A problem here is how much a reasonable coal price should be in Mongolia. Even in the economic analysis, the price to gain 10% of EIRR is 4,743.5 Tg/t (4,312.3 Tg/t without trade tax) in Case 6. Apparently, the current price of 2,750.0 Tg/t (2,500.0 Tg/t) is insufficient to sustainable operation in the mine. The reasonable coal sale price, however, should be at least held below the economic value of the Baganuur coal (6,057.1 Tg/t) and is discussed later in the analyses.

8.3.4 Discounted cash flow analysis

(1) General assumptions

The objective of the DCF analysis is to determine the positive cash flow that accrues to the project, the amounts of debt required to finance it and the return on the total project. Procedures several added to the analysis are as follows:

1) The balances of investment/depreciation, remaining net working capital and also mine close reclamation costs are all included in the cash flow at the end of the final year of the project life;

2) A salvage value of equipment for the railway system in Case 2 is added to the after tax profits in 1998 when superseded by a truck & shovel system; and

3) The simplifying assumption is made that all revenues are received and costs are incurred at the end of the year.

(2) Cash flow formulae

Formulae for cash flow used in the analyses are as follows:

1) Cash flow for FIRR on total project

Revenue
− Total operating costs (payable interest = 0)
− Tax
− After tax expenses (adjustment o operating costs)
+ Depreciation
− Total capital costs
− Increase in working capital
+ *Project liquidation (at the end of the project life)
= Cash flow for FIRR on total project

*Project liquidation
= Retained working capital + Equipment salvage - Reclamation costs

2) Cash flow for FIRR on equity

Revenue
− Total operating costs
− Tax
− After tax expenses (adjustment of operating coats)
+ Depreciation
− Total capital costs
− Increase in working capital
+ Debt
− Debt repayment
+ **Project liquidation (at the end of the project life)
= Cash flow for FIRR on equity

** Project Liquidation
= Retained working capital + Equipment salvage - Reclamation costs- Loan unrepaid

(3) Cash flow analyses

Table 8.11 illustrates the summary of coal sale prices at a 10% after tax FIRR on the total project for all the scenarios. Details are presented in Appendix 8. Comparing the financial sale price (7,493 Tg/t) the economic price (4,743.5 Tg/t) with at a 10% IRR in Case 6, the financial price is 160% of the economic price.

The base case analyses at the economic value of 6,057.1 Tg/t resulted in:

	FIRR on Total Project
Case 2: Improvement abandoning railway in 1998	(-1.7%)
Case 4: Expansion in 1998	5.6%
Case 6: Renovation combined (Case 2 + Case 4)	0.9% (after fixed assets revaluation)

Under the current taxation regimes in Mongolia, this project cannot be viable at the sale price of 6,057.1 Tg/t even after the fixed assets revaluation. This suggests that, in order to lower a price sustainable to mine operation, amendment of Mongolian taxation rates including tax exemption

will be necessary to profit redistribution from the Government to the coal mine. Of course, fixed assets revaluation is one of measures in the amendment.

(4) Effect of tax exemption

Since there are many approaches to mitigation of the above-mentioned situation of the project, the most possible steps to the project viable so as to gain a 10% FIRR on the total project in Case 6 at the economic value of 6,057.1 Tg/t are illustrated on Table 8.12. Details are presented in Appendix 8.

FIRRs on the total project for the tax exempted case at the economic value of 6,057.1 Tg/t resulted in:

	FIRR on Total Project
Tax Exempted Case 2	8.0%
Tax Exempted Case 4	13.7%
Tax Exempted Case 6	10.0%

FIRRs on the total project are greater than the financing cost of 8% assumed in the analysis. Therefore those tax exemptions make the project viable; however, any effects of borrowed money (leverage) have not been reflected in the procedures.

(5) Effect of leverage

In order to assess the effects of leverage, FIRRs on equity of the base case (Case 6) with tax exemption, at 6,057.1 Tg/t have been calculated as illustrated in Table 8.13 for reference. Around a 85% debt, FIRRs on equity for every foreign loan interest rate become an infinite, while the amount of loan unrepaid at the end of the project life is unfavorably increased.

(6) Leverage and tax exemption steps in Case 6

Leverage applications may shorten the tax exemption procedures illustrated in Table 8.11. Then variation in debt/equity ratio and corresponding tax exemption steps to gain 10% FIRR have been examined under the following assumptions.

- Variation in debt/equity ratio studied

  Debt/Equity 50/50, 70/30, 80/20

- Variation in foreign loan interest rate studied

  Interest Rate 1%, 2%, 3%, 5%, 8%, 10%

- Restrictions

  · Sound Operation

  In order to avoid an unhealthy debt ridden operation, all the debt is desired to be repaid by the end of the project life.

  · Required FIRR

  Since a domestic loan interest rate is assumed to be 8% after year 2,000, FIRR on equity required is assumed to be more than 8%.

Relationships between leverage and tax exemption steps as shown in Table 8.14 through Table 8.16 indicate that the high debt/equity ratio with low interest rate loan can decrease the necessary tax exemption steps; while the high debt/equity ratio with high interest rate loan causes higher unrepaid loan at the end of the project life. The more money borrows, the more tax exemption steps need. Highly leveraged projects are difficult to achieve sound operation.

(7) Desired financial conditions for renovation

The above-mentioned studies show that a 80% debt option is more advantageous than that of 90% debt in terms of tax exemption steps and operation soundness. Then, for the time being, the desired financial conditions which Case 6 is economically feasible are assumed to be:

- project financing of a 80% debt and a 20% equity
- fixed assets revaluation
- tax deductible of accumulated operation loss
- no after tax expenses but treated as before tax costs
- import tax of 0% for equipment and spare parts
- trade tax of 5% for equipment and spare parts
- trade tax on coal sale of 5% and the remaining 5% kept by the mine

8.3.5 Financial sensitive analysis

(1) Coal sale prices and financial soundness

Relationships between coal sale prices (including a 5% trade tax) and financial soundness of the project examined on the financial base case by the amount of loan unrepaid at the end of the project life are illustrated in Table 8.17.

Comparisons made on after corporate tax basis are as follows;

- debt/equity 0.001/0.999, 0.8/0.2, 0.999/0.001
- Coal sale prices (i) price at no loan unrepaid on a 99.9% debt
  (ii) price at the economic value of 6,057.1 Tg/t
  (iii) price at no loan unrepaid on a 80% debt
  (iv) price at a 10% FIRR on equity on a 80% debt
  (v) price at a 8% FIRR on equity on a 80% debt
- foreign loan interest rates 1%, 2%, 3%, 5%, 8%, 10%

The findings are as follows:

1) on a 0.1% debt case

(a) FIRR on equity at 6,057.1 Tg/t is 8.0% and loan repayment is always fulfilled for every price level. FIRRs, however, are low due to almost no leverage.

2) on a 80% debt case

(a) Even at 10% FIRR on equity for every price level, the amount of loan unrepaid at the end of the project life ranges from 4,100.7 to 7,153.1 (10^6Tg).

(b) A price with no loan unrepaid is always lower than the economic coal value of 6,057.1 Tg/t unless a interest rate is more than 7.6% and seems to be the most reasonable sale price level.

(c) Reasonable sale price on different foreign loan interest rates (FLIR) are 5,874.6 Tg/t (FLIR = 1%), 5,902.1 Tg/t (2%), 5,929.6 Tg/t (3%), 5,984.8 Tg/t (5%), 6,067.9 Tg/t (8%), 6,123.4 Tg/t (10%).

(d) FIRRs at 6,057.1 Tg/t vary from 11.0% (interest rate of 10%) to 22.2% (interestrate of 1%).

3) on a 99.9% debt case

(a) A price with no loan unrepaid is always higher than the economic coal value of 6,057.1 Tg/t.

(b) The amount of loan unrepaid at no-loan-unrepaid price on a 80% debt, which ranges from 36,438.8 to 58,250.6 (10^6Tg), is almost prohibitive to finance the coal mine. The equivalent coal amount is from 13 to 21 million tons by the current price of 2,750 Tg/t.

(c) A 99.9% debt financing cannot achieve a healthy operation at the reasonable price level on a 80% debt.

(2) Financial sensitivity analyses for other conditions

Financial sensitivity analyses have been conducted to evaluate the impact of changes in the base case assumptions for the taxation amended financial base case (a 80% debt with a 2% foreign loan interest rate), in which two cases are included, one for sensitivity on FIRR on the total project and the other for sensitivity on FIRR on equity. The changes evaluated are as follows:

- foreign exchange rate;
- capital costs;
- operating costs; and
- total excavation with no changes in coal production.

The range of changes analyzed is ±20% at every 5% step for all the items.

1) FIRR on the total project

The results of the sensitivity analyses on the financial base case at the economic value of 6,057.1 Tg/t are presented on Table 8.18 in terms of FIRR on the total project.

FIRR on the total project for the base case is 8.4%. A 5% change in operating costs, total excavation and capital costs cannot keep a 8% FIRR on the total project. Only a 5% change in foreign exchange rates can keep a 8% FIRR on the total project. This implies that further mitigation steps including a low cost loan will be required for a stable operation in the mine.

2) FIRR on equity

The results of the sensitivity analyses on a 80% debt with a 2% foreign loan interest rate at the economic value of 6,057.1 Tg/t are presented on Table 8.19 in terms of FIRR on equity. Resulting from leverage, FIRR on equity for the base case is 20.3% with no-loan-unrepaid, shifted from an original 8.4% FIRR. A $\pm$15% change in foreign exchange rates show no loan unrepaid at the end of the project life. The amounts of loan unrepaid at the end of the project life for a 5% change in operating costs, total excavation and capital costs are 1,634.9 $\times 10^6$ Tg, 1,382.5 $\times 10^6$ Tg and zero respectively. This level of loan unrepaid can be manageable.

The results of the sensitivity analyses on a 80% debt with a 2% foreign loan interest rate at the critical price of no-loan-unrepaid at the end of the project life, which is 5,902.1 Tg/t including a 5% trade tax, are presented on Table 8.20 in terms of FIRR on equity. The amounts of loan unrepaid at the end of the project life for a $\pm$5% change in operating costs, total excavation, capital costs and exchange rates are 7,330.9, 7,080.2, 4,114.9 and 1,473.8 (10^6Tg) respectively. This level of loan unrepaid is not unmanageable; however the amount of loan unrepaid at a 5% change in operating costs, which is equivalent to a five-month production by the current price of 2,750 Tg/t, cannot be called a healthy operation.

