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No. 8

THE STUDY ON THE DEVELOPMENT PROJECT OF DUMAI PORT IN THE REPUBLIC OF INDONESIA

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3) Estimate the ship length by ship type and size and to convert DWT to GT.

4) Estimate the berthing time at new and existing berths by ship type and size (Port Plan).

5) Establish the unit charges (Management and operation).
Harbour dues & fees based on 1 US$ @ 625 Rp

(1) Harbour dues

Ocean going ship and tanker	$0.07^{US\$}=44^{Rp}$/GT/30 days
Domestic ship	$0.035^{US\$}=22^{Rp}$/GT/30 days

(2) Berthage fee

Ocean going ship and tanker	$0.07^{US\$}=44^{Rp}$/GT/24 hours
Domestic ship	$0.026^{US\$}=16.5^{Rp}$/GT/24 hours

(3) Pilotage fee

a. Per ship

Ocean going ship and tanker

$30{,}700^{Rp} \times 2 = 61{,}400^{Rp}$

$49.1^{US\$} \times 2 = 98.2^{US\$}$/ship

Domestic ship

$20{,}400^{Rp} \times 2 = 40{,}800^{Rp} = 65.28^{US\$}$/ship

b. Per GT

Ocean going ship and tanker

$14.95^{Rp} \times 2 = 29.9^{Rp}$

$$14.95^{Rp} = \underset{\text{Harbour Pilot}}{7.44} + \left(\frac{\underset{\text{Rupat Strait}}{10.3} + \underset{\text{Bengkalis strait}}{4.8}}{2}\right) \quad \text{(Sea Pilot)}$$

$0.0245^{US\$} \times 2 = 0.049^{US\$}$/GT

$$0.0245^{US\$} = \underset{\text{Harbour Pilot}}{0.012} + \left(\frac{\underset{\text{Rupat Strait}}{0.017} + \underset{\text{Bengkalis Strait}}{0.008}}{2}\right) \quad \text{(Sea Pilot)}$$

Domestic ship $9.95^{Rp} \times 2 = 19.9^{Rp} = 0.31^{US\$}/GT$

$$19.9^{Rp} = \underset{\text{Harbour Pilot}}{5} + \left(\frac{\underset{\text{Rupat Strait}}{6.6} + \underset{\text{Bengkalis Strait}}{3.3}}{2}\right) \quad \text{(Sea Pilot)}$$

c. Additional fee (delay etc.)

Ocean going ship $70^{US\$} = 43,750^{Rp}$/ship

Domestic ship $35^{US\$} = 218,750^{Rp}$/ship

(4) Towage fee

Required tugboat			Per tugboat		Per hour	
L.O.A	Number	HP	Ocean going ship	Domestic ship	Ocean going ship	Domestic ship
71~100m	1	600~1,200	$62^{US\$} \times 2 = 124^{US\$} = 38,500^{Rp} \times 2 = 77,000^{Rp}$	$25,500^{Rp} \times 2 = 51,000^{Rp} = 81.6^{US\$}$	$168^{US\$} \times 2 = 336^{US\$} = 105,000^{Rp} \times 2 = 210,000^{Rp}$	$68,500^{Rp} \times 2 = 137,000^{Rp} = 219.2^{US\$}$
101~150m	2	1,700~3,400	$62^{US\$} \times 2 \times 2 = 248^{US\$} = 38,500^{Rp} \times 2 \times 2 = 154,000^{Rp}$	$25,500^{Rp} \times 2 \times 2 = 102,000^{Rp} = 163.2^{US\$}$	$168^{US\$} \times 2 \times 2 = 672^{US\$} = 105,000 \times 2 \times 2 = 420,000^{Rp}$	$68,500^{Rp} \times 2 \times 2 = 274,000^{Rp} = 438.4^{US\$}$
151~200m	2	3,400~4,000	$90^{US\$} \times 2 \times 2 = 360^{US\$} = 56,000^{Rp} \times 2 \times 2 = 224,000^{Rp}$	$37,000^{Rp} \times 2 \times 2 = 148,000^{Rp} = 236.8^{US\$}$	$245^{US\$} \times 2 \times 2 = 980^{US\$} = 152,500 \times 2 \times 2 = 610,000^{Rp}$	$100,000^{Rp} \times 2 \times 2 = 400,000^{Rp} = 640^{US\$}$
201~	3	4,000~	$138^{US\$} \times 3 \times 2 = 828^{US\$} = 86,000^{Rp} \times 3 \times 2 = 516,000^{Rp}$	$60,000^{Rp} \times 3 \times 2 = 360,000^{Rp} = 576^{US\$}$	$341^{US\$} \times 3 \times 2 = 2,046^{US\$} = 213,000^{Rp} \times 3 \times 2 = 1,278,000^{Rp}$	$142,000^{Rp} \times 3 \times 2 = 852,000^{Rp} = 1,363.2^{US\$}$

(5) Rope handling fee

Domestic ship $11,500^{Rp} \times 2 = 23,000^{Rp} = 36.8^{US\$}$/ less than 70m ship

6) 50% of the ocean going ships are ships from the Indonesian merchant fleet and fees are calculated based in Rp. But the amounts are all converted to US$ in this report.

From items 2), 3), and 4), the numeric values shown in the following table were obtained;

Ship Type and Size Number of Ship Calls by Cargo

Commodity	Ship Type and Size				Berth Occupancy Time		Number of Ship Calls		
	Trade Type	DWT	GT	L.O.A (m)	New Wharf (h)	Exisiting Wharf (h)	1987	1988	1989
Palm Oil	For export								
	① Percel Tanker	26,000	16,250	170	31	–	6	8	10
	② Deep Tank For domestic use	10,000	6,670	144	12	–	44	58	75
	③ Percel Tanker	2,300	1,438	82	12	12	46	62	80
Sawn Timber	④ For export	12,000	8,000	150	143	158	11	12	13
	⑤ For domestic use	1,000	667	58	–	77	13	15	16
Fertilizer	⑥ For domestic use	8,000	5,336	135	173	192	21	23	25
	⑦ For domestic use	5,000	3,335	102	173	192	25	26	28
Rice	⑧ For import	8,000	5,336	135	185	205	8	8	9
	⑨ For domestic use	1,000	667	58	–	58	80	84	88
	⑩ For domestic use	500	334	50	–	25	90	95	95
Palm Kernels and Rubber	⑪ For export	10,000	6,670	144	54	60	10	15	20
	⑫ For domestic use	1,000	667	58	–	72	25	34	45
General Cargo	⑬ For domestic use	5,000	3,335	102	152	169	21	23	25
	⑭ For domestic use	300	200	40	–	15	150	160	180
	⑮ For import	10,000	6,670	144	189	210	7	7	7
Total							557	630	716

1.2. Assumptions for Tanker Sector

1) From the past records and the capacities of the hydro-cracker factory at Pertamina and the Caltex Dumai Refinery, the number of ship calls by ship size is estimated as follows.

Trade Type	DWT	GT	L.O.A (m)	Number of Ship Calls		
				1987	1988	1989
For export	100,000	58,800	270	520	535	550
For domestic use	35,000	20,580	200	287	295	303
	15,000	8,320	157	182	187	192
	12,500	7,350	150	32	39	40
Total				1,027	1,056	1,085

2) Setting unit charges

These are the same as those of the commercial port sector and are based on US$ for all ships. But a berthage fee will not be charged.

3) Outlook of petroleum demand and supply and the growth rate of revenue for the tanker sector

The growth rate of petroleum from 1985 to 1990 is 3.03% annually from the data "Outlook of energy demand and supply in the free world" prepared for the 3rd IEA Meeting and thus an annual growth rate of 3% is employed here for the years from 1982 to 1989.

Outlook of Energy Demand and Supply in the Free World Prepared for the 3rd IEA Meeting
(Unit: Converted to 1 million barrels of oil per day)

Commodity	1976	1985	1990	2000
Oil	45.9	64.2	74.5	93.0
Coal	15.8	22.8	27.8	34.8
Natural Gas	14.8	19.1	21.1	25.6
Nuclear Power	1.9	6.5	10.3	23.2
Hydro/Geothermal	5.6	8.1	9.6	14.2
Total	84.0	120.7	143.3	190.6

Oil Demand and Supply

	1976	1985	1990	2000
Demand	45.9	64.2	74.5	93.0
Supply				
OECD Areas	12.0	16.5	15.5	14.0
Non-OPEC Areas	5.5	8.9	11.5	13.0
Subtotal	17.5	25.4	27.0	27.0
Expected Production by OPEC	28.4	38.8	47.5	66.0
Possible Production by OPEC	28.4	35.5	38.0	38.0
Demand and Supply Gap	—	△3.3	△9.5	△28.0

2. Revenues from Cargos

1) Estimate the cargo volume passing through the wharves of the Port of Dumai (Cargo Forecast).

2) Separate the cargos handled in to domestic and ocean going cargoes (see Table 9.2.2).

3) Estimate the cargo volumes in the transit sheds and the open storage yard (see Table 9.2.3).

4) Establish unit charges (Management and operation).
Values are converted with a rate of 1US$ = 625 Rp.

