(Subtotal (2)/94,600)				1.45	
(3).Drilling equipment (V=468m3)						
(3)-1	Jumbo drill	hr	4.40	990.99	4,360.36	
(3)-2	Allowance	((3)-1+(3)-2)*2%			87.21	
	Subtotal (3)				4,447.57	
	(Subtotal (3)/468)				9.50	

17.Tunnel excavation -3						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(4).Other equipment (1 day)						
(4)-1	Blower	day	1.00	167.72	167.72	
(4)-2	Water pump	day	1.00	10.01	10.01	
	Subtotal (4)				177.73	
	(Subtotal (4)/468)				0.38	
(5).Electricity						
(5)-1	Pump , Blower & Lighting	day	4,479.25	0.20	895.85	
	Subtotal (5)				895.85	
	(Subtotal (5)/468)				1.91	
(6).Labour						
(6)-1	Foreman	hr	208.00	10.01	2,082.08	
(6)-2	Ganger	hr	830.00	4.81	3,992.30	
(6)-3	Crawler operator	hr	889.00	5.23	4,649.47	
(6)-4	Ditto ,Assistant	hr	445.00	3.03	1,348.35	
(6)-5	Operator (Equipment)	hr	3,786.00	4.81	18,210.66	
(6)-6	Ditto ,Assistant	hr	1,245.00	3.44	4,282.80	
(6)-7	General labour	hr	830.00	2.48	2,058.40	
	Subtotal (6)				36,624.06	
	(Subtotal (6)/94,600)				0.39	
	Lower half total				17.74	
3. Total of(Upper half + Lower half)*1/2						
	= (23.32 + 17.74) *1/2 =				20.53	
4. Blasting materials						
4-(1)	Dynamite	kg	702.00	14.08	9,884.16	
4-(2)	Detonator	No	287.00	1.70	487.90	
	Subtotal 3				10372.06	
	(Subtotal 3/468)				22.16	
5. Allowance (3.+ 4.)*2%					0.85	
6. General Overhead (3.+ 4.+ 5.)*35%					15.24	
	TOTAL				58.78	

18.Rock bolt

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Material						
(1)-1	Rock bolt	ton	0.00398	946.05	3.77	
(2).Equipment (per 1 m)						
(2)-1	Crawler drill	hr	0.066	31.17	2.06	
(2)-2	Compressor 7.5m3/min	hr	0.066	8.45	0.56	
	Subtotal (2)				2.62	
(3).Labour						
(3)-1	Foreman	hr	0.017	10.01	0.17	
(3)-2	Ganger	hr	0.066	4.81	0.32	
(3)-3	Operator (Equipment)	hr	0.066	4.81	0.32	
(3)-4	Ditto ,Assistant	hr	0.066	3.44	0.23	
	Subtotal (3)				1.04	
(4).Fuel & Lubricant						
(4)-1	Fuel	liter	1.042	0.40	0.42	
(4)-2	Lubricant	(4)-1*20%			0.08	
	Subtotal (4)				0.50	
(5).Allowance	(1)to(4)*2%				0.16	
(6).General overhead	(1)to(5)*35%				2.83	
	Total (per 1.0 m)				10.92	
	Total (per 1.0 ton)				2,744.20	

19.Concrete, open

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1) Materials						
(1)-1	Concrete	m3	1.00	94.86	94.86	
(1)-2	Formwork	m2	0.55	12.77	7.02	
	Subtotal (1)				101.88	
(2).Equipment	30m3/hr					
(2)-1	Truck mixer (4.5m3)	hr	3.33	21.15	70.43	
(2)-2	Concrete pump 60m3/hr	hr	1.00	66.05	66.05	
(2)-3	Truck crane (25t)	hr	0.50	57.81	28.91	
(2)-4	Allowance	((2)-1+(2)-2)*5%			6.82	
	Subtotal (2)				172.21	
	(Subtotal (2)/30)				5.74	
(3).Labour						
(3)-1	Foreman	hr	0.20	10.01	2.00	
(3)-2	Ganger	hr	1.00	4.81	4.81	
(3)-3	Concrete and concrete vibrator	hr	5.00	3.58	17.90	
(3)-4	General labour	hr	3.00	2.48	7.44	
(3)-5	Mechanician	hr	0.20	5.23	1.05	
(3)-6	Electrician	hr	0.20	5.23	1.05	
(3)-7	Operator	hr	3.33	4.81	16.02	
(3)-8	Operator (Crane)	hr	0.50	6.19	3.10	
	Subtotal (3)				53.37	
	(Subtotal (3)/30)				1.78	
(4).Fuel & Lubricant						
(4)-1	Fuel	liter	248.40	0.40	99.36	
(4)-2	Lubricant	(4)-1*20%			19.87	
	Subtotal (4)				119.23	
	(Subtotal (4)/30)				3.97	
(5).General Overhead	(1)to(4)*35%				39.68	
	Total				153.05	

20.Concrete, tunnel - 1						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials						
(1)-1	Concrete	m3	1.00	94.86	94.86	
(2)-1	Form works	m3	1.00	12.09	12.09	
	Subtotal (1)				106.95	
(2).Equipment (30m3/hr)						
(2)-1	Truck mixer	hr	4.44	21.15	93.91	
(2)-2	Concrete pump	hr	1.00	66.05	66.05	
(2)-3	Truck crane (25t)	hr	0.50	57.81	28.91	
(2)-4	Allowance	((2)-1)to(2)-3)*5%			9.44	
	Subtotal (2)				198.31	
	(Subtotal (2)/30)				6.61	
(3).Other equipment (per 453m3)						
(3)-1	Blower	day	3.00	167.72	503.16	
(3)-2	Water pump	day	3.00	10.01	30.03	
(3)-3	Allowance	((2)-1)to(2)-3)*5%			53.32	
	Subtotal (3)				586.51	
	(Subtotal (3)/453)				1.29	
(4).Fuel & Lubricant						
(4)-1	Fuel	liter	310.64	0.40	124.26	
(4)-2	Lubricant	(4)-1*20%			24.85	
	Subtotal (4)				149.11	
	(Subtotal (4)/30)				4.97	
(5).Electricity						
(5)-1	Pump , Blower & Lighting	kwh	8,868.00	0.20	1,773.60	
	Subtotal (5)				1,773.60	
	(Subtotal (5)/453)				3.92	

20.Concrete, tunnel - 2

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(6).Labour	453m3					
(6)-1	Foreman	hr	15.10	10.01	151.15	
(6)-2	Ganger	hr	15.10	4.81	72.63	
(6)-3	Operator (Equipment)	hr	82.14	4.81	395.09	
(6)-4	Ditto ,Assistant	hr	15.10	3.03	45.75	
(6)-5	Operator (Crane)	hr	3.02	6.19	18.69	
(6)-6	Ditto ,Assistant	hr	7.55	3.44	25.97	
(6)-7	Mechanician	hr	3.02	5.23	15.79	
(6)-8	Electrician	hr	3.02	5.23	15.79	
	Subtotal (6)				740.86	
	(Subtotal (6)/453)				1.64	
(7).General	Overhead (1)to(6)*35%				43.88	
	Total				169.26	

21.Re-bar Works						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials						
(1)-1	Re-bar (site)	ton	1.00	901.00	901.00	
(1)-2	Miscellaneous	kg	4.50	1.40	6.30	
	Subtotal (1)				907.30	
(2).Labour						
(2)-1	Foreman	hr	2.50	10.01	25.03	
(2)-2	Ganger	hr	10.00	4.81	48.10	
(2)-3	Steel bar bender/steel fixer	hr	50.00	3.30	165.00	
(2)-4	Ditto ,Assistant	hr	25.00	3.03	75.75	
(2)-5	General labour	hr	25.00	2.48	62.00	
	Subtotal (2)				375.88	
(3).Miscellaneous Equipment						
(3)-1	Truck with crane	hr	0.50	13.14	6.57	
	Subtotal (3)				6.57	
(4).Allowance (3)*(5%)					0.33	
(5).Subtotal					1,290.08	
(6).General Overhead		Subtotal(5)*35%			451.53	
(7).Subtotal					1,741.61	
(8).Loss (10%)					174.16	
(9).Total unit price					1,915.77	
		Final adjusted			1,920.00	

22.Shotcrete, open						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials (per/m3)						
(1)-1	Cement	ton	0.84	229.98	193.18	Loss rate 40 %
(1)-2	Aggregate	ton	2.66	4.33	11.52	
(1)-3	Admixture	liter	2.10	1.00	2.10	
	Subtotal (1)				206.80	
(2).Equipment (1.5m3/hr)						
(2)-1	Shotcrete gun	hr	1.00	17.85	17.85	
(2)-2	Compressor	hr	1.00	16.67	16.67	
(2)-3	Mixer	hr	1.00	4.82	4.82	
(2)-4	Allowance	((2)-1to(2)-3)*5%			1.97	
	Subtotal (2)				41.31	
	(Subtotal (2)/1.5)				27.54	
(3).Labour						
(3)-1	Foreman	hr	0.25	10.01	2.50	
(3)-2	Ganger	hr	1.00	4.81	4.81	
(3)-3	Shotcrete gun operator	hr	1.00	3.58	3.58	
(3)-4	Ditto ,Assistant	hr	2.00	3.03	6.06	
	Subtotal (3)				16.95	
	(Subtotal (3)/1.5)				11.30	
(4).Fuel & Lubricant						
(4)-1	Fuel	liter	37.40	0.40	14.96	
(4)-2	Lubricant	(4)-1*20%			2.99	
(4)-3	Electricity	kwh	7.50	0.20	1.50	
	Subtotal (4)				19.45	
	(Subtotal (4)/1.5)				12.97	
(5).General Overhead (1)to(4)*35%					90.51	
	Total				349.12	

23.Shotcrete, tunnel						
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials						
(1)-1	Cement	ton	0.90	229.98	206.98	Loss rate 50 %
(1)-2	Aggregate	ton	2.85	4.33	12.34	
(1)-3	Admixture	liter	3.00	1.00	3.00	
	Subtotal (1)				222.32	
(2).Equipment (2m3/hr)						
(2)-1	Shotcrete gun	hr	1.00	11.48	11.48	
(2)-2	Compressor 10m3/min	hr	1.00	8.45	8.45	
(2)-3	Mixer	hr	1.00	4.82	4.82	
(2)-4	Robot	hr	1.00	31.01	31.01	
(2)-5	Allowance	((2)-1to(2)-3)*10%			5.58	
	Subtotal (2)				61.34	
	(Subtotal (2)/2)				30.67	
(3).Labour						
(3)-1	Foreman	hr	0.25	10.01	2.50	
(3)-2	Ganger	hr	1.00	4.81	4.81	
(3)-3	Shotcrete operator (Robot)	hr	2.00	4.81	9.62	
(3)-4	Ditto ,Assistant	hr	2.00	3.03	6.06	
	Subtotal (3)				22.99	
	(Subtotal (3)/12)				11.50	
(4).Fuel & Lubricant						
(4)-1	Fuel	liter	35.20	0.40	14.08	
(4)-2	Lubricant	(4)-1*20%			2.82	
	Subtotal (4)				16.90	
	(Subtotal (4)/2)				8.45	
(5).General Overhead (1)to(4)*35%					95.53	
	Total				368.47	