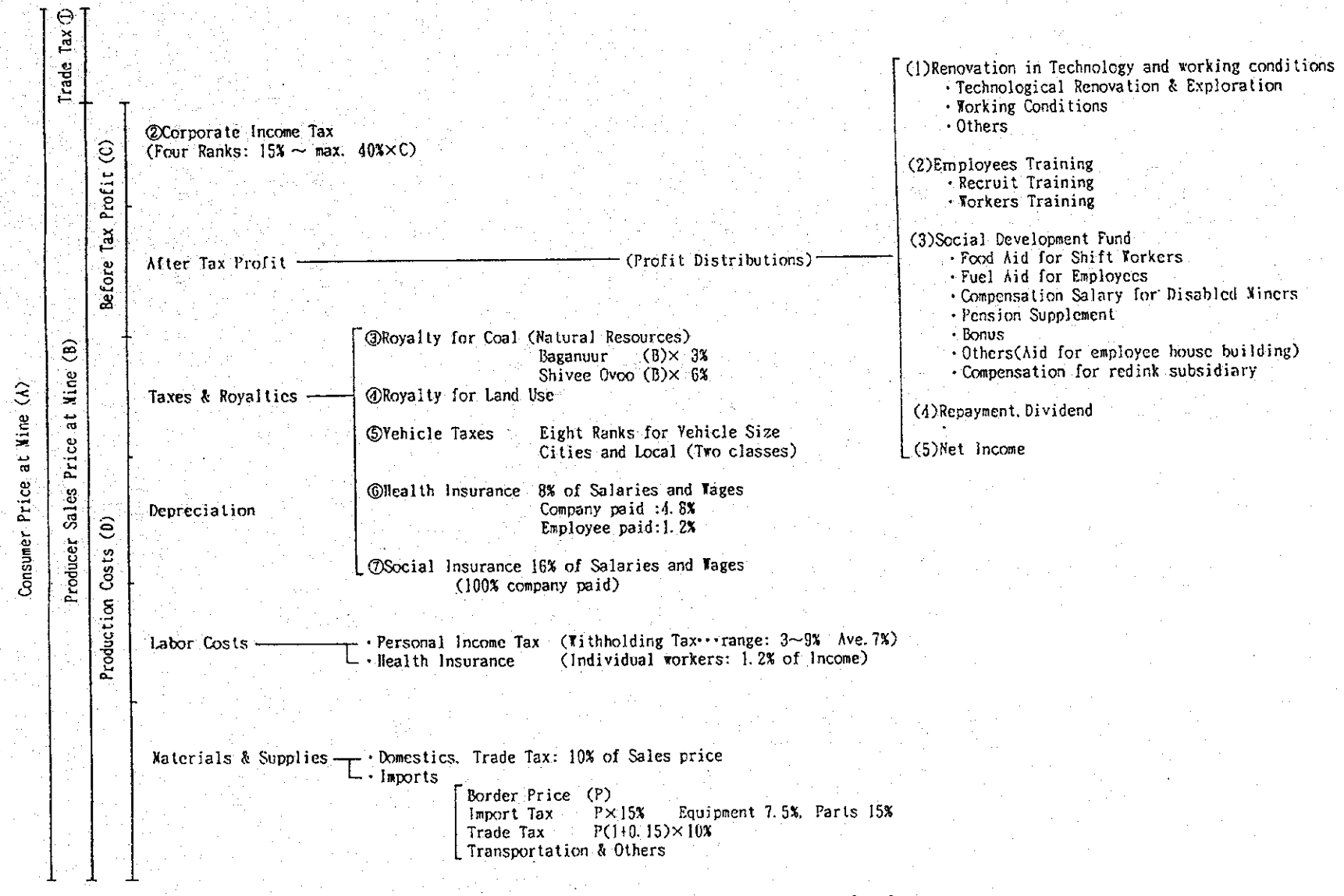


Figure 8.1 Tax System and Coal Price Structure

Table 8.1 Datong Coal (thermal) Exported to Japan

Year	Quantity (1,000ton)	FOB price (US$)	Heating Value (kcal/kg)
1985	2,285	40.44 **(39.85)	6,900
1986	2,308	36.51	6,800
1987	2,421	29.51	6,800
1988	2,405	35.10	6,800
1989	2,484	38.90	6,800
1990	2,546	40.45	6,800
1991	* 2,700	39.45	6,800
1992	2,641	38.59	6,800
1993	* 2,540	35.90	6,800
1994	* 2,660	32.60	6,800
Average	———	36.627	6,800

(AD)

* Contract Basis

** 6,800kcal/kg equivalent

Datong Coal Specification

Total Moisture	(%)	≦ 8
Inherent Moisture	(%)	≦ 4
Volatile Matter	(%)	≧ 26
Ash	(%)	≦ 12
Sulphur	(%)	≦ 1.0
Size	(mm)	≦ 50

Calculation Example

Unit price on a dry-ash free basis.

6,800 ÷ {1- (0.04 + 0.12)} = 8,095

3,662.7¢ ÷8,095 = 0.4525¢/kcal

Table 8.2 Russian Coal (thermal) Exported to Japan

Quantity

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992
1,000t	774	963	892	954	1,788	2,469	2,729	2,278	1,522

FOB Prices (US$)

Brand	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Neryungri-SS	30/ 31.5	30.25	24.5	25.0	30.5	33/ 33.5	33.2/ 33.5	32.2	30.2	28.0
Kuznetskey-SS							33.75	33.25/ 33.5	30.75/ 31.0	28.5
Kuznetskey-G6		38.5	35.5	37.0	42.5	43.0	41.6	41.5	39/ 39.5	36.0
Kuznetskey-GK	39.0	37.5	34.25	35.0	40.5	43/ 43.5	43/ 43.5	42/ 42.5	40/ 40.5	37.5
Tugnui									28.5/ 29	27.5

Specification

Brand	Neryungri-SS	Kuznetskey-SS	Kuznetskey-G6	Kuznetskey-GK	Tugnui
Heating Value (Basis) kcal/kg	6,500 (AR)	8,050 (DAF)	7,200 (AD)	8,150/8,200 (DAF)	6,100/6,200 (AD)
Total Moisture (As received:AR) (%)	8.0	8~13	10.0	9.0	11.0
Inherent Moisture (Air Dry:AD) (%)	———	———	2.3	———	———
Ash (AD) (%)	16.0	15.0	10.1	9.0	16.0
Volatile Matter (%)	20.0 (DAF)	20~30 (DAF)	36.2 (AD)	37~41 (DAF)	45 (DAF)
Fixed Carbon (AD) (%)	———	———	51.4	———	———
Total Sulphur (AD) (%)	0.30	0.30	0.40	0.60	0.60
H.G.I. (AD)	60	———	61	65	———
A.F.T. (Flow) (℃)	1,450	———	1,450	1,350	———
Heaating Value (DAF) (kcal/kg)	8,553	8,050	8,219	8,175	?

Table 8.3 FOB Unit Price (Dry-Ash-Free Basis)

US ¢/100kcal/kg

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Average
[CHINA] Datong	49.23	45.10	36.45	43.36	48.05	49.97	47.50	47.67	44.35	40.27	451.95	45.20
[RUSSIA] Neryungri-ss	35.95	35.37	28.64	29.23	35.66	38.88	38.99	37.65	35.31	32.74	348.42	34.84
Kuznetsky-ss	——	——	——	——	——	——	41.93	41.46	38.35	35.40	157.14	39.28
Kuznetsky-G6	——	46.84	43.19	45.02	51.71	52.32	50.61	50.49	47.76	43.80	431.74	47.97
Kuznetsky-GK	47.71	45.87	41.90	42.81	49.54	52.91	52.91	51.68	49.24	45.87	480.44	48.04
Russian Average	——	——	——	——	——	——	——	——	——	——	——	42.53
Overall Average	——	——	——	——	——	——	——	——	——	——	——	43.86

Table 8.4 Economic Coal Price at a 10% EIRR

Unit: Tg/t

	Production Coal (10^3t)	Economic (EIRR = 10%)		
	Total Excavation (10^3 BCM)	Improved	Non Railway (1998)	Non Railway (2002)
A. Rehabilitation	3,716	(Case 1) 5,257.3	(Case 2) 4,916.2	(Case 3) 4,971.0
(Existing)	18,489			
B. Expansion	2,294	(Case 4) 4,369.7	(Case 4) 4,369.7	(Case 4) 4,369.7
(Additional)	11,411			
C. Total	6,010	(Case 5) 4,976.8	(Case 6) 4,743.5	(Case 7) 4,781.0
(Combined)	29,900			

Coal prices on the table are including a 10% trade tax.
Baganuur coal economic value 6,057.1 Tg/t (3,563 kcal/kg)

Table 8.5 DCF Cash Flow and Foreign & Local Currency Requirement of Case 6

EQUIPMENT:NON RAILWAY SYSTEM fo 1998

RAGANUUR COAL MINE RENOVATION PROJECT

Foreign E.R (Tg/US$): 400.0
TBCM (M): 100.0
Coal (M): 100.0

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
[PRODUCTION]																								
A Coal (10^3 t)	4,000.0	4,000.0	3,853.2	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	3,716.3	98,178.6
Overburden (10^3 BCM)	14,193.2	14,193.2	14,997.6	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	15,608.3	355,472.4
Stripping Ratio (BCM/t)	3.5	3.5	3.9	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1
Total Excavation (10^3 BCM)	17,300.0	17,300.0	17,894.6	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	18,488.1	422,277.5
B Coal (10^3 t)	0.0	0.0	1,146.8	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	2,293.5	47,017.8
Overburden (10^3 BCM)	0.0	0.0	4,816.5	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	9,632.9	197,474.6
Stripping Ratio (BCM/t)	0.0	0.0	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Total Excavation (10^3 BCM)	0.0	0.0	5,795.4	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	11,410.9	233,922.5
C Coal (10^3 t)	4,000.0	4,000.0	5,000.0	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	6,009.8	133,196.3
Overburden (10^3 BCM)	14,193.2	14,193.2	18,724.0	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	25,241.2	552,347.6
Stripping Ratio (BCM/t)	3.5	3.5	3.9	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Total Excavation (10^3 BCM)	17,300.0	17,300.0	23,000.0	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	29,900.9	656,266.9
[Revenue]																								
Sale Price (Tg/t)	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	4,743.5	
Trade Tax (Tg/t)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Economic Benefit (10^6 Tg)	18,974.0	18,974.0	23,717.5	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	28,507.6	631,816.8
[OPERATING COSTS] (10^6 Tg)																								
Material & Energy																								
Parts	7,200.9	7,200.9	8,333.6	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	10,276.9	228,272.8
Diesel Oil	811.5	811.5	1,492.8	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	1,865.0	42,416.7
Gas & Lub.	215.0	215.0	493.0	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	530.4	11,442.7
Electricity	716.0	810.4	976.7	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	1,298.5	28,472.8
Explosives	554.8	554.8	756.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	958.8	21,842.8
M & E Others	912.2	912.2	1,192.5	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	1,472.8	32,473.4
Labor Costs																								
Salaries & Wages	874.7	874.7	874.2	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	969.3	21,823.1
Social Insurance	156.5	156.5	156.4	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	165.2	3,755.6
Others																								
Royalties & Charges	175.1	175.1	207.6	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	5,455.5
Payable Interest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Depreciation																								
Past Depreciation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Investment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Operating Costs	11,614.7	11,789.2	14,387.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	17,872.8	395,167.3
[PROFIT] (10^6 Tg)																								
Before Tax Profit(Loss)	7,359.3	7,284.8	9,329.9	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	236,649.5
Corporate Income Tax (0%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
After Tax Profit(Loss)	7,359.3	7,284.8	9,329.9	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	10,634.8	236,649.5
After Tax Expenses	722.7	736.8	864.6	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	1,128.1	24,919.0
Retained Earning(Loss)	6,636.6	6,534.8	8,425.2	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	211,730.4
[INVESTMENT] (10^6 Tg)																								
Existing Eq. Replacement	1,758.4	12,375.9	4,628.3	1,417.2	7,050.2	1,548.9	696.3	2,439.6	7,183.8	1,823.9	8,328.9	1,413.1	1,486.2	1,128.5	1,058.6	139.2	11,418.2	1,128.1	4,888.2	7,185.4	1,774.6	312.6	2,889.4	83,987.5
Additional Investment	4,515.7	0.0	23,676.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34,192.3
Additional Replacement	0.0	0.0	0.0	0.0	0.0	1,620.8	277.2	0.0	7,812.5	0.0	18,693.1	0.0	870.7	0.0	8,057.8	2,148.0	1,993.8	103.8	14,765.4	0.0	7,880.8	0.0	1,817.1	68,855.3
Total Capital Cost	6,306.2	12,375.9	34,314.8	1,417.2	7,050.2	3,169.9	967.5	2,439.6	15,006.3	1,823.9	24,925.2	1,413.1	2,079.9	1,128.5	7,114.5	2,279.3	13,321.7	1,223.9	19,653.6	7,185.4	9,655.4	312.6	3,886.5	179,946.1
[CASH FLOW] (10^6 Tg)																								
Retained Earning(Loss)	6,636.6	6,534.8	8,425.2	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	9,506.7	211,730.4
Depreciation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LESS:Total Capital Cost	6,306.2	12,375.9	34,314.8	1,417.2	7,050.2	3,169.9	967.5	2,439.6	15,006.3	1,823.9	24,925.2	1,413.1	2,079.9	1,128.5	7,114.5	2,279.3	13,321.7	1,223.9	19,653.6	7,185.4	9,655.4	312.6	3,886.5	179,946.1
LESS:Working Capital	3,813.4	38.7	873.1	1,317.2	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	
Payable Interest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash Flow	-3,282.9	-5,877.8	-26,762.7	6,372.3	2,456.5	6,337.7	8,539.2	7,067.1	-5,499.7	7,670.8	-15,422.5	8,093.6	7,427.7	8,378.2	2,392.2	7,228.4	-3,815.1	8,282.8	-10,146.9	2,317.3	-148.7	9,194.1	5,619.2	27,844.8