(1) Wharfage charge

a. Export cargo			$90^{Rp} = 0.144^{US\$}$/Ton
b. Non export cargo			
	a) Palm oil, Fertilizer, Rice		$220^{Rp} = 0.352^{US\$}$/Ton
	b) Others cargo		$275^{Rp} = 0.44^{US\$}$/Ton
c. Container		a) Empty	$7^{Rp} = 0.0112^{US\$}$/TEU
		b) Loaded	$15^{Rp} = 0.024^{US\$}$/TEU

(2) Transit shed charge

$748^{Rp} = 1.1968^{US\$}$/Ton/15 days

($44^{Rp} = 0.0704^{US\$}$/Ton/1 ~ 5 days
$264^{Rp} = 0.4224^{US\$}$/Ton/6 ~ 10 days
$440^{Rp} = 0.704^{US\$}$/Ton/11 ~ 15 days)

(3) Open storage charge

$374^{Rp} = 0.5984^{US\$}$/Ton/15 days

($22^{Rp} = 0.0352^{US\$}$/Ton/1 ~ 5 days
$132^{Rp} = 0.2112^{US\$}$/Ton/6 ~ 10 days
$220^{Rp} = 0.352^{US\$}$/Ton/11 ~ 15 days)

(4) Container charge

Empty $550^{Rp} = 0.88^{US\$}$/TEU/day
Loaded $1,250^{Rp} = 2^{US\$}$/TEU/day

(5) Crane rental fee

2.5 ton forklift	$2,300^{Rp} = 3.68^{US\$}$/hour
5 ton forklift	$2,650^{Rp} = 4.24^{US\$}$/hour
15 ton mobile crane	$6,000^{Rp} = 9.6^{US\$}$/hour

(6) Entry Permit

8 ton Truck	$250^{Rp} = 0.4^{US\$}$/once
8 ton Trailer	$300^{Rp} = 0.48^{US\$}$/once

5) Assumptions made as a result of the determination of the unit charges

(1) Percentage of containerization (Port Plan)

	1988	1989
Palm Kernels	10%	20%
Rice	10%	15%
General cargo	8%	17%

Container cargos of 20 TEU are considered to be one load of 7 tons.

(2) Capacity of cargo handling machines

One forklift: 20 tons per hour

One mobile crane: 12 containers per hour

(3) Capacity of trucks in the waterfront area

8 tons for truck and trailer

(4) Handling empty containers

The difference in the numbers (TEU) of incoming and outgoing containers, as calculated by the percentage of containerization, is used as the number of empty containers.

A 20% of the empty containers will be stacked on the open storage.

3. Other Revenues

(1) Land rent, revenue from the Health Center and interest on bank loans are calculated with an annual growth rate of 3% basing upon the financial data of the Port of Dumai in 1981.

(2) Interest is calculated for both the commercial port and tanker sectors depending upon the number of ship calls.

4. Revenues of the Port of Dumai

Revenues obtained by the calculations described in Sections 1, 2 and 3 are indicated in the table below.

Total Revenues of Dumai Port

Commodity \ Year	1987					1988					1989				
	Total Revenue ('000US$)	Commercial Port			Tanker	Total Revenue ('000US$)	Commercial Port			Tanker	Total Revenue ('000US$)	Commercial Port			Tanker
		Total ('000US$)	US$ ('000US$)	Rp '000Rp ('000US$)	('000US$)		Total ('000US$)	US$ ('000US$)	Rp '000Rp ('000US$)	('000US$)		Total ('000US$)	US$ ('000US$)	Rp '000Rp ('000US$)	('000US$)
Revenues from Ships	7,439	543	163	237,759 (380)	6,896	7,721	628	189	274,154 (439)	7,093	8,002	712	229	301,934 (483)	7,290
Revenues from Cargos	1,067	1,067	-	667,110 (1,067)	-	1,300	1,300	-	812,447 (1,300)	-	1,559	1,559	-	974,197 (1,559)	-
Other Revenues	297	167	-	104,288 (167)	130	306	176	-	110,002 (176)	130	315	188	-	117,296 (188)	127
Total	8,803	1,777	163	1,009,157 (1,614)	7,026	9,327	2,104	189	1,196,603 (1,915)	7,223	9,876	2,459	229	1,393,427 (2,230)	7,417

II. Case Study in Financial Analysis

1.1 Analysis of Financial Statements

1. Premises

(1) Estimated financial statements are to be prepared for the target period from 1984 to 2009 when the project life ceases.

(2) Present port tariff as of 1983 is to be used for calculating revenue.

(3) Costs are to be based on prices in 1982.

(4) The amount of the project investment is to be counted in the financial statements in accordance with the three cases of fund raising methods shown in Table II-1. (Relevant to R/D Para. 14)

Table II-1 Fund Raising Method

Case	Foreign currency portion (57.5%)	Domestic currency portion (42.5%)
1.	Long-term loan from foreign bank *Annual interest rate*: 3.5% Grace period: 10 years Repayment period: 30 years Term of loan: 40 years	National Development Funds, interest free
2.	Long-term loan from foreign bank *Annual interest rate*: 11% Other conditions are the same as Case 1.	Same as the Case 1
3.	Long-term loan from foreign bank Annual interest rate: 8% Other conditions are the same as Case 1.	Same as the Case 1

(5) Depreciation of fixed assets is to be based on the regulations established by the Government of Indonesia in March 1983, and life cycle is to be as set forth in Table II-2. (Relevant to R/D Para. 11)

Table II-2 Depreciation Rate and Life Cycle by Facilities

Item	Depreciation Rate	Life Cycle (years)
Quay (Concret)	0.04	25
(Wooden/Steel)	0.1	10
Open Storage	0.04	25
Warehouse	0.04	25
Road	0.05	20
Office Building	0.04	25
Water Supply	0.04	25
Power Supply	0.04	25
Navigation Aids	0.04	25
Cargo Handling Equipment	0.1	10
Vessel	0.05	20
Bouy	0.04	25

(6) Operating expenses are to be calculated for two cases of expenses; expenses (Type A) related to the whole of the Port of Dumai, and expenses related to the commercial port (Type B).

(7) Surplus is to be the same as that of the report.

(8) All numeric values for the above are to be in US$ 1,000.

1.2 Analysis of Financial Rate of Return (FRR)

Method of analysis is to be the same as that of the report.

2. Revenue

This is to be the same as that described in Para. I in this report. Revenue is separated into two cases; revenue for the whole of the Port of Dumai (Type A), and revenue for the commercial port (Type B). (Relevant to R/D Para. 13)

3. Expenditures

Expenditures may be divided into five categories, as in the report; personnel costs, general administrative costs, depreciation expenses, and interest on loans.

(1) Personnel Costs

Personnel costs are the same as those of the report for Type A. However, for Type B, the personnel working in the Secretariat, the Technical Division, the Finance Division, the Pilotage Division and the Fire Brigade is divided between the tanker sector and the commercial port sector on the basis of the ratio of the number of ship calls in each sector.

(2) General Administrative Costs

The Calculation method is the same as that of the report.

(3) Maintenance/Operating Costs

These are the same as those of the report.

(4) Depreciation Expenses

These are calculated by cumulating the amount of depreciation basing on the depreciation rate and life cycle (Table II-2) stated before.

Since the mean life cycle of newly invested assets to be depreciated is 21 years, the completion year of this project is set to be 2009.

The fixed assets schedule after 1984 is indicated in Table II-3.

Table II-3 Fixed Assets Schedule

Unit: '000 US$

		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994~1998	1999~2003	2004~2009
Fixed Assets at Beginning Year		17,307	21,930	30,234	49,365	65,837	75,177	71,554	67,931	64,308	60,685	57,232	41,047	24,862
Non-Depreciable Assets (land)		84	84	84	84	84	84	7,033	7,033	7,033	7,033	7,033	7,033	7,033
Depreciable Assets		19,594	24,273	28,952	30,431	34,390	35,146	79,302	79,302	79,302	79,302	79,302	79,302	79,302
Depreciation		3,850	4,972	6,313	7,654	9,391	11,158	14,781	18,404	22,027	25,650	29,103	45,288	61,473
Written down value		15,744	19,301	22,639	22,777	24,999	23,988	64,521	60,898	57,275	53,652	50,199	34,014	17,829
Construction in Process		1,479	2,545	7,511	26,504	40,754	51,105							
Investment		5,745	9,645	20,472	18,209	11,107								
Existing Facilities		4,679	4,679											
New Facilities		1,066	4,966	20,472	18,209	11,107								
Non-Depreciable Assets							6,949							
Depreciable Assets		4,679	4,679	1,479	3,959	756	44,156							
Construction in Process		2,545	6,445	20,472	18,209	11,107								
Depreciation		1,122	1,341	1,341	1,737	1,767	3,623	3,623	3,623	3,623	3,453	16,185	16,185	17,662
Fixed Assets at End of Year	17,307	21,930	30,234	49,365	65,837	75,177	71,554	67,931	64,308	60,685	57,232	41,047	24,862	7,200
Non-Depreciable Assets (land)	84	84	84	84	84	84	7,033	7,033	7,033	7,033	7,033	7,033	7,033	7,033
Depreciable Assets	19,594	24,273	28,952	30,431	34,390	35,146	79,302	79,302	79,302	79,302	79,302	79,302	79,302	79,302
Depreciation	3,850	4,972	6,313	7,654	9,391	11,158	14,781	18,404	22,027	25,650	29,103	45,288	61,473	79,135
Written down value	15,744	19,301	22,639	22,777	24,999	23,988	64,521	60,898	57,275	53,652	50,199	34,014	17,829	167
Construction in Process	1,479	2,545	7,511	26,504	40,754	51,105								

(5) Interest on Long Term Loans

This is the same as that of the report for Case 1 (Table 9.3.6), and is shown Table II-4 for Case 2 and in Table II-5 for Case 3.

