表 9.4 代替火力kWコストkWhコスト算定

(1) Cost Data of Alternative Thermals

Items		Oil Thermal	Coal Thermal	C-Cycle	Remarks
1. Construction cost	:$/kW	701	973	619	
2. Economic life	:year	20	30	20	
3. Capital recovery factor	for 10%	0.117460	0.106079	0.117460	
4. Fuel cost		22.09	40.18	2.98	
		($/barrel)	($/t)	($/mcf)	
5. Calorific value		1.534E+06	5,500	2.520E+05	
		(kcal/barrel)	(kcal/kg)	(kcal/mcf)	
6. Thermal efficiency	:%	38%	38%	45%	
7. Fixed O&M ratio	:%	3%	5%	3%	: % to construction cost per kW

Source: "Commodity Price Outlook" WB in November 1998 for fuel cost and other data from IOE.

(2) Computation of cost per kW

Items		Oil Thermal	Coal Thermal	C-Cycle
1) Annualized construction cost:	($/kW)	101.3	127.0	89.4
2) Fixed O&M (annual cost):	($/kW)	21.0	48.7	18.6
3) Cost per kW (annual cost)	($/kW)	122.3	175.6	108.0
4) Adjustment factor		1.141	1.262	1.077
5) Cost per kW (after adjusted)	($/kW)	139.6	221.6	116.3

Note for annualized construction cost:
Assumed construction period : 3 years Assumed disbursement: 35%, 45%, 20%

(3) Computation of cost per kWh

Items		Oil Thermal	Coal Thermal	C-Cycle
1) Fuel cost per kWh	($/kWh)	0.033	0.017	0.023
2) Adjustment factor		1.032	1.043	0.990
3) Cost per kWh (after adjusted)	(C/kWh)	3.364	1.725	2.238

(4) Total cost comparison of three alternatives

Items		Oil Thermal	Coal Thermal	C-Cycle
1) kW cost	(US$ mil.)	66.2	105.0	55.1
2) kWh cost	(US$ mil.)	53.1	27.2	35.3
3) Total cost	(US$ mil.)	119.2	132.2	90.4

Note : Capacity and output of Dong Nai Project:
Installed capacity(MW) 474 Annual generation (GWh) 1,577

(5) Computation of Adjustment Coefficients for Losses:

		Oil Thermal	Coal Thermal	C-Cycle	Hydropower
(1) Loss ratios					
1) Transmission and distribution		1.4%	1.4%	1.4%	4.0%
2) Overhaul and maintenance		10.0%	17.7%	8.5%	2.5%
3) Station consumption		6.0%	7.0%	2.0%	0.3%
4) Forced outage		2.5%	2.5%	2.5%	0.5%
(2) Overall operation efficiency (%	kW cost:	81.3%	73.6%	86.2%	92.8%
	kWh cost:	92.7%	91.7%	96.6%	95.7%
(3) Adjustment coefficients for	kW cost:	1.141	1.262	1.077	
	kWh cost:	1.032	1.043	0.990	

表 9.5 長期限界費用計算書

(Base Case computation in the Power Development Master Plan Phase V)

Voltage level	Current cost as of 2010					Current cost as of 2020				
	Total real cost	Capital recovery	Total	Capital recovery + operating cost	Total	Total real cost	Capital recovery	Total	Capital recovery + operating cost	Total
1) Generation up to bus bar	6,927	2,962	2,962	5,166	5,166	12,598	6,024	6,024	10,007	10,007
2) To main bar of 500 kV	1,155	214	3,176	263	5,429	3,403	550	6,574	674	10,681
3) To main bar of 220 kV	2,175	514	3,690	631	6,060	5,678	1,104	7,678	1,355	12,036
4) To main bar of 110 kV	2,110	557	4,247	684	6,744	5,561	1,146	8,824	1,406	13,442
5) To medium voltage	3,048	722	4,969	886	7,630	7,777	1,539	10,363	1,888	15,330
6) To low voltage	656	157	5,126	192	7,822	1,738	336	10,699	412	15,742
Total	16,071	5,126		7,822		36,755	10,699		15,742	

LRMC by voltage	Marginal cost as of 2010						Marginal cost as of 2020					
	Capacity MW	Generation GWh	Losses GWh	Energy Sales GWh	Marginal cost C/kWh	Average basic cost	Capacity MW	Generation GWh	Losses GWh	Energy Sales GWh	Marginal cost C/kWh	Average basic cost
1) Generation up to bus bar	18,978	119,879	4,051	0	4.460	272.2	40,746	256,539	9,085	0	4.044	245.6
2) To main bar of 500,200 k	18,978	115,828	1,003	0	5.274	319.1	40,746	247,455	1,885	0	4.900	295.3
3) To main bar of 110 kV	18,814	114,825	669	12,640	5.900	358.0	40,436	245,570	1,257	27,327	5.499	332.2
4) To medium voltage	16,633	101,518	2,340	59,511	6.932	413.3	35,729	216,986	4,399	128,664	6.500	386.8
5) To low voltage	6,498	39,665	6,487	33,179	8.873	453.0	13,818	83,924	12,191	71,733	8.189	425.1
Total		491,715	14,550	105,330	7.426	419		1,050,474	28,817	227,724	6.913	392

Source: Institute of Energy, EVN

Note: With discount rate of 10%.

表 9.6 經濟的內部收益率計算

(Unit: US$ million)

		Capital costs					Economic benefits				Total benefits		B - C	
					O & M	Total	Case A		Case B		Case A:	Case B:	Case A:	Case B:
No.	Year	F.C.	L.C.	Total	costs	costs	Dong Nai	Tri An	Dong Nai	Tri An	Alt.Therm.	LRMC	Alt.Therm.	LRMC
1	2001	5.1	2.3	7.4		7.4					0.0	0.0	(7.4)	(7.4)
2	2002	6.4	9.2	15.6		15.6					0.0	0.0	(15.6)	(15.6)
3	2003	16.8	22.0	38.8		38.8					0.0	0.0	(38.8)	(38.8)
4	2004	38.3	34.7	73.0		73.0					0.0	0.0	(73.0)	(73.0)
5	2005	68.7	50.5	119.2		119.2					0.0	0.0	(119.2)	(119.2)
6	2006	119.1	59.8	178.9		178.9					0.0	0.0	(178.9)	(178.9)
7	2007	112.5	56.3	168.8		168.8					0.0	0.0	(168.8)	(168.8)
8	2008	27.3	14.2	41.5	2.6	44.1	49.5	1.9	50.3	5.9	51.4	56.2	7.3	12.1
9	2009	3.3	0.4	3.7	5.6	9.3	106.0	1.9	106.5	5.9	107.9	112.4	98.6	103.1
10	2010				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	106.2
11	2011				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
12	2012				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
13	2013				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
14	2014				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
15	2015				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
16	2016				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
17	2017				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
18	2018				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
19	2019				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
20	2020				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
21	2021				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
22	2022				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
23	2023				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
24	2024				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
25	2025				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
26	2026				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
27	2027				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
28	2028				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
29	2029			178.5	6.2	184.7	116.6	1.9	117.1	5.9	118.5	123.0	(66.2)	(61.7)
30	2030				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
31	2031				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
32	2032				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
33	2033				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
34	2034				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
35	2035				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
36	2036				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
37	2037				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
38	2038				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
39	2039				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
40	2040				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
41	2041				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
42	2042				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
43	2043				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
44	2044				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
45	2045				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
46	2046				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
47	2047				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
48	2048			178.5	6.2	184.7	116.6	1.9	117.1	5.9	118.5	123.0	(66.2)	(61.7)
49	2049				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
50	2050				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
51	2051				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
52	2052				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
53	2053				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
54	2054				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
55	2055				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
56	2056				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
57	2057				6.2	6.2	116.6	1.9	117.1	5.9	118.5	123.0	112.3	116.8
58	2058			(124.3)	6.2	(118.1)	116.6	1.9	117.1	5.9	118.5	123.0	236.6	241.1
												EIRR =	13.1%	13.5%

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
O & M: Operation and maintenance costs
Alt.Therm.: Alternative thermal

表 9.7 経済便益の計算

Power station	Dong Nai No.3	Dong Nai No.4	Dong Nai Total	Tri An	Dong Nai + Tri An
(1) Case A (Alternative thermal)					
1) Capacity and annual generation					
90% peak power (MW)	218	256	474	2	476
Total energy					
2008 (GWh/year)	677	0	677	80	757
2009 (GWh/year)	736	698	1434	80	1514
2010 (GWh/year)	736	841	1577	80	1657
2) Unit value of alternative thermal					
Capacity value (US$/kW)	182.3	182.3	182.3	182.3	
Energy value (Usc/kWh)	1.916	1.916	1.916	1.916	
3) Assumption on commissioning					
2008 (%)	92		-	100	
2009 (%)	100	83	-	100	
2010 (%)	100	100	-	100	
4) Annual economic benefit (US$ million)					
2008 Capacity value	36.6		36.6	0.4	36.9
Total energy	13.0		13.0	1.5	14.5
Total benefit	49.5		49.5	1.9	51.4
2009 Capacity value	39.7	38.7	78.5	0.4	78.8
Total energy	14.1	13.4	27.5	1.5	29.0
Total benefit	53.8	52.1	106.0	1.9	107.9
2010 Capacity value	39.7	46.7	86.4	0.4	86.8
Total energy	14.1	16.1	30.2	1.5	31.8
Total benefit	53.8	62.8	116.6	1.9	118.5
(2) Case B (LRMC)					
1) LRMC (USc/kWh)	7.426	7.426	7.426	7.426	
2) Annual economic benefit (US$ million)					
2008 Total benefit	50.3		50.3	5.9	56.2
2009 Total benefit	54.7	51.8	106.5	5.9	112.4
2010 Total benefit	54.7	62.5	117.1	5.9	123.0

Note:
1) Commissioning was assumed as shown 3) above.

表 9.8 財務的內部收益率計算 (1/2)

(Case of USc 4.5 /kWh)

(Unit: US$ million)

No.	Year	Capital costs F.C.	Capital costs L.C.	Capital costs Total	O&M costs	Total costs	Saleable energy (GWh)	Power rate (USc/kWh)	Financial revenue	Resources tax & VAT	Current surplus	B - C
1	2001	5.2	2.7	7.9		7.9						(7.9)
2	2002	6.6	11.8	18.4		18.4						(18.4)
3	2003	17.4	26.8	44.2		44.2						(44.2)
4	2004	40.1	42.4	82.5		82.5						(82.5)
5	2005	72.6	62.3	134.9		134.9						(134.9)
6	2006	124.6	75.7	200.3		200.3						(200.3)
7	2007	119.2	70.0	189.2		189.2						(189.2)
8	2008	28.2	17.4	45.6	2.5	48.1	757	4.5	34.1	4.1	30.0	(18.2)
9	2009	3.6	0.6	4.2	5.4	9.6	1,514	4.5	68.1	8.2	60.0	50.3
10	2010				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
11	2011				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
12	2012				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
13	2013				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
14	2014				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
15	2015				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
16	2016				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
17	2017				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
18	2018				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
19	2019				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
20	2020				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
21	2021				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
22	2022				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
23	2023				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
24	2024				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
25	2025				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
26	2026				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
27	2027				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
28	2028				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
29	2029			169.8	6.0	175.8	1,657	4.5	74.6	8.9	65.6	(110.2)
30	2030				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
31	2031				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
32	2032				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
33	2033				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
34	2034				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
35	2035				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
36	2036				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
37	2037				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
38	2038				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
39	2039				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
40	2040				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
41	2041				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
42	2042				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
43	2043				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
44	2044				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
45	2045				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
46	2046				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
47	2047				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
48	2048			169.8	6.0	175.8	1,657	4.5	74.6	8.9	65.6	(110.2)
49	2049				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
50	2050				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
51	2051				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
52	2052				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
53	2053				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
54	2054				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
55	2055				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
56	2056				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
57	2057				6.0	6.0	1,657	4.5	74.6	8.9	65.6	59.6
58	2058			(120.8)	6.0	(114.8)	1,657	4.5	74.6	8.9	65.6	180.4
									FIRR=			6.5%

Note: 1) Abbreviations:

F.C.: Foreign currency portion

L.C.: Local currency portion

2) Project construction cost excluding Transmission Line cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.8 財務的內部收益率計算 (2/2)

(Case of USc 5.0 /kWh)

(Unit: US$ million)

No.	Year	Capital costs F.C.	Capital costs L.C.	Capital costs Total	O&M costs	Total costs	Saleable energy (GWh)	Power rate (USc/kWh)	Financial revenue	Resources tax & VAT	Current surplus	B - C
1	2001	5.2	2.7	7.9		7.9						(7.9)
2	2002	6.6	11.8	18.4		18.4						(18.4)
3	2003	17.4	26.8	44.2		44.2						(44.2)
4	2004	40.1	42.4	82.5		82.5						(82.5)
5	2005	72.6	62.3	134.9		134.9						(134.9)
6	2006	124.6	75.7	200.3		200.3						(200.3)
7	2007	119.2	70.0	189.2		189.2						(189.2)
8	2008	28.2	17.4	45.6	2.5	48.1	757	5.0	37.9	4.5	33.3	(14.8)
9	2009	3.6	0.6	4.2	5.4	9.6	1,514	5.0	75.7	9.1	66.6	57.0
10	2010				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
11	2011				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
12	2012				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
13	2013				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
14	2014				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
15	2015				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
16	2016				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
17	2017				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
18	2018				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
19	2019				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
20	2020				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
21	2021				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
22	2022				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
23	2023				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
24	2024				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
25	2025				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
26	2026				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
27	2027				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
28	2028				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
29	2029			169.8	6.0	175.8	1,657	5.0	82.9	9.9	72.9	(102.9)
30	2030				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
31	2031				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
32	2032				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
33	2033				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
34	2034				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
35	2035				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
36	2036				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
37	2037				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
38	2038				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
39	2039				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
40	2040				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
41	2041				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
42	2042				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
43	2043				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
44	2044				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
45	2045				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
46	2046				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
47	2047				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
48	2048			169.8	6.0	175.8	1,657	5.0	82.9	9.9	72.9	(102.9)
49	2049				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
50	2050				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
51	2051				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
52	2052				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
53	2053				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
54	2054				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
55	2055				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
56	2056				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
57	2057				6.0	6.0	1,657	5.0	82.9	9.9	72.9	66.9
58	2058			(120.8)	6.0	(114.8)	1,657	5.0	82.9	9.9	72.9	187.7
									FIRR=			7.4%

Note: 1) Abbreviations:

F.C.: Foreign currency portion

L.C.: Local currency portion

2) Project construction cost excluding Transmission Line cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9　プロジェクトローン返済計画検討 (ケース 1-1)