24.Grouting hole , curtain

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1). Equipment	(3.5m/day)					
(1)-1	Boring machine 5.5kw	day	1.00	57.20	57.20	
(1)-2	Allowance	(1)-1*3%			1.72	
	Subtotal (1)				58.92	
(2).Labour						
(2)-1	Foreman	hr	2.00	10.01	20.02	
(2)-2	Ganger	hr	2.00	4.81	9.62	
(2)-3	Operator (boring machine)	hr	10.00	3.85	38.50	
(2)-4	Ditto ,Assistant	hr	5.00	3.30	16.50	
	Subtotal (2)				84.64	
(3).Electricity						
(3)-1	Electricity	kwh	44.00	0.20	8.80	
(4).Subtotal	(1)+(2)+(3)				152.36	
(5).Subtotal	(per m) (4)/3.5				43.53	
(6).General	Overhead (5)*35%				15.24	
	Total				58.77	

25.Grouting hole , consolidation

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).'Equipment	(per 15m)					
(1)-1	Boring machine 5.5kw	day	1.00	57.20	57.20	
(1)-2	Allowance	(1)-1*5%			2.86	
	Subtotal (1)				60.06	
(2).Labour						
(2)-1	Foreman	hr	2.00	10.01	20.02	
(2)-2	Ganger	hr	2.00	4.81	9.62	
(2)-3	Operator (boring machine)	hr	10.00	3.85	38.50	
(2)-4	Ditto ,Assistant	hr	5.00	3.30	16.50	
	Subtotal (2)				84.64	
(3).Electricity						
(3)-1	Electricity	kwh	55.00	0.20	11.00	
(4).Subtotal	(1)+(2)+(3)				155.70	
(5).Subtotal	(per m) (4)/15				10.38	
(6).General	Overhead (5)*35%				3.63	
	Total				14.01	

26.Cement grouting (per meter)

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Equipment	(240m/day)					
(1)-1	Grouting pump	day	1.00	20.21	20.21	
(1)-2	Grouting mixer	day	1.00	3.11	3.11	
(1)-3	Allowance	((1)-1)+(1)-2)*5%			1.17	
	Subtotal (1)				24.49	
	(Subtotal (1)/240m)				0.10	
(2).Material						
(2)-1	Cement	ton	0.10	229.98	23.00	
(3).Labour						
(3)-1	Foreman	hr	2.00	10.01	20.02	
(3)-2	Ganger	hr	2.00	4.81	9.62	
(3)-3	Operator (grouting machine)	hr	10.00	3.85	38.50	
(3)-4	Ditto ,Assistant	hr	5.00	3.30	16.50	
	Subtotal (3)				84.64	
	(Subtotal (3)/240m)				0.35	
(4).General Overhead	((1)+(2)+(3))*35%				8.21	
	Total				31.66	

27.Steel rib

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)	REMARKS
(1).Materials (per/ton)						
(1)-1	H shape steel	ton	1.00	1,172.00	1,172.00	
(1)-2	Steel lagging etc.	(1)-1*55%			644.60	
	Subtotal (1)				1816.6	
(2).Labour						
(2)-1	Foreman	hr	0.25	10.01	2.50	
(2)-2	Ganger	hr	1.00	4.81	4.81	
(2)-3	Steel erector	hr	3.00	3.30	9.90	
(2)-4	General labour	hr	3.00	2.48	7.44	
	Subtotal (2)				24.65	
(3).Equipment						
(3)-1	Truck crane (25t)	hr	0.10	57.81	5.78	
(3)-2	Truck lorry (11t)	hr	0.20	20.18	4.04	
	Subtotal (3)				9.82	
(4).General Overhead	(1)to(3)*35%				647.87	
	Total				2,498.94	

JICA STUDY TEAM
c/o The New Japan Engineering Consultants, Inc.,
20 - 19, Shimanouchi Ichome, Minami-ku,
Osaka, Japan.

Mr. Th'ng Yong Huat,
Chief Engineer for Hydro Projects,
National Electricity Board,
129, Jalan Bangsar,
Kuala Lumpur,
MALAYSIA.

March 12, 1988

Dear Sir,

Re: Submission of Minutes of Meeting
for the feasibility study for the Lebir Dam Project

We are pleased to submit herewith a copy of the Minutes of Meeting which was held on March 7, 1988 regarding the Interim Report of Feasibility Study for the captioned project prepared by us as a record of the meeting.

Thank you for your kind attention.

Yours faithfully,

Y. Takemura

Yoichi Takemura
Team Leader
JICA STUDY TEAM
for the Lebir Dam Project

MINUTES OF MEETING

ON

INTERIM REPORT

THE FEASIBILITY STUDY FOR THE LEBIR DAM PROJECT

MARCH 7, 1988

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

1. A Technical Committee Meeting has been held at NEB Head Office on March 7, 1988 regarding the Interim Report of Feasibility Study for the Lebir Dam Project which was submitted to the authorities concerned through NEB in February 1988 by Japan International Cooperation Agency (JICA).

2. Parcitipants of the Meeting are as per attached attendance list.

3. The following points have been raised and discussed in the meeting.

1) Results of Seismic Prospecting

No weak zone nor major faults have been found through the seismic prospecting.

Deep weathering at the Saddle Dam No. 1 is a major concern among the results.

In the survey site, the rock is, in general, lightly weathered and fresh.

2) Rocks in Tuff Group

- This type of rock usually contains sulphides which are harmfull to concrete. Therefore, tests should be made when this type of rock was planned to be used for concrete aggregate.

3) Matrix System in Environmental Assessment

- A utilization of the matrix system in the screening process on the environmental items which are not applied to the Interim Report was recommended to e adopted by D.O.E.

4) Environmental Impact Statement by JICA

- The Environmental Impact Statement which was submitted to NEB does not cover medico-ecological aspects being handled by IMR (Institute for Medical Research),except which the statement is the final.

5) Regulation of Generation Discharge

- The reregulating pondage site studied by JICA Team has a limited storage capacity of approx. 1,000,000 m^3 at WL 27 m which corresponds to the tailrace water level at the proposed Lebir Hydro Power Station.

- It is difficult to regulate the generation discharge with this limited storage which is one sixth of the required storage for a complete regulation.

- JICA Team is studying on the flow of the generation discharge towards the downstream area where the pump stations are operated for their use of water by a analytical method. The preliminary result indicates rather levelized flow in these area.

- JICA Team is also studying on the necessity of the establishment of a downstream discharge warning system to make downstream inhabitants up to Kuala Krai take precaution against the generation discharge.

- DID recommended to study a bank erosion problem due to the peak generation discharge.

6) Flood Analysis

- DID pointed out that the contribution of the Dabong Dam to the flood mitigation at the Guillemard Bridge is almost the same extent as the Lebir Dam in the Interim Report. This is somewhat inconsistent with their catchment areas, the former having three times as much as the latter.

- JICA Team commented that the possible reason for that seems due to lesser rainfalls in the Dabong Dam catchment area.

7) Dam Break Analysis

- JKR questioned whether a dam break analysis is necessary or not.

- JICA Team stated that the modern dam construction techniques and the foundations in the Lebir Dam Project would permit to construct very safe dams in this Project. Therefore, such analysis appears unnecessary.

ATTENDANCE LIST

NAME	ASSIGNMENT & FUNCTION	ORGANIZATION
Y. Takemura	Team Leader	JICA Study Team
Y. Tsurumaki	Flood Control	JICA Study Team
R. Kobayashi	Hydrology	JICA Study Team
S. Yamada	Agricultural Eng.	JICA Study Team
M. Kawahara	Geologist	JICA Study Team
A. Muramatsu	Environmental Analyist	JICA Study Team
S. Ogawa	Power Economist	JICA Study Team
T. Kimura	Coordinator	JICA Study Team
S. Shibata		JICA HQ
T. Sugawara		MITI
Th'ng Yong Hua t	Chief Engineer, Hydro Projects.	NEB
Soh Chak Yuen	Senior Planning Eng.	NEB
Lam Sit Chi		NEB
Sanusi Paijan		Water Supply Branch, PWD HQ
V. R. Vijayan		GSD
Chow Weng Sum	Acting Principal Geologist	GSD
Rahmah Tahir		Environmental Control Office, DOE
Lim Teik Keat	Senior Engineer	DID HQ
T. Matsuishi	Colombo Plan Expert	DID

MINUTES OF MEETING
ON
INTERIM REPORT
FOR THE
FEASIBILITY STUDY OF THE LEBIR DAM PROJECT

A Steering Committee Meeting was held on 8 March, 1988 at EPU in Kuala Lumpur, attended by participants listed attached herewith, to discuss the Interim Report for the above project. This Minutes of Meeting is to endorse the proceedings of the meeting.

11 March 1988
Kuala Lumpur.

On behalf of the Econ. Planning Unit Prime Minister's Dept the Government of Malaysia.	On behalf of Japan International Cooperation Agency	On behalf of National Electricity Board.
Leong So Seh Principal Assistant Director, Economic Planning Unit.	Yoichi Takemura Team Leader JICA STUDY TEAM	Th'ng Yong Huat Chief Engineer Hydro Projects.

1. Coordination between Lebir Dam Project Study and Kelantan River Basin Flood Control Master Plan Study.

- Since the Kelantan River Basin Flood Control Master Plan Study is expected to be commenced around April 1988, it is necessary to coordinate the Lebir Dam Project Study with the Master Plan Study.

- Interim results of the Master Plan Study in relation with the Lebir Dam Project are expected to be available around August, 1988. Therefore, the submittal of the draft final report on the Lebir Dam Project Study originally scheduled in August, 1988 should be extended for some three months towards November or December 1988.

2. Briefing to the State Government of Kelantan

- EPU requested JICA Team to brief relevant Kelantan State agencies on the Interim Report and JICA Team agreed to do so.