Table II-4 Long Term Loans Schedule (Case 2)

(Unit: '000US$)

Year	Project Cost			Loan Repayment Amount	Loan Balance at End	Interest on Loan
	National Development Loan	Long Term Loan	Total			
1984	376	690	1,066		690	76
1985	1,704	3,262	4,966		3,952	435
1986	7,908	12,564	20,472		16,516	1,817
1987	8,950	9,259	18,209		25,775	2,835
1988	4,803	6,304	11,107		32,079	3,529
1989					32,079	3,529
1990					32,079	3,529
1991					32,079	3,529
1992					32,079	3,529
1993					32,079	3,529
1994				1,069	31,010	3,411
1995				1,069	29,941	3,294
1996				1,069	28,872	3,176
1997				1,069	27,803	3,058
1998				1,069	26,734	2,941
1999				1,069	25,665	2,823
2000				1,069	24,596	2,706
2001				1,069	23,527	2,588
2002				1,069	22,458	2,470
2003				1,069	21,389	2,353
2004				1,069	20,320	2,235
2005				1,069	19,251	2,118
2006				1,069	18,182	2,000
2007				1,069	17,113	1,882
2008				1,069	16,044	1,765
2009				1,069	14,975	1,647

Table II-5 Long Term Loans Schedule (Case 3)

(Unit: '000US$)

Year	Project Cost			Loan Repayment Amount	Loan Balance at End	Interest on Loan
	National Development Loan	Long Term Loan	Total			
1984	376	690	1,066		690	55
1985	1,704	3,262	4,966		3,952	316
1986	7,908	12,564	20,472		16,516	1,321
1987	8,950	9,259	18,209		25,775	2,062
1988	4,803	6,304	11,107		32,079	2,566
1989					32,079	2,566
1990					32,079	2,566
1991					32,079	2,566
1992					32,079	2,566
1993					32,079	2,566
1994				1,069	31,010	2,481
1995				1,069	29,941	2,395
1996				1,069	28,872	2,310
1997				1,069	27,803	2,224
1998				1,069	26,734	2,139
1999				1,069	25,665	2,053
2000				1,069	24,596	1,968
2001				1,069	23,527	1,882
2002				1,069	22,458	1,797
2003				1,069	21,389	1,711
2004				1,069	20,320	1,626
2005				1,069	19,251	1,540
2006				1,069	18,182	1,455
2007				1,069	17,113	1,369
2008				1,069	16,044	1,284
2009				1,069	14,975	1,198

4. Financial Situations

Financial statements for the years from 1984 to 2009 are prepared in conformity with the revenues and expenditures described above. The estimated income statement, the statement of sources and applications of funds and the balance sheets for the years from 1984 to 2009 are respectively shown in Tables II-6, II-7 and II-8.

Financial statements are prepared for the following four cases:

Cases A1, A2 and A3

Case B1

(A and B designate the types of revenue and operating expenses, and numerals 1 to 3 designate the fund raising method.)

4.1 Evaluation

The financial ratios are the same as those of the report. The financial ratios are calculated for each case and indicated in Table II-9.

Also, the financial rate of return (FRR) for each case is as indicated in Table II-10. Calculations of FRR for A1, A2 and A3 are as indicated in Table II-16.

Table II-6 Income Statement

Unit: '000US$

Item \ Year	Case	(1983)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994~1998	1999~2003	2004~2009
Operating Revenue	A1,A2,A3	7,373	7,631	7,997	8,389	8,803	9,327	9,876	9,876	9,876	9,876	9,876	49,386	49,386	59,256
	B1	1,075	1,161	1,350	1,552	1,776	2,104	2,459	2,459	2,459	2,459	2,459	12,295	12,295	14,754
Operating Expenditure	A1,A2,A3	3,421	3,684	3,947	3,958	3,978	4,204	4,409	4,409	4,409	4,409	4,409	22,045	22,045	26,454
	B1	947	1,089	1,378	1,383	1,443	1,620	1,832	1,832	1,832	1,832	1,832	9,160	9,160	10,992
Operating Profit	A1,A2,A3	3,952	3,947	4,050	4,431	4,825	5,123	5,467	5,467	5,467	5,467	5,467	27,335	27,335	32,802
	B1	128	72	△28	169	333	484	627	627	627	627	627	3,135	3,135	3,762
Depreciation		903	1,122	1,341	1,341	1,737	1,767	3,623	3,623	3,623	3,623	3,453	16,185	16,185	17,662
Interest on Loan	A1,B1		24	138	578	902	1,123	1,123	1,123	1,123	1,123	1,123	5,053	4,120	3,706
	A2		76	435	1,817	2,835	3,529	3,529	3,529	3,529	3,529	3,529	15,880	12,940	11,647
	A3		55	316	1,321	2,062	2,566	2,566	2,566	2,566	2,566	2,566	11,549	9,411	8,472
Profit after Depreciation and Interest on Loan	A1	3,049	2,801	2,571	2,512	2,186	2,233	721	721	721	721	891	6,097	7,030	11,434
	A2	3,049	2,749	2,274	1,273	253	△213	△1,685	△1,685	△1,685	△1,685	△1,515	△4,730	△1,790	3,493
	A3	3,049	2,770	2,393	1,769	1,026	790	△722	△722	△722	△722	△552	△399	1,739	6,668
	B1	△775	△1,074	△1,507	△1,750	△2,306	△2,406	△4,119	△4,119	△4,119	△4,119	△3,949	△18,103	△17,170	△17,606
Tax	A1	1,372	1,260	1,157	1,130	984	1,005	324	324	324	324	401	2,744	3,164	5,145
	A2	1,372	1,237	1,023	573	114	-	-	-	-	-	-	-	-	1,572
	A3	1,372	1,247	1,077	796	462	356	-	-	-	-	-	-	783	3,001
	B1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
National Development Fund Reserve	A1	922	848	778	760	661	675	218	218	218	218	270	1,844	2,126	3,459
	A2	922	832	688	385	76	-	-	-	-	-	-	-	-	1,057
	A3	922	838	724	535	310	239	-	-	-	-	-	-	526	2,017
	B1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Profit	A1	755	693	636	622	541	553	179	179	179	179	220	1,509	1,740	2,830
	A2	755	680	563	315	63	△213	△1,685	△1,685	△1,685	△1,685	△1,515	△4,730	△1,790	864
	A3	755	685	592	438	254	195	△722	△722	△722	△722	△552	△399	430	1,650
	B1	△775	△1,074	△1,507	△1,750	△2,306	△2,406	△4,119	△4,119	△4,119	△4,119	△3,942	△18,103	△17,170	△17,606
Accumulated Net Profit from 1981	A1	7,041	7,734	8,370	8,992	9,537	10,086	10,265	10,444	10,623	10,802	11,022	12,531	14,271	17,101
	A2	7,041	7,721	8,284	8,599	8,662	8,449	6,764	5,079	3,394	1,709	194	△4,536	△6,326	△5,462
	A3	7,041	7,726	8,318	8,756	9,010	9,205	8,483	7,761	7,039	6,317	5,765	5,366	5,796	7,446
	B1	5,511	4,437	2,930	1,180	△1,126	△3,532	△7,651	△11,770	△15,889	△20 008	△23,957	△42,060	△59,230	△76,836

Table II-7 Statement of Source and Application of Funds

(Unit: '000US$)

Item \ Year	Case	(1983)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994~1998	1999~2003	2004~2009
Source of Funds (A)															
Net Profit	A1	755	693	636	622	541	553	179	179	179	179	220	1,509	1,740	2,830
	A2	755	680	563	315	63	△213	△1,685	△1,685	△1,685	△1,685	△1,515	△4,730	△1,790	864
	A3	755	685	592	438	254	195	△722	△722	△722	△722	△552	△399	430	1,650
	B1	△775	△1,074	△1,507	△1,750	△2,306	△2,406	△4,119	△4,119	△4,119	△4,119	△3,949	△18,103	△17,170	△17,606
Depreciation		903	1,122	1,341	1,341	1,737	1,767	3,623	3,623	3,623	3,623	3,453	16,185	16,185	17,662
Long Term Loan			690	3,262	12,564	9,259	6,304								
National Development Fund		1,479	5,055	6,383	7,908	8,950	4,803								
Total	A1	3,137	7,560	11,622	22,435	20,487	13,427	3,802	3,802	3,802	3,802	3,673	17,694	17,925	20,492
	A2	3,137	7,547	11,549	22,128	20,009	12,661	1,938	1,938	1,938	1,938	1,938	11,455	14,395	18,526
	A3	3,137	7,552	11,578	22,251	20,200	13,069	2,901	2,901	2,901	2,901	2,901	15,786	16,615	19,312
	B1	1,607	5,793	9,479	20,063	17,640	10,468	△496	△496	△496	△496	△496	△1,918	△985	56
Application of Fund (B) Cost of Fixed Assets Addition		1,479	5,745	9,645	20,472	18,209	11,107								
Repayment of Long Term Loan													5,345	5,345	6,414
Total		1,479	5,745	9,645	20,472	18,209	11,107						5,345	5,345	6,414
Increase/Decrease of	A1	1,658	1,815	1,977	1,963	2,278	2,320	3,802	3,802	3,802	3,802	3,673	12,349	12,580	14,708
Net Current Assets (C)	A2	1,658	1,802	1,904	1,656	1,800	1,554	1,938	1,938	1,938	1,938	1,938	6,110	9,050	12,112
(C = A − B)	A3	1,658	1,807	1,933	1,779	1,991	1,962	2,901	2,901	2,901	2,901	2,901	10,441	11,270	12,898
	B1	128	48	△166	△409	△569	△639	△496	△496	△496	△496	△496	△7,263	△6,330	△6,358
Net Current Assets	A1	1,028	2,686	4,501	6,478	8,441	10,719	13,039	16,841	20,643	24,445	28,247	31,920	44,269	56,849
at Begining of Year	A2	1,028	2,686	4,488	6,392	8,048	9,848	11,402	13,340	15,278	17,216	19,154	21,092	27,202	36,252
(D)	A3	1,028	2,686	4,493	6,426	8,205	10,196	12,158	15,059	17,960	20,861	23,762	26,663	37,104	48,374
	B1	1,028	1,156	1,204	1,038	629	60	△579	△1,075	△1,571	△2,067	△2,563	△3,059	△10,322	△16,652
Net Current Assets	A1	2,686	4,501	6,478	8,441	10,719	13,039	16,841	20,643	24,445	28,247	31,920	44,269	56,849	70,927
at End of Year (E)	A2	2,686	4,488	6,392	8,048	9,848	11,402	13,340	15,278	17,216	19,154	21,092	27,202	36,252	48,364
(E = C + D)	A3	2,686	4,493	6,426	8,205	10,196	12,158	15,059	17,960	20,861	23,762	26,663	37,104	48,374	61,272
	B1	1,156	1,204	1,038	629	60	△579	△1,075	△1,571	△2,067	△2,563	△3,059	△10,322	△16,652	△23,010

Table II-8 Ballance Sheet

(Unit: '000US$)