Tariff rate=USc4.5/kWh;FC:LC=85%:15%; FC=3.5% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (85%)	Loans received: Domestic (15%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (3.5%)	Interest payment: Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		6.7	1.2	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		15.6	2.8	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		37.6	6.6	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		70.1	12.4	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		114.7	20.2	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		170.3	30.0	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		160.8	28.4	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	34.1	38.8	6.8	79.7	28.2	17.4	45.6	2.5	723.0				4.1	52.2	27.4	6.9	20.6	20.6	2008
9	2009	68.1	3.6	0.6	72.3	3.6	0.6	4.2	5.4	727.2				8.2	17.8	54.5	13.6	40.9	61.5	2009
10	2010	74.6			74.6				6.0	695.7	31.5	21.7	14.9	8.9	83.1	(8.5)	0.0	(8.5)	53.0	2010
11	2011	74.6			74.6				6.0	664.2	31.5	20.2	11.3	8.9	78.0	(3.5)	0.0	(3.5)	49.5	2011
12	2012	74.6			74.6				6.0	632.7	31.5	19.5	9.9	8.9	75.9	(1.3)	0.0	(1.3)	48.1	2012
13	2013	74.6			74.6				6.0	601.2	31.5	18.7	8.5	8.9	73.8	0.8	0.2	0.6	48.7	2013
14	2014	74.6			74.6				6.0	569.6	31.5	18.0	7.1	8.9	71.6	2.9	0.7	2.2	51.0	2014
15	2015	74.6			74.6				6.0	538.1	31.5	17.3	5.7	8.9	69.5	5.1	1.3	3.8	54.8	2015
16	2016	74.6			74.6				6.0	506.6	31.5	16.6	4.3	8.9	67.3	7.2	1.8	5.4	60.2	2016
17	2017	74.6			74.6				6.0	475.1	31.5	15.9	2.8	8.9	65.2	9.4	2.3	7.0	67.2	2017
18	2018	74.6			74.6				6.0	443.6	31.5	15.1	1.4	8.9	63.1	11.5	2.9	8.6	75.8	2018
19	2019	74.6			74.6				6.0	412.1	31.5	14.4	0.0	8.9	60.9	13.6	3.4	10.2	86.1	2019
20	2020	74.6			74.6				6.0	391.5	20.6	13.7	0.0	8.9	49.3	25.3	6.3	19.0	105.0	2020
21	2021	74.6			74.6				6.0	370.9	20.6	13.0	0.0	8.9	48.6	26.0	6.5	19.5	124.5	2021
22	2022	74.6			74.6				6.0	350.3	20.6	12.3	0.0	8.9	47.9	26.7	6.7	20.0	144.5	2022
23	2023	74.6			74.6				6.0	329.7	20.6	11.5	0.0	8.9	47.1	27.4	6.9	20.6	165.1	2023
24	2024	74.6			74.6				6.0	309.1	20.6	10.8	0.0	8.9	46.4	28.2	7.0	21.1	186.2	2024
25	2025	74.6			74.6				6.0	288.5	20.6	10.1	0.0	8.9	45.7	28.9	7.2	21.7	207.9	2025
26	2026	74.6			74.6				6.0	267.9	20.6	9.4	0.0	8.9	45.0	29.6	7.4	22.2	230.1	2026
27	2027	74.6			74.6				6.0	247.2	20.6	8.7	0.0	8.9	44.2	30.3	7.6	22.7	252.8	2027
28	2028	74.6			74.6				6.0	226.6	20.6	7.9	0.0	8.9	43.5	31.0	7.8	23.3	276.1	2028
29	2029	74.6			74.6			169.8	6.0	206.0	20.6	7.2	0.0	8.9	212.6	(138.0)	0.0	(138.0)	138.1	2029
30	2030	74.6			74.6				6.0	185.4	20.6	6.5	0.0	8.9	42.1	32.5	8.1	24.4	162.4	2030
31	2031	74.6			74.6				6.0	164.8	20.6	5.8	0.0	8.9	41.4	33.2	8.3	24.9	187.3	2031
32	2032	74.6			74.6				6.0	144.2	20.6	5.0	0.0	8.9	40.6	33.9	8.5	25.4	212.8	2032
33	2033	74.6			74.6				6.0	123.6	20.6	4.3	0.0	8.9	39.9	34.6	8.7	26.0	238.8	2033
34	2034	74.6			74.6				6.0	103.0	20.6	3.6	0.0	8.9	39.2	35.4	8.8	26.5	265.3	2034
35	2035	74.6			74.6				6.0	82.4	20.6	2.9	0.0	8.9	38.5	36.1	9.0	27.1	292.4	2035
36	2036	74.6			74.6				6.0	61.8	20.6	2.2	0.0	8.9	37.8	36.8	9.2	27.6	320.0	2036
37	2037	74.6			74.6				6.0	41.2	20.6	1.4	0.0	8.9	37.0	37.5	9.4	28.1	348.1	2037
38	2038	74.6			74.6				6.0	20.6	20.6	0.7	0.0	8.9	36.3	38.3	9.6	28.7	376.8	2038
39	2039	74.6			74.6				6.0	0.0	20.6	0.0	0.0	8.9	35.6	39.0	9.7	29.2	406.0	2039
40	2040	74.6			74.6				6.0	0.0	0.0	0.0	0.0	8.9	15.0	59.6	14.9	44.7	450.7	2040

Note: 1) Abbreviations:

F.C.: Foreign currency portion

L.C.: Local currency portion

2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9 プロジェクトローン返済計画検討 (ケース 1-2)

Tariff rate=USc4.5/kWh:FC:LC=85%:15%; FC=3.5% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received Foreign (85%)	Loans received Domestic (15%)	Total sources	Capital costs F.C.	Capital costs L.C.	Capital costs Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment Foreign (5.0%)	Interest payment Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		6.7	1.2	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		15.6	2.8	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		37.6	6.6	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		70.1	12.4	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		114.7	20.2	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		170.3	30.0	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		160.8	28.4	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	34.1	38.8	6.8	79.7	28.2	17.4	45.6	2.5	723.0				4.1	52.2	27.4	6.9	20.6	20.6	2008
9	2009	68.1	3.6	0.6	72.3	3.6	0.6	4.2	5.4	727.2				8.2	17.8	54.5	13.6	40.9	61.5	2009
10	2010	74.6			74.6				6.0	695.7	31.5	31.5	14.9	8.9	92.9	(18.3)	0.0	(18.3)	43.1	2010
11	2011	74.6			74.6				6.0	664.2	31.5	28.8	11.3	8.9	86.7	(12.1)	0.0	(12.1)	31.0	2011
12	2012	74.6			74.6				6.0	632.7	31.5	27.8	9.9	8.9	84.2	(9.7)	0.0	(9.7)	21.3	2012
13	2013	74.6			74.6				6.0	601.2	31.5	26.8	8.5	8.9	81.8	(7.2)	0.0	(7.2)	14.1	2013
14	2014	74.6			74.6				6.0	569.6	31.5	25.8	7.1	8.9	79.3	(4.8)	0.0	(4.8)	9.3	2014
15	2015	74.6			74.6				6.0	538.1	31.5	24.7	5.7	8.9	76.9	(2.3)	0.0	(2.3)	7.0	2015
16	2016	74.6			74.6				6.0	506.6	31.5	23.7	4.3	8.9	74.5	0.1	0.0	0.1	7.1	2016
17	2017	74.6			74.6				6.0	475.1	31.5	22.7	2.8	8.9	72.0	2.6	0.6	1.9	9.0	2017
18	2018	74.6			74.6				6.0	443.6	31.5	21.6	1.4	8.9	69.6	5.0	1.3	3.8	12.8	2018
19	2019	74.6			74.6				6.0	412.1	31.5	20.6	0.0	8.9	67.1	7.5	1.9	5.6	18.4	2019
20	2020	74.6			74.6				6.0	391.5	20.6	19.6	0.0	8.9	55.2	19.4	4.8	14.5	32.9	2020
21	2021	74.6			74.6				6.0	370.9	20.6	18.5	0.0	8.9	54.1	20.4	5.1	15.3	48.2	2021
22	2022	74.6			74.6				6.0	350.3	20.6	17.5	0.0	8.9	53.1	21.5	5.4	16.1	64.3	2022
23	2023	74.6			74.6				6.0	329.7	20.6	16.5	0.0	8.9	52.1	22.5	5.6	16.9	81.2	2023
24	2024	74.6			74.6				6.0	309.1	20.6	15.5	0.0	8.9	51.0	23.5	5.9	17.6	98.8	2024
25	2025	74.6			74.6				6.0	288.5	20.6	14.4	0.0	8.9	50.0	24.5	6.1	18.4	117.2	2025
26	2026	74.6			74.6				6.0	267.9	20.6	13.4	0.0	8.9	49.0	25.6	6.4	19.2	136.4	2026
27	2027	74.6			74.6				6.0	247.2	20.6	12.4	0.0	8.9	48.0	26.6	6.7	20.0	156.4	2027
28	2028	74.6			74.6				6.0	226.6	20.6	11.3	0.0	8.9	46.9	27.6	6.9	20.7	177.1	2028
29	2029	74.6			74.6			169.8	6.0	206.0	20.6	10.3	0.0	8.9	215.7	(141.1)	0.0	(141.1)	36.0	2029
30	2030	74.6			74.6				6.0	185.4	20.6	9.3	0.0	8.9	44.9	29.7	7.4	22.3	58.3	2030
31	2031	74.6			74.6				6.0	164.8	20.6	8.2	0.0	8.9	43.8	30.7	7.7	23.0	81.3	2031
32	2032	74.6			74.6				6.0	144.2	20.6	7.2	0.0	8.9	42.8	31.8	7.9	23.8	105.1	2032
33	2033	74.6			74.6				6.0	123.6	20.6	6.2	0.0	8.9	41.8	32.8	8.2	24.6	129.7	2033
34	2034	74.6			74.6				6.0	103.0	20.6	5.2	0.0	8.9	40.7	33.8	8.5	25.4	155.1	2034
35	2035	74.6			74.6				6.0	82.4	20.6	4.1	0.0	8.9	39.7	34.9	8.7	26.1	181.2	2035
36	2036	74.6			74.6				6.0	61.8	20.6	3.1	0.0	8.9	38.7	35.9	9.0	26.9	208.1	2036
37	2037	74.6			74.6				6.0	41.2	20.6	2.1	0.0	8.9	37.7	36.9	9.2	27.7	235.8	2037
38	2038	74.6			74.6				6.0	20.6	20.6	1.0	0.0	8.9	36.6	37.9	9.5	28.5	264.3	2038
39	2039	74.6			74.6				6.0	0.0	20.6	0.0	0.0	8.9	35.6	39.0	9.7	29.2	293.5	2039
40	2040	74.6			74.6				6.0	0.0	0.0	0.0	0.0	8.9	15.0	59.6	14.9	44.7	338.2	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9　プロジェクトローン返済計画検討 (ケース 1-3)

Tariff rate=USc4.5/kWh;FC:LC=85%:15%; FC=3.5% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (85%)	Loans received: Domestic (15%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (8.5%)	Interest payment: Domestic (13%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		6.7	1.2	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		15.6	2.8	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		37.6	6.6	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		70.1	12.4	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		114.7	20.2	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		170.3	30.0	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		160.8	28.4	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	34.1	38.8	6.8	79.7	28.2	17.4	45.6	2.5	723.0				4.1	52.2	27.4	6.9	20.6	20.6	2008
9	2009	68.1	3.6	0.6	72.3	3.6	0.6	4.2	5.4	727.2				8.2	17.8	54.5	13.6	40.9	61.5	2009
10	2010	74.6			74.6				6.0	695.7	31.5	55.7	14.9	8.9	117.0	(42.5)	0.0	(42.5)	19.0	2010
11	2011	74.6			74.6				6.0	664.2	31.5	49.0	11.3	8.9	106.9	(32.3)	0.0	(32.3)	(13.3)	2011
12	2012	74.6			74.6				6.0	632.7	31.5	47.3	9.9	8.9	103.7	(29.1)	0.0	(29.1)	(42.5)	2012
13	2013	74.6			74.6				6.0	601.2	31.5	45.5	8.5	8.9	100.5	(26.0)	0.0	(26.0)	(68.5)	2013
14	2014	74.6			74.6				6.0	569.6	31.5	43.8	7.1	8.9	97.4	(22.8)	0.0	(22.8)	(91.3)	2014
15	2015	74.6			74.6				6.0	538.1	31.5	42.0	5.7	8.9	94.2	(19.6)	0.0	(19.6)	(110.9)	2015
16	2016	74.6			74.6				6.0	506.6	31.5	40.3	4.3	8.9	91.0	(16.5)	0.0	(16.5)	(127.4)	2016
17	2017	74.6			74.6				6.0	475.1	31.5	38.5	2.8	8.9	87.9	(13.3)	0.0	(13.3)	(140.7)	2017
18	2018	74.6			74.6				6.0	443.6	31.5	36.8	1.4	8.9	84.7	(10.1)	0.0	(10.1)	(150.8)	2018
19	2019	74.6			74.6				6.0	412.1	31.5	35.0	0.0	8.9	81.5	(7.0)	0.0	(7.0)	(157.8)	2019
20	2020	74.6			74.6				6.0	391.5	20.6	33.3	0.0	8.9	68.9	5.7	1.4	4.3	(153.5)	2020
21	2021	74.6			74.6				6.0	370.9	20.6	31.5	0.0	8.9	67.1	7.4	1.9	5.6	(147.9)	2021
22	2022	74.6			74.6				6.0	350.3	20.6	29.8	0.0	8.9	65.4	9.2	2.3	6.9	(141.0)	2022
23	2023	74.6			74.6				6.0	329.7	20.6	28.0	0.0	8.9	63.6	11.0	2.7	8.2	(132.8)	2023
24	2024	74.6			74.6				6.0	309.1	20.6	26.3	0.0	8.9	61.9	12.7	3.2	9.5	(123.3)	2024
25	2025	74.6			74.6				6.0	288.5	20.6	24.5	0.0	8.9	60.1	14.5	3.6	10.8	(112.4)	2025
26	2026	74.6			74.6				6.0	267.9	20.6	22.8	0.0	8.9	58.4	16.2	4.1	12.2	(100.3)	2026
27	2027	74.6			74.6				6.0	247.2	20.6	21.0	0.0	8.9	56.6	18.0	4.5	13.5	(86.8)	2027
28	2028	74.6			74.6				6.0	226.6	20.6	19.3	0.0	8.9	54.9	19.7	4.9	14.8	(72.0)	2028
29	2029	74.6			74.6			169.8	6.0	206.0	20.6	17.5	0.0	8.9	222.9	(148.3)	0.0	(148.3)	(220.4)	2029
30	2030	74.6			74.6				6.0	185.4	20.6	15.8	0.0	8.9	51.4	23.2	5.8	17.4	(203.0)	2030
31	2031	74.6			74.6				6.0	164.8	20.6	14.0	0.0	8.9	49.6	25.0	6.2	18.7	(184.3)	2031
32	2032	74.6			74.6				6.0	144.2	20.6	12.3	0.0	8.9	47.9	26.7	6.7	20.0	(164.2)	2032
33	2033	74.6			74.6				6.0	123.6	20.6	10.5	0.0	8.9	46.1	28.5	7.1	21.3	(142.9)	2033
34	2034	74.6			74.6				6.0	103.0	20.6	8.8	0.0	8.9	44.4	30.2	7.6	22.7	(120.2)	2034
35	2035	74.6			74.6				6.0	82.4	20.6	7.0	0.0	8.9	42.6	32.0	8.0	24.0	(96.2)	2035
36	2036	74.6			74.6				6.0	61.8	20.6	5.3	0.0	8.9	40.8	33.7	8.4	25.3	(71.0)	2036
37	2037	74.6			74.6				6.0	41.2	20.6	3.5	0.0	8.9	39.1	35.5	8.9	26.6	(44.4)	2037
38	2038	74.6			74.6				6.0	20.6	20.6	1.8	0.0	8.9	37.3	37.2	9.3	27.9	(16.4)	2038
39	2039	74.6			74.6				6.0	0.0	20.6	0.0	0.0	8.9	35.6	39.0	9.7	29.2	12.8	2039
40	2040	74.6			74.6				6.0	0.0	0.0	0.0	0.0	8.9	15.0	59.6	14.9	44.7	57.5	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9　プロジェクトローン返済計画検討 (ケース 2-1)

Tariff rate=USc4.5/kWh;FC:LC=70%:30%; FC=3.5% p.a.