Salvage 0.0
Reclamation -219.8
Loan Unrepaid 0.0
Working Capital 5,848.4
Equipment 38,822.1
TOTAL 44,342.8

(%) IRR = 10.8
Discount Rate (%) = 10.0 (10^6 Tg) NPV = 0.0

Table 8.5 Cont. (1) DCF Cash Flow and Foreign & Local Currency Requirement of Case 6

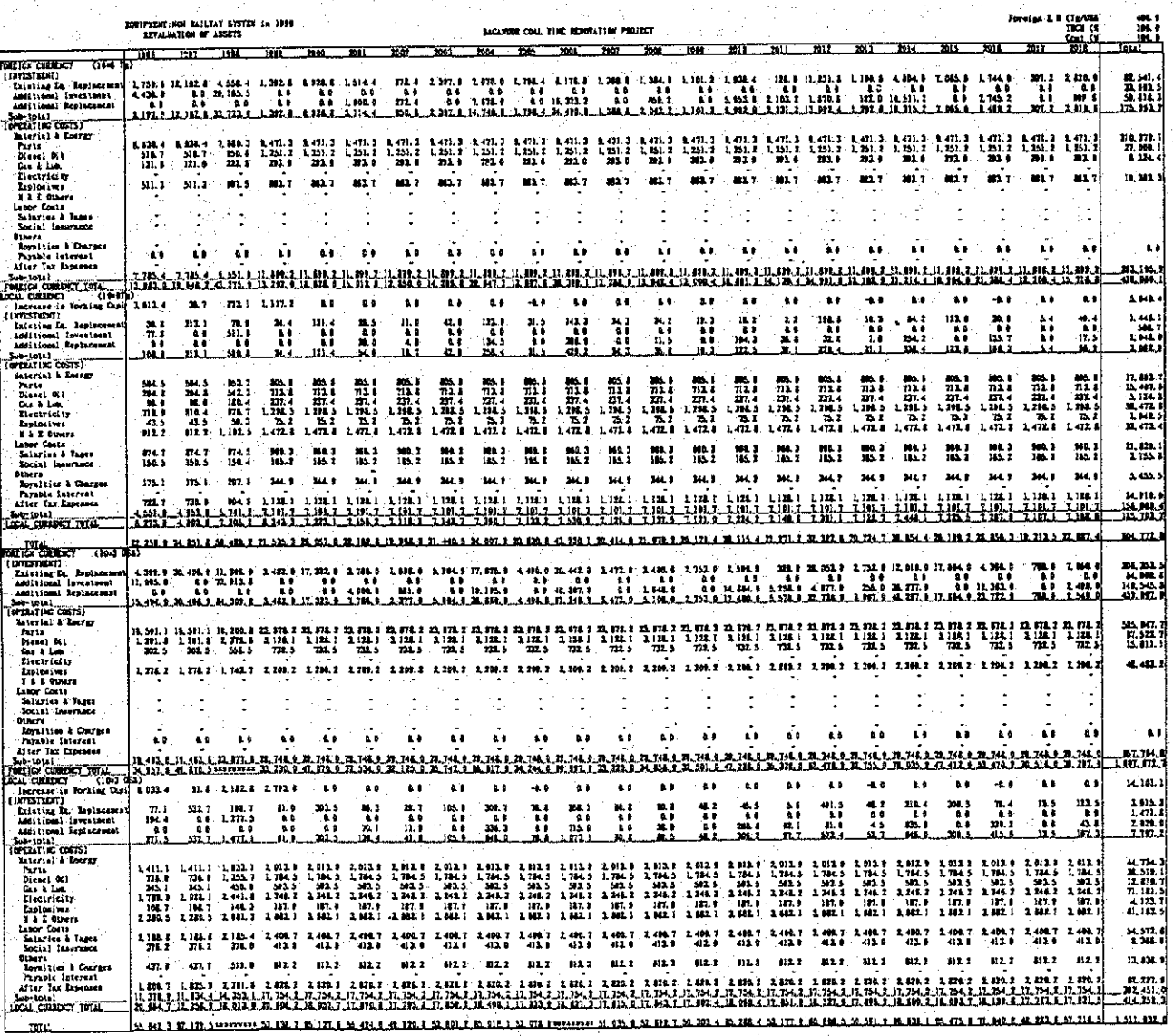


Table 8.6 Variation in Equipment Price Level for Base Case Selection

Unit: Tg/t

International Price Level	Comparison Index	Times Current Price	Coal Price at a 10% EIRR Case 1	Case2	Case 3
0.8 (used in study)	1.0	2.25	* ③ 5,257.3	① 4,916.2	② 4,971.0
0.7	0.875	1.90	③ 4,828.1	① 4,600.0	② 4,633.8
0.6	0.750	1.70	③ 4,399.0	① 4,283.9	② 4,296.5
** 0.5	0.625	1.40	③ 3,969.9	② 3,967.7	① 3,959.3
0.36 (current)	0.450	1.00	① 3,369.1	③ 3,525.1	② 3,487.2

Note: Total Excavation: 18,489 × 10^3 BCM

Case 1: Improvement of existing system with railway

Case 2: Improvement abandoning railway in 1998

Case 3: Improvement abandoning railway in 2002

The international price level means the price of equipment to be supplied from the ex-COMECON countries, which is indicated by the ratio to the international price.

* ①, ②, ③ indicate order of favorableness.

** Threshold equipment price level which change order of favorableness.

Coal prices on the table are including a 10% trade tax.

Table 8.7 Economic Sensitivity Analyses

Unit: EIRR %

Variation Factor	Price (1.00: 6,057.1 Tg/t)			Exchange Rate (1.00: 400Tg/US$)			Capital Costs			Operating Costs			Total Excavation Volume (No changes in coal)			
	Case 2	Case 4	Case 6	Case 2	Case 4	Case 6	Case 2	Case 4	Case 6	Case 2	Case 4	Case 6	Case 2	Case 4	Case 6	(S/R)*
1.20	NA**	57.3	NA	NA	38.3	NA	69.3	28.6	39.3	31.7	27.0	28.9	34.2	27.3	30.0	(5.2)
1.15	NA	52.0	NA	NA	37.9	NA	NA	30.3	45.5	49.5	29.4	36.2	53.1	29.6	37.3	(4.9)
1.10	NA	46.7	NA	NA	37.5	NA	NA	32.2	53.9	94.2	31.7	45.9	104.8	31.9	46.9	(4.7)
1.05	NA	41.6	NA	NA	37.1	NA	NA	34.3	66.9	NA	34.2	60.6	NA	34.3	61.4	(4.4)
1.00	NA	36.6	97.0	NA	36.6	97.0	NA	36.6	97.0	NA	36.6	97.0	NA	36.0	97.0	(4.2)
0.95	NA	31.8	48.6	NA	36.1	81.7	NA	39.2	NA	NA	39.2	NA	NA	39.1	NA	(4.0)
0.90	39.3	27.0	31.5	NA	35.6	71.8	NA	42.1	NA	NA	41.7	NA	NA	41.6	NA	(3.7)
0.85	18.4	22.2	20.5	NA	34.9	64.0	NA	45.3	NA	NA	44.3	NA	NA	44.1	NA	(3.5)
0.80	8.1	17.5	12.3	NA	34.2	57.3	NA	48.9	NA	NA	47.0	NA	NA	46.6	NA	(3.2)

* Stripping ratio
** NA = Not available

Base Case at the economic value of 6,057.1 Tg/t

Coal prices mentioned here are including a 10% trade tax.

Table 8.8 General Inflation

Consumer Price Index

Year-Month-Date	1991-1-16	1994-5	Monthly (%)
Food, beverages and tobacco	100	2,853.27	8.5
Clothing and footwear	100	1,620.96	7.0
Rent and utilities	100	1,182.83	6.2
Household goods	100	2,741.50	8.4
Medical care	100	1,933.93	7.5
Transport and communication	100	1,683.07	7.1
Education and recreation	100	2,827.33	8.5
Other goods and services	100	2,141.17	7.8
Overall indexes	100	2,291.47	7.9

Table 8.9 Economic Indices

Various Prices and Indices related to Coal Mining

Year		1990	1991	1992	1993	1994	Remarks
Consumer Price Index		100	153	650	1,839	2,293 (20)	
Exchange Rate	(Tg/US$)	5.48	25.51	40.00	299.3	400.0	
Coal Price	(Tg/t)	31.87	83	180	1,723	2,396	
Coal Production Cost	(Tg/t)	27.30	38.4	150	779	1,545	
Explosives	(1,000Tg/t)	2.26	6.52	20.8	108.7	210.0	
Detonator	(Tg/each)	0.57	4.05	4.05	4.87	150.0	
Dragline 10/70 Bit	(1,000Tg/each)	0.81	0.81	13.5	18.25	81.25	(168)
Dragline 20/90 Bit	(1,000Tg/each)	0.52	0.52	13.5	76.0	131.25	
Wire Rope	(1,000Tg/t)	19.20	33.2	33.2	132.3	200.0	(480)
Cable	(1,000Tg/km)	85.0	460.0	600.0	2,625.0	6,700.0	
Sleeper	(Tg/each)	245.0	245.0	500.0	957.0	1,500.0	
Diesel Oil	(1,000Tg/t)	1.13	2.14	11.8	50.0	144.0	
Gasoline	(1,000Tg/t)	1.1	2.2	18.0	42.0	130.0	
Lubricant	(1,000Tg/t)	37.5	37.5	62.0	240.0	375.6	
Electricity	(Tg/kwh)	0.18	0.35	0.35	4.4	13.2	
Heat	(Tg/Gcal)	37.0	55.0	110.0	1,971.0	3,862.0	
Water (Potable)	(Tg/㎥)	1.40	4.50	9.40	38.90	54.0	
Water (Industrial)	(Tg/㎥)	1.40	4.50	9.40	41.25	54.0	
Mine Average Salary	(1,000Tg/man·yr)	8.8	29.5	N.A.	253.30	533.10	
Parts							
Truck Tires	(1,000Tg/each)	11.0	11.0	45.0	235.0	535.5	
Mining Equipment							
Shovel 5A	(1,000Tg/unit)	—	1,944.7	—	1,944.7	126,000	
Diesel Loco TEM-2	(1,000Tg/unit)	1,840	—	—	—	160,000	(480,000)
Drill CbP-160	(1,000Tg/unit)	1,425.0	—	—	—	37,600	
Haul Truck Belaz 40t	(1,000Tg/unit)	829.2	829.2	829.2	—	21,200	(46,312)
Dozer Det-250	(1,000Tg/unit)	700	700	696.1	—	60,000	
Dragline 20/90	(1,000Tg/unit)	22,900	—	—	—	2,400,000	(Quotation)
Rail Tariff (B.N-U.B)	(Tg/t)	12.43	31.14	106.87	376.71	376.71	

( ) shows the offer price.