3. Optimization of Project

- EPU queried on the low cost-benefit ratio of the Project, and asked whether a FIRR analysis would also be undertaken to assess the financial viability of the project. JICA Team explained that the results at this stage are preliminary and steps would be taken to optimize the project through possible reduction of costs. JICA Team also confirmed that FIRR analysis will be carried out.

4. Environmental Impact Statement by JICA

- JICA Team was asked whether the Environmental Impact Statement Report submitted by JICA Team at this stage is the finalised report. JICA Team responded affirmatively except for medico-ecological aspects which would be incorporated later.

5. Potential Relocation Area

- SEPU questioned whether potential relocation areas have been identified or not and whether consideration have been made to relocate affected FELDA and KESEDAR settlers to the future planned land schemes so as to minimise cost.

- JICA Team replied that according to the USM Sub-Study Report, potential areas scattered in and outside of the Lebir River catchment for future development of agriculture were surveyed and their total areas were about 55,000 ha. Among these areas, several small plots south of Gua Musang appear to be suitable for the Lebir riverine settlers while a large area extended in the north of Ciku land scheme area is attractive for the land scheme settlers. The USM report also looked into the possibility of accomodating the FELDA and KESEDAR settlers to the planned land schemes.

6. Potential of Granite used as Construction Material

- GSD questioned JICA Team whether consideration has been made on the use of granite as a potential construction material. JICA Team responded that the Team does not consider granite for the concrete aggregate since the weathered granite layer in the region is estimated to be 25-40 metres deep. JICA Team recommended that volcanic tuff (greenrock) could be used as concrete aggregate. The rock has to be tested for sulphide content.

7. Rainfall distribution Analysis

- JICA stated that the 1983 rainfall distribution pattern was used for the flood mitigation study; from this distribution, the flood volume of Lebir is about the same as that of Sg. Galas even though the latter's drainage basin is 3 times that of Lebir. DID pointed out that for the 1967 floods, the runoff of Sg. Galas was about double that of Sg. Lebir.

8. Field Investigation

- JICA Team explained that at present 22 drilling holes have been made covering 780 metres. It was found that the rock foundation condition is competent to support the project. So far, there is no major fault or weak zone identified. JICA Team reiterated that there is a low probability of defects in the area and the volume of investigation work done by them is sufficient.

9. Comments on the Interim Report

- JICA Team expects to have comments on the Interim Report within two months.

ATTENDANCE LIST

FEASIBILITY STUDY OF THE LEBIR DAM PROJECT

	Government Officials	Agency
1.	Leong So Seh (Chairman)	EPU
2.	Noraini bte Ismail	EPU
3.	Wan Norma Wan Daud	EPU
4.	Abd. Aziz Abd. Rahman	SEPU
5.	Tadatoshi Matsuishi	DID
6.	Lim Teck Keat	DID
7.	Ho Yuen Chuen	DOE
8.	V.R. Vijayan	GSD
9.	Chow Weng Sum	GSD
10.	Soh Chak Yuen	LLN
11.	Th'ng Yong Huat	LLN
12.	Lam Sit Chi	LLN
	JICA Study Team	
13.	T. Sugawara	MITI
14.	S. Shibata	JICA Tokyo
15.	Y. Takemura	JICA Team (Leader)
16.	Y. Tsurumaki	JICA Team
17.	R. Kobayashi	JICA Team
18.	S. Yamada	JICA Team
19.	M. Kawahara	JICA Team
20.	A. Muramatsu	JICA Team
21.	S. Ogawa	JICA Team
22.	T. Kimura	JICA Team

Attachment 1-3

Notes of Discussions

for

Technical Committee Meeting

on

Lebir Dam Project

The meeting was held to explain to and discuss with on the results presented in the Draft Final Report for Lebir Dam Project, the agencies concerned, mostly on the technical aspects, prior to the Steering Committee Meeting to be held at EPU on February 28, 1989.

The meeting commenced at 9.00 am at NEB on February 25, 1989 by the participants listed in the attached attendance list, and adjourned at 11.45 am.

As a memorandum of what have been discussed in the meeting, NEB and JICA Study Team concluded this Note of Discussions.

We the undersigned hereby certify that the contents of the note attached herewith are correct and authentic.

Kuala Lumpur, February 25, 1989.

On behalf of National Electricity Board	On behalf of JICA Study Team
Lim Hui Koon Hydro Projects National Electricity Board	Yoichi Takemura Team Leader JICA Study Team

1. Following the welcoming speech of the chairman, Mr Lim Hui Koon, NEB, Mr Y. Takemura, Team Leader for Lebir Dam Project gave a briefing of the Lebir Dam Project on the development size, flood control effects, inundation area and designs of the major project components such as dams, spillway, waterways and powerhouse.

2. JICA Team further explained on the findings during the course of feasibility grade design, and the benefits derived from the Lebir Dam Project are referred in the monetary terms as follows.

   1) Power Generation

      The benefit of M$64 million/year can be expected from the power generation.

   2) Flood Control

      M$16 million/year (based on the estimate made by Lebir Team from the past records) are kept as a flood control benefit. If calculated based on the figures referred in the Interim Report for Kelantan River Basin - Wide Flood Mitigation Study, M$27 million/year can be expected as a benefit derived from the flood mitigation effect. In the draft final report, JICA Team referred this M$27 million/year for economic evaluation. Because this seems to be more accurate since the figure has been obtained based on the detailed field survey.

   3) Agricultural Irrigation Benefit

      By having the Lebir Dam, the seasonal river flow fluctuations shall be levelized to a certain extent at the downstream area where irrigation pumping stations exist.

      As a nett benefit derived from the stabilized water supply, M$15 million/year can be enumerated.

   4) Potentiality on aquacultural development

      As a secondary benefit arising from the implementation of the project, JICA Team suggested that there are much potentialities on aquacultural development, because the proposed reservoir area is very flat and suitable for such development.

      Furthermore, it was suggested that the industrial development in the downstream area of the Kelantan River, if the flood control was achieved, could produce another secondary benefit.

3. JICA Team explained about the results of economic evaluation referring the figures of EIRR as stated in the report, and the difference of the project cost between the one estimated in the interim stage (M$800 million) and the draft final stage (M$640 million).

4. As the results of the base-line study conducted by USM and the field survey and study made by JICA Team, the JICA Team finally concluded that there are no serious impacts found except for the inundation area of agricultural plantations. For minimizing the impacts, JICA Team proposed and designed the following structures and facilities to be adopted as measures other than relocation measures.

   1) Fish ladder for migrating fish species.

   2) Reregulating pondage for regulating the peak generation discharge and supplying the minimum discharge to the downstream course of the Lebir River.

   3) Discharge warning systems to let the inhabitants know the water release from the powerhouse and the spillway.

5. Detail discussions on the technical aspects:-

   1) DOE raised the questions and replied by JICA Team:

   i. Whether the agricultural, logging and mining losses were considered for compensation or not?

   - JICA Team explained about the basic concept on the compensation considered for the agricultural plantation, i.e. only to compensate the development cost for the relocated plantation area to ensure continuous productions. However, no compensation on the logging loss is considered because valuable timbers will be logged prior to the impoundment. JICA Team agreed, however, to consider certain compensation for loss on the future opportunity for logging.

   - For mining loss, no compensation is considered. However, should the valuable mineral deposit be found to exist during the future stages the extraction of such deposit should be considered taking priority of the implementation of the Project.

   ii. What kind of arrangement or measures have been considered for management of catchment area?

- JICA Team suggested that the preservation of the forest around the reservoir area is a significant measure to protect shoreline erosion of the reservoir and to minimize the production of sediment materials in the basin. And the necessity of water quality monitoring was emphasized following determination of the responsible agency to handle these matters.

iii. Is the relocation plan included in the report?

- JICA Team replied that these plans should be prepared in the next stage, however, the decision on the implementation of the project should precede.

iv. Are there any plans of abandonment of the project?

- JICA Team and NEB jointly explained that no such abandonment can be expected because the plant will be operated forever at the maximum extent by rehabilitating when required.

  DOE asked, however, to comment these in the final report.

2) DID expressed their comments on the draft final report;

- DID has no major points on the method and figures adopted for the Lebir Project since most of the figures referred in the report is consistent with the figures reported in the Kelantan River Basin - Wide Flood Mitigation Study even though the agricultural benefit seems rather optimistic and also DID expressed his intention to share a part of the project cost for the multi-purpose scheme.

3) JKR raised a question on the impact caused by the power generation discharge on bank erosion in the downstream course of the river.

- JICA Team explained that no major impact on the river bank erosion is expected according to the river flow analysis although the minor erosion may occur in the limited area, just downstream of the dam site.

4) GSD raised the following questions and suggestions.

i. GSD suggested to mention about the mineral potentiality in the Summary of the Report.

ii. GSD raised the question whether the occurrence of reservoir-induced-earthquake was considered in the dam design or not.

- JICA Team replied that it has been considered.

iii. GSD further asked about the location of the Lebir Fault.

- JICA Team replied that the Lebir Fault is located outside the reservoir area. Even thought the topography shows the potential existence of fault zone near the project area, as the result of field reconnaissance by JICA's Geologist, no outcrops of such fault zone were found in the reservoir area.

iv. GSD raised the question on the alkaline-silical reaction of the aggregate.

- JICA Team replied th
at no alkaline silical
reaction is expected to occur according to the judgement of JICA's Geologist, however, it is recommended to carry out the laboratory test during the detailed design stage.

5. JICA Team stressed the necessity of renewal of aerophoto map covering the reservoir area in order to measure the accurate inundation area and for other planning purposes, and it should be prepared in the detailed design stage.

NEB understood that it would be essential to the determination of compensation area and the planning of the relocation road.

The meeting was closed at 11.45 am.

February 25, 1989

Technical Committee Meeting

ATTENDANCE LIST

No.	Name	Position	Department	
1.	Y. Takemura	Team Leader	JICA	
2.	R. Kebayashi	Hydrologist	JICA	
3.	M. Doi	Civil	"	
4.	S. Ogawa	Economic Analysis	JICA	
5.	Y. Kawakami	Ele. Mech. Eng.	JICA	
6.	T. Kimura	Coordinator	"	
7.	Chow Weng Sum	Geologist	Geological Survey Dgpt.	
8.	Nordin Abu Bakar	Civil Engineer	Ibu Pejabat JKR (Bekalan Air)	
9.	Lim Teik Keat	Engineer	JPT	
10.	Lim Hui Koon	"	LLN	
11.	Lam Sit Chi	"	LLN	
12.	Omar Md. Zain	ENV. Control Officer.	DOE	

MINUTES OF MEETING
ON
DRAFT FINAL REPORT
FOR THE
FEASIBILITY STUDY OF THE LEBIR DAM PROJECT

A Steering Committee Meeting was held on 28 February 1989 at EPU in Kuala Lumpur, attended by participants listed on Appendix A, to discuss the Draft Final Report of the above-stated project. These minutes of meeting record the proceedings of the meeting.