(US$ million)

No.	Year	Power sales revenue	Loans received Foreign (70%)	Loans received Domestic (30%)	Total sources	Capital costs F.C.	Capital costs L.C.	Capital costs Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment Foreign (3.5%)	Interest payment Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		5.5	2.4	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		12.9	5.5	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		30.9	13.3	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		57.8	24.8	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		94.4	40.5	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		140.2	60.1	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		132.4	56.8	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	34.1	31.9	13.7	79.7	28.2	17.4	45.6	2.5	723.0				4.1	52.2	27.4	6.9	20.6	20.6	2008
9	2009	68.1	2.9	1.3	72.3	3.6	0.6	4.2	5.4	727.2				8.2	17.8	54.5	13.6	40.9	61.5	2009
10	2010	74.6			74.6				6.0	688.4	38.8	17.9	29.8	8.9	101.4	(26.8)	0.0	(26.8)	34.6	2010
11	2011	74.6			74.6				6.0	649.6	38.8	16.6	22.7	8.9	93.1	(18.5)	0.0	(18.5)	16.1	2011
12	2012	74.6			74.6				6.0	610.8	38.8	16.0	19.9	8.9	89.7	(15.1)	0.0	(15.1)	1.0	2012
13	2013	74.6			74.6				6.0	572.1	38.8	15.4	17.0	8.9	86.2	(11.7)	0.0	(11.7)	(10.7)	2013
14	2014	74.6			74.6				6.0	533.3	38.8	14.8	14.2	8.9	82.8	(8.2)	0.0	(8.2)	(18.9)	2014
15	2015	74.6			74.6				6.0	494.5	38.8	14.3	11.3	8.9	79.4	(4.8)	0.0	(4.8)	(23.7)	2015
16	2016	74.6			74.6				6.0	455.7	38.8	13.7	8.5	8.9	75.9	(1.4)	0.0	(1.4)	(25.1)	2016
17	2017	74.6			74.6				6.0	416.9	38.8	13.1	5.7	8.9	72.5	2.1	0.5	1.5	(23.5)	2017
18	2018	74.6			74.6				6.0	378.1	38.8	12.5	2.8	8.9	69.1	5.5	1.4	4.1	(19.4)	2018
19	2019	74.6			74.6				6.0	339.4	38.8	11.9	0.0	8.9	65.7	8.9	2.2	6.7	(12.7)	2019
20	2020	74.6			74.6				6.0	322.4	17.0	11.3	0.0	8.9	43.2	31.3	7.8	23.5	10.8	2020
21	2021	74.6			74.6				6.0	305.4	17.0	10.7	0.0	8.9	42.6	31.9	8.0	23.9	34.7	2021
22	2022	74.6			74.6				6.0	288.5	17.0	10.1	0.0	8.9	42.1	32.5	8.1	24.4	59.1	2022
23	2023	74.6			74.6				6.0	271.5	17.0	9.5	0.0	8.9	41.5	33.1	8.3	24.8	83.9	2023
24	2024	74.6			74.6				6.0	254.5	17.0	8.9	0.0	8.9	40.9	33.7	8.4	25.3	109.2	2024
25	2025	74.6			74.6				6.0	237.6	17.0	8.3	0.0	8.9	40.3	34.3	8.6	25.7	134.9	2025
26	2026	74.6			74.6				6.0	220.6	17.0	7.7	0.0	8.9	39.7	34.9	8.7	26.2	161.1	2026
27	2027	74.6			74.6				6.0	203.6	17.0	7.1	0.0	8.9	39.1	35.5	8.9	26.6	187.7	2027
28	2028	74.6			74.6				6.0	186.6	17.0	6.5	0.0	8.9	38.5	36.1	9.0	27.1	214.7	2028
29	2029	74.6			74.6			169.8	6.0	169.7	17.0	5.9	0.0	8.9	207.7	(133.1)	0.0	(133.1)	81.6	2029
30	2030	74.6			74.6				6.0	152.7	17.0	5.3	0.0	8.9	37.3	37.3	9.3	27.9	109.6	2030
31	2031	74.6			74.6				6.0	135.7	17.0	4.8	0.0	8.9	36.7	37.9	9.5	28.4	137.9	2031
32	2032	74.6			74.6				6.0	118.8	17.0	4.2	0.0	8.9	36.1	38.5	9.6	28.8	166.8	2032
33	2033	74.6			74.6				6.0	101.8	17.0	3.6	0.0	8.9	35.5	39.0	9.8	29.3	196.1	2033
34	2034	74.6			74.6				6.0	84.8	17.0	3.0	0.0	8.9	34.9	39.6	9.9	29.7	225.8	2034
35	2035	74.6			74.6				6.0	67.9	17.0	2.4	0.0	8.9	34.3	40.2	10.1	30.2	256.0	2035
36	2036	74.6			74.6				6.0	50.9	17.0	1.8	0.0	8.9	33.7	40.8	10.2	30.6	286.6	2036
37	2037	74.6			74.6				6.0	33.9	17.0	1.2	0.0	8.9	33.1	41.4	10.4	31.1	317.7	2037
38	2038	74.6			74.6				6.0	17.0	17.0	0.6	0.0	8.9	32.6	42.0	10.5	31.5	349.2	2038
39	2039	74.6			74.6				6.0	0.0	17.0	0.0	0.0	8.9	32.0	42.6	10.7	32.0	381.1	2039
40	2040	74.6			74.6				6.0	0.0	0.0	0.0	0.0	8.9	15.0	59.6	14.9	44.7	425.8	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9 プロジェクトローン返済計画検討 (ケース 2-2)

Tariff rate=USc4.5/kWh;FC:LC=70%:30%; FC=5.0% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received Foreign (70%)	Loans received Domestic (30%)	Total sources	Capital costs F.C.	Capital costs L.C.	Capital costs Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment Foreign (5.0%)	Interest payment Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		5.5	2.4	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		12.9	5.5	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		30.9	13.3	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		57.8	24.8	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		94.4	40.5	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		140.2	60.1	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		132.4	56.8	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	34.1	31.9	13.7	79.7	28.2	17.4	45.6	2.5	723.0				4.1	52.2	27.4	6.9	20.6	20.6	2008
9	2009	68.1	2.9	1.3	72.2	3.6	0.6	4.2	5.4	727.2				8.2	17.8	54.5	13.6	40.9	61.5	2009
10	2010	74.6			74.6				6.0	688.4	38.8	25.9	29.8	8.9	109.5	(34.9)	0.0	(34.9)	26.6	2010
11	2011	74.6			74.6				6.0	649.6	38.8	23.8	22.7	8.9	100.2	(25.7)	0.0	(25.7)	0.9	2011
12	2012	74.6			74.6				6.0	610.8	38.8	22.9	19.9	8.9	96.5	(22.0)	0.0	(22.0)	(21.1)	2012
13	2013	74.6			74.6				6.0	572.1	38.8	22.1	17.0	8.9	92.8	(18.3)	0.0	(18.3)	(39.3)	2013
14	2014	74.6			74.6				6.0	533.3	38.8	21.2	14.2	8.9	89.2	(14.6)	0.0	(14.6)	(53.9)	2014
15	2015	74.6			74.6				6.0	494.5	38.8	20.4	11.3	8.9	85.5	(10.9)	0.0	(10.9)	(64.9)	2015
16	2016	74.6			74.6				6.0	455.7	38.8	19.5	8.5	8.9	81.8	(7.2)	0.0	(7.2)	(72.1)	2016
17	2017	74.6			74.6				6.0	416.9	38.8	18.7	5.7	8.9	78.1	(3.5)	0.0	(3.5)	(75.6)	2017
18	2018	74.6			74.6				6.0	378.1	38.8	17.8	2.8	8.9	74.4	0.1	0.0	0.1	(75.5)	2018
19	2019	74.6			74.6				6.0	339.4	38.8	17.0	0.0	8.9	70.7	3.8	1.0	2.9	(72.7)	2019
20	2020	74.6			74.6				6.0	322.4	17.0	16.1	0.0	8.9	48.1	26.5	6.6	19.9	(52.8)	2020
21	2021	74.6			74.6				6.0	305.4	17.0	15.3	0.0	8.9	47.2	27.3	6.8	20.5	(32.3)	2021
22	2022	74.6			74.6				6.0	288.5	17.0	14.4	0.0	8.9	46.4	28.2	7.0	21.1	(11.2)	2022
23	2023	74.6			74.6				6.0	271.5	17.0	13.6	0.0	8.9	45.5	29.0	7.3	21.8	10.6	2023
24	2024	74.6			74.6				6.0	254.5	17.0	12.7	0.0	8.9	44.7	29.9	7.5	22.4	33.0	2024
25	2025	74.6			74.6				6.0	237.6	17.0	11.9	0.0	8.9	43.8	30.7	7.7	23.0	56.1	2025
26	2026	74.6			74.6				6.0	220.6	17.0	11.0	0.0	8.9	43.0	31.6	7.9	23.7	79.8	2026
27	2027	74.6			74.6				6.0	203.6	17.0	10.2	0.0	8.9	42.1	32.4	8.1	24.3	104.1	2027
28	2028	74.6			74.6				6.0	186.6	17.0	9.3	0.0	8.9	41.3	33.3	8.3	25.0	129.0	2028
29	2029	74.6			74.6			169.8	6.0	169.7	17.0	8.5	0.0	8.9	210.2	(135.7)	0.0	(135.7)	(6.6)	2029
30	2030	74.6			74.6				6.0	152.7	17.0	7.6	0.0	8.9	39.6	35.0	8.7	26.2	19.6	2030
31	2031	74.6			74.6				6.0	135.7	17.0	6.8	0.0	8.9	38.7	35.8	9.0	26.9	46.5	2031
32	2032	74.6			74.6				6.0	118.8	17.0	5.9	0.0	8.9	37.9	36.7	9.2	27.5	74.0	2032
33	2033	74.6			74.6				6.0	101.8	17.0	5.1	0.0	8.9	37.0	37.5	9.4	28.1	102.1	2033
34	2034	74.6			74.6				6.0	84.8	17.0	4.2	0.0	8.9	36.2	38.4	9.6	28.8	130.9	2034
35	2035	74.6			74.6				6.0	67.9	17.0	3.4	0.0	8.9	35.4	39.2	9.8	29.4	160.3	2035
36	2036	74.6			74.6				6.0	50.9	17.0	2.5	0.0	8.9	34.5	40.1	10.0	30.0	190.3	2036
37	2037	74.6			74.6				6.0	33.9	17.0	1.7	0.0	8.9	33.7	40.9	10.2	30.7	221.0	2037
38	2038	74.6			74.6				6.0	17.0	17.0	0.8	0.0	8.9	32.8	41.8	10.4	31.3	252.3	2038
39	2039	74.6			74.6				6.0	0.0	17.0	0.0	0.0	8.9	32.0	42.6	10.7	32.0	284.3	2039
40	2040	74.6			74.6				6.0	0.0	0.0	0.0	0.0	8.9	15.0	59.6	14.9	44.7	329.0	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9 プロジェクトローン返済計画検討 (ケース 2-3)

Tariff rate=US¢4.5/kWh:FC:LC=70%:30%; FC=8.5% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (70%)	Loans received: Domestic (30%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (8.5%)	Interest payment: Domestic (13%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		5.5	2.4	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		12.9	5.5	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		30.9	13.3	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		57.8	24.8	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		94.4	40.5	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		140.2	60.1	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		132.4	56.8	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	34.1	31.9	13.7	79.7	28.2	17.4	45.6	2.5	723.0				4.1	52.2	27.4	6.9	20.6	20.6	2008
9	2009	68.1	2.9	1.3	72.3	3.6	0.6	4.2	5.4	727.2				8.2	17.8	54.5	13.6	40.9	61.5	2009
10	2010	74.6			74.6				6.0	688.4	38.8	45.8	29.8	8.9	129.4	(54.8)	0.0	(54.8)	6.7	2010
11	2011	74.6			74.6				6.0	649.6	38.8	40.4	22.7	8.9	116.8	(42.3)	0.0	(42.3)	(35.6)	2011
12	2012	74.6			74.6				6.0	610.8	38.8	38.9	19.9	8.9	112.6	(38.0)	0.0	(38.0)	(73.6)	2012
13	2013	74.6			74.6				6.0	572.1	38.8	37.5	17.0	8.9	108.3	(33.7)	0.0	(33.7)	(107.3)	2013
14	2014	74.6			74.6				6.0	533.3	38.8	36.1	14.2	8.9	104.0	(29.4)	0.0	(29.4)	(136.8)	2014
15	2015	74.6			74.6				6.0	494.5	38.8	34.6	11.3	8.9	99.7	(25.2)	0.0	(25.2)	(162.0)	2015
16	2016	74.6			74.6				6.0	455.7	38.8	33.2	8.5	8.9	95.5	(20.9)	0.0	(20.9)	(182.8)	2016
17	2017	74.6			74.6				6.0	416.9	38.8	31.7	5.7	8.9	91.2	(16.6)	0.0	(16.6)	(199.5)	2017
18	2018	74.6			74.6				6.0	378.1	38.8	30.3	2.8	8.9	86.9	(12.3)	0.0	(12.3)	(211.8)	2018
19	2019	74.6			74.6				6.0	339.4	38.8	28.8	0.0	8.9	82.6	(8.1)	0.0	(8.1)	(219.8)	2019
20	2020	74.6			74.6				6.0	322.4	17.0	27.4	0.0	8.9	59.4	15.2	3.8	11.4	(208.4)	2020
21	2021	74.6			74.6				6.0	305.4	17.0	26.0	0.0	8.9	57.9	16.6	4.2	12.5	(196.0)	2021
22	2022	74.6			74.6				6.0	288.5	17.0	24.5	0.0	8.9	56.5	18.1	4.5	13.6	(182.4)	2022
23	2023	74.6			74.6				6.0	271.5	17.0	23.1	0.0	8.9	55.0	19.5	4.9	14.6	(167.7)	2023
24	2024	74.6			74.6				6.0	254.5	17.0	21.6	0.0	8.9	53.6	21.0	5.2	15.7	(152.0)	2024
25	2025	74.6			74.6				6.0	237.6	17.0	20.2	0.0	8.9	52.1	22.4	5.6	16.8	(135.2)	2025
26	2026	74.6			74.6				6.0	220.6	17.0	18.7	0.0	8.9	50.7	23.9	6.0	17.9	(117.3)	2026
27	2027	74.6			74.6				6.0	203.6	17.0	17.3	0.0	8.9	49.3	25.3	6.3	19.0	(98.3)	2027
28	2028	74.6			74.6				6.0	186.6	17.0	15.9	0.0	8.9	47.8	26.7	6.7	20.1	(78.3)	2028
29	2029	74.6			74.6			169.8	6.0	169.7	17.0	14.4	0.0	8.9	216.2	(141.6)	0.0	(141.6)	(219.9)	2029
30	2030	74.6			74.6				6.0	152.7	17.0	13.0	0.0	8.9	44.9	29.6	7.4	22.2	(197.7)	2030
31	2031	74.6			74.6				6.0	135.7	17.0	11.5	0.0	8.9	43.5	31.1	7.8	23.3	(174.4)	2031
32	2032	74.6			74.6				6.0	118.8	17.0	10.1	0.0	8.9	42.1	32.5	8.1	24.4	(150.0)	2032
33	2033	74.6			74.6				6.0	101.8	17.0	8.7	0.0	8.9	40.6	34.0	8.5	25.5	(124.5)	2033
34	2034	74.6			74.6				6.0	84.8	17.0	7.2	0.0	8.9	39.2	35.4	8.8	26.5	(98.0)	2034
35	2035	74.6			74.6				6.0	67.9	17.0	5.8	0.0	8.9	37.7	36.8	9.2	27.6	(70.3)	2035
36	2036	74.6			74.6				6.0	50.9	17.0	4.3	0.0	8.9	36.3	38.3	9.6	28.7	(41.6)	2036
37	2037	74.6			74.6				6.0	33.9	17.0	2.9	0.0	8.9	34.8	39.7	9.9	29.8	(11.8)	2037
38	2038	74.6			74.6				6.0	17.0	17.0	1.4	0.0	8.9	33.4	41.2	10.3	30.9	19.0	2038
39	2039	74.6			74.6				6.0	0.0	17.0	0.0	0.0	8.9	32.0	42.6	10.7	32.0	51.0	2039
40	2040	74.6			74.6				6.0	0.0	0.0	0.0	0.0	8.9	15.0	59.6	14.9	44.7	95.7	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9　プロジェクトローン返済計画検討 (ケース 3-1)

Tariff rate=USc5.0/kWh; FC:LC=85%:15%; FC=3.5% p.a.