Item \ Year	Case	(1983)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994~1998	1999~2003	2004~2009
Assets															
Fixed Assets		17,307	21,930	30,234	49,365	65,837	75,177	71,554	67,931	64,308	60,685	57,232	41,047	24,862	7,200
Net Current Assets	A1	2,686	4,501	6,478	8,441	10,719	13,039	16,841	20,643	24,445	28,247	31,920	44,269	56,849	70,927
	A2	2,686	4,488	6,392	8,048	9,848	11,402	13,340	15,278	17,216	19,154	21,092	27,202	36,252	48,364
	A3	2,686	4,493	6,426	8,205	10,196	12,158	15,059	17,960	20,861	23,762	26,663	37,104	48,374	61,272
	B1	1,156	1,204	1,038	629	60	△579	△1,075	△1,571	△2,067	△2,563	△3,059	△10,322	△16,652	△23,010
Total	A1	19,993	26,431	36,712	57,806	76,556	88,216	88,395	88,574	88,753	88,932	89,152	85,316	81,711	78,127
	A2	19,993	26,418	36,626	57,413	75,685	86,579	84,894	83,209	81,524	79,839	78,324	68,249	61,114	55,564
	A3	19,993	26,423	36,660	57,570	76,033	87,335	86,613	85,891	85,167	84,447	83,895	78,151	73,236	68,472
	B1	18,463	23,134	31,272	49,994	65,897	74,598	70,479	66,360	62,241	58,122	54,173	30,725	8,210	△15,810
Liabilities															
Capital Loan by Government (National Development Fund)		12,952	18,007	24,390	32,298	41,248	46,051	46,051	46,051	46,051	46,051	46,051	46,051	46,051	46,051
Long Term Loan			690	3,952	16,516	25,775	32,079	32,079	32,079	32,079	32,079	32,079	26,734	21,389	14,975
Capital and Reserve	A1	7,041	7,734	8,370	8,992	9,533	10,086	10,265	10,444	10,623	10,802	11,022	12,531	14,271	17,101
	A2	7,041	7,721	8,284	8,599	8,662	8,449	6,764	5,079	3,394	1,709	194	△4,536	△6326	△5,462
	A3	7,041	7,726	8,318	8,756	9,010	9,205	8,483	7,761	7,039	6,317	5,765	5,366	5,796	7,446
	B1	5,511	4,437	2,930	1,180	△1,126	△3,532	△7,651	△11,770	△15,889	△20,008	△23,957	△42,060	△59,230	△76,836
Total	A1	19,993	26,431	36,712	57,806	76,556	88,216	88,395	88,574	88,753	88,932	89,152	85,316	81,711	78,127
	A2	19,993	26,418	36,626	57,413	75,685	86,579	84,894	83,209	81,524	79,839	78,324	68,249	61,114	55,564
	A3	19,993	26,423	36,660	57,570	76,033	87,335	86,613	85,891	85,169	84,447	83,895	78,151	73,236	68,472
	B1	18,463	23,134	31,272	49,994	65,897	74,598	70,479	66,360	62,241	58,122	54,173	30,725	8,210	△15,810

Table II-9 Financial Ratios

(%)

Item \ Case	A1		A2		A3		B1	
	1989	1994~1998	1989	1994~1998	1989	1994~1998	1989	1994~1998
Working Ratio	45	45	45	45	45	45	75	75
Operating Ratio	89	80	117	110	107	103	268	256
Return on Net Fixed Assets	3	4	3	5	3	5	–	–
Interest Earned Ratio	196	218	52	63	72	87	–	–
Debt Service Coverage	407	263	280	233	385	292	–	–

Table II-10 FRR

Case	A1, A2, A3	B1
%	8.6	–

1) Evaluation for Each Case

(1) Case A1

Same as the report.

(2) Case A2

Since the execution of payment of interest on loans and depreciation will create a large burden, an average deficit of US$883,000 will occur in each fiscal period for 17 years from 1988 to 2004, but this deficit will disappear after 2005. However, this deficit will not obstruct the repayment of principal and interest on loans in each fiscal period after the execution of the project.

(3) Case A3

For the same reasonas in Case A2, an average deficit of US$343,000 will occur in each fiscal period for 11 years from 1989 to 1999 but it will disappear after 2000. However, this deficit will not obstruct the repayment of principal and interest on loans in each fiscal period after the execution of the project, the same as for Case A2.

(4) Case B1

A cumulative deficit of US$82,347,000 will occur for the entire period of 26 years from 1984 to 2009, and the average deficit of US$3,167,000 occurs in each fiscal period. This is greater than 10% of the cumulative amount of the depreciation of US$75,285,000. Therefore, the operating costs for the Port of Dumai can be covered with revenue from the commercial port sector, but it was found that the expenses required for the repayment of principal and interest on loans in each fiscal period and the execution of depreciation cannot be covered.

2) Countermeasures (relevant to R/D Para. 15)

Countermeasures for these cases will be described below.

(1) Case A2

If one of the following countermeasures can be taken in order to repay the principal and interest on loans and to carry out the depreciation in accordance with the corporate accounting method, then a sound financial state can be maintained for the Port of Dumai:

a. To raise the present level of tariff rates by 20% after 1988.
b. To obtain a subsidy from the central government at an average rate of US$883,000 in each fiscal period for the 17 years from 1988 to 2004.

(2) Case A3

In a similar manner as stated for Case A2, a sound financial state can be maintained for the Port of Dumai if one of the following countermeasures can be taken:

a. To raise the present level of tariff rates by 8% after 1989.
b. To obtain a subsidy from the central government at an average rate of US$343,000 in each fiscal period for the 11 years from 1989 to 1999.

(3) Case B1

In a similar manner as stated for Case A2, a sound financial state can be maintained for the Port of Dumai if one of the following countermeasures can be taken:

a. To raise the present level of tariff rates by 170% after 1984.
b. To obtain a subsidy from the central government at an average rate of US$3,167,000 in each fiscal period from 1984.

The income statement, the statement of sources and applications of funds and the balance sheet for the countermeasures with raised levels of tariff rates for the Cases A2, A3 and B1 are respectively indicated in Tables II-11, II-12 and II-13. Corresponding financial ratios are shown in Table II-14.

Also, financial rates of return (FRR) for all cases are shown in Table II-15. FRR for the Cases A2, A3 and B1 is respectively shown in Tables II-17, II-18 and II-19.

4.2 Conclusion

Case A1 is the same as that of the report.

From the results of the financial analysis of the Cases A2, A3 and B1, it can be seen that the soundness and the profitability of this project can be ensured by raising the current tariff rates.

Introduction of funds from the central government to secure financial self-support seems to be a recommendable alternative since this project contributes greatly to the regional development and is expected to yield great benefit to the national economy.

Table II-11 Income Statement

(Unit: '000US$)

Item \ Year	Case	(1983)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994~1998	1999~2003	2004~2009
Operating Revenue	A2	7,373	7,631	7,997	8,389	8,803	11,192	11,851	11,851	11,851	11,851	11,851	59,255	59,255	71,106
	A3	7,373	7,631	7,997	8,389	8,803	9,327	10,666	10,666	10,666	10,666	10,666	53,330	53,330	63,996
	B1	1,075	3,135	3,645	4,190	4,795	5,681	6,639	6,639	6,639	6,639	6,639	33,195	33,195	39,834
Operating Expenditure	A2, A3	3,421	3,685	3,947	3,958	3,978	4,204	4,409	4,409	4,409	4,409	4,409	22,045	22,045	26,454
	B1	947	1,089	1,378	1,383	1,443	1,620	1,832	1,832	1,832	1,832	1,832	9,160	9,160	10,992
Operating Profit	A2	3,952	3,947	4,050	4,431	4,825	6,988	7,442	7,442	7,442	7,442	7,442	37,210	37,210	44,652
	A3	3,952	3,947	4,050	4,431	4,825	5,123	6,257	6,257	6,257	6,257	6,257	31,285	31,285	37,542
	B1	128	2,046	2,267	2,807	3,352	4,041	4,807	4,807	4,807	4,807	4,807	24,035	24,035	28,842
Depreciation		903	1,122	1,341	1,341	1,737	1,767	3,623	3,623	3,623	3,623	3,453	16,185	16,185	17,662
Interest on Loan	A2		76	435	1,817	2,835	3,529	3,529	3,529	3,529	3,529	3,529	15,880	12,940	11,647
	A3		55	316	1,321	2,062	2,566	2,566	2,566	2,566	2,566	2,566	11,549	9,411	8,472
	B1		24	138	578	902	1,123	1,123	1,123	1,123	1,123	1,123	5,053	4,120	3,706
Profit after	A2	3,049	2,749	2,274	1,273	253	1,692	290	290	290	290	460	5,145	8,085	15,343
Depreciation and	A3	3,049	2,770	2,393	1,769	1,026	790	68	68	68	68	238	3,551	5,689	11,408
Interest on Loan	B1	△775	900	788	888	713	1,151	61	61	61	61	231	2,797	3,730	7,474
Tax	A2	1,372	1,237	1,023	573	114	761	131	131	131	131	207	2,315	3,638	6,904
	A3	1,372	1,247	1,077	796	462	356	31	31	31	31	107	1,598	2,560	5,134
	B1		405	355	400	321	518	27	27	27	27	104	1,259	1,679	3,363
National Development Fund	A2	922	832	688	385	76	512	87	87	87	87	139	1,557	2,446	4,641
	A3	922	838	724	535	310	239	20	20	20	20	72	1,074	1,721	3,451
Reserve	B1		272	238	268	216	348	19	19	19	19	70	846	1,128	2,261
Net Profit	A2	755	680	563	315	63	419	72	72	72	72	114	1,273	2,001	3,798
	A3	755	685	592	438	254	195	17	17	17	17	59	879	1,368	2,823
	B1	△775	223	-195	220	176	285	15	15	15	15	57	692	923	1,850
Accumulated Net	A2	7,041	7,721	8,284	8,599	8,662	9,081	9,153	9,225	9,297	9,369	9,483	10,756	12,757	16,555
Profit from 1981	A3	7,041	7,726	8,318	8,756	9,010	9,205	9,222	9,239	9,256	9,273	9,332	10,211	11,579	14,402
	B1	5,511	5,734	5,929	6,149	6,325	6,610	6,625	6,640	6,655	6,670	6,727	7,419	8,342	10,192