1 March 1989
Kuala Lumpur

Economic Planning Unit
Prime Minister's Dept.

.....
(Sit Hadaar Ismail)
Director, Energy Division

Japan International
Cooperation Agency

.....
(Yoichi Takemura)
JICA Study Team Leader

National Electricity Board
(Project Executing Agency)

.....
(Th'ng Yong Huat)
Chief Engineer (Hydro Projects)

Lebir Dam Project Feasibility Report

Minutes of Joint Meeting Between the Steering Committee and JICA Study Team

1. Briefing to Steering Committee

The JICA Study Team briefed the meeting on the findings of the study as contained in the Draft Final Report. The aspects touched on included the optimisation of Lebir dam, changes in design and cost estimates, and the economic evaluation of the proposed project.

The project with an investment cost of M$640 million will provide significant power generation, irrigation and flood mitigation benefits. The major significant impacts are the flooding of 10,000 ha of agricultural plantation and the displacement of 4,700 inhabitants from 775 families.

Viewed solely as a power project, Lebir is assessed to be sub-economic (EIRR = 6%). However taking into agricultural and flood mitigation benefits, the rate of return is considered to be satisfactory (EIRR = 11%). If the decision to proceed is made in 1989, then the project can be completed by 1998.

2. Other Briefings and Discussions

The meeting noted that the JICA Study Team briefed the Kelantan SEPU on 20 February 1989. It was also reported that the Technical Committee deliberated on the technical and environmental aspects of the report on 25 February 1989.

3. Request by Kelantan SEPU

Kelantan SEPU suggested that the project study report should include a plan for resettlement of displaced inhabitants. It was noted that this matter is outside the scope of works. However it was pointed out that the USM socio-economic study did identify possible resettlement areas.

The JICA Study Team also clarified that the Lebir reservoir could provide some potential for aquaculture development. If developed, this industry could be expected to support the livelihood of an appreciable number of displaced inhabitants.

4. Other Technical Aspects

The following technical aspects were also briefly discussed by the Steering Committee:-

a) The need for a detailed Environmental Impact Statement (EIS) was requested by DOE if the project were to proceed. The meeting agreed that this matter would be reviewed at the appropriate time.

(b) The State Government of Kelantan was requested to initiate action on further mineralogical exploration in order to determine the extent of mineral resources.

(c) The method of economic evaluation could be made more equitable by comparison with both combined cycle and gas turbine plants instead of only combined cycle plant.

(d) The meeting noted that Lebir as a multipurpose project should be reviewed together with the Masterplan Study for Flood Mitigation currently under study and scheduled for completion later this year.

5. Steering Committee's Conclusions

In the review of the Draft Final Report of the Lebir Dam Project, the Steering Committee reached the following conclusions:-

(a) The JICA Study Team was requested to consider the comments and incorporate agencies' suggestions into the final Feasibility Report,

(b) It was noted that the JICA Study Team has complied with study requirements as detailed in the Scope of Works document,

(c) The study findings were noted, and it was clarified that more detailed reviews would be made after the completion of the Kelantan River Basin-Wide Flood Mitigation Study, and

(d) It was noted that the final Feasibility Report is scheduled to be submitted in March 1989.

6. Acknowledgements

The Steering Committee gratefully acknowledges the technical assistance given by JICA and the Study Team in the fulfillment of the Lebir project study.

Appendix A. Attendance List
Lebir Steering Committee Meeting
on 28 February 1989

Malaysian Government Representatives		Agency
1.	Siti Hadzar Ismail (Chairperson)	EPU
2.	Leong So-Seh	EPU
3.	Mohd. Yazi Mohd. Zin	EPU
4.	Wan Norma Wan Daud	EPU
5.	Abdul Aziz Abdul Rahim	SEPU
6.	Ishak Manaf	KTTP
7.	Th'ng Yong Huat	LLN
8.	Lim Hui Koon	LLN
9.	Lam Sit Chi	LLN
10.	Lim Teik Kiat	DID
11.	Chow Weng Sum	GSD
12.	Omar Md. Zain	DOE

JICA Representatives/Study Team		
13.	Yoichi Takemura	Team Leader
14.	Hirofumi Ohnishi	Japanese Embassy
15.	Yoshiyuki Kita	JICA Tokyo
16.	Keizo Kagawa	JICA KL
17.	Moboyuki Doi	Study Team
18.	Rokuro Kobayashi	Study Team
19.	Yukio Kawakami	Study Team
20.	Shuhei Ogawa	Study Team
21.	Tomokazu Kimura	Coordinator

Attachment 13-1

Explanatory Demonstration of Project Cost Allocation

1. There are several methods which have been proposed in various countries for the allocation of a project cost among beneficiary sectors which are participating in a multi-purpose project, as mentioned below:

   - Benefits Method
   - Justifiable Expenditure Method
   - Alternative Expenditure Method
   - Alternative Justifiable Expenditure Method
   - Modified AJEM in consideration of Priority of Development
   - Modified AJEM in consideration of Priority of Usage
   - Separable Cost Remaining Benefit Method
   - Equal Charge Method
   - Individual Project Cost Method
   - Main Developer Burdening Method

   Each method has advantages and disadvantages involving assumptions, but none of them is considered to be perfect. It is rather more important to select one which may fit the situation of a country and make participants easily agree.

2. The following demonstration is a preliminary indication of a cost allocation of the Lebir dam project which has been made by applying Alternative Justifiable Expenditure Method.

   (1) Total Project Cost and Cost for Common Facilities

   Referring to Section 13.3.3 Estimated Cost by Purpose, the total project cost is divided into the following three categories:

	10^6M$
- Dam	238.9
- Power	262.2
- Environment	139.0
Total	640.1

Whereas the category of Power is the specific cost for the power generation facilities, the categories Dam and Environment can be considered to be the cost for the common facilities of the power sector, the flood mitigation sector and the agriculture irrigation sector. The purpose of the cost allocation here is to allocate the cost for the common facilities among the participants, while the costs for the individual facilities should be born by each individual sector.

(2) Alternative Project Cost

The alternative project cost is understood to be a project cost for an alternative scheme which is assumingly worked out should each sector desire to develop a project to produce the same benefit individually.

As for the power sector, the alternative scheme is assumed to be the same one as present, although there is a possibility that a slightly lower dam than the present one can be worked out if a different design of the spillway is employed.

The alternative scheme for the flood sector was selected as a dam with the crest elevation of 80 m, while no alternative scheme was considered for the irrigation sector.

(3) Justifiable Expenditure

The justifiable expenditure in each sector is obtained by the following formula:

$$J.E. = \frac{\text{Annual Benefit} - \text{Annual Cost}}{\text{Capital Recovery Ratio } (1 + \text{Interest during construction})}$$

The capital recovery ratio is computed by the following formula:

For Flood and Irrigation Sector:

$$C.R.R. = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where, i = interest rate
n = project life (year)

For Power Sector:

$$C.R.R. = \frac{i(1+i)^n}{(1+i)^n - 1}\left[1 - \frac{B}{(1+i)^n}\right]$$

where, i = interest rate
n = project life (year)
B = residual value rate

The following inputs are used to compute C.R.R.:

Sector	i	n	B	C.R.R.
Power	0.08	50	0.1	0.0816
Flood	0.045	80	-	0.0464
Irrigation	0.045	50	-	0.0506

The justifiable expenditure of each sector is computed in the following table.

Sector	Annual Benefit 10^6M$	Annual Cost 10^6M$	J.E. 10^6M$
Power	63.8	1.5	658.2
Flood	16.1	0.7	331.9
Irrigation	15.0	0	296.4

Interests during construction are assumed as follow.

	Interest rate
Power	0.4 x i x T = 0.4 x 0.08 x 5 = 0.16
Flood	0
Irrigation	0

(4) Specific Cost for Individual Facilities

As mentioned above the specific cost for individual facilities of the power sector was estimated to be M$262.2 million, whereas that for the flood sector is estimated to be nil and that for the irrigation sector was excluded from the consideration because this had been already taken into account when the net benefit of the irrigation scheme was computed.

(5) Result of Cost Allocation

In accordance with the procedures outlined above and described in the attached table, the following result of the cost allocation of the Lebir dam project has been derived:

Sector	Allocated Cost	
		10^6M$
Power	414.9	(64.8 %)
Flood	105.4	(16.5 %)
Irrigation	119.8	(18.7 %)
Total	640.1	(100 %)

It should be noted that this result is merely a preliminary demonstration, for reference purpose, based on various assumptions used. Further precise study and investigation should be made for discussions on implementation basis.

Note: In preparation of this Attachment 13-1, the reference has been made to the article "Cost Allocation" written by Takamura Suzuki in the Hydro Power No.2 February 1953 published by the Association of Hydro Power Engineering of Japan.

TABLE OF COST ALLOCATION

Item	Unit	Power	Flood	Irrigation	Total
(a) Alternative Project Cost	10^6M$	640.1	260.4 (1)	-	-
(b) Justifiable Expenditure	10^6M$	658.2	331.9	296.4	1,286.5
(c) (a) or (b) whichever smaller	10^6M$	640.1	260.4	296.4	1,196.9
(d) Specific Cost for Individual Facilities (c) - (d)	10^6M$	262.2	0	-	-
(e) Possible Maximum Expenditure for Common Facilities	10^6M$	377.9	260.4	296.4	934.7
(f) Ratio of (e) to the total	%	40.4	27.9	31.7	100.0
(g) Allocation of Cost for Common Facilities	10^6M$	152.7	105.4	119.8	377.9
(h) Allocation of Project Cost (d) + (g)	10^6M$	414.9	105.4	119.8	640.1

(1) estimated cost for a dam with the crest height of EL.80 m

Attachment 14-1

Explanatory Note on the adapted Economic Evaluation Method

1. Basic Concept

The basic concept of the adopted method is based on the following requirements:

(1) The power demand in the entire power system increases continuously,

(2) A long term power development program covering at least 10 years period must be established. The program should be established by optimizing several alternative programs which should include various physically feasible power projects and cover various commissioning years in such a manner that the entire power system on the basis of well defined program would be operated in a most efficient and economical way. In other words, a system-wide approach should be adopted,

(3) The economic evaluation of particular projects should not be made on the basis of a comparison with another alternative project, but on a group basis, which should include various possible projects and various commissioning years.