(US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (85%)	Loans received: Domestic (15%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (3.5%)	Interest payment: Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		6.7	1.2	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		15.6	2.8	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		37.6	6.6	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		70.1	12.4	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		114.7	20.2	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		170.3	30.0	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		160.8	28.4	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	37.9	38.8	6.8	83.5	28.2	17.4	45.6	2.5	723.0				4.5	52.7	30.8	7.7	23.1	23.1	2008
9	2009	75.7	3.6	0.6	79.9	3.6	0.6	4.2	5.4	727.2				9.1	18.7	61.2	15.3	45.9	69.0	2009
10	2010	82.9			82.9				6.0	695.7	31.5	21.7	14.9	9.9	84.1	(1.2)	0.0	(1.2)	67.7	2010
11	2011	82.9			82.9				6.0	664.2	31.5	20.2	11.3	9.9	79.0	3.8	1.0	2.9	70.6	2011
12	2012	82.9			82.9				6.0	632.7	31.5	19.5	9.9	9.9	76.9	6.0	1.5	4.5	75.1	2012
13	2013	82.9			82.9				6.0	601.2	31.5	18.7	8.5	9.9	74.8	8.1	2.0	6.1	81.1	2013
14	2014	82.9			82.9				6.0	569.6	31.5	18.0	7.1	9.9	72.6	10.2	2.6	7.7	88.8	2014
15	2015	82.9			82.9				6.0	538.1	31.5	17.3	5.7	9.9	70.5	12.4	3.1	9.3	98.1	2015
16	2016	82.9			82.9				6.0	506.6	31.5	16.6	4.3	9.9	68.3	14.5	3.6	10.9	109.0	2016
17	2017	82.9			82.9				6.0	475.1	31.5	15.9	2.8	9.9	66.2	16.7	4.2	12.5	121.5	2017
18	2018	82.9			82.9				6.0	443.6	31.5	15.1	1.4	9.9	64.1	18.8	4.7	14.1	135.6	2018
19	2019	82.9			82.9				6.0	412.1	31.5	14.4	0.0	9.9	61.9	20.9	5.2	15.7	151.3	2019
20	2020	82.9			82.9				6.0	391.5	20.6	13.7	0.0	9.9	50.3	32.6	8.1	24.4	175.7	2020
21	2021	82.9			82.9				6.0	370.9	20.6	13.0	0.0	9.9	49.6	33.3	8.3	25.0	200.6	2021
22	2022	82.9			82.9				6.0	350.3	20.6	12.3	0.0	9.9	48.8	34.0	8.5	25.5	226.2	2022
23	2023	82.9			82.9				6.0	329.7	20.6	11.5	0.0	9.9	48.1	34.7	8.7	26.0	252.2	2023
24	2024	82.9			82.9				6.0	309.1	20.6	10.8	0.0	9.9	47.4	35.4	8.9	26.6	278.8	2024
25	2025	82.9			82.9				6.0	288.5	20.6	10.1	0.0	9.9	46.7	36.2	9.0	27.1	305.9	2025
26	2026	82.9			82.9				6.0	267.9	20.6	9.4	0.0	9.9	46.0	36.9	9.2	27.7	333.6	2026
27	2027	82.9			82.9				6.0	247.2	20.6	8.7	0.0	9.9	45.2	37.6	9.4	28.2	361.8	2027
28	2028	82.9			82.9				6.0	226.6	20.6	7.9	0.0	9.9	44.5	38.3	9.6	28.7	390.5	2028
29	2029	82.9			82.9			169.8	6.0	206.0	20.6	7.2	0.0	9.9	213.6	(130.7)	0.0	(130.7)	259.8	2029
30	2030	82.9			82.9				6.0	185.4	20.6	6.5	0.0	9.9	43.1	39.8	9.9	29.8	289.6	2030
31	2031	82.9			82.9				6.0	164.8	20.6	5.8	0.0	9.9	42.4	40.5	10.1	30.4	320.0	2031
32	2032	82.9			82.9				6.0	144.2	20.6	5.0	0.0	9.9	41.6	41.2	10.3	30.9	350.9	2032
33	2033	82.9			82.9				6.0	123.6	20.6	4.3	0.0	9.9	40.9	41.9	10.5	31.5	382.3	2033
34	2034	82.9			82.9				6.0	103.0	20.6	3.6	0.0	9.9	40.2	42.7	10.7	32.0	414.3	2034
35	2035	82.9			82.9				6.0	82.4	20.6	2.9	0.0	9.9	39.5	43.4	10.8	32.5	446.9	2035
36	2036	82.9			82.9				6.0	61.8	20.6	2.2	0.0	9.9	38.8	44.1	11.0	33.1	479.9	2036
37	2037	82.9			82.9				6.0	41.2	20.6	1.4	0.0	9.9	38.0	44.8	11.2	33.6	513.6	2037
38	2038	82.9			82.9				6.0	20.6	20.6	0.7	0.0	9.9	37.3	45.5	11.4	34.2	547.7	2038
39	2039	82.9			82.9				6.0	0.0	20.6	0.0	0.0	9.9	36.6	46.3	11.6	34.7	582.4	2039
40	2040	82.9			82.9				6.0	0.0	0.0	0.0	0.0	9.9	16.0	66.9	16.7	50.1	632.6	2040

Note: 1) Abbreviations:

F.C.: Foreign currency portion

L.C.: Local currency portion

2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9　プロジェクトローン返済計画検討 (ケース 3-2)

Tariff rate=USc5.0/kWh; FC:LC=85%:15%; FC=5.0% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (85%)	Loans received: Domestic (15%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (5.0%)	Interest payment: Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		6.7	1.2	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		15.6	2.8	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		37.6	6.6	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		70.1	12.4	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		114.7	20.2	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		170.3	30.0	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		160.8	28.4	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	37.9	38.8	6.8	83.5	28.2	17.4	45.6	2.5	723.0				4.5	52.7	30.8	7.7	23.1	23.1	2008
9	2009	75.7	3.6	0.6	79.9	3.6	0.6	4.2	5.4	727.2				9.1	18.7	61.2	15.3	45.9	69.0	2009
10	2010	82.9			82.9				6.0	695.7	31.5	31.5	14.9	9.9	93.9	(11.0)	0.0	(11.0)	57.9	2010
11	2011	82.9			82.9				6.0	664.2	31.5	28.8	11.3	9.9	87.7	(4.8)	0.0	(4.8)	53.1	2011
12	2012	82.9			82.9				6.0	632.7	31.5	27.8	9.9	9.9	85.2	(2.4)	0.0	(2.4)	50.7	2012
13	2013	82.9			82.9				6.0	601.2	31.5	26.8	8.5	9.9	82.8	0.1	0.0	0.0	50.8	2013
14	2014	82.9			82.9				6.0	569.6	31.5	25.8	7.1	9.9	80.3	2.5	0.6	1.9	52.6	2014
15	2015	82.9			82.9				6.0	538.1	31.5	24.7	5.7	9.9	77.9	5.0	1.2	3.7	56.4	2015
16	2016	82.9			82.9				6.0	506.6	31.5	23.7	4.3	9.9	75.4	7.4	1.9	5.6	61.9	2016
17	2017	82.9			82.9				6.0	475.1	31.5	22.7	2.8	9.9	73.0	9.9	2.5	7.4	69.3	2017
18	2018	82.9			82.9				6.0	443.6	31.5	21.6	1.4	9.9	70.5	12.3	3.1	9.2	78.5	2018
19	2019	82.9			82.9				6.0	412.1	31.5	20.6	0.0	9.9	68.1	14.8	3.7	11.1	89.6	2019
20	2020	82.9			82.9				6.0	391.5	20.6	19.6	0.0	9.9	56.2	26.7	6.7	20.0	109.6	2020
21	2021	82.9			82.9				6.0	370.9	20.6	18.5	0.0	9.9	55.1	27.7	6.9	20.8	130.4	2021
22	2022	82.9			82.9				6.0	350.3	20.6	17.5	0.0	9.9	54.1	28.7	7.2	21.6	152.0	2022
23	2023	82.9			82.9				6.0	329.7	20.6	16.5	0.0	9.9	53.1	29.8	7.4	22.3	174.3	2023
24	2024	82.9			82.9				6.0	309.1	20.6	15.5	0.0	9.9	52.0	30.8	7.7	23.1	197.4	2024
25	2025	82.9			82.9				6.0	288.5	20.6	14.4	0.0	9.9	51.0	31.8	8.0	23.9	221.3	2025
26	2026	82.9			82.9				6.0	267.9	20.6	13.4	0.0	9.9	50.0	32.9	8.2	24.7	245.9	2026
27	2027	82.9			82.9				6.0	247.2	20.6	12.4	0.0	9.9	48.9	33.9	8.5	25.4	271.4	2027
28	2028	82.9			82.9				6.0	226.6	20.6	11.3	0.0	9.9	47.9	34.9	8.7	26.2	297.6	2028
29	2029	82.9			82.9			169.8	6.0	206.0	20.6	10.3	0.0	9.9	216.7	(133.8)	0.0	(133.8)	163.7	2029
30	2030	82.9			82.9				6.0	185.4	20.6	9.3	0.0	9.9	45.9	37.0	9.2	27.7	191.5	2030
31	2031	82.9			82.9				6.0	164.8	20.6	8.2	0.0	9.9	44.8	38.0	9.5	28.5	220.0	2031
32	2032	82.9			82.9				6.0	144.2	20.6	7.2	0.0	9.9	43.8	39.1	9.8	29.3	249.3	2032
33	2033	82.9			82.9				6.0	123.6	20.6	6.2	0.0	9.9	42.8	40.1	10.0	30.1	279.3	2033
34	2034	82.9			82.9				6.0	103.0	20.6	5.2	0.0	9.9	41.7	41.1	10.3	30.8	310.2	2034
35	2035	82.9			82.9				6.0	82.4	20.6	4.1	0.0	9.9	40.7	42.1	10.5	31.6	341.8	2035
36	2036	82.9			82.9				6.0	61.8	20.6	3.1	0.0	9.9	39.7	43.2	10.8	32.4	374.1	2036
37	2037	82.9			82.9				6.0	41.2	20.6	2.1	0.0	9.9	38.6	44.2	11.1	33.2	407.3	2037
38	2038	82.9			82.9				6.0	20.6	20.6	1.0	0.0	9.9	37.6	45.2	11.3	33.9	441.2	2038
39	2039	82.9			82.9				6.0	0.0	20.6	0.0	0.0	9.9	36.6	46.3	11.6	34.7	475.9	2039
40	2040	82.9			82.9				6.0	0.0	0.0	0.0	0.0	9.9	16.0	66.9	16.7	50.1	526.1	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9 プロジェクトローン返済計画検討 (ケース 3-3)

Tariff rate=USc5.0/kWh; FC:LC=85%:15%; FC=8.5% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received Foreign (85%)	Loans received Domestic (15%)	Total sources	Capital costs F.C.	Capital costs L.C.	Capital costs Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment Foreign (8.5%)	Interest payment Domestic (13%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		6.7	1.2	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		15.6	2.8	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		37.6	6.6	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		70.1	12.4	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		114.7	20.2	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		170.3	30.0	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		160.8	28.4	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	37.9	38.8	6.8	83.5	28.2	17.4	45.6	2.5	723.0				4.5	52.7	30.8	7.7	23.1	23.1	2008
9	2009	75.7	3.6	0.6	79.9	3.6	0.6	4.2	5.4	727.2				9.1	18.7	61.2	15.3	45.9	69.0	2009
10	2010	82.9			82.9				6.0	695.7	31.5	55.7	14.9	9.9	118.0	(35.2)	0.0	(35.2)	33.8	2010
11	2011	82.9			82.9				6.0	664.2	31.5	49.0	11.3	9.9	107.9	(25.0)	0.0	(25.0)	8.7	2011
12	2012	82.9			82.9				6.0	632.7	31.5	47.3	9.9	9.9	104.7	(21.9)	0.0	(21.9)	(13.1)	2012
13	2013	82.9			82.9				6.0	601.2	31.5	45.5	8.5	9.9	101.5	(18.7)	0.0	(18.7)	(31.8)	2013
14	2014	82.9			82.9				6.0	569.6	31.5	43.8	7.1	9.9	98.4	(15.5)	0.0	(15.5)	(47.3)	2014
15	2015	82.9			82.9				6.0	538.1	31.5	42.0	5.7	9.9	95.2	(12.3)	0.0	(12.3)	(59.7)	2015
16	2016	82.9			82.9				6.0	506.6	31.5	40.3	4.3	9.9	92.0	(9.2)	0.0	(9.2)	(68.9)	2016
17	2017	82.9			82.9				6.0	475.1	31.5	38.5	2.8	9.9	88.9	(6.0)	0.0	(6.0)	(74.9)	2017
18	2018	82.9			82.9				6.0	443.6	31.5	36.8	1.4	9.9	85.7	(2.8)	0.0	(2.8)	(77.7)	2018
19	2019	82.9			82.9				6.0	412.1	31.5	35.0	0.0	9.9	82.5	0.3	0.1	0.2	(77.5)	2019
20	2020	82.9			82.9				6.0	391.5	20.6	33.3	0.0	9.9	69.9	13.0	3.2	9.7	(67.7)	2020
21	2021	82.9			82.9				6.0	370.9	20.6	31.5	0.0	9.9	68.1	14.7	3.7	11.1	(56.7)	2021
22	2022	82.9			82.9				6.0	350.3	20.6	29.8	0.0	9.9	66.4	16.5	4.1	12.4	(44.3)	2022
23	2023	82.9			82.9				6.0	329.7	20.6	28.0	0.0	9.9	64.6	18.2	4.6	13.7	(30.6)	2023
24	2024	82.9			82.9				6.0	309.1	20.6	26.3	0.0	9.9	62.9	20.0	5.0	15.0	(15.6)	2024
25	2025	82.9			82.9				6.0	288.5	20.6	24.5	0.0	9.9	61.1	21.7	5.4	16.3	0.7	2025
26	2026	82.9			82.9				6.0	267.9	20.6	22.8	0.0	9.9	59.4	23.5	5.9	17.6	18.3	2026
27	2027	82.9			82.9				6.0	247.2	20.6	21.0	0.0	9.9	57.6	25.2	6.3	18.9	37.2	2027
28	2028	82.9			82.9				6.0	226.6	20.6	19.3	0.0	9.9	55.9	27.0	6.7	20.2	57.5	2028
29	2029	82.9			82.9			169.8	6.0	206.0	20.6	17.5	0.0	9.9	223.9	(141.1)	0.0	(141.1)	(83.6)	2029
30	2030	82.9			82.9				6.0	185.4	20.6	15.8	0.0	9.9	52.3	30.5	7.6	22.9	(60.7)	2030
31	2031	82.9			82.9				6.0	164.8	20.6	14.0	0.0	9.9	50.6	32.3	8.1	24.2	(36.5)	2031
32	2032	82.9			82.9				6.0	144.2	20.6	12.3	0.0	9.9	48.8	34.0	8.5	25.5	(11.0)	2032
33	2033	82.9			82.9				6.0	123.6	20.6	10.5	0.0	9.9	47.1	35.8	8.9	26.8	15.8	2033
34	2034	82.9			82.9				6.0	103.0	20.6	8.8	0.0	9.9	45.3	37.5	9.4	28.1	43.9	2034
35	2035	82.9			82.9				6.0	82.4	20.6	7.0	0.0	9.9	43.6	39.3	9.8	29.4	73.4	2035
36	2036	82.9			82.9				6.0	61.8	20.6	5.3	0.0	9.9	41.8	41.0	10.3	30.8	104.1	2036
37	2037	82.9			82.9				6.0	41.2	20.6	3.5	0.0	9.9	40.1	42.8	10.7	32.1	136.2	2037
38	2038	82.9			82.9				6.0	20.6	20.6	1.8	0.0	9.9	38.3	44.5	11.1	33.4	169.6	2038
39	2039	82.9			82.9				6.0	0.0	20.6	0.0	0.0	9.9	36.6	46.3	11.6	34.7	204.3	2039
40	2040	82.9			82.9				6.0	0.0	0.0	0.0	0.0	9.9	16.0	66.9	16.7	50.1	254.4	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9　プロジェクトローン返済計画検討 (ケース　4-1)