Table 8.10 Economic Indices

Escalation

Year	1990	1991	1992	1993	1994	Remarks
Consumer Price Index	1.00	1.53	6.50	18.39	22.93	
Exchange Rate	1.00	4.66	7.30	54.62	72.99	
Coal Price	1.00	2.60	5.65	54.06	75.18	
Coal Production Cost	1.00	1.41	5.49	28.53	56.59	
Explosives	1.00	2.88	9.20	48.10	92.92	
Detonator	1.00	7.10	7.10	8.54	263.16	
Dragline 10/70 Bit	1.00	1.00	16.67	22.53	100.31	
Dragline 20/90 Bit	1.00	1.00	25.96	146.15	252.40	
Wire Rope	1.00	1.73	1.73	6.89	10.42	
Cable	1.00	5.41	7.06	29.71	78.82	
Sleeper	1.00	1.00	2.04	3.91	6.12	
Diesel Oil	1.00	1.89	10.44	44.25	127.43	
Gasoline	1.00	2.00	16.36	38.18	118.18	
Lubricant	1.00	1.00	1.65	6.40	10.02	
Electricity	1.00	1.94	1.94	24.44	73.33	
Heat	1.00	1.49	2.97	53.27	104.38	
Water (Potable)	1.00	3.21	6.71	27.79	38.57	
Water (Industrial)	1.00	3.21	6.71	29.46	38.57	
Mine Average Salary	1.00	3.35	N.A.	28.78	60.58	
Parts						
Truck Tires	1.00	1.00	4.09	21.36	48.68	
Mining Equipment						
Shovel 5A	—	1.00	—	1.00	64.79	
Diesel Loco T3M-2	1.00	—	—	—	86.96	
Drill CbP-160	1.00	—	—	—	26.39	
Haul Truck Belaz 40t	1.00	1.00	1.00	—	25.57	
Dozer Det-250	1.00	1.00	1.00	—	85.71	
Dragline 20/90	1.00	—	—	—	(104.80)	(Quotation)
Rail Tariff (B.N-U.B)	1.00	2.51	2.51	30.31	30.31	

Table 8.11 Coal Sale Prices at a 10% FIRR

Unit: Tg/t

	Production Coal (10^3t) Total Excavation (10^3 BCM)	Status of Current Fixed Assets	Financial (FIRR = 10%) Improved	Non Railway (1998)	Non Railway (2002)
			(Case 1)	(Case 2)	(Case 3)
A. Rehabilitation	3,716	Not Revalued	8,852.3	8,085.8	8,227.3
(Existing)	18,489	Revalued	8,674.8	7,922.7	8,061.4
B. Expansion	2,294	None	(Case 4) 6,695.9	(Case 4) 6,695.9	(Case 4) 6,695.9
(Additional)	11,411				
			(Case 5)	(Case 6)	(Case 7)
C. Total	6,010	Not Revalued	8,085.8	7,597.6	7,687.5
(Combined)	29,900	Revalued	7,979.8	7,493.0	7,585.7

Baganuur coal economic value 6,057.1 Tg/t (3,563 kcal/kg)

FIRR: FIRR on the total project (debt/equity = 0/100)

Coal sale prices presented on the tabel are including a 10% trade tax.

Table 8.12 Tax Exemption Steps for Case 6 at 6,057.1 Tg/t

Tax Exemption Steps	FIRR *1	NPV at 10% DR *2
① Base Case (Current Taxation Regimes)	0.6	-32,421.6
② Assets Revaluation	0.9	-30,727.4
③ Carry-Over of Gross Operation Loss	0.6	-29,628.2
④ After Tax Expenses into Before Tax Costs	2.3	-25,532.2
⑤ Equipment Import Tax 7.5%a to 0, Trade Tax 10% to 5%	2.9	-22,083.7
⑥ Parts Import Tax 15% to 0, Trade Tax 10% to 5%	6.1	-11,470.4
⑦ Equipment Import Tax 0, Trade Tax 0	6.75	-9,050.7
⑧ Parts Import Tax 0, Trade Tax 0	7.75	-6,680.5
⑨ Coal Trade Tax 10% to 5% The Remaining 5% kept by the Mine	10.0	+120.0

*1 FIRR : FIRR on total Project

*2 NPV at 10% DR: Net Present Value at 10% Discount Rate (Unit:10^6Tg)

Table 8.13 FIRR on Equity for Tax Exempted Case 6 at 6,057.1Tg/t

Debt (%)	Equity (%)	Foreign Loan Interest Rate 1%		2%		3%		5%		8%		10%	
		FIRR*1	Unrepaid*2	FIRR	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid
0.00	100.00	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0
5.00	95.00	9.8	0.0	9.8	0.0	9.8	0.0	9.8	0.0	9.7	0.0	9.7	0.0
10.00	90.00	10.1	0.0	10.1	0.0	10.1	0.0	10.0	0.0	9.9	0.0	9.8	0.0
15.00	85.00	10.4	0.0	10.4	0.0	10.3	0.0	10.2	0.0	10.0	0.0	9.9	0.0
20.00	80.00	10.8	0.0	10.7	0.0	10.6	0.0	10.5	0.0	10.2	0.0	10.1	0.0
25.00	75.00	11.2	0.0	11.1	0.0	11.0	0.0	10.7	0.0	10.4	0.0	10.2	0.0
30.00	70.00	11.6	0.0	11.5	0.0	11.3	0.0	11.0	0.0	10.6	0.0	10.4	0.0
35.00	65.00	12.1	0.0	11.9	0.0	11.7	0.0	11.4	0.0	10.9	0.0	10.5	0.0
40.00	60.00	12.7	0.0	12.4	0.0	12.2	0.0	11.8	0.0	11.1	0.0	10.7	0.0
45.00	55.00	13.3	0.0	13.1	0.0	12.8	0.0	12.2	0.0	11.5	0.0	11.0	0.0
50.00	50.00	14.1	0.0	13.7	0.0	13.4	0.0	12.7	0.0	11.8	0.0	11.3	0.0
55.00	45.00	14.9	0.0	14.5	0.0	14.1	0.0	13.4	0.0	12.3	0.0	11.6	0.0
60.00	40.00	16.1	0.0	15.6	0.0	15.1	0.0	14.2	0.0	12.9	0.0	12.1	0.0
65.00	35.00	17.8	0.0	17.2	0.0	16.5	0.0	15.3	0.0	13.6	0.0	12.6	0.0
70.00	30.00	20.5	0.0	19.5	0.0	18.5	0.0	16.8	0.0	14.7	0.0	13.4	0.0
75.00	25.00	25.0	0.0	23.3	0.0	21.8	0.0	19.2	0.0	16.2	0.0	14.6	0.0
80.00	20.00	36.2	0.0	32.2	0.0	29.1	0.0	24.1	0.0	19.0	0.0	16.5	0.0
85.00	15.00	NA *3	0.0	NA	0.0	NA	0.0	NA	0.0	24.3	0.0	19.3	0.0
90.00	10.00	NA	0.0	NA	0.0	NA	0.0	NA	0.0	NA	1,733.7	NA	4,549.9
95.00	5.00	NA	0.0	NA	105.3	NA	1,627.9	NA	4,760.3	NA	9,847.9	NA	13,614.7
99.99	0.01	NA	7,748.5	NA	9,642.7	NA	11,604.7	NA	15,710.7	NA	22,913.1	NA	28,437.3

*1 FIRR : Financial rate of return on equity (unit: %)
*2 Unrepaid: Loan unrepaid at the end of the project life (unit: 10^6Tg)
*3 NA : Not Available

Table 8.14 Relationship between Leverage and Tax Exemption Steps in Case 6 at 6,057.1 Tg/t

Tax Exemption Steps	DEBT: EQUITY = 50:50 F.L.I.R *1= 1% Unrepaid*2	FIRR*3	F.L.I.R = 2% Unrepaid	FIRR	F.L.I.R = 3% Unrepaid	FIRR	F.L.I.R = 5% Unrepaid	FIRR	F.L.I.R = 8% Unrepaid	FIRR	F.L.I.R = 10% Unrepaid	FIRR
① Base Case	6,537.1	0.6	6,734.9	0.4	6,931.9	0.3	7,309.5	NA *4	7,939.1	NA	8,402.3	NA
② Assets Revaluation	5,642.9	1.0	5,853.5	0.8	6,073.3	0.7	6,550.1	0.3	7,364.6	NA	7,935.3	NA
③ Carry-Over of Gross Operation Loss	5,227.1	1.3	5,435.4	1.2	5,613.6	1.0	5,770.4	0.7	6,132.2	0.1	6,878.6	NA
④ After Tax Expenses into Before Tax Costs	3,264.5	1.7	3,718.7	1.4	4,151.7	1.0	4,963.4	0.4	6,164.4	NA	6,909.9	0.3
⑤ Equipment Import Tax 7.5% to 0 Trade Tax 10% to 5%	626.7	3.0	837.2	2.8	1,297.8	2.5	2,118.5	1.8	3,299.7	0.9	4,072.3	0.3
⑥ Parts Import Tax 15% to 0 Trade Tax 10% to 5%	0.0	7.7	0.0	7.4	0.0	7.2	0.0	6.7	0.0	6.0	0.0	5.6
⑦ Equipment, Parts Import Tax 0 Trade Tax 0	0.0	10.0	0.0	9.7	0.0	9.4	0.0	8.9	0.0	8.2	0.0	7.7
⑧ Coal Trade Tax 10% to 5%	(0.0	14.1) *5	(0.0	13.7)	(0.0	13.4)	(0.0	12.7)	(0.0	11.8)	(0.0	11.3)

*1 F.L.I.R : Foreign loan interest rate
*2 Unrepaid: Loan unrepaid at the end of the project life (Unit: 10^6Tg)
*3 FIRR : FIRR on equity
*4 NA : Not available (Unit: 0%)
*5 ( ) : This Tax exemption is not necessary due to enough financial feasibility