2. Proposed Simplified Method

If the above procedure which involves detail studies for establishing the power development program of the country and economic evaluation of power projects in the context of the system-wide power requirements is applied, the required work becomes very complicated and enormous in volume. Such an approach is not found to be either suitable or appropriate for the purposes of a feasibility study of particular projects. In consideration of this, and keeping the foregoing basic concept in mind, a somewhat different simplified method is proposed and introduced for this Study, as briefly described below.

The basic assumptions of the simplified method are as shown below.

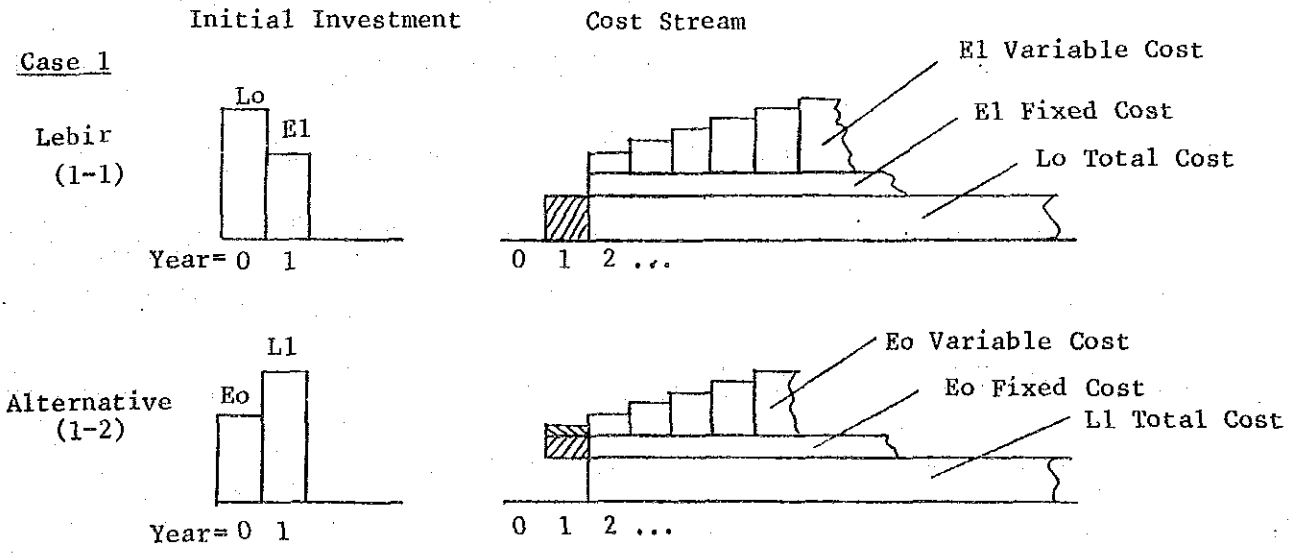
(1) It is assumed that the power demand in the NEB power system will increase after 1988/99 by over 300 MW every year,

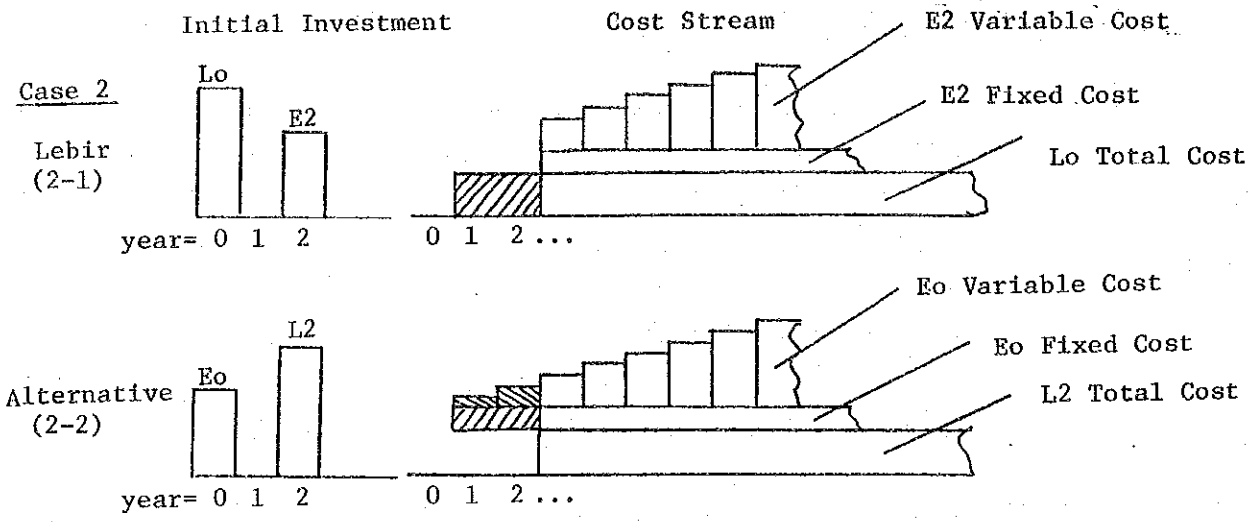
(2) The Lebir Project is considered to be one of the candidate power projects to be developed in the future as required to cope with this continuously increasing power demand. The conceived size of the Lebir Project is in the range of 150 - 300 MW,

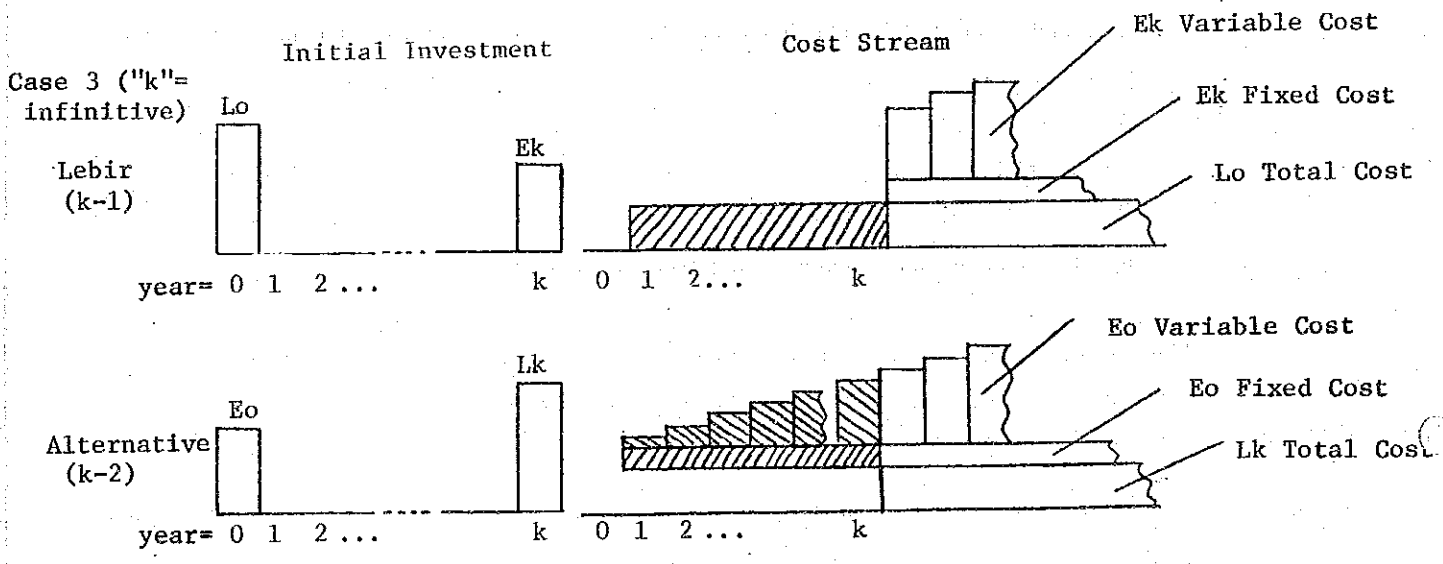
(3) As competitive thermal units against the Lebir Project, the most economical combined cycle and/or gas turbine plants are to be considered,

(4) The purpose of the feasibility study for the Lebir Project is not only to prove the feasibility of the implementation of the project, but also the time of the implementation, i.e., to determine the most appropriate economical year for the commissioning of the project as compared with other projects. The above means that the Lebir Project will continue to be considered a candidate until its implementation.

Illustrated below are some schematic patterns of cost comparison between the Lebir Project and its Alternatives.




Initial Investment
Cost Stream
E2 Variable Cost
E2 Fixed Cost
Lo Total Cost
Case 2
Lebir
(2-1)
Lo
E2
year= 0 1 2
0 1 2 ...
Eo Variable Cost
Eo Fixed Cost
L2 Total Cost
L2
Alternative
(2-2)
Eo
year= 0 1 2
0 1 2 ...


Initial Investment
Cost Stream
Ek Variable Cost
Ek Fixed Cost
Lo Total Cost
Case 3 ("k"=
infinitive)
Lo
Ek
Lebir
(k-1)
year= 0 1 2 ... k
0 1 2... k
Eo Variable Cost
Eo Fixed Cost
Lk Total Cost
Lk
Eo
Alternative
(k-2)
year= 0 1 2 ... k
0 1 2 ... k

In the above illustration, Lk (k = 0, 1, 2, ...) is the initial investment when the Lebir Project is developed in the k-th year, and Ek (k = 0, 1, 2, ...) is the same for the alternative projects. It can be assumed that both Lk and Ek are constant (Lk = constant and Ek = constant) in case the initial investment is considered on a constant price basis.

The variable costs of alternative projects are considered to be increasing annually due to escalation of fuel costs in real term.

3. Comparison between the Lebir and Alternative Projects

For economic comparison of the Lebir Project and the Alternative Projects, three cases have been developed and considered. These three cases, Case 1, 2 and 3 ("k" = infinitive), are shown in the above illustrations. The above investigated cases were based on the cost stream patterns depicted in the illustrations.

In Case 1, comparison is made between the annual costs of the two projects for the first year. These are the cross-hatched areas in the illustration. The annual costs for the following years are assumed identical, thus, cancelling each other. These are the white areas in the illustration.

In Case 2, the annual costs for the first 2 years are considered. Again, the costs for the following years are assumed to be identical. And, finally, in Case 3 ("k" = infinitive), the annual costs to the k-th year are analyzed and compared. The annual costs after the k-th year are assumed to be identical.