Tariff rate=USc5.0/kWh; FC:LC=70%:30%; FC=3.5% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (70%)	Loans received: Domestic (30%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (3.5%)	Interest payment: Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		5.5	2.4	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		12.9	5.5	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		30.9	13.3	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		57.8	24.8	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		94.4	40.5	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		140.2	60.1	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		132.4	56.8	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	37.9	31.9	13.7	83.5	28.2	17.4	45.6	2.5	723.0				4.5	52.7	30.8	7.7	23.1	23.1	2008
9	2009	75.7	2.9	1.3	79.9	3.6	0.6	4.2	5.4	727.2				9.1	18.7	61.2	15.3	45.9	69.0	2009
10	2010	82.9			82.9				6.0	688.4	38.8	17.9	29.8	9.9	102.4	(19.5)	0.0	(19.5)	49.4	2010
11	2011	82.9			82.9				6.0	649.6	38.8	16.6	22.7	9.9	94.1	(11.2)	0.0	(11.2)	38.2	2011
12	2012	82.9			82.9				6.0	610.8	38.8	16.0	19.9	9.9	90.7	(7.8)	0.0	(7.8)	30.4	2012
13	2013	82.9			82.9				6.0	572.1	38.8	15.4	17.0	9.9	87.2	(4.4)	0.0	(4.4)	26.0	2013
14	2014	82.9			82.9				6.0	533.3	38.8	14.8	14.2	9.9	83.8	(0.9)	0.0	(0.9)	25.1	2014
15	2015	82.9			82.9				6.0	494.5	38.8	14.3	11.3	9.9	80.4	2.5	0.6	1.9	26.9	2015
16	2016	82.9			82.9				6.0	455.7	38.8	13.7	8.5	9.9	76.9	5.9	1.5	4.4	31.4	2016
17	2017	82.9			82.9				6.0	416.9	38.8	13.1	5.7	9.9	73.5	9.3	2.3	7.0	38.4	2017
18	2018	82.9			82.9				6.0	378.1	38.8	12.5	2.8	9.9	70.1	12.8	3.2	9.6	47.9	2018
19	2019	82.9			82.9				6.0	339.4	38.8	11.9	0.0	9.9	66.6	16.2	4.1	12.2	60.1	2019
20	2020	82.9			82.9				6.0	322.4	17.0	11.3	0.0	9.9	44.2	38.6	9.7	29.0	89.1	2020
21	2021	82.9			82.9				6.0	305.4	17.0	10.7	0.0	9.9	43.6	39.2	9.8	29.4	118.5	2021
22	2022	82.9			82.9				6.0	288.5	17.0	10.1	0.0	9.9	43.0	39.8	10.0	29.9	148.3	2022
23	2023	82.9			82.9				6.0	271.5	17.0	9.5	0.0	9.9	42.5	40.4	10.1	30.3	178.6	2023
24	2024	82.9			82.9				6.0	254.5	17.0	8.9	0.0	9.9	41.9	41.0	10.2	30.7	209.4	2024
25	2025	82.9			82.9				6.0	237.6	17.0	8.3	0.0	9.9	41.3	41.6	10.4	31.2	240.5	2025
26	2026	82.9			82.9				6.0	220.6	17.0	7.7	0.0	9.9	40.7	42.2	10.5	31.6	272.2	2026
27	2027	82.9			82.9				6.0	203.6	17.0	7.1	0.0	9.9	40.1	42.8	10.7	32.1	304.3	2027
28	2028	82.9			82.9				6.0	186.6	17.0	6.5	0.0	9.9	39.5	43.4	10.8	32.5	336.8	2028
29	2029	82.9			82.9			169.8	6.0	169.7	17.0	5.9	0.0	9.9	208.7	(125.8)	0.0	(125.8)	210.9	2029
30	2030	82.9			82.9				6.0	152.7	17.0	5.3	0.0	9.9	38.3	44.6	11.1	33.4	244.4	2030
31	2031	82.9			82.9				6.0	135.7	17.0	4.8	0.0	9.9	37.7	45.1	11.3	33.9	278.2	2031
32	2032	82.9			82.9				6.0	118.8	17.0	4.2	0.0	9.9	37.1	45.7	11.4	34.3	312.5	2032
33	2033	82.9			82.9				6.0	101.8	17.0	3.6	0.0	9.9	36.5	46.3	11.6	34.8	347.3	2033
34	2034	82.9			82.9				6.0	84.8	17.0	3.0	0.0	9.9	35.9	46.9	11.7	35.2	382.5	2034
35	2035	82.9			82.9				6.0	67.9	17.0	2.4	0.0	9.9	35.3	47.5	11.9	35.6	418.1	2035
36	2036	82.9			82.9				6.0	50.9	17.0	1.8	0.0	9.9	34.7	48.1	12.0	36.1	454.2	2036
37	2037	82.9			82.9				6.0	33.9	17.0	1.2	0.0	9.9	34.1	48.7	12.2	36.5	490.7	2037
38	2038	82.9			82.9				6.0	17.0	17.0	0.6	0.0	9.9	33.5	49.3	12.3	37.0	527.7	2038
39	2039	82.9			82.9				6.0	0.0	17.0	0.0	0.0	9.9	33.0	49.9	12.5	37.4	565.1	2039
40	2040	82.9			82.9				6.0	0.0	0.0	0.0	0.0	9.9	16.0	66.9	16.7	50.1	615.3	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9 プロジェクトローン返済計画検討 (ケース 4-2)

Tariff rate=USc5.0/kWh; FC:LC=70%:30%; FC=5.0% p.a. (US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (70%)	Loans received: Domestic (30%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (5.0%)	Interest payment: Domestic (13.0%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		5.5	2.4	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		12.9	5.5	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		30.9	13.3	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		57.8	24.8	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		94.4	40.5	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		140.2	60.1	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		132.4	56.8	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	37.9	31.9	13.7	83.5	28.2	17.4	45.6	2.5	723.0				4.5	52.7	30.8	7.7	23.1	23.1	2008
9	2009	75.7	2.9	1.3	79.9	3.6	0.6	4.2	5.4	727.2				9.1	18.7	61.2	15.3	45.9	69.0	2009
10	2010	82.9			82.9				6.0	688.4	38.8	25.9	29.8	9.9	110.5	(27.6)	0.0	(27.6)	41.3	2010
11	2011	82.9			82.9				6.0	649.6	38.8	23.8	22.7	9.9	101.2	(18.4)	0.0	(18.4)	23.0	2011
12	2012	82.9			82.9				6.0	610.8	38.8	22.9	19.9	9.9	97.5	(14.7)	0.0	(14.7)	8.3	2012
13	2013	82.9			82.9				6.0	572.1	38.8	22.1	17.0	9.9	93.8	(11.0)	0.0	(11.0)	(2.7)	2013
14	2014	82.9			82.9				6.0	533.3	38.8	21.2	14.2	9.9	90.2	(7.3)	0.0	(7.3)	(10.0)	2014
15	2015	82.9			82.9				6.0	494.5	38.8	20.4	11.3	9.9	86.5	(3.6)	0.0	(3.6)	(13.6)	2015
16	2016	82.9			82.9				6.0	455.7	38.8	19.5	8.5	9.9	82.8	0.1	0.0	0.0	(13.6)	2016
17	2017	82.9			82.9				6.0	416.9	38.8	18.7	5.7	9.9	79.1	3.7	0.9	2.8	(10.8)	2017
18	2018	82.9			82.9				6.0	378.1	38.8	17.8	2.8	9.9	75.4	7.4	1.9	5.6	(5.2)	2018
19	2019	82.9			82.9				6.0	339.4	38.8	17.0	0.0	9.9	71.7	11.1	2.8	8.3	3.1	2019
20	2020	82.9			82.9				6.0	322.4	17.0	16.1	0.0	9.9	49.1	33.8	8.4	25.3	28.5	2020
21	2021	82.9			82.9				6.0	305.4	17.0	15.3	0.0	9.9	48.2	34.6	8.7	26.0	54.4	2021
22	2022	82.9			82.9				6.0	288.5	17.0	14.4	0.0	9.9	47.4	35.5	8.9	26.6	81.1	2022
23	2023	82.9			82.9				6.0	271.5	17.0	13.6	0.0	9.9	46.5	36.3	9.1	27.2	108.3	2023
24	2024	82.9			82.9				6.0	254.5	17.0	12.7	0.0	9.9	45.7	37.2	9.3	27.9	136.2	2024
25	2025	82.9			82.9				6.0	237.6	17.0	11.9	0.0	9.9	44.8	38.0	9.5	28.5	164.7	2025
26	2026	82.9			82.9				6.0	220.6	17.0	11.0	0.0	9.9	44.0	38.9	9.7	29.2	193.8	2026
27	2027	82.9			82.9				6.0	203.6	17.0	10.2	0.0	9.9	43.1	39.7	9.9	29.8	223.6	2027
28	2028	82.9			82.9				6.0	186.6	17.0	9.3	0.0	9.9	42.3	40.6	10.1	30.4	254.1	2028
29	2029	82.9			82.9			169.8	6.0	169.7	17.0	8.5	0.0	9.9	211.2	(128.4)	0.0	(128.4)	125.7	2029
30	2030	82.9			82.9				6.0	152.7	17.0	7.6	0.0	9.9	40.6	42.3	10.6	31.7	157.4	2030
31	2031	82.9			82.9				6.0	135.7	17.0	6.8	0.0	9.9	39.7	43.1	10.8	32.3	189.7	2031
32	2032	82.9			82.9				6.0	118.8	17.0	5.9	0.0	9.9	38.9	44.0	11.0	33.0	222.7	2032
33	2033	82.9			82.9				6.0	101.8	17.0	5.1	0.0	9.9	38.0	44.8	11.2	33.6	256.3	2033
34	2034	82.9			82.9				6.0	84.8	17.0	4.2	0.0	9.9	37.2	45.7	11.4	34.2	290.5	2034
35	2035	82.9			82.9				6.0	67.9	17.0	3.4	0.0	9.9	36.3	46.5	11.6	34.9	325.4	2035
36	2036	82.9			82.9				6.0	50.9	17.0	2.5	0.0	9.9	35.5	47.4	11.8	35.5	360.9	2036
37	2037	82.9			82.9				6.0	33.9	17.0	1.7	0.0	9.9	34.6	48.2	12.1	36.2	397.1	2037
38	2038	82.9			82.9				6.0	17.0	17.0	0.8	0.0	9.9	33.8	49.1	12.3	36.8	433.9	2038
39	2039	82.9			82.9				6.0	0.0	17.0	0.0	0.0	9.9	33.0	49.9	12.5	37.4	471.3	2039
40	2040	82.9			82.9				6.0	0.0	0.0	0.0	0.0	9.9	16.0	66.9	16.7	50.1	521.4	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

表 9.9　プロジェクトローン返済計画検討 (ケース　4-3)

Tariff rate=USc5.0/kWh; FC:LC=70%:30%; FC=8.5% p.a.

(US$ million)