Table 8.15 Relationship between Leverage and Tax Exemption Steps in Case 6 at 6,057.1 Tg/t

Table 8.15 Relationship between Leverage and Tax Exemption Steps in Case 6 at 6,057.1 Tg/t

Tax Exemption Steps	DEBT: EQUITY = 70:30											
	F.L.I.R *1 = 1%		F.L.I.R = 2%		F.L.I.R = 3%		F.L.I.R = 5%		F.L.I.R = 8%		F.L.I.R = 10%	
	Unrepaid*2	FIRR*3	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid	FIRR
① Base Case	20,370.9	0.7	21,132.2	0.4	21,932.0	NA	24,233.3	NA	29,554.8	NA	33,571.4	NA
② Assets Revaluation	18,812.9	1.2	19,662.9	0.8	20,565.7	0.4	23,028.5	NA	28,899.4	NA	33,082.6	NA
③ Carry-Over of Gross Operation Loss	17,140.8	1.8	18,488.7	1.2	19,871.2	0.6	22,672.6	NA	28,899.4	NA	33,082.6	NA
④ After Tax Expenses into Before Tax Costs	17,185.8	NA *4	18,594.8	NA	19,980.5	NA	22,846.5	NA	29,088.2	NA	33,281.0	NA
⑤ Equipment Import Tax 7.5% to 0 Trade Tax 10% to 5%	11,476.4	1.8	12,816.8	0.9	14,149.1	NA	16,785.1	NA	20,733.1	NA	23,874.9	NA
⑥ Parts Import Tax 15% to 0 Trade Tax 10% to 5%	0.0	9.6	0.0	9.0	0.0	8.5	1,131.5	7.5	2,965.5	6.1	4,008.9	5.1
⑦ Equipment, Parts Import Tax 0 Trade Tax 0	(0.0	13.2) *5	(0.0	12.5)	(0.0	11.9)	0.0	10.8	0.0	9.2	0.0	8.2
⑧ Coal Trade Tax 10% to 5%	(0.0	20.5)	(0.0	19.5)	(0.0	18.5)	(0.0	16.8)	(0.0	14.7)	0.0	13.4

*1 F.L.I.R : Foreign loan interest rate
*2 Unrepaid: Loan unrepaid at the end of the project life (Unit: 10^6Tg)
*3 FIRR : FIRR on equity (Unit: %)
*4 NA : Not available
*5 ( ) : This Tax exemption is not necessary due to enough financial feasibility

Table 8.16 Relationship between Leverage and Tax Exemption Steps in Case 6 at 6,057.1 Tg/t

Tax Exemption Steps	DEBT: EQUITY = 80:20 F.L.I.R.*1 = 1% Unrepaid*2	FIRR*3	F.L.I.R. = 2% Unrepaid	FIRR	F.L.I.R. = 3% Unrepaid	FIRR	F.L.I.R. = 5% Unrepaid	FIRR	F.L.I.R. = 8% Unrepaid	FIRR	F.L.I.R. = 10% Unrepaid	FIRR
① Base Case	43,781.2	1.3	46,430.4	0.9	49,171.6	0.5	56,003.3	NA	67,632.2	NA	75,720.7	NA
② Assets Revaluation	40,965.2	1.6	44,448.5	1.1	48,170.7	0.5	55,960.7	NA	68,091.7	NA	76,178.4	NA
③ Carry-Over of Gross Operation Loss	39,796.5	1.8	43,828.0	1.1	47,872.2	0.5	55,960.7	NA	68,091.7	NA	76,178.4	NA
④ After Tax Expenses into Before Tax Costs	40,243.2	NA *4	44,277.4	NA	48,321.7	NA	56,410.1	NA	68,540.9	NA	76,627.6	NA
⑤ Equipment Import Tax 7.5% to 0 Trade Tax 10% to 5%	27,144.2	NA	30,892.5	NA	34,697.3	NA	42,344.1	NA	53,817.7	NA	61,466.1	NA
⑥ Parts Import Tax 15% to 0 Trade Tax 10% to 5%	4,192.7	11.5	5,206.3	10.6	6,219.8	9.7	8,223.0	8.1	11,034.4	5.7	14,370.1	3.9
⑦ Equipment, Parts Import Tax 0 Trade Tax 0	0.0	17.5	0.0	16.1	0.0	14.9	1,019.6	12.8	3,942.1	10.1	5,901.3	8.5
⑧ Coal Trade Tax 10% to 5%	(0.0	36.2) *5	(0.0	32.2)	(0.0	29.1)	(0.0	24.1)	0.0	19.0	0.0	16.51

*1 F.L.I.R : Foreign loan interest rate
*2 Unrepaid: Loan unrepaid at the end of the project life (Unit: 10^6Tg)
*3 FIRR : FIRR on equity (Unit: %)
*4 NA : Not available
*5 ( ) : This Tax exemption is not necessary due to enough financial feasibility

Table 8.17 Relation ship between Coal Prices and Operation Soundness in Financial Base Case (Case 6)

F.L.I.R.*1	Price		Debt/Equity 0.001/0.999		Debt/Equity 0.800/0.200		Debt/Equity 0.999/0.001	
(%)	(Tg/t)	Note	FIRR*2	Unrepaid*3	FIRR	Unrepaid	FIRR	Unrepaid
	6,415.7	a	10.7	0.0	46.4	0.0	NA *4	(CR) 0.0
	6,057.1	b	8.0	0.0	22.2	0.0	NA	21,404.9
1.0	5,874.6	c	6.6	0.0	*6 · 15.3	*5 (CR) 0.0	NA	36,438.8
	5,681.0	d	5.2	0.0	10.0	7,153.1	NA	93,655.6
	5,596.7	e	4.6	0.0	8.0	10,194.8	NA	119,369.8
	6,449.2	a	10.9	0.0	44.2	0.0	NA	(CR) 0.0
	6,057.1	b	8.0	0.0	20.3	0.0	NA	23,566.4
2.0	5,902.1	c	6.8	0.0	· 14.9	(CR) 0.0	NA	38,823.9
	5,716.6	d	5.4	0.0	10.0	6,860.2	NA	93,776.5
	5,631.7	e	4.8	0.0	8.0	9,926.0	NA	119,693.1
	6,483.5	a	11.2	0.0	42.4	0.0	NA	(CR) 0.0
	6,057.1	b	8.0	0.0	18.7	0.0	NA	25,880.2
3.0	5,929.6	c	7.0	0.0	14.5	(CR) 0.0	NA	41,212.8
	5,752.5	d	5.7	0.0	10.0	6,556.3	NA	93,809.5
	5,667.1	e	5.1	0.0	8.0	9,642.6	NA	119,897.1
	6,552.1	a	11.7	0.0	38.7	0.0	NA	(CR) 0.0
	6,057.1	b	8.0	0.0	16.0	0.0	NA	31,358.3
5.0	5,984.8	c	7.4	0.0	· 13.9	(CR) 0.0	NA	46,040.9
	5,826.0	d	6.3	0.0	10.0	5,879.2	NA	93,307.2
	5,737.3	e	5.6	0.0	8.0	9,084.7	NA	120,499.2
	6,655.0	a	12.5	0.0	35.1	0.0	NA	(CR) 0.0
	6,067.9	b	8.0	0.0	· 13.0	(CR) 0.0	NA	53,334.0
8.0	6,057.1	c	8.0	0.0	12.8	416.6	NA	56,259.0
	5,937.6	d	7.1	0.0	10.0	4,835.6	NA	92,327.5
	5,845.0	e	6.4	0.0	8.0	8,208.2	NA	120,691.5
	6,724.5	a	13.0	0.0	33.1	0.0	NA	(CR) 0.0
	6,123.4	b	8.5	0.0	· 12.5	(CR) 0.0	NA	58,250.6
10.0	6,057.1	c	8.0	0.0	11.0	2,461.7	NA	77,948.5
	6,012.5	d	7.6	0.0	10.0	4,100.7	NA	91,540.8
	5,919.7	e	6.9	0.0	8.0	7,509.0	NA	119,948.4

*1 F.L.I.R.: Foreign loan interest rate
*2 FIRR : FIRR on equity (unit: %)
*3 Unrepaid: Loan unrepaid at the end of the project life (unit: 10^6 Tg)
*4 NA : Not available
*5 (CR) : Crical point of loan repaid
*6 · : Reasonable Price Level

Coal price presented on the table are including a 5% trade tax.
Note: a: price at no loan unpaid on a 99.9% debt
b: price at the economic value of 6,057.1 Tg/t
c: price at no loan unrepaid on a 80% debt
d: price at a 10% FIRR on equity on a 80% debt
e: price at a 8% FIRR on equity on a 80% debt

Table 8.18 Financial Sensitivity Analyses on Financal Base Case (Case 6) at 6,057.1 Tg/t (on a total project basis)

Unit: FIRR

Variation Factor	Exchange Rate (1.00: 400Tg/US$)	Capital Costs	Operating Costs	Total Excavation	
	FIRR *1	FIRR	FIRR	FIRR	(S/R)*2
1.20	9.4	5.4	2.3	2.5	(5.2)
1.15	9.2	6.0	3.7	3.9	(4.9)
1.10	8.9	6.8	5.2	5.3	(4.7)
1.05	8.7	7.5	6.8	6.8	(4.4)
1.00	8.4	8.4	8.4	8.4	(4.2)
0.95	8.0	9.3	10.1	10.0	(4.0)
0.90	7.7	10.3	11.8	11.7	(3.7)
0.85	7.3	11.5	13.7	13.5	(3.5)
0.80	6.8	12.8	15.7	15.4	(3.2)

*1 FIRR : FIRR on total project at the economic coal price of 6,057.1 Tg/t (unit: %)

*2 (S/R): Stripping ratio

Table 8.19 Financial Sensitivity Analyses on Financal Base Case (Case 6) at 6,057.1 Tg/t
(80% debt with 2% foreign loan interest rate)

Unit: FIRR

Variation Factor	Exchange Rate (1.00: 400Tg/US$)		Capital Costs		Operating Costs		Total Excavation		
	Unrepaid*1	FIRR *2	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid	FIRR	(S/R)*3
1.20	0.0	26.9	10,579.9	9.3	43,053.8	NA	39,159.5	NA	(5.2)
1.15	0.0	25.4	6,559.0	11.3	19,191.8	1.2	17,478.7	2.2	(4.9)
1.10	0.0	23.8	2,502.9	13.7	8,897.9	7.5	8,407.2	7.8	(4.7)
1.05	0.0	22.2	0.0	16.6	1,634.9	12.6	1,382.5	12.9	(4.4)
1.00	0.0	20.3	0.0	20.3	0.0	20.3	0.0	20.3	(4.2)
0.95	0.0	18.4	0.0	25.2	0.0	33.9	0.0	33.2	(4.0)
0.90	0.0	16.5	0.0	32.3	0.0	64.1	0.0	60.5	(3.7)
0.85	0.0	14.6	0.0	43.4	0.0	NA	0.0	NA	(3.5)
0.80	1,219.1	12.5	0.0	59.5	0.0	NA	0.0	NA	(3.2)

*1 Unrepaid: Loan unrepaid at the end of the project life (unit: 10^6 Tg)

*2 FIRR : FIRR on equity at the economic coal price of 6,057.1 Tg/t (unit: %)