If Cases 1 and 2 are compared, it will be seen that in both cases the annual cost for the Lebir Project remains the same, however, the annual cost for the Alternative Project is increased in Case 2 due to the increased variable costs. This, thus, results in an economic advantage for the Lebir Project.

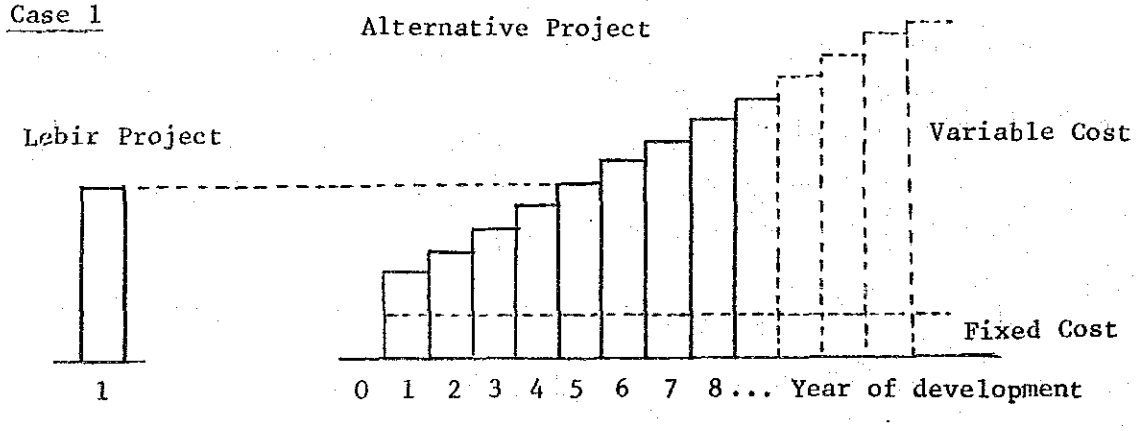
If Case 1 is then compared with Case 3, the annual cost of the alternative for each added year increases drastically as compared to the Lebir Project, so that the economic advantage of the Lebir Project is further significantly increased. As the comparison between the Lebir Project and the Alternative Project, which is most economical, should be made, further comparison in this Study has been made based on Case 1.

When the comparison made on the individual basis, i.e., the Lebir Project is compared with an alternative project without considering the effect of the large scale expending power system, such a comparison, in some special cases, could be quite realistic.

For the above comparison (individual basis), for Case 3, "k" should be assumed infinitive. However, the above approach would be unrealistic if applied to large scale and expanding power systems. The following discussion demonstrates the above point.

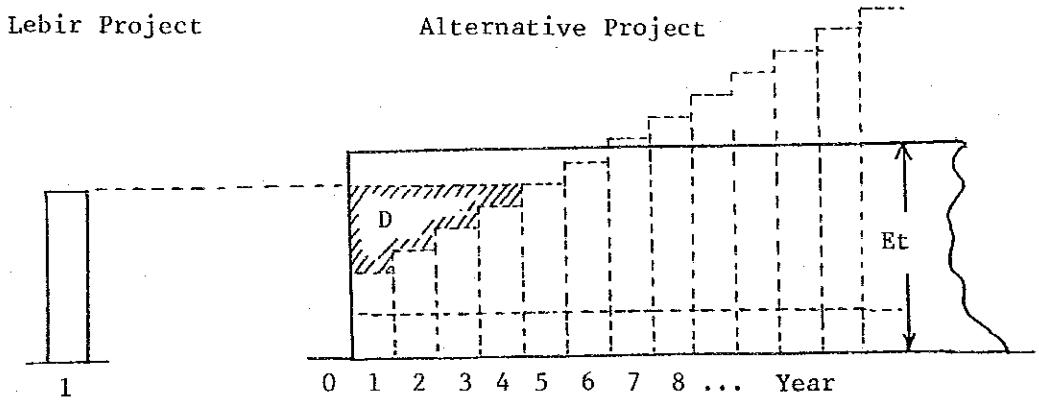
4. Comparison of Cases 1 and 3 (k = infinitive)

In Case 1, the cost comparison between the Lebir Project and the Alternative Project is made on the basis of the annual costs of the 1st year of operation. When the year of development of the Lebir Project is assumed to be variable (uncertain) and the annual costs of the 1st year of operation between the two projects are compared, a schematic diagram of cost comparison can be drawn as shown on the illustration below.



In the illustration above, the 1st year annual cost of the Lebir Project is assumed to be constant regardless of the year of development, whereas that of the Alternative Project is assumed to be increasing year after year. In this Case, even if the Lebir Project is not found to be feasible in the near future, there is still a possibility that it may turn out to be feasible at some time in the far future. This possibility is important and it should not be overlooked.

Case 3 (k = infinitive)



Total Annual Levelized Cost

Total Annual Levelized Cost (Et) through the whole life cycle

In Case 3 (k = infinitive), the total annual levelized cost of the Alternative Project is determined by considering the annual costs extending to the far future (project life time). In this Case, there is a possibility that, even if the Lebir Project is found to be feasible on the basis of the lower total annual levelized cost than that of the Alternative Project, some losses might still be incurred in the earlier years. As indicated in the illustration, the annual costs of the Lebir Project during these early years may be higher than those of the Alternatives. See the cross-hatched area in the illustration. Therefore, this method may likely produce misleading information leading to improper conclusions.

In a case, however, that the 1st year annual cost of the Alternative is higher than that of the Lebir Project at the development year, the conclusion that the Lebir Project could be feasible at that time could be derived by making either comparison, i.e., Case 1 or Case 3. The losses mentioned above in this case may not occur.

It is, therefore, considered that Case 1 is quite reasonable to use for this Study and at this time, and that the above is the main reason why this method has been adopted.

Attachment 14-2

Economic Evaluation of the Lebir Dam Project with Updated Parameters for Alternative Plants

1. Preface

During the discussions of the Draft Final Report on this Study at the meeting of February 1989, the most current information on Gas-turbine (GT) and Combined Cycle (CC) power plants as alternative plants for the Lebir Project was presented by NEB.

For the above reasons, an economic evaluation of this project was made using the new information and as required to determine whether there was any difference or deviation from the previous conclusions. Detail discussion of this evaluation is given below.

2. Updated Parameters for Economic Evaluation of Alternative Plants

The updated parameters for economic evaluation of alternative plants provided by NEB are presented in Table A.

3. Calculation Methods

Fixed cost (M$/kW) for alternative plants of GT and CC were calculated at the discount rates of 6, 8, 10, 12, 14, 18 and 20% which were considered as variable parameters. The above calculations were done for the case of including NOx countermeasure costs, and for the case of excluding them.

After the above, the variable costs (M$/MWh) were calculated accordingly.

The possibility of most economical combination of GT and CC plants as a substitution for the Lebir Project was studied at the discount rate of 10% in order to determine the most suitable alternative plant or combination of plants on the basis of the results of these calculations.

Table-A Updated Parameters for Economic Evaluation of Alternative Plants

Parameters	Alternative Plants		Remarks
	Gas-turbine	Combined Cycle	
Outage (%)	20	12	
Derating (%)	12	8	
Station use* (%)	1*	4*	
Investment (M$/kW)	1081 + 57*	1573 + 57*	+ NOx countermeasure*
Life Cycle (years)	15	20	
Disbursement Schedule (%)	25, 75	10, 15, 35, 40	
Fixed O/M (M$/kW-yr.)	0.96	13.80	
Fuel Price ($M\$x10^{-6}$/Kcal)			
(Yr 1990)	15	15	3.78 M$/MBTU
(Yr 1999)	17.4	17.4	4.385 M$/MBTU
Heat Rate (Kcal/KWh)	3100	2250	
Variable O/M (M$/MWh)	3.0	2.0	

Notes: . NOx countermeasure cost for Combined Cycle plants is based on 3.5% of total investment. The above also applies to Gas-turbine plants.

. Fuel price for the year 1999 is determined on the basis of the assumption of 1% of escalation in real terms per annum between 1990 and 1995, and 2.5% per annum, after 1995.

. Figures with an asterisk are supplied by JICA Team.

Basic economic features of the Lebir Project are as follows:-

- Construction Cost	640.1×10^6 M$
- Output	
Generating-end	240.5 MW
Sending-end	238.6 MW
- Generated energy	
Generating-end	373.3 GWh
Sending-end	372.2 GWh
- Flood control benefit	27.3×10^6 M$/year
- Agricultural incremental benefit	According to economic price

4. Key Calculation Parameters

(1) Fixed Cost (M$/kW-year)

The Fixed Cost calculated for the rate of the sending-end output (MW) is a sum of the Capital Recovery Cost and the Fixed O/M Cost. The calculation results are shown in Table-B, below.

Table-B Fixed Cost (M$/kW-year) of Alternative Plants

Discount Rate (%)	Gas-Turbine Plant			Combined Cycle Plant		
	Capital Recovery Cost	Fixed O/M Cost	Total	Capital Recovery Cost	Fixed O/M Cost	Total
6	162.09 (170.63)	1.38	(172.01)	186.80 (193.57)	17.76	(211.33)
8	184.83 (194.58)	"	(195.96)	222.41 (230.47)	"	(248.23)
10	209.02 (220.04)	"	(221.42)	261.40 (270.88)	"	(288.64)
12	234.56 (246.93)	"	(248.31)	303.65 (314.65)	"	(332.41)
14	261.36 (275.14)	"	(276.52)	349.00 (361.65)	"	(379.41)
16	289.31 (304.57)	"	(305.95)	397.32 (411.72)	"	(429.48)
18	318.33 (335.12)	"	(336.50)	448.49 (464.74)	"	(482.50)
20	348.32 (366.69)	"	(368.07)	502.40 (520.61)	"	(538.37)

Notes: . The above figures in brackets show the cost including NOx countermeasure cost

. Total is equal to: Capital Recovery Cost + Fixed O/M cost

· GT Capital Recovery Cost is equal to: $\text{Investment (M\$/KW)} \times \left[(0.25 \times (1+i) + 0.75) \times \frac{i(1+i)^{15}}{(1+i)^{15}-1}\right] \div k$

· CC Capital Recovery Cost is equal to: $\text{Investment (M\$/KW)} \times \left[(0.10 \times (1+i)^3 + 0.15 \times (1+i)^2 + 0.35 \times (1+i)^1 + 0.40) \times \frac{i(1+i)^{20}}{(1+i)^{20}-1}\right] \div k$

. Fixed O/M Cost is equal to: Fixed O/M (M$/KW-year) ÷ k

. k = (1 - Outage)(1 - Derating)(1 - Station Use)

(2) Variable Cost (M$/MWh)

The Variable Cost calculated for the rate of the sending-end generated energy (MWh) is a sum of the Fuel Cost and the Variable O/M Cost.