No.	Year	Power sales revenue	Loans received: Foreign (70%)	Loans received: Domestic (30%)	Total sources	Capital costs: F.C.	Capital costs: L.C.	Capital costs: Total	O & M costs	Outstanding loan principal	Repayment of principal	Interest payment: Foreign (8.5%)	Interest payment: Domestic (13%)	Resources tax & VAT	Total uses	Current surplus	Corporate tax payment	Surplus after tax	Cumulative surplus	Year
1	2001		5.5	2.4	7.9	5.2	2.7	7.9		7.9				0.0	7.9	0.0	0.0	0.0	0.0	2001
2	2002		12.9	5.5	18.4	6.6	11.8	18.4		26.3				0.0	18.4	0.0	0.0	0.0	0.0	2002
3	2003		30.9	13.3	44.2	17.4	26.8	44.2		70.5				0.0	44.2	0.0	0.0	0.0	0.0	2003
4	2004		57.8	24.8	82.5	40.1	42.4	82.5		153.0				0.0	82.5	0.0	0.0	0.0	0.0	2004
5	2005		94.4	40.5	134.9	72.6	62.3	134.9		287.9				0.0	134.9	0.0	0.0	0.0	0.0	2005
6	2006		140.2	60.1	200.3	124.6	75.7	200.3		488.2				0.0	200.3	0.0	0.0	0.0	0.0	2006
7	2007		132.4	56.8	189.2	119.2	70.0	189.2		677.4				0.0	189.2	0.0	0.0	0.0	0.0	2007
8	2008	37.9	31.9	13.7	83.5	28.2	17.4	45.6	2.5	723.0				4.5	52.7	30.8	7.7	23.1	23.1	2008
9	2009	75.7	2.9	1.3	79.9	3.6	0.6	4.2	5.4	727.2				9.1	18.7	61.2	15.3	45.9	69.0	2009
10	2010	82.9			82.9				6.0	688.4	38.8	45.8	29.8	9.9	130.4	(47.5)	0.0	(47.5)	21.4	2010
11	2011	82.9			82.9				6.0	649.6	38.8	40.4	22.7	9.9	117.8	(35.0)	0.0	(35.0)	(13.5)	2011
12	2012	82.9			82.9				6.0	610.8	38.8	38.9	19.9	9.9	113.6	(30.7)	0.0	(30.7)	(44.3)	2012
13	2013	82.9			82.9				6.0	572.1	38.8	37.5	17.0	9.9	109.3	(26.4)	0.0	(26.4)	(70.7)	2013
14	2014	82.9			82.9				6.0	533.3	38.8	36.1	14.2	9.9	105.0	(22.2)	0.0	(22.2)	(92.8)	2014
15	2015	82.9			82.9				6.0	494.5	38.8	34.6	11.3	9.9	100.7	(17.9)	0.0	(17.9)	(110.7)	2015
16	2016	82.9			82.9				6.0	455.7	38.8	33.2	8.5	9.9	96.4	(13.6)	0.0	(13.6)	(124.3)	2016
17	2017	82.9			82.9				6.0	416.9	38.8	31.7	5.7	9.9	92.2	(9.3)	0.0	(9.3)	(133.6)	2017
18	2018	82.9			82.9				6.0	378.1	38.8	30.3	2.8	9.9	87.9	(5.0)	0.0	(5.0)	(138.7)	2018
19	2019	82.9			82.9				6.0	339.4	38.8	28.8	0.0	9.9	83.6	(0.8)	0.0	(0.8)	(139.4)	2019
20	2020	82.9			82.9				6.0	322.4	17.0	27.4	0.0	9.9	60.4	22.5	5.6	16.9	(122.6)	2020
21	2021	82.9			82.9				6.0	305.4	17.0	26.0	0.0	9.9	58.9	23.9	6.0	18.0	(104.6)	2021
22	2022	82.9			82.9				6.0	288.5	17.0	24.5	0.0	9.9	57.5	25.4	6.3	19.0	(85.6)	2022
23	2023	82.9			82.9				6.0	271.5	17.0	23.1	0.0	9.9	56.0	26.8	6.7	20.1	(65.5)	2023
24	2024	82.9			82.9				6.0	254.5	17.0	21.6	0.0	9.9	54.6	28.3	7.1	21.2	(44.3)	2024
25	2025	82.9			82.9				6.0	237.6	17.0	20.2	0.0	9.9	53.1	29.7	7.4	22.3	(22.0)	2025
26	2026	82.9			82.9				6.0	220.6	17.0	18.7	0.0	9.9	51.7	31.1	7.8	23.4	1.4	2026
27	2027	82.9			82.9				6.0	203.6	17.0	17.3	0.0	9.9	50.3	32.6	8.1	24.4	25.8	2027
28	2028	82.9			82.9				6.0	186.6	17.0	15.9	0.0	9.9	48.8	34.0	8.5	25.5	51.3	2028
29	2029	82.9			82.9			169.8	6.0	169.7	17.0	14.4	0.0	9.9	217.2	(134.3)	0.0	(134.3)	(83.0)	2029
30	2030	82.9			82.9				6.0	152.7	17.0	13.0	0.0	9.9	45.9	36.9	9.2	27.7	(55.3)	2030
31	2031	82.9			82.9				6.0	135.7	17.0	11.5	0.0	9.9	44.5	38.4	9.6	28.8	(26.5)	2031
32	2032	82.9			82.9				6.0	118.8	17.0	10.1	0.0	9.9	43.0	39.8	10.0	29.9	3.3	2032
33	2033	82.9			82.9				6.0	101.8	17.0	8.7	0.0	9.9	41.6	41.2	10.3	30.9	34.3	2033
34	2034	82.9			82.9				6.0	84.8	17.0	7.2	0.0	9.9	40.2	42.7	10.7	32.0	66.3	2034
35	2035	82.9			82.9				6.0	67.9	17.0	5.8	0.0	9.9	38.7	44.1	11.0	33.1	99.4	2035
36	2036	82.9			82.9				6.0	50.9	17.0	4.3	0.0	9.9	37.3	45.6	11.4	34.2	133.6	2036
37	2037	82.9			82.9				6.0	33.9	17.0	2.9	0.0	9.9	35.8	47.0	11.8	35.3	168.8	2037
38	2038	82.9			82.9				6.0	17.0	17.0	1.4	0.0	9.9	34.4	48.5	12.1	36.3	205.2	2038
39	2039	82.9			82.9				6.0	0.0	17.0	0.0	0.0	9.9	33.0	49.9	12.5	37.4	242.6	2039
40	2040	82.9			82.9				6.0	0.0	0.0	0.0	0.0	9.9	16.0	66.9	16.7	50.1	292.7	2040

Note: 1) Abbreviations:
F.C.: Foreign currency portion
L.C.: Local currency portion
2) Project construction cost:

	F.C.	L.C.	Total
Civil	176.9	182.4	359.3
Metal	150.6	19.2	169.8
Others	90.0	108.1	198.1
Total	417.5	309.7	727.2

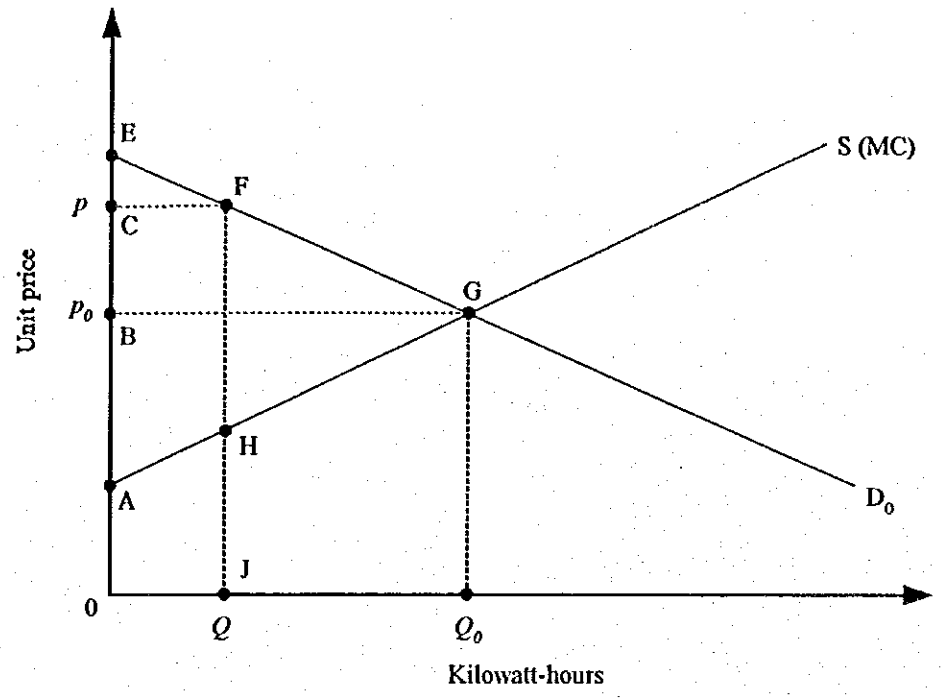


図 9.1　電力消費純便益

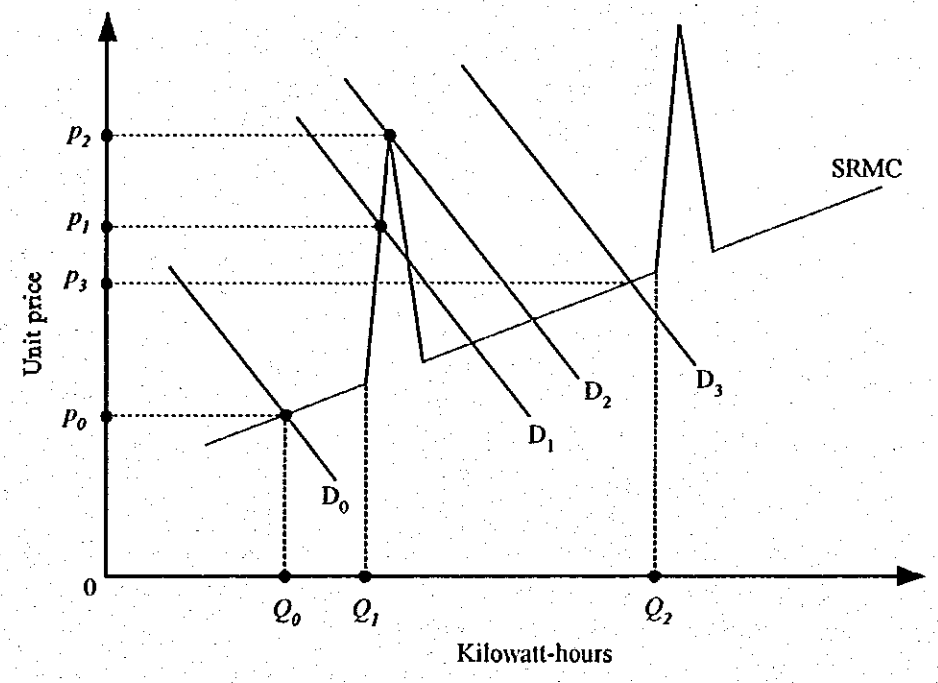


図 9.2　需要変化と短期限界費用

第10章　技術移転

10.1　実施状況

本調査における現地調査期間中に、長期あるいは短期で、調査団の業務遂行に協力してきた各分野のカウンターパートに対して、調査団の各専門家は、日々の密接な打合せや協議の場を通じて、本調査業務に関わる最新の知識及び技術等について、教育及び訓練を実施してきた。これによる成果(カウンターパートの技術力の向上)は、十分に上がっており、効果的な技術移転がなされたものと考える。

10.2　技術移転セミナーの開催

着手報告書に記載してある通り、調査団はヴィエトナム国カウンターパート機関(EVN)に対して、第5次現地調査時(2000年2月)に技術移転セミナーを開催することを提案したところ、この開催について、中間報告書説明時（1999年12月）の会議で、EVNより了解を得た。

第5次現地調査時に、調査団は予定通りこのセミナーを開催し、本調査のドラフトファイナルレポートの内容について、ヴィエトナム国側と活発な議論を行うことができた。その成果は、本報告書に反映されている。

10.3　日本でのカウンターパート研修

JICA主催のもと、EVN所属のカウンターパート1名が2000年3月に来日し、1ヶ月間の技術移転研修を受ける予定である。この研修を通じて、カウンターパートは、当計画に類似する既設あるいは建設中の水力発電所の現場視察並びに専門分野に関わる講義等を通じて、その技術力を高めることができると確信する。この研修の実施にあたっては、本調査団も全面的な協力を行う予定である。

第11章　提言

11.1　概説

本調査により、ドンナイ第3･第4連係水力発電計画は、技術面、経済面及び環境面の全てにおいて、十分に開発可能な計画であることが確認された。したがって、本調査団は、当計画の詳細設計段階への進展を強く推奨する。

当計画を推進するには、資金の調達から始まり、コンサルタントの選定、詳細設計のための現地詳細調査の実施、詳細設計の実施、コントラクターの選定、建設工事の実施に至る一連の過程で、様々な課題を解決しなければならず、これにはヴィエトナム国政府及びEVNの強力な指導力が必要である。

特に当計画は2007年の運転開始が期待されていることから、当調査の終了後、約7年半の短期間しかない。したがって、本調査終了後、この目標に向けて、綿密かつ素早い対応が、ヴィエトナム国政府をはじめとする関係機関に望まれる。

11.2　各政府機関による承認

前述の通り、当計画の実施に当たっては、解決すべき課題がいくつか有り、そのうち最も優先されるべき課題は、当計画の環境影響評価(EIA)および住民移転計画(RAP)についてヴィエトナム国内の承認を得ることである。計画推進のための各種金融機関並びに援助機関からの資金調達には、この承認が不可欠である。この承認手続きに必要となる資料は、本報告書のサポーティングレポートに添付されている。

11.3　詳細設計

本調査で実施した設計は概略設計レベルであり、したがって当計画の推進には、優秀なコンサルタントによる詳細設計が必要である。本調査の成果を考慮した上で、詳細設計段階において主に検討すべき事項として下記が挙げられる。

- 本調査で新たに設置した水文観測所での観測記録を基にした、水文解析（特に低水量解析）のレビュー
- 詳細設計の実施に必要な地形測量調査並びに地質調査
- ダム洪水吐き設備に関わる水理模型実験
- 上記水文解析のレビュー並びに地形・地質調査工事の結果に基づく、本調査での主要構造物の設計諸元のレビュー

添付資料

概略設計に関わる設計基準

FEASIBILITY STUDY

ON

DONG NAI NO.3 AND NO.4 COMBINED HYDROPOWER PROJECT

IN

THE MIDDLE REACHES OF THE DONG NAI RIVER

IN

THE SOCIALIST REPUBLIC OF VIETNAM

DESIGN CRITERIA FOR FEASIBILITY-GRADE DESIGN

Table of Contents

List of Table

List of Figures

List of Annexes

Design Condition on Feasibility Study
On Dong Nai No.3 and No.4 Combined Hydropower Project

1. Main Dam

The Dong Nai No.3 dam and No.4 dam are categorized to be the Grade-I dam in accordance with the Vietnamese criteria as shown in Annex-1. The principal dam design criteria to be adopted in the feasibility-grade design are shown in Annex-2, which also presents the Vietnamese and Japanese design codes.

(1) Location of main dam axes : to be selected on 1 to 1,000 scaled topographic maps to be newly produced, that would be almost same as those selected in the stage of Progress Report No.1.

(2) Type of main dam : Rock-fill dam with vertical clay core, Concrete gravity dam and Combined dam of rock-fill and concrete dam portions.

(3) Crest level of main dam : Crest level of Non-overflow section + 0.5m (in case of Rockfill dam)

(4) Crest level of Non-overflow section of main dam (=Crest level of Vertical clay core):

Based on the Design Criteria for Dams (Japanese National Committee on Large dams) and compared to the Vietnamese standard (refer to (7) of Annex-II).

(a) Crest level of Non-overflow section :

[(Flood water level + Freeboard 1*) or (Full supply water level + Freeboard 2*)]

Note:

- Freeboard 1 = Wave height due to wind + Allowance for Uncertainty in calculating these effects.
- Freeboard 2 = Wave height due to wind + Wave height due to earthquake + Allowance for Uncertainty in calculating these effects.

(b) Wave height due to wind : Calculated by SMB method and Saville's method.

(c) Wave height (he) due to earthquake : Calculated by Sato's formula.

$he = 1/2kT/\pi (gHo)^{1/2}$ where; k : Design seismic intensity
T : Period of seismic wave in second
H0 : Depth of reservoir water

(d) Allowance for uncertainty :

- Rise of water level caused by unexpected accident in operating spillway gates (=0.5m)
- Additional height according to type and importance of dams (Fill type : 1.0m)

(5) Zoning and details of main dam

(a) Upstream and downstream slopes : To be decided through a stability analysis against sliding (refer to (9) of Annex-II):

Zone of Main Dam	Slope	
	Upstream	Downstream
Rock	-	-
Vertical clay zone	1:0.30 or 0.4	1:0.30 or 0.4
Filter zone	1:0.35 same thickness	1:0.35 same thickness

(b) Dam crest width : 10.0 m (refer to (2) of Annex-II)

(c) Crest width of the clay core zone : 4.0 m

(d) Upstream and downstream width of the filter zone : 4.5 m and 6.5 m ,respectively.

(e) Upstream cofferdam : Placed in the dam body.

(f) Berms on the dam body : Not placed except the crest of the upstream cofferdam as required

(g) Slope protection : Provided for upstream slope surface from dam crest to 2-3m below MOL (Refer to (4) of Annex-II)

(h) Stability of Dam : Checked up the safety against sliding of slope in rock-fill dam and sliding of foundation in concrete gravity dam (Refer to (9) of Annex-II for the safety factor rock-fill dam, and refer to (10) of Annex-II for the safety factor concrete gravity dam).

(i) Seismic coefficient : determined to be to be 0.1 with reference to the value adopted in the Dai Nin HPP and other seismic quiet areas such as Korea and Sri Lanka.(Refer to (8) of Annex-II).