Table II-12 Statement of Source and Application of Funds

(Unit: '000US$)

Item \ Year	Case	(1983)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994~1998	1999~2003	2004~2009
Source of Funds (A)															
Net Profit	A2	755	680	563	315	63	419	72	72	72	72	114	1,273	2,001	3,798
	A3	775	685	592	438	254	195	17	17	17	17	59	879	1,368	2,823
	B1	775	223	195	220	176	285	15	15	15	15	57	692	923	1,850
Depreciation		903	1,122	1,341	1,341	1,737	1,767	3,623	3,623	3,623	3,623	3,453	16,185	16,185	17,662
Long Term Loan			690	3,262	12,564	9,259	6,304								
National Development Fund		1,479	5,055	6,383	7,908	8,950	4,803								
Total	A2	3,137	7,547	11,549	22,128	20,009	13,293	3,695	3,695	3,695	3,695	3,567	17,458	18,186	21,460
	A3	3,137	7,552	11,578	22,251	20,200	13,069	3,640	3,640	3,640	3,640	3,512	17,064	17,553	20,485
	B1	1,607	7,090	11,181	22,033	20,122	13,159	3,638	3,638	3,638	3,638	3,510	16,877	17,108	19,512
Application of Funds (B)															
Cost of Fixed Assets Addition		1,479	5,745	9,645	20,472	18,209	11,107								
Repayment of Long Term Loan													5,345	5,345	6,414
Total		1,479	5,745	9,645	20,472	18,209	11,107						5,345	5,345	6,414
Increase/Decrease of	A2	1,658	1,802	1,904	1,656	1,800	2,186	3,695	3,695	3,695	3,695	3,567	12,113	12,841	15,046
Net Current Assets (C)	A3	1,658	1,807	1,933	1,779	1,991	1,962	3,640	3,640	3,640	3,640	3,512	11,719	12,208	14,071
(C = A – B)	B1	128	1,345	1,536	1,561	1,913	2,052	3,638	3,638	3,638	3,638	3,510	11,532	11,763	13,098
Net Current Assets	A2	1,028	2,686	4,488	6,392	8,048	9,848	12,034	15,729	19,424	23,119	26,814	30,381	42,494	55,335
at Begining of Year	A3	1,028	2,686	4,493	6,426	8,205	10,196	12,158	15,798	19,438	23,078	26,718	30,230	41,949	54,157
(D)	B1	1,028	1,156	2,501	4,037	5,598	7,511	9,563	13,201	16,839	20,477	24,115	27,625	39,157	50,920
Net Current Assets	A2	2,686	4,488	6,392	8,048	9,848	12,034	15,729	19,424	23,119	26,814	30,381	42,494	55,335	70,381
at End of Year (E)	A3	2,686	4,493	6,426	8,205	10,196	12,158	15,798	19,438	23,078	26,718	30,230	41,949	54,157	68,228
(E = C + D)	B1	1,156	2,501	4,037	5,598	7,511	9,563	13,201	16,839	20,477	24,115	27,625	39,157	50,920	64,018

Table II-13 Ballance Sheet

(Unit: '000US$)

Item \ Year	Case	(1983)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994~1998	1999~2003	2004~2009
Assets															
Fixed Assets		17,307	21,930	30,234	49,365	65,837	75,177	71,554	67,931	64,308	60,685	57,232	41,047	24,862	7,200
Net Current Assets	A2	2,686	4,488	6,392	8,048	9,848	12,034	15,729	19,424	23,119	26,814	30,381	42,494	55,335	70,381
	A3	2,686	4,493	6,426	8,205	10,196	12,158	15,798	19,438	23,078	26,718	30,230	41,949	54,157	68,228
	B1	1,156	2,501	4,037	5,598	7,511	9,563	13,201	16,839	20,477	24,115	27,625	39,157	50,920	64,018
Total	A2	19,993	26,418	36,626	57,413	75,685	87,211	87,283	87,355	87,427	87,499	87,613	83,541	80,197	77,581
	A3	19,993	26,423	36,660	57,570	76,033	87,335	87,352	87,369	87,386	87,403	87,462	82,996	79,019	75,428
	B1	18,463	24,431	34,271	54,963	73,348	84,740	84,755	84,770	84,785	84,800	84,857	80,204	75,782	71,218
Liabilities															
Capital Loan by Government (National Development Fund)		12,952	18,007	24,390	32,298	41,248	46,051	46,051	46,051	46,051	46,051	46,051	46,051	46,051	46,051
Long Term Loan			690	3,952	16,516	25,775	32,079	32,079	32,079	32,079	32,079	32,079	26,734	21,389	14,975
Capital and Reserve	A2	7,041	7,721	8,284	8,599	8,662	9,081	9,153	9,225	9,297	9,369	9,483	10,756	12,757	16,555
	A3	7,041	7,726	8,318	8,756	9,010	9,205	9,222	9,239	9,256	9,273	9,332	10,211	11,579	14,402
	B1	5,511	5,734	5,929	6,149	6,325	6,610	6,625	6,640	6,655	6,670	6,727	7,419	8,342	10,192
Total	A2	19,993	26,418	36,626	57,413	75,685	87,211	87,283	87,355	87,427	87,499	87,613	83,541	80,197	77,581
	A3	19,993	26,423	36,660	57,570	76,033	87,335	87,352	87,369	87,386	87,403	87,462	82,996	79,019	75,428
	B1	18,463	24,431	34,271	54,963	73,348	84,740	84,755	84,770	84,785	84,800	84,857	80,204	75,782	71,218

Table II-14 Financial Ritios

(%)

Case / Item	A2		A3		B1	
	1989	1994~1998	1989	1994~1998	1989	1994~1998
Working Ratio	37	37	43	43	28	28
Operating Ratio	98	91	99	96	99	92
Return on Net Fixed Assets	5	10	4	7	2	3
Interest Earned Ratio	108	126	103	121	105	134
Debt Service Coverage	211	175	244	219	428	231
Remarks	Operating Revenue 20% up		Operating Revenue 8% up		Operating Revenue 170% up	

Table II-15 FRR

Case	A2	A3	B1
%	12.7	10.1	6.7
Remarks	Operating Revenue 20% up	Operating Revenue 8% up	Operating Revenue 170%

Table II-16 Financial Rate of Return Calculation Sheet

(A1~3 Case)

FRR = 8.56%
(Unit: '000US$)

Year		Balance			Discounted Value (B – C)
		Project Cost (C)	Operating Profit (B)	(B – C)	
1	1984	1,066	0	△ 1,066	△ 1,066.00
2	1985	4,966	0	△ 4,966	△ 4,574.33
3	1986	20,472	0	△20,472	△17,370.12
4	1987	18,209	4,825	△13,384	△10,460.43
5	1988	11,107	5,123	△ 5,984	△ 4,308.01
6	1989	0	5,467	5,467	3,625.39
7	1990	0	5,467	5,467	3,339.46
8	1991	0	5,467	5,467	3,076.08
9	1992	0	5,467	5,467	2,833.47
10	1993	0	5,467	5,467	2,610.00
11	1994	0	5,467	5,467	2,404.15
12	1995	0	5,467	5,467	2,214.54
13	1996	0	5,467	5,467	2,039.88
14	1997	0	5,467	5,467	1,878.99
15	1998	0	5,467	5,467	1,730.80
16	1999	0	5,467	5,467	1,594.29
17	2000	0	5,467	5,467	1,468.55
18	2001	0	5,467	5,467	1,352.73
19	2002	0	5,467	5,467	1,246.04
20	2003	0	5,467	5,467	1,147.76
21	2004	0	5,467	5,467	1,057.24
22	2005	0	5,467	5,467	973.86
23	2006	0	5,467	5,467	897.05
24	2007	0	5,467	5,467	826.30
25	2008	0	5,467	5,467	761.13
26	2009	0	5,467	5,467	701.10
Total		55,820	124,755	68,935	0.0

Table II-17 Financial Rate of Return Calculation Sheet

FRR = 12.65%

(A-2 Case) (Unit: '000US$)

Year		Balance			Discounted Value (B – C)
		Project Cost (C)	Operating Profit (B)	(B – C)	
1	1984	1,066	0	△ 1,066	△ 1,066.00
2	1985	4,966	0	△ 4,966	△ 4,408.19
3	1986	20,472	0	△20,472	△16,131.23
4	1987	18,209	4,825	△13,384	△ 9,361.53
5	1988	11,107	6,988	△ 4,119	△ 2,557.44
6	1989	0	7,442	7,442	4,101.64
7	1990	0	7,442	7,442	3,640.92
8	1991	0	7,442	7,442	3,231.95
9	1992	0	7,442	7,442	2,868.92
10	1993	0	7,442	7,442	2,546.67
11	1994	0	7,442	7,442	2,260.61
12	1995	0	7,442	7,442	2,006.68
13	1996	0	7,442	7,442	1,781.28
14	1997	0	7,442	7,442	1,581.20
15	1998	0	7,442	7,442	1,403.59
16	1999	0	7,442	7,442	1,245.93
17	2000	0	7,442	7,442	1,105.98
18	2001	0	7,442	7,442	981.75
19	2002	0	7,442	7,442	871.47
20	2003	0	7,442	7,442	773.58
21	2004	0	7,442	7,442	686.69
22	2005	0	7,442	7,442	609.56
23	2006	0	7,442	7,442	541.09
24	2007	0	7,442	7,442	480.31
25	2008	0	7,442	7,442	426.36
26	2009	0	7,442	7,442	378.47
Total		55,820	168,095	112,275	0.32

Operating Revenue 20% up

Table II-18 Financial Rate of Return Calculation Sheet

(A-3 Case) FRR = 10.10%
(Unit: '000US$)