The results are as shown below:

Plant	Fuel Cost	Variable O/M Cost	Total
Gas-turbine	54.48	3.00	57.48
Combined Cycle	40.78	2.00	42.78

Note:

Total = [Fuel Price (M$ x 10^{-6}/Kcal) x Heat Rate (Kcal/KWh) x 10^{-3}] ÷ (1 - Station Use) + Variable O/M (M$/MWh)

(3) Total Cost (M$/kW-year)

The Total Cost which is the sum of the Fixed Cost and the Variable Cost is given by the following equations as a function of f (Plant Factor) using a discount rate of 10%.

GT Total Cost = 221.42 + 57.48 x 8.76f (M$/kW-year)
CC Total Cost = 288.64 + 42.78 x 8.76f (M$/kW-year)

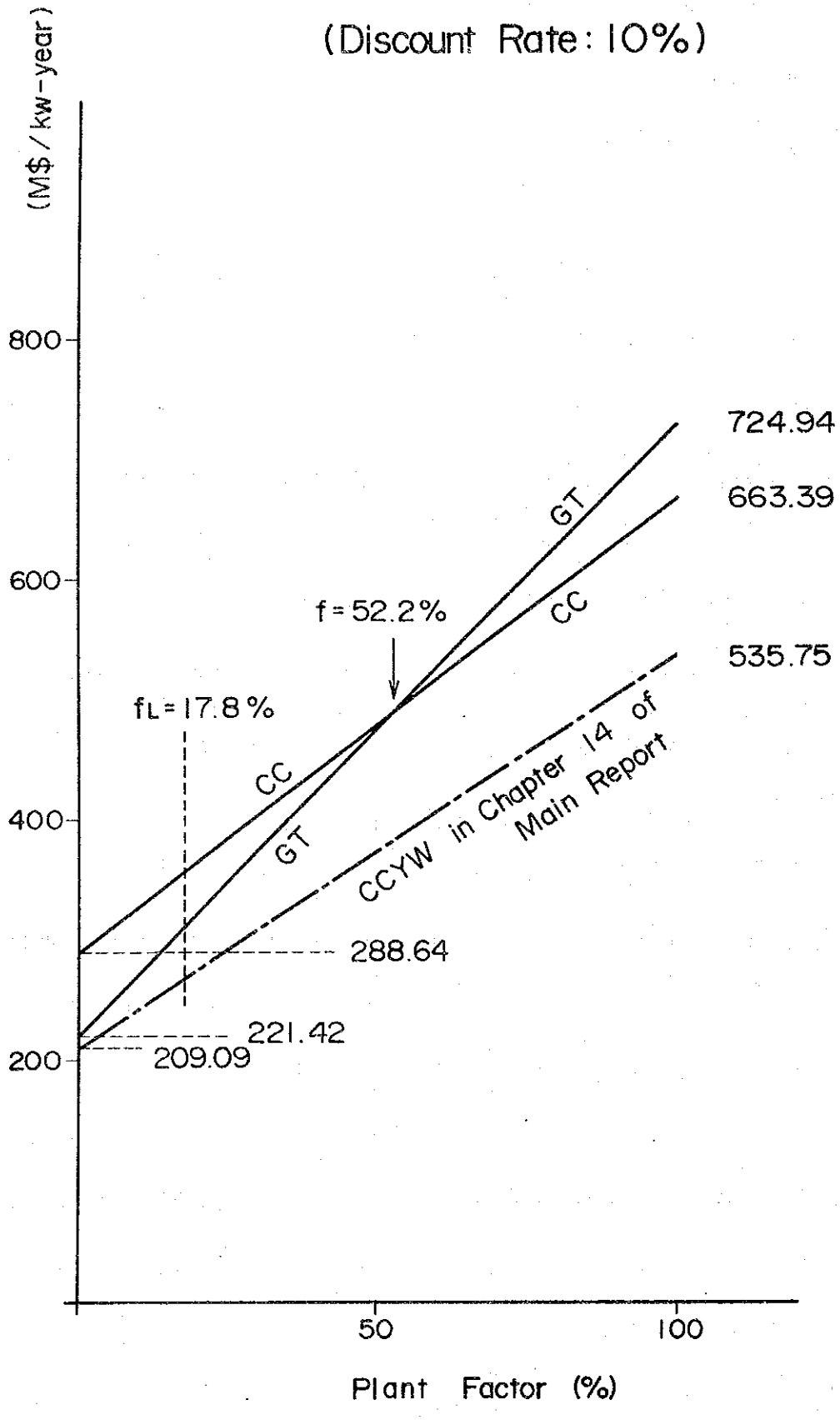
The Plant Factor at which the total GT and CC costs are equal (break-even plant factor) is determined as follows:

$$f = \frac{(288.64 - 221.42)}{(57.48 - 42.78) \times 8.76} = 0.522$$

The results of the calculations are shown in Fig. I.

Fig. I Total Cost (Fixed Cost + Variable Cost)

(Discount Rate : 10%)



(4) Study of Alternative Plants

Total cost of GT and CC alternative plants, alone or in combination with each other, were studied in order to determine the feasibility of substituting the Lebir Project with one of these plants.

The following symbols and input data were used in these studies:

- Lebir Project

Sending-end output	P_L = 238.6 MW
Sending-end generated energy	G_L = 372.2 GWh

- GT

Fixed Cost	F_G = 221.42 M$/kW-year
Variable Cost	V_G = 57.48 M$/MWh

- CC

Fixed Cost	F_C = 288.64 M$/kW-year
Variable Cost	V_C = 42.78 M$/MWh

- Others

Composition ratio of GT	X
Plant Factor of GT	f_G
Yearly hours x 10^{-3}	T = 8.76
Total Cost (10^3M$)	$TC(X, f_G)$

The values of F_G and F_C shown above were obtained at the discount rate of 10%.

The total cost $TC(X, f_G)$ is determined as follows:

$$
\begin{aligned}
TC(X, f_G) &= P_L \cdot X \times F_G + P_L \cdot (1 - X) \times F_C \\
&\quad + P_L \cdot X \cdot T \cdot f_G \times V_G + (G_L - P_L \cdot X \cdot T \cdot f_G) \times V_C \\
&= X \cdot (P_L \cdot F_G - P_L \cdot F_C) + P_L \cdot F_C \\
&\quad + X \cdot f_G(P_L \cdot T \cdot V_G - P_L \cdot T \cdot V_C) + G_L \cdot V_C \\
&= P_L \cdot F_C + G_L \cdot V_C + P_L(F_G - F_C) \cdot X \\
&\quad + P_L \cdot T(V_G - V_C) \cdot X \cdot f_G
\end{aligned}
$$

The Plant Factor (f_L) for the Lebir Project is given by the following formula:

$$f_L = \frac{G_L}{P_L \cdot T}$$

Also, f_G is a function of X, and $f_G(1) = f_L$, if expressed as $f_G(X)$.

If the operation curve of the Lebir Project is approximated by a triangle, $f_G(X)$ can be expressed by the following formula:

$$f_G(X) = f_L \cdot X = \frac{G_L}{P_L \cdot T} \cdot X$$

The following equation is obtained when the above formula is introduced into the expression for $TC(X, f_G)$ given above:

$$\begin{aligned} TC(X, f_G) &= P_L \cdot F_C + G_L \cdot V_C + P_L(F_G - F_C) \cdot X \\ &\quad + P_L \cdot T(V_G - V_C) \cdot X \cdot \frac{G_L}{P_L \cdot T} X \\ &= P_L \cdot F_C + G_L \cdot V_C + P_L(F_G - F_C) \cdot X + (V_G - V_C) \cdot \\ &\quad G_L \cdot X^2 \\ &\equiv TC(X) \end{aligned}$$

The condition of X at which TC(X) will be minimum is derived as follows:

$$\frac{dTC(X)}{dX} = P_L(F_G - F_C) + 2(V_G - V_C) \cdot G_L \cdot X = 0$$

$$X = \frac{P_L(F_C - F_G)}{2(V_G - V_C)G_L}$$

For a 10% discount rate, the following value for X is obtained using the input data given above.

$$X = \frac{238.6(288.64 - 221.42)}{2(57.48 - 42.78) \times 372.2} = 1.47$$

The range of practical existence of X is shown to be as follows:

$$0 \leq X \leq 1.0$$

This means that the above obtained value for X of 1.47 is not within the practical range of existence.

Thus, the condition of X at which TC(X) is minimum within the range of practical existence of X was studied further, as described below.

TC(X) is a quadratic equation as a function of "X", and it is of a U shape. Its value is minimum for X = 1.47. Then, the condition at which TC(X), within the range of practical existence of X, becomes minimum, is for X=1.0.

On the basis of the above, the following equation for TC(X) is obtained by applying the above condition:

$$\begin{aligned} TC(X) &= P_L \cdot F_C + G_L \cdot V_C + P_L(F_G - F_C) + (V_G - V_C) \cdot G_L \\ &= P_L \cdot F_G + G_L \cdot V_G \end{aligned}$$

In case of a discount rate of 10%, the above formula shows, on the basis of the latest information, that a GT plant is the most economical alternative plant to be considered as a substitution of the Lebir Project.

The results of the calculations are shown below.

X	0.0	0.2	0.4	0.6	0.8	1.0
TC(X)	84.79	81.80	79.25	77.14	75.46	74.22

(Unit: 10^6 M$)

According to these results, TC(X) is getting smaller with the increase of X, which is composition ratio of GT, and it takes the minimum value at X = 1.0.

Based on the above studies and calculations, it is found that there is no suitable combination of GT and CC plants which could be considered as an economical substitution for the Lebir Project. The above studies clearly show that a GT plant is the only alternative which can be considered as most economical.

The necessary conditions for the combination of GT and CC plants to become most economical are reviewed further below.

The condition at which TC(X) is minimum is given with the formula:

$$X = \frac{P_L(F_C - F_G)}{2(V_G - V_C)G_L} < 1$$

The break-even plant factor, or the plant factor at which the total GT and CC costs are equal is defined as follows:

$$f = \frac{F_C - F_G}{(V_G - V_C)T}$$

The plant factor for the Lebir Project is given with the following expression:

$$f_L = \frac{GL}{P_L \cdot T}$$

If f and f_L are introduced into the formula for X, the following is obtained:

$$X = \frac{f}{2f_L} < 1$$

$$f_L > \frac{f}{2}$$

The above shows that for the combination alternative of GT and CC to become most economical, the plant factor of the Lebir Project f_L must be larger than the break-even plant factor f.