*3 (S/R) : Stripping ratio

Table 8.20 Financial Sensitivity Analyses on Financal Base Case (Case 6) at 5,902.1 Tg/t
(80% debt with 2% foreign loan interest rate)

Unit: FIRR

Variation Factor	Exchange Rate (1.00: 400Tg/US$)		Capital Costs		Operating Costs		Total Excavation		
	Unrepaid*1	FIRR *2	Unrepaid	FIRR	Unrepaid	FIRR	Unrepaid	FIRR	(S/R)*3
1.20	0.0	20.1	15,976.7	6.2	63,927.7	NA	60,034.4	NA	(5.2)
1.15	0.0	18.9	12,139.9	8.0	36,595.3	NA	33,700.5	NA	(4.9)
1.10	0.0	17.7	8,164.4	10.0	15,463.0	3.7	14,460.4	4.3	(4.7)
1.05	0.0	16.3	4,114.9	12.2	7,330.9	9.0	7,080.2	9.2	(4.4)
1.00	0.0	14.9	0.0	14.9	0.0	14.9	0.0	14.9	(4.2)
0.95	1,473.8	13.5	0.0	18.4	0.0	24.3	0.0	23.9	(4.0)
0.90	2,914.6	12.0	0.0	22.8	0.0	43.5	0.0	41.4	(3.7)
0.85	4,344.8	10.4	0.0	29.1	0.0	NA	0.0	97.3	(3.5)
0.80	5,775.8	8.7	0.0	38.8	0.0	NA	0.0	NA	(3.2)

*1 Unrepaid: Loan unrepaid at the end of the project life (unit: 10^6 Tg)

*2 FIRR : FIRR on equity at the critical coal price for loan unpaid of 5,902.1 Tg/t (unit: %)

*3 (S/R) : Stripping ratio

9 Conclusions and Recommendation

1) Issues of present Baganuur coal mine

In 1993, the total excavation volume of coal and overburden was only 55% of the designed capacity. The issues were caused mainly by:

- Low achievement of the railway system due to frequent troubles of whole system and/or individual equipment
- Lack of spare parts due to shortage of the fund
- Lack of experts for maintenance due to repatriation of foreign engineers

2) Recommended mining system for renovation

Following three renovation programs were investigated in technical and economic standpoints :

Case A: Rehabilitation (18.5 million BCM/y) and expansion (11.4 million BCM/y) using the existing railway system through the project life.

Case B: Rehabilitation and expansion changing the existing railway system (abandoned) into a new shovel and truck system in 1998.

Case C: Rehabilitation and expansion changing the existing railway system into the new shovel and truck system in 2002.

After detailed technical and economic evaluation, Case B was selected as a most favorable system for renovation.

3) Environmental impact

No limitation on the renovation project was recognized in all environmental aspects.

Major expected environmental issues and countermeasures are as follows:

- Precipitation in the river of Fe exhausted from groundwater;
  To expand the existing water treatment system of groundwater drainage.
- Possibility of drawdown of the water level of Baga Gun Lake;
  To monitor the level and to introduce the flow of Hutsaa River into Baga Gun Lake, if necessary.

The proposed facilities and equipment to preserve the environment were included in the renovation cost.

4) Major equipment and facilities

Major equipment of Case B after changing the railway system into a shovel and truck system in 1998 are as follows:

	Existing equipment	Change of railway	Equipment for expansion	Major services
Dragline	5	-	-	Overburden removal
Shovel	11	2	3	Excavation (overburden & coal)
Truck	18	18	41	Transportation (")
Bulldozer	16	-	11	Supporting and multi-services
Scraper	2	-	-	Road maintenance
Grader	2	-	3	Road maintenance

Note: Above equipment consists of different types and capacities.

5) Capital and operating costs

Capital and operating costs of Case B for 23 years (1996-2018) of the project period, which consist of initial cost and replacement cost, are as follows:

	Capacity (mil.t/y)	Capital cost (mil.US$)	Operating cost (mil.US$)
Rehabilitation of existing system	3.7	326	716
Expansion of the capacity	2.3	135	334
Total	6.0	461	1,050
(Unit cost: US$/ton coal)	-	3.46	7.88

Foreign currency portion of the above-mentioned capital and operating costs for first 3 years (1996-1998) is as follows:

	Capital cost (mil.US$)	Operating cost (mil.US$)
Rehabilitation of existing system	79	58
Expansion of the capacity	51	5
Total	130	63

6) Results of economic evaluation

Economic evaluation proves that the renovation project of Baganuur coal mine is highly advantageous in terms of national economy.

EIRR of Case B, which represents the point of the view of Mongolian economy, is as high as 97% at the economic coal value of 6,057 Tg/t, and the coal prices at 10% of Economic Internal Rate of return(EIRR) shown below are significantly low compared with the economic coal value of 6,057 Tg/t.

	Coal production (m.t/y)	Total excavation (m.BCM/y)	Economic coal price (Tg/t coal) Case A	Case B	Case C
Rehabilitation	3.7	18.5	5,257	4,916	4,971
Expansion	2.3	11.4	4,370	4,370	4,370
Whole system	6.0	29.9	4,977	4,743	4,781

The economic sensitivity analysis illustrates that ±20% changes in conditions such as capital cost, operating cost and stripping ratio don't give a serious impact on the feasibility of the project.

7) Results of financial analysis

Under severe Mongolian taxation system, the renovation project of Baganuur coal mine cannot be viable financially.

FIRR of Case B, which represents the investor's point of view, is as low as 0.9% at the economic coal value of 6,057 Tg/t, and the financial coal price to gain 10% FIRR on the total project (debt/equity = 0/100) is 7,493 Tg/t which is extremely high compared with 6,057 Tg/t.

	Coal production (m.t/y)	Total excavation (m.BCM/y)	Financial coal price (Tg/t coal) Case A	Case B	Case C
Rehabilitation	3.7	18.5	8,675	7,923	8,061
Expansion	2.3	11.4	6,696	6,696	6,696
Whole system	6.0	29.9	7,980	7,493	7,586

Comparing the financial coal price (7,493 Tg/t) with the economic coal price (4,743 Tg/t) at 10% EIRR in Case B, the financial price is 160% of the economic price.

8) Improvement of financial feasibility

Since the renovation is highly advantageous for Mongolian economy, the amendment of the current taxation regime is recommended to improve the financial feasibility resulting in profit redistribution from the Government to the coal mine.

Regarding effect of tax exemption, the most possible steps so as to gain 10% FIRR on the total project in Case B at the economic coal value of 6,057 Tg/t are examined and presented in the following Table.

Tax items and exemption steps	FIRR on total project	NPV at 10% discount rate
(Present situation after assets revaluation)	0.9	-30,730
1 Increase of tax exemption item in operating cost	2.3	-25,530
2 Tax exemption for equipment and spare parts: Import tax 7.7/15% to 0, Trade tax 10% to 0	7.8	- 6,680
3 Coal trade tax redistribution: 5% to the coal mine	10.0	+ 120

Even after tax exemption above, 10% of FIRR on the total project (debt/equity = 0/100) is critical at 6,057 Tg/t.

For further improvement of the financial feasibility, introduction of low cost loan together with tax exemption is effective .

The study on relationships between FIRR, debt/equity ratio, foreign loan interest rate and corresponding tax exemption steps necessary to gain required FIRR on equity (more than 8%) at 6,057 Tg/t indicates that:

- High debt/equity ratio with low interest rate loans can decrease necessary tax exemption steps.
- High debt/equity ratio with high interest rate loans needs the more tax exemption steps to prevent the unrepaid loan.

9) Desired financial conditions for renovation

Above-mentioned examinations indicate that the desired financial conditions for renovation project of Baganuur coal mine are as follows:

- Project financing of 80% debt and 20% equity
- Foreign loan of low interest rate
- Fixed assets revaluation
- Tax deductible of accumulated operation loss
- Tax exemption:
    - After tax expenses into tax exemption
    - Import tax of 0% for equipment and spare parts
    - Trade tax of 5% for equipment and spare parts

-Redistribution of coal trade tax: 5% to the coal mine

If the Mongolian government plans to promote the privatization, it is recommended to create the similar conditions in effect described above.

10) Improvement of management system

Improvement of management system in the following sections is recommended:

- Maintenance section:

  The section be reorganized from the experts belonging to the current Railway section into General Technique section and Materials section and take responsibilities for the maintenance of equipment including stock of spare parts.

  Development of maintenance capability is the top urgent subject of the new maintenance section.
- Coal quality control section:

  The section takes actions in resolving coal quality troubles and holds good communication with the coal users on coal quality issues.
- Environmental section:

  The section will act to preserve the environment through implementation of the monitoring plan and the proposed countermeasures.
- Coal sales section:

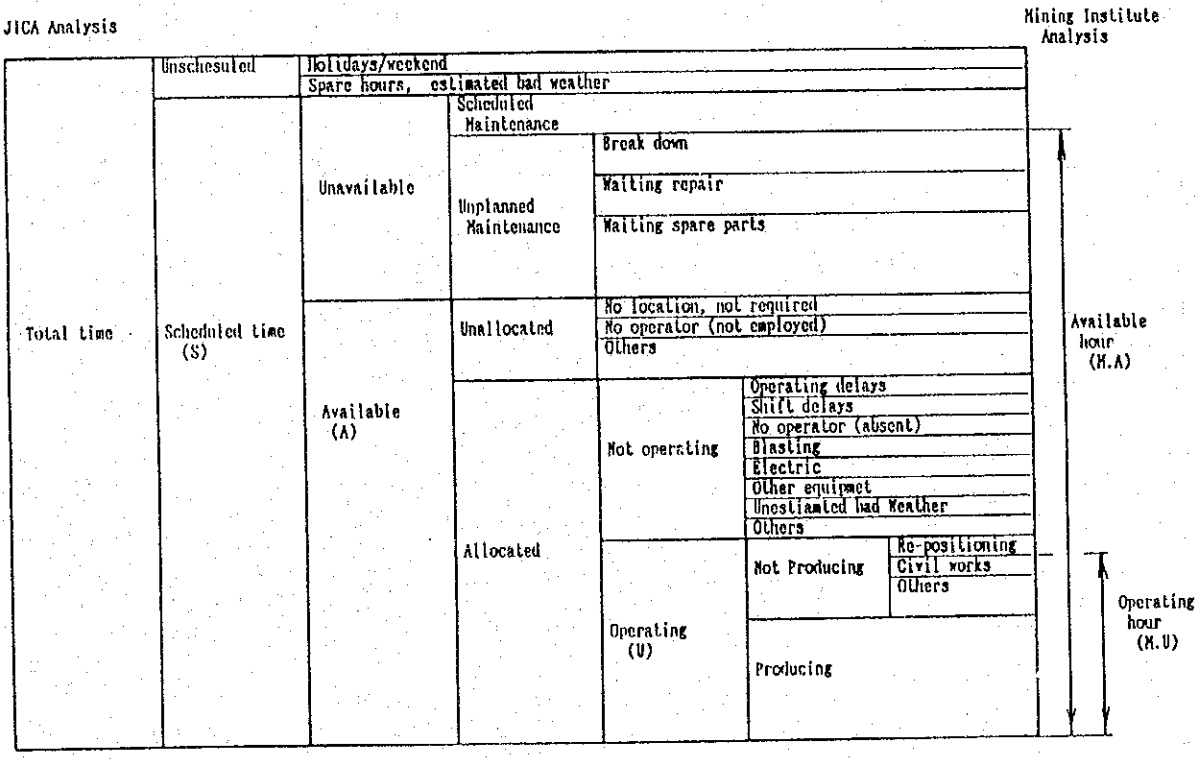
  The section sells the product, negotiates the price, manages the claims from users and prepares the sales plan in short and long terms.