Year		Balance			Discounted Value (B – C)
		Project Cost (C)	Operating Profit (B)	(B – C)	
1	1984	1,066	0	△ 1,066	△ 1,066.00
2	1985	4,966	0	△ 4,966	△ 4,510.38
3	1986	20,472	0	△20,472	△16,887.80
4	1987	18,209	4,825	△13,384	△10,027.79
5	1988	11,107	5,123	△ 5,984	△ 4,072.09
6	1989	0	6,257	6,257	3,867.21
7	1990	0	6,257	6,257	3,512.41
8	1991	0	6,257	6,257	3,190.15
9	1992	0	6,257	6,257	2,897.46
10	1993	0	6,257	6,257	2,631.63
11	1994	0	6,257	6,257	2,390.18
12	1995	0	6,257	6,257	2,170.89
13	1996	0	6,257	6,257	1,971.71
14	1997	0	6,257	6,257	1,790.81
15	1998	0	6,257	6,257	1,626.51
16	1999	0	6,257	6,257	1,477.28
17	2000	0	6,257	6,257	1,341.74
18	2001	0	6,257	6,257	1,218.64
19	2002	0	6,257	6,257	1,106.83
20	2003	0	6,257	6,257	1,005.28
21	2004	0	6,257	6,257	913.05
22	2005	0	6,257	6,257	829.28
23	2006	0	6,257	6,257	753.19
24	2007	0	6,257	6,257	684.09
25	2008	0	6,257	6,257	621.33
26	2009	0	6,257	6,257	564.32
Total		55,820	141,345	85,525	0.01

Operating Revenue 8% up

Table II-19 Financial Rate of Return Calculation Sheet

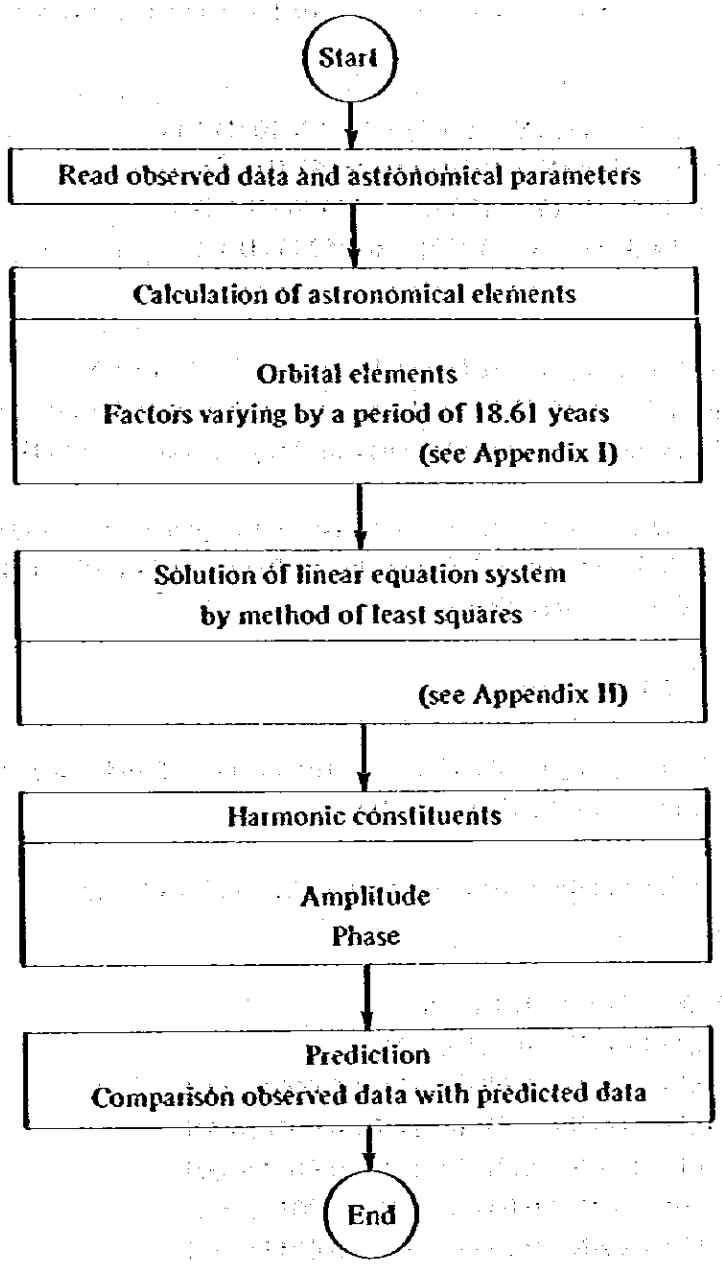
(B-1 Case) FRR = 6.65% (Unit: '000US$)

Year		Balance			Discounted Value (B – C)
		Project Cost (C)	Operating Profit (B)	(B – C)	
1	1984	1,066	0	△ 1,066	△ 1,066.00
2	1985	4,966	0	△ 4,966	△ 4,656.31
3	1986	20,472	0	△20,472	△17,998.31
4	1987	18,209	3,352	△14,857	△12,247.25
5	1988	11,107	4,061	△ 7,046	△ 5,446.10
6	1989	0	4,807	4,807	3,483.80
7	1990	0	4,807	4,807	3,266.54
8	1991	0	4,807	4,807	3,062.84
9	1992	0	4,807	4,807	2,871.84
10	1993	0	4,807	4,807	2,692.75
11	1994	0	4,807	4,807	2,524.83
12	1995	0	4,807	4,807	2,367.38
13	1996	0	4,807	4,807	2,219.75
14	1997	0	4,807	4,807	2,081.32
15	1998	0	4,807	4,807	1,951.53
16	1999	0	4,807	4,807	1,829.83
17	2000	0	4,807	4,807	1,715.72
18	2001	0	4,807	4,807	1,608.73
19	2002	0	4,807	4,807	1,508.40
20	2003	0	4,807	4,807	1,414.34
21	2004	0	4,807	4,807	1,326.14
22	2005	0	4,807	4,807	1,243.44
23	2006	0	4,807	4,807	1,165.90
24	2007	0	4,807	4,807	1,093.19
25	2008	0	4,807	4,807	1,025.02
26	2009	0	4,807	4,807	961.10
Total		55,820	108,360	52,540	0.48

Operating Revenue 170% up

III. Tidal Harmonic Analysis

Flow Chart for Tidal Harmonic Analysis



Appendix I Calculation of astronomical elements

1. Calculation of astronomical elements s,h,p,N

The values of the lunar and solar orbital elements s,h,p,N at zero hour G.M.T.* are given by the following formulae to obtain the values of a factor f and an angle u varying in a period of 18.61 years.

$$s = 277.^{\circ}025 + 129.^{\circ}38481\,(Y - 1900) + 13.^{\circ}17640\,(D + \ell)$$
$$h = 280.^{\circ}190 - 0.^{\circ}23872\,(Y - 1900) + 0.^{\circ}98565\,(D + \ell)$$
$$p = 334.^{\circ}385 + 40.^{\circ}66249\,(Y - 1900) + 0.^{\circ}11140\,(D + \ell)$$
$$N = 259.^{\circ}157 - 19.^{\circ}32818\,(Y - 1900) - 0.^{\circ}05295\,(D + \ell)$$

Where, Y: the year

D: the number of days elapsed since January 1st in the year Y

ℓ: the integral part of (Y-1901)/4 i.e., the number of leap years between 1900 and the Year Y, excluding Y, as the leap day in this year is counted in D

The increments in the angles per mean solar day are the coefficients of (D + ℓ) and the increments in a year of 365 mean solar days are the coefficients of (Y-1900). The factors Y and D are the middle time during observation.

2. Calculation of nodal variations

To make use of the foregoing orbital elements, the values of f and u for elementary harmonic constituents are given by the following formulae.

The suffix of f and u is a notation corresponding to the number of harmonic constituents indicated in Appendix III.

$$f_3 = 1.0 - 0.1300\cos N + 0.0013\cos 2N$$
$$f_5 = 1.0429 + 0.4135\cos N - 0.0040\cos 2N$$
$$f_7 = 1.0060 + 0.1150\cos N - 0.0088\cos 2N + 0.0006\cos 3N$$
$$f_{11} = 1.0129 + 0.1676\cos N - 0.0170\cos 2N + 0.0016\cos 3N$$
$$f_{16} = 1.0089 + 0.1871\cos N - 0.0147\cos 2N + 0.0014\cos 3N$$
$$f_{19} = 1.1027 + 0.6504\cos N + 0.0317\cos 2N - 0.0014\cos 3N$$
$$f_{27} = 1.0241 + 0.2863\cos N + 0.0083\cos 2N - 0.0015\cos 3N$$
$$f_{28}\cos u_{28} = 1 - 0.2505\cos 2p - 0.1102\cos(2p - N) - 0.0156\cos(2p - 2N) - 0.0370\cos N$$
$$f_{32} = 1.0004 - 0.0373\cos N + 0.0002\cos 2N$$
$$u_3 = 0$$
$$u_5 = -23.^{\circ}74\sin N + 2.^{\circ}68\sin 2N - 0.^{\circ}38\sin 3N$$
$$u_7 = -8.^{\circ}86\sin N + 0.^{\circ}68\sin 2N - 0.^{\circ}07\sin 3N$$

* the Greenwich mean time

$u_{14} = -12.^{\circ}94\sin N + 1.^{\circ}34\sin 2N - 0.^{\circ}19\sin 3N$
$u_{16} = 10.^{\circ}80\sin N - 1.^{\circ}34\sin 2N + 0.^{\circ}19\sin 3N$
$u_{19} = -36.^{\circ}68\sin N + 4.^{\circ}02\sin 2N - 0.^{\circ}57\sin 3N$
$u_{27} = -17.^{\circ}74\sin N + 0.^{\circ}68\sin 2N - 0.^{\circ}04\sin 3N$
$f_{28}\sin u_{28} = -0.2505\sin 2p - 0.1102\sin(2p - N) - 0.0156\sin(2p - 2N) - 0.0370\sin N$
$u_{32} = -2.^{\circ}14\sin N$

The procedure will be illustrated for the case of the constituent M_1. The values of f and u are given by the following formulae.

$f_{12}\cos u_{12} = 2\cos p + 0.4\cos(p - N)$
$f_{12}\sin u_{12} = \sin p + 0.2\sin(p - N)$

if the right-hand terms above equations are equal to a and b, we then have

$f_{12}\cos u_{12} = a$
$f_{12}\sin u_{12} = b$

and we can then obtain the following relations.

$$f_{12} = \sqrt{a^2 + b^2}$$
$$u_{12} = \tan^{-1}\frac{b}{a}$$

The values of f and u for harmonic constituents except above mentioned elementary ones are given by the following relationships where "known" terms are already calculated above.