2. Foundation

2.1 Dam Foundation

(1) The foundation of the core zone :

Dam height	Rock classification *
H< 30m	IA_1
30m<H<80m	IA_2
80m<H	IB

Note : The rock classification standard in Vietnam is shown in Table-1

(2) The foundation of filter and rock zone : IA_1

(3) Blanket grouting : 5m deep for whole area of the core zone

(4) Curtain grouting : A single line in the center of the core zone and both abutments from the dam body to the point of intersection between FSL and ground water level.

(5) Depth of Curtain grouting (D) : Determined by the upstream water head (H) using following equation.

$$D = 1/3\ H + C$$, where; C: Constant (8-25m), D min : 10m.

(6) Grouting gallery : Not installed.

2.2 Excavation and Embankment Slopes for Structures Other than Dam

(1) Excavation slope (refer to Figure-1) :

Rock Classification	Temporary Slope	Permanent Slope
Soil and deposit	1:1.25	1:1.5
IA	1:0.5-1:0.3	1:1.0
IB	1:0.3	1:0.5
IIA	1:0.3	1:0.3

(2) Berms for excavation slope : Placed on all slopes at maximum 10 m height with 2m wide except the dam foundation.

(3) Embankment slope (refer to Figure-1)

Material	Permanent and Temporary		
	Slope 1:n	Height H(m)	Berm W(m)
1. Excavated rock	1.5	5.0	2.5
2. Earth with compaction	2.0	5.0	3.0
3. Earth without compaction	2.5	5.0	3.0

3. Spillway

(1) Design flood : 1,000-year flood , and its freeboard will be checked for 10,000-year flood (refer to (6) of Annex-II)

(2) Location : Compared right bank and left bank

(3) Spillway type (Control structure) : Center overflow type with radial gates on ogee crest
(Discharge carrier) : Chute type
(Dissipation structure) : Flip bucket type with plunge pools

(4) Approach velocity of the flood flow : Less than 4 m/sec

(5) Ratio width to height (w/h) : More than 1/5
Where, w : approach channel water depth below overflow crest
H : design overflow depth

(6) Freeboard on spillway crest gate : 0.5m at full supply level.

(7) Pier thickness : 3.5m.

(8) Maximum spillway gate size : Within 18m wide and 21m high.

(9) Foundation of spillway structure : Rock classification of IB.

4. Outlet facilities : The necessity of their installation is to be decided subject to environmental requirements (Refer to (13) of Annex-II).

5. Diversion tunnel

(1) Design flood for diversion facility: 20-year probable flood with check up against 3% recurrence flood to ensure non-overtopping (Refer to (1) of Annex-II)

(2) Shape of diversion tunnel : Circle shape

(3) Number of diversion tunnels : Two (for presently proposed discharge volume 3,500 and 3,750m^3/s in Pre-F/s, which will be revised through the present hydrological study.)

(4) Distance between tunnels : Thee times of tunnel diameter at center to center of the tunnel.

(5) Lining thickness of diversion tunnel : No reinforcement bars at sound rock portions

Location	Thickness (m)
Entrance to 1.0 x D	0.10 x D
Other portions	0.06 x D (The max. thickness is 60 cm)

Note: D is inner diameter of tunnel.

(6) Outlet structure : To be decided subject to environmental requirements

(7) Foundation of tunnel entrance : Rock classification of IA.

6. Cofferdam

(1) Type of cofferdam : Rockfill dam with inclined clay facing or other type in case of combined dam.

(2) Cofferdam crest level : Flood water level + Freeboard (=1.0 m)

(3) Flood water level : Determined to provide the sufficient diversion capacity for the design flood.

(4) Crest width of cofferdam : 10 m.

(5) Upstream and downstream slopes of each zone :

Zone Cofferdam	Slope	
	Upstream	Downstream
Rock	Same as main dam	1:1.5
Transition	Depending on upstream rock slope	1:1.5
Impervious	1:3.0	-

7. Intake

(1) Design velocity in Intake : Less than 1.0 m/sec.

(2) Type of intake : The inclined type that consists of the inlet inclined trashrack and inclined gates or vertical type of intake as an alternative

8. Headrace tunnel

(1) Diameter of headrace tunnel : Economical diameter minimized construction cost and benefit decrease due to head loss.

(2) Thickness of lining concrete : 0.08D m at maximum (D: Inner diameter of headrace tunnel). No reinforcement bars at sound rock portions

(3) Foundation of tunnel entrance portion : Rock classification of IB.

9. Surge tank

(1) Type : Restricted orifice surge tank , non-overflow type in consideration of easy construction as well as the cheapest cost among the conceivable types for the Project

(2) Diameter of surge shaft : to be determined by hydraulic analysis. While, the required internal diameter thereof is estimated at about 17 m under the project features presented in the Progress Report No.1.

(3) Thickness of lining concrete : 1.0 m

(4) Top level of headrace tunnel at surge tank : 5m lower than the lowest surging level.

(5) Basic conditions for hydraulic analysis : to be performed under the two cases, namely the full load rejection and half load increase, applying the following hydraulic design values;

Item	Case	
	Full Load Rejection	Half Load Increase
i) Reservoir water level	FSL	MOL
ii) Coefficient of roughness of concrete		
- Initial value(Normal condition)	0.014(0.012)	0.014(0.012)
- For rejection or increase	0.012(0.011)	0.016(0.013)
iii) Change of discharge	From Q=Qp to Q=0.0	From Q=Qp/2 to Q=Qp

Note : (1) Qp is maximum power discharge.
(2). Figures in parenthesis are coefficient of roughness to steel

10. Penstock

(1) Type : Embedded pipe

(2) Diameter of penstock pipe : Economical diameter minimized construction cost and benefit decrease due to head loss

(3) Inclined angle of penstock : 45 degrees.

(4) Minimum ground cover : Three times of the tunnel diameter.

(5) Diameter of penstock pipe :

- Upper horizontal, inclined and lower horizontal portion before the bifurcation : Same size
- Downstream of bifurcation : Half of the section area of the pipe upstream of the bifurcation.

(6) Filling concrete thickness around penstock pipe : 0.6 m.

(7) Maximum design head of penstock pipe at center of turbine (Hmax) :

$$Hmax = Hp1 + Hwh + Hp2$$

Where, Hp1 : Hydrostatic pressure between Full Supply Level(FSL) and center of turbine
Hwh : Water hammer pressure
Hp2 : Hydrostatic pressure between FSL and upper surging water level .

(10) Design load of penstock pipe : Inner hydro pressure.

(11) Minimum thickness (Tmin) of penstock pipe :

$$T\,min = (800+D)/400$$

Where, Tmin : Minimum thickness (mm)
D : Diameter of pipe (mm)

(12) Material of penstock pipe : SM490, allowable tension stress 1,750 kgf/cm^2.

11. Powerhouse

(1) Number of generating units : Two or three.

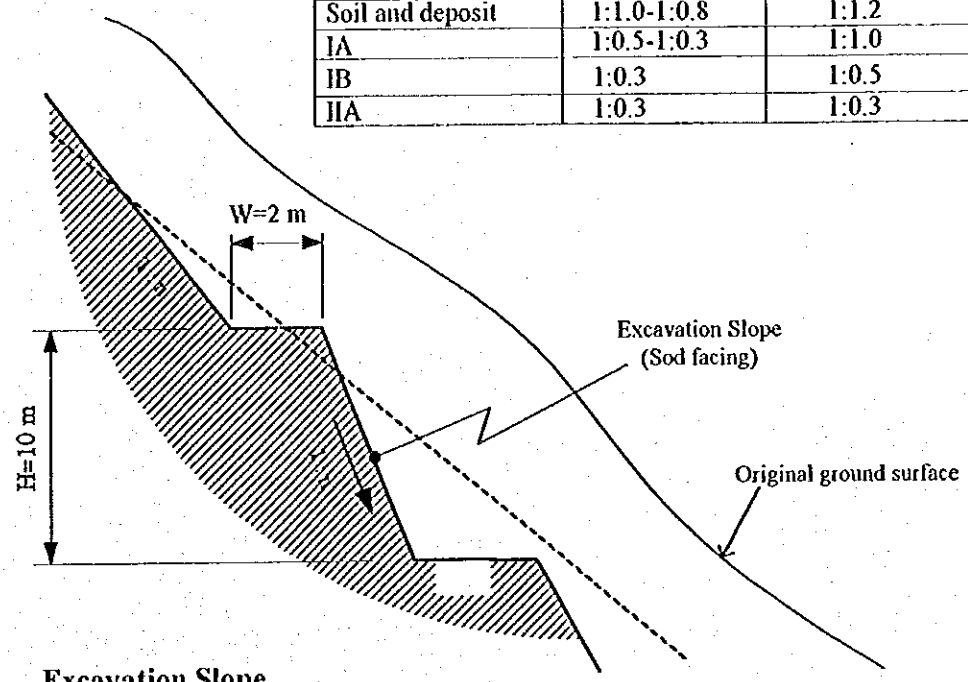
(2) Design water level for the tailrace wall and assembly floor: Calculated by the 100-year probable flood.

Table-1 Comparison of Rock Classification

Grade		Weathering	Description
PIDC2	ISRM		
IIB	I/Fr	Very Fresh	No visible sign of material weathering, very strong, shape of cores 0.3-1.0 m. Physical mechanical property is high and does not change by depth. The permeability is very low and does not change by depth.
IIA		Fresh	No visible sign of material weathering. Perhaps, slight discoloration on major discontinuity surfaces, very strong, shape of cores 0.3-1.0 m. Physical mechanical property is high and change by depth. The permeability is low and changes by depth.
IB	II/SW	Slightly weathered	All or some of the rock material may be discolored by weathering and may be somewhat weaker extremely then when fresh, hard rock shape of cores 0.05-0.1 m. Physico-mechanical property is high and decreases by depth. The permeability is high and changes by depth.
IA2	III/MW	Moderately weathered	< Half the rock material is decomposed and disintegrated to a soil. Fresh and discolored rock is present as either continuous framework or corestones.
IA1	IV/HW	Highly weathered	> Half the rock material is decomposed and disintegrated to a soil. Fresh and discolored rock is present as either continuous framework or corestones.
dQ - eQ	V/CW	Completely weathered	All rock material is decomposed and/or disintegrated to or soil. The original mass structure is still largely intact.

Excavation Slope by Rock Classification (1: n)

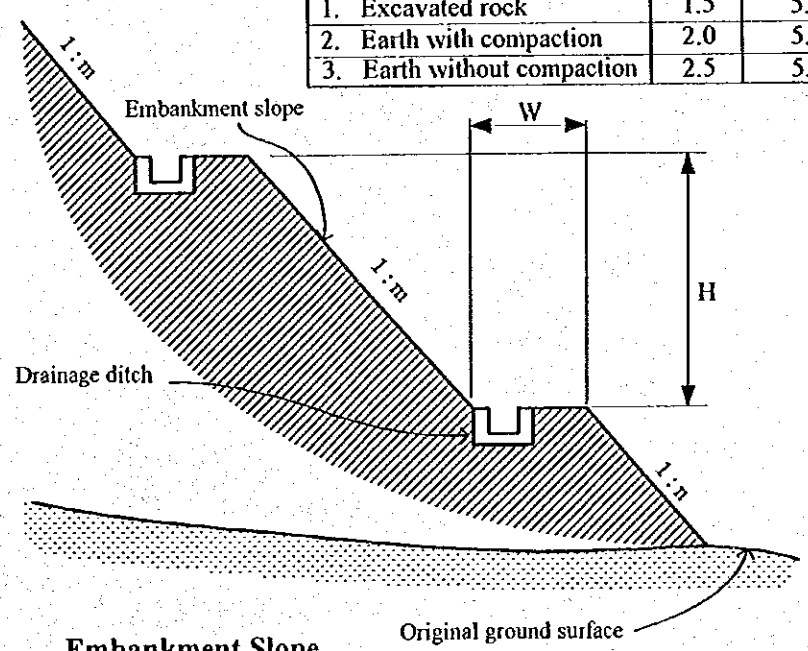
Rock Classification	Temporary Slope	Permanent Slope
Soil and deposit	1:1.0-1:0.8	1:1.2
IA	1:0.5-1:0.3	1:1.0
IB	1:0.3	1:0.5
IIA	1:0.3	1:0.3



Excavation Slope

Embankment Slope (1: m)

Embankment Material	Slope 1:m	Permanent and Temporary	
		Height H(m)	Berm W(m)
1. Excavated rock	1.5	5.0	2.5
2. Earth with compaction	2.0	5.0	3.0
3. Earth without compaction	2.5	5.0	3.0



Embankment Slope

Note: Concrete drainage ditch shall be provided on each berm.
Besides a circumfluent drainage ditch is necessary on outer edge of slope.

Figure-1 Slopes of Excavation and Embankment (for Structures Other than Dam)

Annex-I : Grade of Dam and Powerhouse in Vietnam

Table 1-1 Grade of Dam in Vietnam (in accordance with Dam Height)

Local Material Dam			Concrete and reinforced concrete dam, masonry submerged structure of power station, lock, lift ship, retaining wall , and the other concrete and reinforced concrete works forming the pressure site			Grade of Works
Foundation condition						
Rock	Sand gravel, clay at solid and semi-solid state	Saturated clay at plastic state	Rock	Sand gravel, clay at solid and semi-slid state	Saturated clay at plastic state	
Dam Height (m)						
H>100	H>75	H>50	H>100	H>50	H>25	I
100>=H>70	75>=H>35	50>=H>25	100>=H>60	50>=H>25	25>=H>20	II
70>=H>25	35>=H>15	25>=H>15	60>=H>25	25>=H>10	20>=H>10	III
25>=H>15	8>=H>15	15>=H>8	25>=H>10	10>=H>5	10>=H>5	IV
15>H	8>H	8>H	10>H	5>H	5>H	V

Notes:

1. If the damage of storage works has serious consequences for the cities, industrial area and the defense region, the traffic lines, populated area at the head works downstream, grade of works will be decided from above Table 1-1, and upgraded to suit the consequences scale when there is an appropriate feasibility.
2. If the damage of storage works has not serious consequences for downstream (works laying at a thinly populated area, near the sea), its grade will be determined from above Table 1-1, and lower one grade.
3. Both of Dong Nai No 3 and No.4 dams are defined to be the Grade I dam from above Table 1-1.

Table 1-2 Grade of Hydraulic Work in Vietnam

Output of Power Station (10^3 kW)	Hydrosystem		Water Supply Works with Discharge (m3/sec)	Grade of Long-term Works	
	Irrigation	Drainage		Main	Secondary
1,000>H>300				I	III
300>=H>50	H>50	H>50	20>=H>15	II	III
50>=H>2	50>=H>10	50>=H>10	15>=H> 5	III	IV
2>=H>0.2	10>=H>2	10>=H>2	5>=H>1	IV	IV
0.2>H	2>H	2>H	1>H	V	V

Notes:

1. Power station with installed output of more than 1,000,000 kW, belongs to a special grade, and it must be designed with an exceptional design standard.
2. Both of Dong Nai No.3 and No.4 power stations are defined to be the Grade-II power station from above Table 1-2.