Appendix - Baganuur Coal Mine

Appendix 1 Definition of Availability and Utilization

In Mongolia, ratio between operating hour and scheduled hour is analyzed. In this style of analysis, it is difficult to recognize the mechanical problem and management problem. In this study, both availability and utilization are analyzed in order to identify the real problems. Availability is calculated from scheduled from available hour and operation hour.

Table 1.1 Definition of Availability and Utilization



Mining Institute analysis
Availability= (M.U) / (M.A) > JICA Efficiency

JICA Analysis
Availability= A/S
Utilization = U/A
Efficiency = A/S x U/A = U/S

Appendix 2 Operating Hour Analysis

Two tables are prepared for this analysis. One table is for year 1992 and the other is for 1993. In accordance with the definition of the Availability and Utilization, data prepared by Mining Institute were analyzed.

Table 2.1 Operating Hours Analysis : January - December, 1992

Mining Institute Analysis

	Total Hour	Unschedule Hour	Spare Hour	Scheduled Mainte.	Available Hour	Operating Hour	Not Operating	Electric	Parts	Transport	No Operator	Break Down	Waiting repair	No Wagon	Blasting	Road No Shovel	Other equipment	Others	Availabili (Mongol std)	Note
D/L 20/90	8784	892	0	446	7446	4881	2565	182	54	0	0	665	578	0	0	0	0	1086	65.6	Pit 2, OB
D/L 15/90 N137	8784	1200	0	640	6944	5465	1479	111	72	0	0	634	96	0	230	0	0	336	78.7	Pit 1, OB
D/L 10/70 N201	8784	1004	0	502	7278	6087	1191	176	25	0	8	696	46	0	0	0	0	240	83.6	Pit 5, OB
D/L 10/70 N492	8784	1360	0	680	6744	5058	1686	306	0	0	0	439	845	0	9	0	0	87	75.0	Pit 1, OB
D/L 13/50 N35	8784	640	0	320	7824	4976	2848	354	0	357	92	319	148	168	0	969	0	441	63.6	Waste Dump
D/L 13/50 N50	8784	700	0	350	7734	4116	3618	138	0	421	98	423	31	33	0	872	0	1602	53.2	Waste Dump
D/L 13/50 N61	8784	912	0	456	7416	4188	3228	143	0	0	71	727	10	0	0	0	0	2277	56.5	Pit 2, OB
Total	35136	4456	0	2268	28412	21491	6921	775	151	0	8	2434	1565	0	239	0	0	1749	75.6	
%							100	11.2	2.2	0	0.1	35.2	22.6	0	3.5	0	0	25.2		
Shovel 8u N1941	8784	1380	0	690	6714	4091	2623	326	41	265	91	609	572	0	0	144	0	575	60.9	Rail OB
Shovel 8u N1946	8784	1652	0	826	6306	3877	2429	405	0	176	52	311	36	23	0	391	0	1035	61.5	Rail OB
Shovel 8u N2074	8784	760	0	380	7644	3921	3723	481	0	167	49	1524	116	37	0	614	0	735	51.3	Waste Dump
Shovel 8u N2250	8784	744	0	387	7653	4763	2890	315	0	594	84	518	186	28	6	591	0	568	62.2	Rail OB
Shovel 4y N294	8784	800	0	400	7584	3235	4349	180	1944	705	71	355	103	0	12	473	0	506	42.7	Rail OB
Shovel 4y N323	8784	836	0	418	7530	3977	3553	169	0	723	122	623	60	38	6	741	0	1071	52.8	Rail OB
Shovel 5i N1085	8784	644	0	322	7818	4824	2994	206	0	247	24	411	116	0	0	118	0	1872	61.7	Coal
Shovel 5A N1178	8784	1184	0	592	7008	4624	2384	173	0	411	35	713	0	0	26	41	64	921	66.0	Coal
Shovel 5A N1426	8784	768	45	384	7587	5569	2018	219	0	156	17	227	92	734	0	56	0	517	73.4	Coal
Shovel 5A N1592	8784	664	0	332	7788	6196	1592	279	0	249	7	168	20	82	0	92	0	695	79.6	Loading
Shovel 4.6N1060	8784	2760	240	1380	4404	3220	1184	267	0	191	0	269	56	0	0	31	0	370	73.1	Loading
Shovel 4.6N1061	8784	968	0	484	7332	4823	2509	299	0	215	0	947	321	268	0	74	5	380	65.8	Loading
Shovel 4.6N981	8784	1238	0	619	6927	4658	2269	327	0	192	10	649	181	43	0	133	0	734	67.2	Loading
Total	114192	14398	285	7214	92295	57778	34517	3646	1985	4291	562	7324	1859	1253	50	3499	69	9979	62.6	
%							100	10.6	5.8	12.4	1.6	21.2	5.4	3.6	0.1	10.1	0.2	29.0		
Bulldozer D6T-250 8	70272	8800	3294	4040	54138	25151	28987	215	14295	30	2275	8532	2563	0	0	0	0	1077	46.5	
D8-110 4	35136	3446	3699	1723	26268	11148	15120	0	5935	0	1166	4802	441	0	0	0	0	2776	42.4	
D-155a 5	19720	0	663	1666	17391	12757	4634		1125		669	704	70					2066	73.4	
Total	125128	12246	7656	7429	97797	49056	48741	215	21355	30	4110	14038	3074	0	0	0	0	5919	50.2	
%							100	0.4	43.8	0.1	8.4	28.8	6.3	0	0	0	0	12.2		
D/T Belaz 548 22	224582	26736	1092	13366	183388	129099	54289	1497	12502	2607	2735	23327	1128	0	0	1192	0	9301	70.4	
D/T Tomatsu	110640			3388	107252	76635	30617		11310	2752	4453	5200	882			1499		4521	71.5	
Total	335222	26736	1092	16754	290640	205734	84906	1497	23812	5359	7188	28527	2010	0	0	2691	0	13822	70.8	
%							100	1.8	28	6.3	8.5	33.6	2.4	0	0	3.2	0	16.2		
Drill CBR-160 9	72398	30344	6539	15172	20343	9845	10498	96	0	0	633	1542	1104	0	135	0	0	6988	48.4	
Total							100	0.9	0	0	6	14.7	10.5	0	1.3	0	0	66.6		
%																				
Shovel for Wagon Loading																				
Shovel 8u N1941	8784	1380	0	690	6714	4091	2623	326	41	265	91	609	572	0	0	144	0	575	60.9	Rail OB
Shovel 8u N1946	8784	1652	0	826	6306	3877	2429	405	0	176	52	311	36	23	0	391	0	1035	61.5	Rail OB
Shovel 8u N2250	8784	744	0	387	7653	4763	2890	315	0	594	84	518	186	28	6	591	0	568	62.2	Rail OB
Shovel 4y N294	8784	800	0	400	7584	3235	4349	180	1944	705	71	355	103	0	12	473	0	506	42.7	Rail OB
Shovel 4y N323	8784	836	0	418	7530	3977	3553	169	0	723	122	623	60	38	6	741	0	1071	52.8	Rail OB
Total	43920	5412	0	2721	35787	19943	15844	1395	1985	2463	420	2416	957	89	24	2340	0	3755	55.7	
%							100	8.8	12.5	15.5	2.7	15.2	6	0.6	0.2	14.8	0	23.7		
D/L for Overburden removal																				
D/L 20/90	8784	892	0	446	7446	4881	2565	182	54	0	0	665	578	0	0	0	0	1086	65.6	Pit 2, OB
D/L 15/90 N137	8784	1200	0	640	6944	5465	1479	111	72	0	0	634	96	0	230	0	0	336	78.7	Pit 1, OB
D/L 10/70 N201	8784	1004	0	502	7278	6087	1191	176	25	0	8	696	46	0	0	0	0	240	83.6	Pit 5, OB
D/L 10/70 N492	8784	1360	0	680	6744	5058	1686	306	0	0	0	439	845	0	9	0	0	87	75.0	Pit 1, OB
D/L 13/50 N61	8784	912	0	456	7416	4188	3228	143	0	0	71	727	10	0	0	0	0	2277	56.5	Pit 2, OB
Total	43920	5368	0	2724	35828	25679	10149	918	151	0	79	3161	1575	0	239	0	0	4026	71.7	
%							100	9	1.5	0	0.8	31.1	15.5	0	2.4	0	0	39.7		
D/L for Waste Dump																				
D/L 13/50 N35	8784	640	0	320	7824	4976	2848	354	0	357	92	319	148	168	0	969	0	441	63.6	Waste Dump
D/L 13/50 N50	8784	700	0	350	7734	4116	3618	138	0	421	98	423	31	33	0	872	0	1602	53.2	Waste Dump
Total	17568	1340	0	670	15558	9092	6466	492	0	778	190	742	179	201	0	1841	0	2043	58.4	
%							100	7.6	0	12	2.9	11.5	2.8	3.1	0	28.5	0	31.6		