$f_1 = 1$	$u_1 = 0$
$f_2 = 1$	$u_2 = 0$
$f_3 =$ known	$u_3 = 0$
$f_4 = f_{32}$(known)	$u_4 = -u_{32}$(known)
$f_5 =$ known	$u_5 =$ known
$f_6 = 1$	$u_6 = 0$
$f_7 =$ known	$u_7 =$ known
$f_8 = 1$	$u_8 = 0$
$f_9 = 1$	$u_9 = 0$
$f_{10} = 1$	$u_{10} = 0$
$f_{11} = 1$	$u_{11} = 0$
$f_{12} =$ known	$u_{12} =$ known
$f_{13} = f_{14}$(known)	$u_{13} = u_{14}$ (known)
$f_{14} =$ known	$u_{14} =$ known
$f_{15} = f_{14}$	$u_{15} = u_{14}$
$f_{16} =$ known	$u_{16} =$ known
$f_{17} = f_{32}$ (known)	$u_{17} = u_{32}$ (known)
$f_{18} = f_{16}$	$u_{18} = -u_{16}$
$f_{19} =$ known	$u_{19} =$ known
$f_{20} = f_{16}$	$u_{20} = u_{16}$
$f_{21} = f_{16}$	$u_{21} = u_{16}$
$f_{22} = f_{16}$	$u_{22} = u_{16}$
$f_{23} = f_{16}$	$u_{23} = u_{16}$
$f_{24} = 1$	$u_{24} = 0$
$f_{25} = 1$	$u_{25} = 0$
$f_{26} = 1$	$u_{26} = 0$
$f_{27} =$ known	$u_{27} =$ known
$f_{28} =$ known	$u_{28} =$ known
$f_{29} = f_{32}$ (known)	$u_{29} = u_{32}$ (known)
$f_{30} = f_{32} \times f_{32}$	$u_{30} = 0$
$f_{31} = f_7 \times f_{14}$	$u_{31} = u_7 + u_{14}$
$f_{32} =$ known	$u_{32} =$ known
$f_{33} = f_{32}$	$u_{33} = -u_{32}$
$f_{34} = f_{16}$	$u_{34} = u_{16}$
$f_{35} = f_{27} \times f_{32}$	$u_{35} = u_{27} + u_{32}$
$f_{36} = f_{32}$	$u_{36} = u_{32}$
$f_{37} = f_{32}$	$u_{37} = u_{32}$
$f_{38} = f_{32}$	$u_{38} = u_{32}$
$f_{39} = f_{32}$	$u_{39} = u_{32}$
$f_{40} = f_{32} \times f_{32}$	$u_{40} = 2\,u_{32}$
$f_{41} = f_{16} \times f_{16}$	$u_{41} = 2\,u_{16}$
$f_{42} = f_7$	$u_{42} = u_7$
$f_{43} = f_7 \times f_{32}$	$u_{43} = u_7 + u_{32}$
$f_{44} = f_{16}$	$u_{44} = u_{16}$
$f_{45} = (f_{32})^{3/2}$	$u_{45} = 1.5\,u_{32}$
$f_{46} = f_{16} \times f_{32}$	$u_{46} = u_{16} + u_{32}$
$f_{47} = 1$	$u_{47} = 0$
$f_{48} = f_{27}$	$u_{48} = u_{27}$
$f_{49} = f_{32}$	$u_{49} = u_{32}$
$f_{50} = f_{27} \times f_{32}$	$u_{50} = u_{27} + u_{32}$
$f_{51} = f_{32}$	$u_{51} = u_{32}$
$f_{52} = f_{32} \times f_{32}$	$u_{52} = 2\,u_{32}$
$f_{53} = f_{52}$	$u_{53} = u_{52}$
$f_{54} = f_{32}$	$u_{54} = u_{32}$
$f_{55} = f_{50}$	$u_{55} = u_{50}$
$f_{56} = f_{52}$	$u_{56} = u_{52}$
$f_{57} = f_{27} \times f_{52}$	$u_{57} = u_{27} + u_{52}$
$f_{58} = f_{52}$	$u_{58} = u_{52}$
$f_{59} = f_{32} \times f_{52}$	$u_{59} = u_{32} + u_{52}$
$f_{60} = f_{59}$	$u_{60} = u_{59}$

Now, the values of an angle changing steadily at the mean speed of the constituent (Vg) are given by the following relationships to make use of the foregoing orbital elements s.h.p. where t_0 is the original time of the middle day during observations.

$Vg_1 = h + \sigma_1 t_0$
$Vg_2 = 2h + \sigma_2 t_0$
$Vg_3 = s - p + \sigma_3 t_0$
$Vg_4 = 2s - 2h + \sigma_4 t_0$
$Vg_5 = 2s + \sigma_5 t_0$
$Vg_6 = 180° + \sigma_6 t_0$
$Vg_7 = h + 90° + \sigma_7 t_0$
$Vg_8 = -h + 270° + \sigma_8 t_0$
$Vg_9 = -2h + 192° + \sigma_9 t_0$
$Vg_{10} = 2h + 168° + \sigma_{10} t_0$
$Vg_{11} = 3h + 90° + \sigma_{11} t_0$
$Vg_{12} = -s + h + 90° + \sigma_{12} t_0$
$Vg_{13} = s - h + p + 90° + \sigma_{13} t_0$
$Vg_{14} = s + h - p + 90° + \sigma_{14} t_0$
$Vg_{15} = -s + 3h - p + 90° + \sigma_{15} t_0$
$Vg_{16} = -2s + h + 270° + \sigma_{16} t_0$
$Vg_{17} = -2s + 3h + 90° + \sigma_{17} t_0$
$Vg_{18} = -Vg_{16} + \sigma_{24} t_0$
$Vg_{19} = 2s + h + 90° + \sigma_{19} t_0$
$Vg_{20} = -3s + 3h - p + 270° + \sigma_{20} t_0$
$Vg_{21} = -3s + h + p + 270° + \sigma_{21} t_0$
$Vg_{22} = -4s + 3h + 270° + \sigma_{22} t_0$
$Vg_{23} = -4s + h + 2p + 270° + \sigma_{23} t_0$
$Vg_{24} = \sigma_{24} t_0$
$Vg_{25} = -h + 282° + \sigma_{25} t_0$
$Vg_{26} = h + 258° + \sigma_{26} t_0$
$Vg_{27} = 2h + \sigma_{27} t_0$
$Vg_{28} = -s + 2h - p + 180° + \sigma_{28} t_0$
$Vg_{29} = -s + p + 180° + \sigma_{29} t_0$
$Vg_{30} = s - p + \sigma_{30} t_0$

$Vg_{31} = Vg_7 + Vg_{14}$
$Vg_{32} = -2s + 2h + \sigma_{32} t_0$
$Vg_{33} = -Vg_{32} + \sigma_{47} t_0$
$Vg_{34} = Vg_8 + Vg_{16}$
$Vg_{35} = Vg_{32} + Vg_{27} - Vg_{24}$
$Vg_{36} = -3s + 2h + p + \sigma_{36} t_0$
$Vg_{37} = -3s + 4h - p + \sigma_{37} t_0$
$Vg_{38} = -4s + 4h + \sigma_{38} t_0$
$Vg_{39} = -4s + 2h + 2p + \sigma_{39} t_0$
$Vg_{40} = Vg_{32} + Vg_{36} - Vg_{24}$
$Vg_{41} = Vg_{16} + Vg_{21}$
$Vg_{42} = Vg_7 + Vg_{24}$
$Vg_{43} = Vg_{32} + Vg_7$
$Vg_{44} = Vg_{16} + Vg_{24}$
$Vg_{45} = -3s + 3h + 180° + \sigma_{45} t_0$
$Vg_{46} = Vg_{16} + Vg_{32}$
$Vg_{47} = \sigma_{47} t_0$
$Vg_{48} = Vg_{24} + Vg_{27}$
$Vg_{49} = Vg_{24} + Vg_{32}$
$Vg_{50} = Vg_{27} + Vg_{32}$
$Vg_{51} = Vg_{24} + Vg_{36}$
$Vg_{52} = 2Vg_{32}$
$Vg_{53} = Vg_{32} + Vg_{36}$
$Vg_{54} = Vg_{32} + Vg_{47}$
$Vg_{55} = Vg_{27} + Vg_{49}$
$Vg_{56} = Vg_{24} + Vg_{52}$
$Vg_{57} = Vg_{27} + Vg_{52}$
$Vg_{58} = Vg_{36} + Vg_{49}$
$Vg_{59} = Vg_{32} + Vg_{52}$
$Vg_{60} = Vg_{36} + Vg_{52}$

As mentioned above, we have already obtained values for Vg and u for each constituent, thus we now obtain (Vg + u) for each constituent.

Appendix II Solution of linear equation system

1. Solution of linear equation system

First, suppose that a tidal height h(t) at time t is given by the following formulae.

$$h(t) = a_1 \cos\sigma_1 t + a_2 \cos\sigma_2 t + \cdots + a_{60} \cos\sigma_{60} t + a_{61} + b_1 \sin\sigma_1 t + b_2 \sin\sigma_2 t + \cdots + b_{60} \sin\sigma_{60} t \quad (1)$$

Where, $\sigma_1\ \sigma_2\ \ldots,\ \sigma_{60}$ are known angular velocities shown in Appendix III, and $a_1 \sim a_{61}$ $b_1 \sim b_{60}$ are unknown values that we are attempting to obtain. Next, suppose that time origin is during the middle of observation and that the number of values for hourly tidal heights are (2n+1) from the time $-n$ to n.