Annex-II : Principal Design Criteria of Dam to be Adopted for Feasibility-Grade Design on Dong Nai N0.3 and No.4 Combined HPP (1/5)

Item of Design Criteria	Vietnamese Code	Japanese Code	Recommended Deign Criteria in the Dong Nai No.3 & No.4 HPP F/S
(1) Design flood for diversion facilities	In case of fill type dam of the Grade-I dam (refer to Annex-I), a 20-year probable flood is adopted as the design flood for diversion facilities.	Not definitely coded. Usually, the similar magnitude of flood to that in the Vietnamese code is adopted.	The following magnitudes of design floods for diversion facilities will be adopted taking the Vietnamese code into consideration: - Fill type dam : 20-year probable flood with check up by 3% recurrence flood as an extraordinary flood - Concrete dam : 5-year probable flood
(2) Crest width of dam	Taking into consideration the workability during construction and preparation of the service road after completion of the Project, the dam crest width should be 10.0 m for all dams in the project.	Not definitely coded.	The Vietnamese Code is to be adopted. The dam crest width is to be taken at 10 m.
(3) Step (for fill type dam)	(Article 3.16-3.17) Although steps should be arranged on both upstream and downstream slopes of homogeneous earthfill dams because of construction requirement (step should be provided with each 10 to 15 m in height and width of those steps to be 5.0 m), whereas in case of rockfill dam those steps do not need to be provided if the construction technology does not require.	Not definitely coded.	The steps will not be provided unless they are needed for the purpose of the construction, following the Vietnamese code.
(4) Slope protection (for fill type dam)	(Article 3.16-3.17, 3.41) Riprap with selected rock should be provided on the upstream slope of rockfill dams for the reinforcement against sliding, weathering and erosion, and for good appearance as well. As for the homogeneous earthfill dams, upstream side slope should be also reinforced by rock material. The thickness of riprap layer and the rock size should be determined to ensure that the dam body is durable against erosion by wave. The reinforced layer of upstream side should be laid out from the top of dam to the foot of upstream slope. Basalt and/or sandstone available at the site, which have a sufficient strength and durability, will be used for the material of slope protection. Rock used for the slope protection should be selected by its quality, size and shape, however, it is possible to use less qualified material within the limit of 25 % of total amount if it can be spread and be trimmed equally as the selected rock along the slope. The top of each dam should be covered with cobblestones or macadam, and asphalt concrete.	Not definitely coded. On the other hand, it is recommended to provide riprap for the upstream slope from dam crest to minimum operation level of reservoir (MOL).	The upstream dam slope will be covered with riprap from dam crest level to 2-3m below MOL.
(5) Impervious structure (for fill type dam)	(Article 4.44-3.52) The dimensions of impervious core of rockfill dam must be determined according to the requirement of permeability capacity to be enough against the seepage gradient as well as taking the condition of construction work and capability of the machines into consideration. The thickness of impervious core in rockfill dam should be increased gradually from the top to the bottom. The thickness at the top should not be less than 0.8 m and that at bottom taken from the gradient of seepage flow should be the value of not less than 10 % of static water head. The top elevation of impervious core zone must be higher than the normal high water level with the water surge caused by wind, and not be lower than flood water level. The dam foundation treatment must be performed for the impervious core zone.	Not definitely coded.	The impervious core zone will be designed adopting the Vietnamese design criteria which are judged to be appropriate and applicable to this Project.

Annex-II : Principal Design Criteria of Dam to be Adopted for Feasibility-Grade Design on Dong Nai N0.3 and No.4 Combined HPP (2/5)

Item of Design Criteria	Vietnamese Code	Japanese Code	Recommended Deign Criteria in the Dong Nai No.3 & No.4 HPP F/S
(6) Design flood for spillway	For the Dong Nai No.3 and No.4 dams that are both categorized to be the Grade-1 dam in accordance with the Vietnamese criteria in Annex-I, a 1,000-year probable flood is to be adopted as the design flood for spillway.	In Japan, the design floods are adopted by the dam type as follows: - Fill type dam including rockfill dam : 1.2 times of 200-year probable flood - Concrete gravity dam : 200-year probable flood	The Vietnamese design code will be adopted.
(7) Freeboard	Dam crest elevation of each dam should be the design maximum water surface level plus freeboard. Freeboard above the full supply level should consist of the several kind of allowances and be evaluated by the more critical case out of the following two cases: Case-1 : $hf + hw_1 + ha_1 + hb$ Case-2 : $hw_2 + ha_2 + hb$ Where, hf : surcharge height due to the flood of 1,000-year return period (0.1 %) hw : height of wave due to design wind velocity, including the wash of water at upstream face of dam(hw_1 is wave height due to the wind of 2-year return period (50 %) and hw_2 is that of 50-year return period (2 %)) ha : constant by the water level (ha1 is 0.7 m for flood condition, and ha2 is 1.0 m for normal condition) hb : constant by the dam height, adopted 1 % of maximum dam height	The crest elevation of non-overflow section of dams must be equal to the maximum design water surface level plus freeboard. The freeboard has to be determined considering the extraordinary flood discharge, wave due to wind or earthquake, rise of water surface level caused by unexpected accident in operating the spillway gate, and operation method of the reservoir. Type and importance of dam must also remain in consideration. The crest elevation of non-overflow section, in case of fill type dam, means to be equal to the elevation of the top in impervious core zone. The design values of freeboard should be larger one of the values computed by the following two formulae: Case-1 : $h_w + h_e + h_a + h_1$ Case-2 : $h_f + h_w + h_a + h_1$ Where, hf : surcharge height due to the design flood hw : height of wave due to design wind velocity, including the rise of water at upstream face of the dam he : height of wave due to the earthquake ha : constant by the spillway gates, ha is normally 0.5 m h_1 : constant by the type of dam, h_1 is normally 1.0 m Height of wave due to the wind should be obtained by combining the S.M.B. Method with Saville Method, and height of wave due to earthquake should be estimated by the following formula: $h_e = \frac{1}{2} \cdot \frac{kT}{\pi} \sqrt{gH_0}$ where, k : seismic coefficient T : period of earthquake wave (sec) H_0 : maximum water depth in the reservoir (m)	The freeboard will be determined to satisfy both the Vietnamese and Japanese codes in terms of the design flood. Besides, a freeboard of 0.5 m will be secured against Probable Maximum Flood (PMF).
(8) Seismic coefficient	Not known. The seismic coefficient is determined for each project.	The design value is determined based on the regional coefficients in Japan, which are coded by the Japanese authorities.	The seismic coefficient is finally determined to be 0.1 in accordance with the current international practice against uncertainities such as artificial earthquake to be triggered by reservoir filling.

Item of Design Criteria	Vietnamese Code	Japanese Code	Recommended Deign Criteria in the Dong Nai No.3 & No.4 HPP F/S
(9) Minimum safety factor against sliding stability of fill (rockfill) type dam by Slip Circle Method (for fill type dam)	(i) Method The slip circle method should be applied for checking the safety factors against sliding failure in several conditions, which are obtained by following formula. The method conforms to the contents in Handbook for Hydraulic Design. $sf = \frac{\sum (G - P_B)\cos\alpha \cdot \tan\phi + C \cdot B / \cos\alpha}{\sum G \cdot \sin\alpha + f \cdot F / R}$ $P_B = \gamma_w \cdot h \cdot B / \cos\alpha$ Where, G : weight of each slice C : cohesion of material on each slice of slip circle B : width of each slice α : angle between vertical line and the line connected center of circle and the slice ϕ : angle of internal friction of material on slip circle of each slice f : seismic force acting on each slice F : vertical length from the center of circle to gravity center in each slice R : radius of circle γ_w : unit weight of water h : water depth above each slice (ii) Calculation Cases The stability analysis should be done for the following cases applying the above formula to determine the upstream and downstream slopes of each dam: <table><tr><th>Calculation Case</th><th>Conditions</th></tr><tr><td>Case-A</td><td>steady condition of the reservoir water level being at normal high water level under the condition with and without earthquake by design seismic coefficient.</td></tr><tr><td>Case-B</td><td>flood condition that the reservoir water level is at the maximum water level under the condition without earthquake.</td></tr><tr><td>Case-C</td><td>at low water level after rapid drawdown from normal high water level under the condition without earthquake.</td></tr><tr><td>Case-D</td><td>at high water level under the condition that the drainage structure is out of function by plugging, without earthquake.</td></tr></table> (To be Continued)	(i) Method The slip circle method should be applied for checking the safety factors against sliding failure in several conditions, which are obtained by the following formula: $S_f = \frac{\sum \{C \cdot l + (N - U - N_e)\tan\phi\}}{\sum (T + T_e)}$ where, Sf : safety factor N : normal force acting on slip circle of each slice T : tangential force acting on slip circle of each slice U : pore pressure acting on slip circle of each slice Ne : normal force of earthquake loading acting on slip circle of each slice Te : tangential force of earthquake load acting on slip circle of each slice ϕ : angle of internal friction of materials on slip circle of each slice C : cohesion of materials on slip circle of each slice l : arc length of slip circle of each slice ii) Loads to be considered The loads to be considered in the slip circle analysis are as follows: <table><tr><th>Load</th><th>Conditions</th></tr><tr><td>Dead weight</td><td>Dead weight to be adopted for analyzing the safety of dam should be wet density of materials used for the portion above pheratic line, and saturated density of materials used below that.</td></tr><tr><td>Hydrostatic Pressure</td><td>A difference between upstream side water pressure and downstream side one should be considered as effective hydrostatic pressure to act on the slices, however the value is small enough as a rule.</td></tr><tr><td>Pore Pressure</td><td>Pore pressure should be assumed to act normally on sliding faces. In analyzing the safety of dam, pore pressure due to the seepage of reservoir water should be considered for impervious zone. In case of rapid drawdown, ebbing water in the upstream side of impervious zone should be regarded as negligible owing to low permeability coefficient of material.</td></tr><tr><td>Earthquake load</td><td>Hydrodynamic pressure caused by earthquake should be estimated as extremely small to be neglected in case of rockfill and earth fill dams.</td></tr></table> (To be Continued)	The Japanese design criteria will be used.

<table>
<tr><th>Item of Design Criteria</th><th>Vietnamese Code</th><th>Japanese Code</th><th>Recommended Deign Criteria in the Dong Nai No.3 & No.4 HPP F/S</th></tr>
<tr>
<td></td>
<td>iii) Safety Factor
The target of the minimum safety factor in each combined calculation case above is as follows:
<table>
<tr><th>Earthquake Condition</th><th>Case-A</th><th>Case-B</th><th>Case-C</th><th>Case-D</th></tr>
<tr><td>with earthquake</td><td>1.125</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>without earthquake</td><td>1.250</td><td>1.125</td><td>1.125</td><td>1.125</td></tr>
</table></td>
<td>(iii) Calculation Cases
The stability analysis should be done for the following conditions by applying the above formula to determine the upstream and downstream slopes of each dam:
<table>
<tr><th>Calculation Case</th><th>Conditions</th></tr>
<tr><td>Case-A</td><td>steady condition of the reservoir water level being at full supply level under the condition with and without earthquake by design seismic coefficient.</td></tr>
<tr><td>Case-B</td><td>flood condition at maximum water level under the condition without earthquake.</td></tr>
<tr><td>Case-C</td><td>at low water level after rapid drawdown from full supply level under the condition with and without earthquake by design seismic coefficient.</td></tr>
</table>
In the earthquake condition in Case-C above, the seismic coefficient can be reduced or be neglected depending on the probability of occurrence of the combined severe situation.

(iv) Safety factor
The target of the minimum safety factor in each combined calculation case of the above should be as follows:
<table>
<tr><th>Earthquake Condition</th><th>Case-A</th><th>Case-B</th><th>Case-C</th></tr>
<tr><td>with earthquake</td><td>1.10</td><td>-</td><td>1.10</td></tr>
<tr><td>without earthquake</td><td>1.25</td><td>1.20</td><td>1.25</td></tr>
</table></td>
<td></td>
</tr>
<tr>
<td>(10) Safety factor for sliding stability of concrete dam

(for concrete gravity dam)</td>
<td>Not known.</td>
<td>The concrete gravity dam has to satisfy the following conditions under the critical loading combination:
(1) At the upstream end of dam body, no tensile stress take place in concrete-rock contact face,
(2) The maximum compressive strength in concrete-rock contact face is not larger than the allowable one,
(3) The shear-friction factor of safety computed by the following Henney's formula is more than 4.0:
$$n = \frac{fV + \tau o l}{H}$$
where,
n : shear-friction factor of safety
f : coefficient of internal friction (=tan ø)
ø : internal friction angle (°)
V : total vertical force per unit length acting on concrete-rock contact surface (ton/m)
o : shear strength (ton/m2)
l : length of shear strength considered for concrete-rock contact face (m)
H : shear force (total horizontal force) per unit width, including seismic force (ton/m)
For the foundation rock of the Dong Nai No.3 and No.4 dams, the shear strength (o) and internal friction (ø) angle are determined with reference to the values adopted for the similar rocks in Japan as follows:
o = 250 ton/m2
ø = 40°</td>
<td>The Japanese code will be used.</td>
</tr>
</table>

Annex-II : Principal Design Criteria of Dam to be Adopted for Feasibility-Grade Design on Dong Nai N0.3 and No.4 Combined HPP (5/5)

Item of Design Criteria	Vietnamese Code	Japanese Code	Recommended Deign Criteria in the Dong Nai No.3 & No.4 HPP F/S
(11) Seepage calculation (for fill type dam)	In case of comparative thin impervious core such as that for rockfill dam, the total seepage amount can be estimated by the following formula with the functions obtained by flow net. $q = k \cdot \Omega$ where, q : unit seepage water through the dam body k : permeability coefficient Ω : total integrated provided by vertical and horizontal components of hydraulic gradient in each flow line	The dam body and foundation must be safe against seepage. The quantity and the velocity of seepage water should be confirmed to be small enough to prevent piping phenomena. Seepage flow should be analyzed by Finite Element Method (FEM) with two dimensional steady flow condition. Assuming that the seepage flow in the dam body and foundation is subject the Darcy's Low, continuous equation of seepage flow is given as the following quasi-harmonic equation: $\frac{\partial}{\partial x}\left(k_x \frac{\partial \phi}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial \phi}{\partial y}\right) + Q = 0$ where, kx, ky : permeability coefficient in x and y dimension Q : seepage water in element ϕ : static pressure at each element by static hydrostatic pressure and fluid density Considering the boundary conditions, solution of the above equation should be obtained by working out the following functional equation: $E = \iint \left[\frac{1}{2}\left\{k_x\left(\frac{\partial \phi}{\partial x}\right)^2 + k_y\left(\frac{\partial \phi}{\partial y}\right)^2\right\} - Q \cdot \phi\right] dxdy + \int q\phi dS$ $\frac{\partial E}{\partial \phi_i} = 0$ Safety for piping phenomena should be confirmed by the comparison of seepage flow with the critical flow velocity on Justin's Theory.	The seepage analysis dose not need to be carried out in the feasibility study stage.
(12) Measuring devices	The measuring devices such as pore pressure meters, water level, settlement and horizontal displacement measuring devices should be installed for observation and monitoring of the performance and conditions of dams and its foundations during construction and after completion. Installation of seismometers will be examined for major dams such as Dong Nai No.3 main dam and Dong Nai No.4 main dam, if required.	The measuring devices are installed in accordauce with the dam operation and maintenance regulation in Japan..	The necessity of the measuring devices will not be examined in the feasibility study stage, but necessary costs will be estimated in accordance with the past experiences.
(13) Outlet facilities	Not definitely coded, but usually the outlet facilities are not provided.	The outlet facilities need to be installed to release the required maintenance flow and to cope with the emergency situation on dam adequately.	Principally, the outlet facilities should be installed. Whether or not the outlet facilities are installed will be determined through the discussion with EVN.

JICA