(5) Total Cost of a GT plant as a substitution for the Lebir Project

The total costs of a GT plant considered as a substitution for the Lebir Project for various discount rates are shown below.

Discount Rate (%)	$P_L \cdot F_G$		$G_L \cdot V_G$	Total	
6	39.00	(41.04)	21.39	60.39	(62.43)
8	44.43	(46.76)	"	65.82	(68.15)
10	50.20	(52.83)	"	71.59	(74.22)
12	56.30	(59.25)	"	77.69	(80.64)
14	62.69	(65.98)	"	84.08	(87.37)
16	69.36	(73.00)	"	90.75	(94.39)
18	76.28	(80.29)	"	97.67	(101.68)
20	83.44	(87.82)	"	104.83	(109.21)

(Unit: 10^6 M$)

The figures in brackets show the cost including NOx countermeasure cost.

(6) Total Cost of the Lebir Project

The total cost of the Lebir Project as calculated and reported in Chapter 14, Volume 1 of the Final Report, is summarized below.

Discount Rate (%)	Fixed Cost	Less Benefit from Flood Control	Less Benefit from Flood Control/Irrigation
6	51.319	24.019	1.288
8	67.675	40.375	21.655
10	86.193	58.893	43.899
12	106.775	79.475	67.949
14	129.426	102.126	93.824
16	154.224	126.924	122.117
18	181.294	153.997	151.555
20	210.806	183.506	183.781

(Unit: 10^6M$)

Notes: - Flood control benefit of 27.3 x 10^6M$.
- Agricultural incremental benefit is calculated at Economic Price.

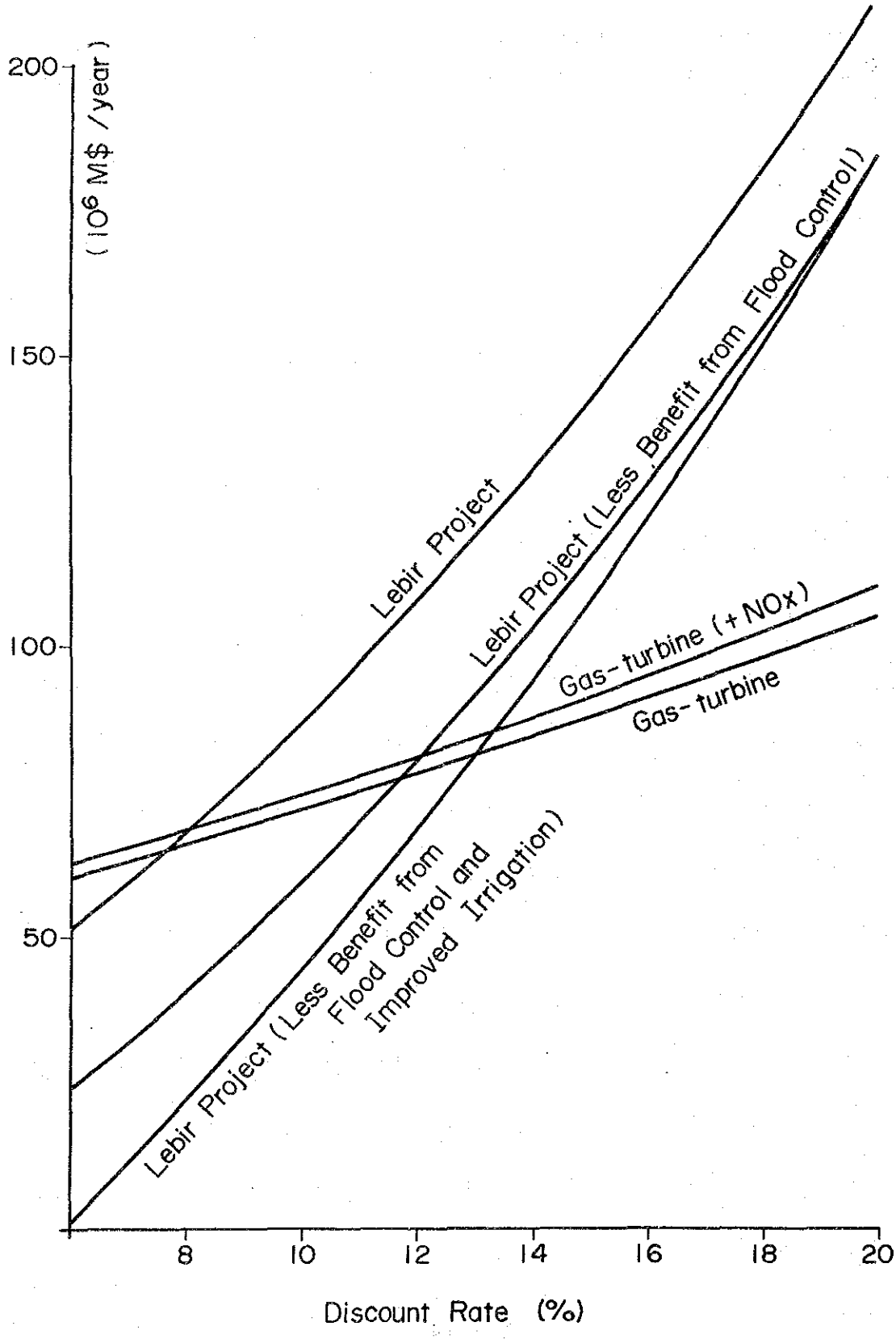
5. EIRR

The results of the studies described in this Section are summarized in Fig. II. From Fig. II, the following values of EIRR are derived:

Item	Gas-turbine without NOx Countermeasure Cost	Gas-turbine with NOx Countermeasure Cost
EIRR for power benefits only	7.7 %	8.1 %
EIRR for power plus flood control benefits	11.8 %	12.2 %
EIRR for power, flood control and agricultural benefits	13.0 %	13.4 %

It is clear from the above that the EIRR is about 8% for power benefits only, about 12% for power plus flood control benefits, and about 13% for power, flood control and agricultural benefits. Furthermore, if NOx countermeasure costs for gas-turbine as alternative plant are considered, the EIRR increases by about 0.4% above the values obtained when no such consideration is made.

Fig. II Annual Levelized Cost



6. Conclusion

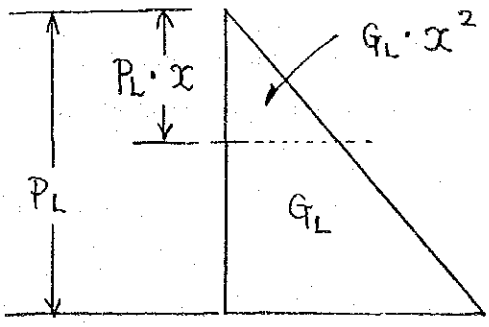
The EIRR is about 8% when the Lebir Project is substituted with a Gas-turbine plant evaluated to be the most economical alternative plant.

The EIRR will be about 12%, an increase of 4%, when the flood control benefits are considered additionally. Furthermore, the EIRR will become about 13%, if the agricultural incremental benefits are added resulting in a 1% further increase.

The previous conclusions with regard to the EIRR, as given in the Draft Final Report and consisting of below 6% for power only, 10.7% for power plus flood, and 12.4% for power, flood and irrigation, should be slightly modified as affected by this updated data, but the basic conclusions remain unchanged.

A supplemental explanation and further details on the plant factor $f_G(X)$, for the GT plant considered as a substitution for the Lebir Project, are given below.

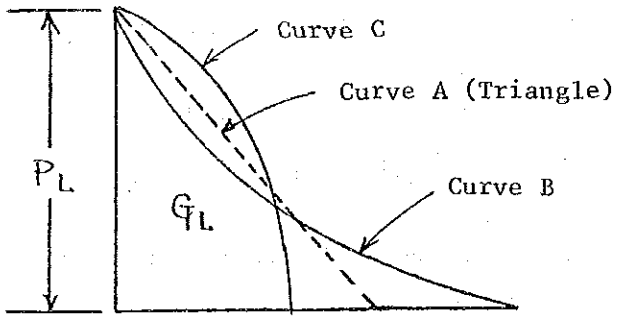
The following equation is derived when the operation curve of the Lebir Project is approximated by a triangle.



$$f_G(X) = \frac{G_L \cdot X^2}{P_L \cdot X \cdot T} = \frac{G_L}{P_L \cdot T} \cdot X = f_L \cdot X$$

However, the operation curve of the Lebir Project can not always be approximated by a triangle.

For instance, the following operation curves can also be assumed.



The operation curve of the Lebir Project will depend on both, the shape of the duration curve for the gross power system demand, and the composition situation of the gross power supply in the total power system of NEB.

The equation for $f_G(X)$ can be expressed as follows:

$$f_G(X) = f_L \cdot X^2 = \frac{G_L}{P_L \cdot T} X^2$$

If the above expression is introduced into the equation for TC(X, f_G), given is Section 4(4) above, the following is derived:

$$TC(X) = P_L \cdot F_C + G_L \cdot V_C + P_L(F_G - F_C) \cdot X + (V_G - V_C)G_L \cdot X^3$$

$$\frac{dTC(X)}{dX} = P_L(F_G - F_C) + 3(V_G - V_C)G_L X^2$$

Thus,

$$X = \sqrt{\frac{P_L(F_C - F_G)}{3(V_G - V_C)G_L}} \doteq 0.99$$

Even in case when $f_G(X) = f_L \cdot X^2$, it is clear from the above that the most economical alternative plant to be considered as a substitution for the Lebir Project is a GT plant.

If $f_G(X)$ is assumed to be equal to $f_L \cdot X$ or $f_L \cdot X^2$, the solutions of $f_G(X)$ for X = 0.7, as a composition ratio of GT, are shown below.

$f_G(X)$	$f_L \cdot X$	$f_L \cdot X^2$
X = 0.7	12.46 %	8.72 %

In the economic evaluation of other projects owned by NEB, there was a case in which $f_G(X) = 10\%$ for X = 0.7.

It is not unusual that f(X) is normally being forecasted to be much smaller in case of insufficiency of peak supply, and much larger in case of superfluous peak supply.

Based on the above, it is concluded that the most suitable alternative plant to be considered as a possible substitution for the Lebir Project is a GT plant under the condition of $f_G(X) = f_L \cdot X^n$ ($n \leq 2$). For these studies, the value of n was assumed to be 1, that is, $f_G(X) = f_L \cdot X$.

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