We can get the following observational equations are thus obtained:

$$\left.\begin{aligned}
h(-n) &= a_1 \cos(-n\sigma_1) + a_2 \cos(-n\sigma_2) + \cdots + a_{60} \cos(-n\sigma_{60}) + a_{61} \\
&\quad + b_1 \sin(-n\sigma_1) + b_2 \sin(-n\sigma_2) + \cdots + b_{60} \sin(-n\sigma_{60}) \\
h(-n+1) &= a_1 \cos(-n+1)\sigma_1 + a_2 \cos(-n+1)\sigma_2 + \cdots + a_{60} \cos(-n+1)\sigma_{60} + a_{61} \\
&\quad + b_1 \sin(-n+1)\sigma_1 + b_2 \sin(-n+1)\sigma_2 + \cdots b_{60} \sin(-n+1)\sigma_{60} \\
&\cdots\cdots \\
h(0) &= a_1 \cos 0 + a_2 \cos 0 + \cdots + a_{60} \cos 0 + a_{61} \\
&\quad + b_1 \sin 0 + b_2 \sin 0 + \cdots + b_{60} \sin 0 \\
&\cdots\cdots \\
h(n-1) &= a_1 \cos(n-1)\sigma_1 + a_2 \cos(n-1)\sigma_2 + \cdots + a_{60} \cos(n-1)\sigma_{60} + a_{61} \\
&\quad + b_1 \sin(n-1)\sigma_1 + b_2 \sin(n-1)\sigma_2 + \cdots + b_{60} \sin(n-1)\sigma_{60} \\
h(n) &= a_1 \cos n\sigma_1 + a_2 \cos n\sigma_2 + \cdots + a_{60} \cos n\sigma_{60} + a_{61} \\
&\quad + b_1 \sin n\sigma_1 + b_2 \sin n\sigma_2 + \cdots + b_{60} \sin n\sigma_{60}
\end{aligned}\right\} \quad (2)$$

From eq (2), normal equations are given using the following formulae.

$$\left.\begin{aligned}
&\sum_{t=-n}^{n} h(t) \cos\sigma_1 t = \alpha_{1,1} a_1 + \alpha_{1,2} a_2 + \cdots + \alpha_{1,j} a_j + \cdots + \alpha_{1,61} a_{61} \\
&\sum_{t=-n}^{n} h(t) \cos\sigma_2 t = \alpha_{2,1} a_1 + \alpha_{2,2} a_2 + \cdots + \alpha_{2,j} a_j + \cdots + \alpha_{2,61} a_{61} \\
&\cdots\cdots \\
&\sum_{t=-n}^{n} h(t) \cos\sigma_i t = \alpha_{i,1} a_1 + \alpha_{i,2} a_2 + \cdots + \alpha_{i,j} a_j + \cdots + \alpha_{i,61} a_{61} \\
&\cdots\cdots \\
&\sum_{t=-n}^{n} h(t) \cos\sigma_{60} t = \alpha_{60,1} a_1 + \alpha_{60,2} a_2 + \cdots + \alpha_{60,j} a_j + \cdots + \alpha_{60,61} a_{61} \\
&\sum_{t=-n}^{n} h(t) = \alpha_{61,1} a_1 + \alpha_{61,2} a_2 + \cdots + \alpha_{61,j} a_j + \cdots + \alpha_{61,61} a_{61}
\end{aligned}\right\} \quad (3)$$

$$
\left.
\begin{aligned}
&\sum_{t=-n}^{n} h(t) \sin \sigma_1 t = \beta_{1,1} b_1 + \beta_{1,2} b_2 + \cdots\cdots + \beta_{1,j} b_j + \cdots\cdots + \beta_{1,60} b_{60} \\
&\sum_{t=-n}^{n} h(t) \sin \sigma_2 t = \beta_{2,1} b_1 + \beta_{2,2} b_2 + \cdots\cdots + \beta_{2,j} b_j + \cdots\cdots + \beta_{2,60} b_{60} \\
&\qquad\cdots\cdots \\
&\sum_{t=-n}^{n} h(t) \sin \sigma_i t = \beta_{i,1} b_1 + \beta_{i,2} b_2 + \cdots\cdots + \beta_{i,j} b_j + \cdots\cdots + \beta_{i,60} b_{60} \\
&\qquad\cdots\cdots \\
&\sum_{t=-n}^{n} h(t) \sin \sigma_{60} t = \beta_{60,1} b_1 + \beta_{60,2} b_2 + \cdots\cdots + \beta_{60,60} b_{60}
\end{aligned}
\right\} \quad (4)
$$

From eqs. (3), (4), $\alpha_{i,j}$ are given as:

$$
\alpha_{i,j} = \frac{\sin (2n+1)\left(\frac{\sigma_j - \sigma_i}{2}\right)}{2 \sin\left(\frac{\sigma_j - \sigma_i}{2}\right)} + \frac{\sin (2n+1)\left(\frac{\sigma_j + \sigma_i}{2}\right)}{2 \sin\left(\frac{\sigma_j + \sigma_i}{2}\right)} \quad \cdots\cdots (5)
$$

Where, i and j are integers from 1 to 61.
And $\beta_{i,j}$ are given as:

$$
\beta_{i,j} = \frac{\sin (2n+1)\left(\frac{\sigma_j - \sigma_i}{2}\right)}{2 \sin\left(\frac{\sigma_j - \sigma_i}{2}\right)} - \frac{\sin (2n+1)\left(\frac{\sigma_j + \sigma_i}{2}\right)}{2 \sin\left(\frac{\sigma_j + \sigma_i}{2}\right)} \quad \cdots\cdots (6)
$$

Where i and j are integers from 1 to 60.
If i = j in eqs. (5) and (6), then the following relationship obtains:

$$
\frac{\sin (2n+1)\left(\frac{\sigma_j - \sigma_i}{2}\right)}{2 \sin\left(\frac{\sigma_j - \sigma_i}{2}\right)} = \frac{2n+1}{2}
$$

especially $\alpha_{61} = 0$, so that $\alpha_{61,61}$ are given as follows:

$$
\alpha_{61,61} = 2n + 1
$$

Thus, we can get coefficients $\alpha_{i,j}$ and $\beta_{i,j}$ for eqs. (3) and (4) if (2n+1) is given and if σ is given (see appendix III).
And, from hourly tidal hights and α in Appendix III, we know the left-hand terms of eqs. (3), (4)

Thus, normal equations (3) and (4) are solved, and values are obtained for $a_1 \sim a_{61}$, $b_1 \sim b_{60}$. As for harmonic constituents, to obtain these from (1), we write

$$h(t) = S_0 + R_1 \cos(\sigma_1 t - \zeta_1) + R_2 \cos(\sigma_2 t - \zeta_2) + \cdots\cdots + R_{60} \cos(\sigma_{60} t - \zeta_{60})$$
$$= S_0 + \Sigma f_i H_i \cos\left\{(Vg+u)_i + \sigma_i t - g_i\right\} \quad \cdots\cdots (7)$$

Then, the terms H_i and g_i in eq (7) are obtained through the following relationships:

$$S_0 = a_{61}$$
$$R_i = \sqrt{a_i^2 + b_i^2}, \quad \zeta_i = \tan^{-1}\frac{b_i}{a_i}$$

Moreover, after calculating $f_i\,(Vg+u)_i$, the harmonic constituents H_i, g_i, K_i can be obtained:

$$H_i = \frac{R_i}{f_i}, \quad g_i = \zeta_i + (Vg+u)_i, \quad K_i = g_i - n_i L + \sigma_i S \quad \cdots\cdots (8)$$

Where

n_i, σ_i: a suffix (n) of the constituents and an argular velocity (x) as shown in Appendix III

L, S: longitude (unit in degree) of the specified place west of Greenwich and standard time S hours later than Greenwich (symbols for L, S are "+" at west longitude, or "−" at east longitude)

Appendix III Harmonic Constituents

Constituent	No.	n	Angular Velosity σ	Constituent	No.	n	Angular Velocity σ	Constituent	No.	n	Angular Velocity σ
S_{sa}	1	0	0.0410686	S_2	24	2	30.0000000	S_4	47	4	60.0000000
S_{sa}	2	0	0.0821373	T_2	25	2	29.9589333	SK_4	48	4	60.0821373
Mm	3	0	0.5443747	R_2	26	2	30.0410667	MS_4	49	4	58.9841042
MSf	4	0	1.0158958	K_2	27	2	30.0821373	MK_4	50	4	59.0662415
Mf	5	0	1.0980331	L_2	28	2	29.5284789	SN_4	51	4	58.4397295
				λ_2	29	2	29.4556253	M_4	52	4	57.9682084
S_1	6	1	15.0000000	MSN_2	30	2	30.5443747	MN_4	53	4	57.4238337
K_1	7	1	15.0410686	KJ_2	31	2	30.6265120				
P_1	8	1	14.9589314	M_2	32	2	28.9841042	$2SM_6$	54	6	88.9841042
π_1	9	1	14.9178647	$2SM_2$	33	2	31.0158958	MSK_6	55	6	89.0662415
ψ_1	10	1	15.0821353	OP_2	34	2	28.9019669	$2MS_6$	56	6	87.9682084
ϕ_1	11	1	15.1232059	MKS_2	35	2	29.0662415	$2MK_6$	57	6	88.0503457
M_1	12	1	14.4920521	N_2	36	2	28.4397295	MSN_6	58	6	87.4238337
θ_1	13	1	15.5125897	ν_2	37	2	28.5125831	M_6	59	6	86.9523127
J_1	14	1	15.5854433	μ_2	38	2	27.9682084	$2MN_6$	60	6	86.4079380
χ_1	15	1	14.5695476	$2N_2$	39	2	27.8953548	S_0	61	0	0.0000000
	16	1	13.9430356	MNS_2	40	2	27.4238337				
MP_1	17	1	14.0251729	OQ_2	41	2	27.3416964				
SO_1	18	1	16.0569644								
OO_1	19	1	16.1391017	SK_3	42	3	45.0410686				
ρ_1	20	1	13.4715145	MK_3	43	3	44.0251729				
Q_1	21	1	13.3986609	SO_3	44	3	43.9430356				
σ_1	22	1	12.9271398	M_3	45	3	43.4761563				
$2Q_1$	23	1	12.8542862	MO_3	46	3	42.9271398				

Note: Marked constituents are shown in Table 3.2.1.