JICA analysis

	Scheduled Hour	Scheduled Mainte	Un-schedul Mainte	Available Hour	Avail. %	Operating Hour	Utiliza. %	Efficien. %
D/L 20/90	7892	446	1297	6149	77.9	4881	79.4	61.8
D/L 15/90 N137	7584	640	802	6142	81.0	5465	89.0	72.1
D/L 10/70 N201	7780	502	767	6511	83.7	6087	93.5	78.2
D/L 10/70 N492	7424	680	1284	5460	73.5	5058	92.6	68.1
D/L 13/50 N35	8144	320	467	7357	90.3	4976	67.6	61.1
D/L 13/50 N50	8084	350	454	7280	90.1	4116	56.5	50.9
D/L 13/50 N61	7872	456	737	6679	84.8	4188	62.7	53.2
Total	30680	2268	4150	24262	79.1	21491	88.6	70.0
Shovel 8u N1941	7404	690	1222	5492	74.2	4091	74.5	55.3
Shovel 8u N1946	7132	826	347	5959	83.6	3877	65.1	54.4
Shovel 8u N2074	8024	380	1640	6004	74.8	3921	65.3	48.9
Shovel 8u N2250	8040	387	704	6949	86.4	4763	68.5	59.2
Shovel 4y N294	7984	400	2402	5182	64.9	3235	62.4	40.5
Shovel 4y N323	7948	418	683	6847	86.1	3977	58.1	50.0
Shovel 5i N1085	8140	322	527	7291	89.6	4824	66.2	59.3
Shovel 5A N1178	7600	592	713	6295	82.8	4624	73.5	60.8
Shovel 5A N1426	7971	384	319	7268	91.2	5569	76.6	69.9
Shovel 5A N1592	8120	332	188	7600	93.6	6196	81.5	76.3
Shovel 4.6N1060	5784	1380	325	4079	70.5	3220	78.9	55.7
Shovel 4.6N1061	7816	484	1268	6064	77.6	4823	79.5	61.7
Shovel 4.6N981	7546	619	830	6097	80.8	4658	76.4	61.7
Total	99509	7214	11168	81127	81.5	57778	71.2	58.1
Bulldozer D6T-250 8	58178	4040	25390	28748	49.4	25151	87.5	43.2
D8-110 4	27991	1723	11178	15090	53.9	11148	73.9	39.8
D-155a 5	19057	1666	1899	15492	81.3	12757	82.3	66.9
Total	105226	7429	38467	59330	56.4	49056	82.7	46.6
D/T Belaz 548 22	196754	13366	36957	146431	74.4	129099	88.2	65.6
D/T Tomatsu	110640	3388	17392	89860	81.2	76635	85.3	69.3
Total	307394	16754	54349	236291	76.9	205734	87.1	66.9
Drill CBR-160 9	35515	15172	2646	17697	49.8	9845	55.6	27.7
Shovel for Wagon Loading								
Shovel 8u N1941	7404	690	1222	5492	74.2	4091	74.5	55.3
Shovel 8u N1946	7132	826	347	5959	83.6	3877	65.1	54.4
Shovel 8u N2250	8040	387	704	6949	86.4	4763	68.5	59.2
Shovel 4y N294	7984	400	2402	5182	64.9	3235	62.4	40.5
Shovel 4y N323	7948	418	683	6847	86.1	3977	58.1	50.0
Total	38508	2721	5358	30429	79.0	19943	65.5	51.8
D/L for Overburden removal								
D/L 20/90	7892	446	1297	6149	77.9	4881	79.4	61.8
D/L 15/90 N137	7584	640	802	6142	81.0	5465	89.0	72.1
D/L 10/70 N201	7780	502	767	6511	83.7	6087	93.5	78.2
D/L 10/70 N492	7424	680	1284	5460	73.5	5058	92.6	68.1
D/L 13/50 N61	7872	456	737	6679	84.8	4188	62.7	53.2
Total	38552	2724	4887	30941	80.3	25679	83.0	66.6
D/L for Waste Dump								
D/L 13/50 N35	8144	320	467	7357	90.3	4976	67.6	61.1
D/L 13/50 N50	8084	350	454	7280	90.1	4116	56.5	50.9
Total	16228	670	921	14637	90.2	9092	62.1	56.0

Table 2.2 Operating Hours Analysis : January - October, 1993

	Mining Institute Analysis																		JICA Analysis							
	Total Hour	Unschedule Hour	Spare Hour	Schedule Mainte.	Available Hour	Operating Hour	Not Operating	Electric	No Parts	Transport	No Operator	Break Down	Waiting Repair	No Wagon	Blasting	Road No Shovel	Other Equipment	Others	Note Availability (Mongol std)	Schedule Hour	Schedule Mainte.	Un-schedul Mainte.	Available Hour	Availab. %	Operation Hour	Utilizat. %	Efficienc. %
D/L 20/90	7296	2480	0	1240	3576	1298	2278	0	526	0	36	1371	290	0	0	0	0	55	36.3 No.2 Pit	4816	1240	2187	1389	28.8	1298	93.4	27.0
D/L 15/90 N137	7296	824	0	412	6060	5313	747	60	75	0	20	266	79	0	22	0	0	225	87.7 No.1 Pit	6472	412	420	5640	87.1	5313	94.2	82.1
D/L 10/70 N201	7296	1360	0	680	5256	3750	1506	22	303	27	28	890	48	0	24	0	0	164	71.3 No.5 Pit	5936	680	1241	4015	67.6	3750	93.4	63.2
D/L 10/70 N492	7296	848	0	424	6024	4590	1434	0	276	0	6	794	67	0	51	0	0	240	76.2 No.2 Pit	6448	424	1137	4887	75.8	4590	93.9	71.2
D/L 13/50 N35	7296	892	0	446	5958	3691	2267	67	166	492	12	532	99	200	0	403	0	296	62.0 Waste Dump	6404	446	797	5161	80.6	3691	71.5	57.6
D/L 13/50 N50	7296	352	0	176	6768	3429	3339	52	0	879	0	1811	0	170	0	229	0	198	50.7 Waste Dump	6944	176	1811	4957	71.4	3429	69.2	49.4
D/L 13/50 N61	7296	384	0	192	6720	5503	1217	0	0	0	4	915	100	0	20	0	0	178	81.9 No.2 Pit	6912	192	1015	5705	82.5	5503	96.5	79.6
Total	51072	7140	0	3570	40362	27574	12788	201	1346	1398	106	6579	683	370	117	632	0	1356	68.3	43932	3570	8608	31754	72.3	27574	86.8	62.8
%							100	1.6	10.5	10.9	0.8	51.4	5.3	2.9	0.9	4.9	0.0	10.8									
Shovel 8u N1941	7296	280	0	140	6876	4456	2420	223	0	1474	11	78	292	43	63	32	0	204	64.8 No.2 Pit	7016	140	370	6506	92.7	4456	68.5	63.5
Shovel 8u N1946	7296	160	0	80	7056	1289	5767	38	4652	237	0	450	12	106	262	10	0	0	18.3 No.2 Pit	7136	80	5114	1942	27.2	1289	66.4	18.1
Shovel 8u N2074	7296	1400	0	700	5196	2472	2724	50	672	974	49	113	5	78	0	73	0	710	47.6 Waste Dump	5896	700	790	4406	74.7	2472	56.1	41.9
Shovel 8u N2250	7296	648	0	424	6224	4123	2101	129	1040	244	40	388	28	13	37	20	0	162	66.2 No.2 Pit	6648	424	1456	4768	71.7	4123	86.5	62.0
Shovel 4y N294	7296	132	0	66	7098	4713	2385	112	1087	418	54	327	61	13	7	55	13	238	66.4 No.2 Pit	7164	66	1475	5623	78.5	4713	83.8	65.8
Shovel 4y N323	7296	840	0	420	6036	4833	1203	93	0	285	45	289	12	36	154	36	0	253	80.1 No.2 Pit	6456	420	301	5735	88.8	4833	84.3	74.9
Shovel SA N1085	7296	896	0	448	5952	4093	1859	2	0	110	35	1123	76	11	41	105	0	356	68.8 Coal Load	6400	448	1199	4753	74.3	4093	86.1	64.0
Shovel SA N1178	7296	1200	0	600	5496	4026	1470	0	0	51	9	418	0	64	5	58	10	855	73.3 No.5 Pit	6096	600	418	5078	83.3	4026	79.3	66.0
Shovel SA N1426	7296	734	0	367	6195	3959	2236	0	0	58	163	227	0	1082	14	37	217	438	63.9 No.2 Pit	6562	367	227	5968	90.9	3959	66.3	60.3
Shovel SA N1592	7296	944	0	472	5880	4073	1807	38	288	49	15	184	336	0	20	315	0	562	69.3 No.2 Pit	6352	472	808	5072	79.8	4073	80.3	64.1
Shovel SA N1581	3672	96	0	48	3528	2562	966	2	0	38	10	285	16	0	2	184	0	429	72.6 No.1 Pit	3576	48	301	3227	90.2	2562	79.4	71.6
Shovel 4.6N1060	7296	1372	0	686	5238	4070	1168	24	0	17	20	626	12	0	9	217	0	243	77.7 Train load	5924	686	638	4600	77.7	4070	88.5	68.7
Shovel 4.6N1061	7296	1338	0	669	5289	4005	1284	31	0	30	19	434	5	93	30	79	0	563	75.7 Train load	5958	669	439	4850	81.4	4005	82.6	67.2
Shovel 4.6N981	7296	1190	0	595	5511	3737	1774	37	117	57	8	655	15	504	6	16	77	282	67.8 No.3 Pit	6106	595	787	4724	77.4	3737	79.1	61.2
Total	98520	11230	0	5715	81575	52411	29164	779	7858	4042	478	5597	870	2043	650	1237	317	5295	64.2	87290	5715	14323	67252	77.0	52411	77.9	60.0
%							100	2.7	26.9	13.9	1.6	19.2	3.0	7.0	2.2	4.2	1.1	18.2									
Bull DozerDET-250 8	46656	2040	845	1020	42751	17622	25129	0	11927	26	1271	8886	1748	0	0	0	0	1271	41.2	43771	1020	22561	20190	46.1	17622	87.3	40.3
D8-110 4	29184	966	3966	483	23769	12266	11503	10	3390	0	931	5825	525	0	0	0	0	822	51.6	24252	483	9740	14029	57.8	12266	87.4	50.6
D-155a 5	43776	736	948	368	41728	31456	10270	7	5973	9	994	1143	127	0	0	13	0	2004	75.4	42094	368	7243	34483	81.9	31456	91.2	74.7
Total	119616	3742	5757	1871	108246	61344	46902	17	21290	35	3196	15854	2400	0	0	13	0	4097	56.7	110117	1871	39544	68702	62.4	61344	89.3	55.7
%							100	0.0	45.4	0.1	6.8	33.8	5.1	0.0	0.0	0.0	0.0	8.8									
D/T Belaz 548 22	129770	6084	29	3042	120615	45558	75057	22	14451	332	6788	30587	4534	22	202	6882	57	11180	37.8	123657	3042	49572	71043	57.5	45558	64.1	36.8
D/T Komatsu	145920	4040	96	2020	139764	79439	60325	36	8927	408	16840	14006	1841	467	0	7933	885	8982	56.8	141784	2020	24774	114990	81.1	79439	69.1	56.0
Total	275690	10124	125	5062	260379	124997	135382	58	23378	740	23628	44593	6375	489	202	14815	942	20162	48.0	265441	5062	74346	186033	70.1	124997	67.2	47.1
%							100	0.0	17.3	0.5	17.5	32.9	4.7	0.4	0.1	10.9	0.7	15.0									
Drill Ch2-160 9	Data not available																										
Total																											
%																											
Electric Loco 6	43776	6174	90	3087	34425	15261	19164	750	567	1957	521	2147	0	760	58	7211	0	5193	44.3	37512	3087	2714	31711	84.5	15261	48.1	40.7
%							100	3.9	3.0	10.2	2.7	11.2	0.0	4.0	0.3	37.6	0.0	27.1									
Shovel for Wagon Loading																											
Shovel 8u N1941	7296	280	0	140	6876	4456	2420	223	0	1474	11	78	292	43	63	32	0	204	64.8	7016	140	370	6506	92.7	4456	68.5	63.5
Shovel 8u N1946	7296	160	0	80	7056	1289	5767	38	4652	237	0	450	12	106	262	10	0	0	18.3	7136	80	5114	1942	27.2	1289	66.4	18.1
Shovel 8u N2250	7296	648	0	424	6224	4123	2101	129	1040	244	40	388	28	13	37	20	0	162	66.2	6648	424	1456	4768	71.7	4123	86.5	62.0
Shovel 4y N294	7296	132	0	66	7098	4713	2385	112	1087	418	54	327	61	13	7	55	13	238	66.4	7164	66	1475	5623	78.5	4713	83.8	65.8
Shovel 4y N323	7296	840	0	420	6036	4833	1203	93	0	285	45	289	12	36	154	36	0	253	80.1	6456	420	301	5735	88.8	4833	84.3	74.9
Total	36480	2060	0	1130	33290	19414	13876	595	6779	2658	150	1532	405	211	523	153	13	857	58.3	34420	1130	8716	24574	71.4	19414	79.0	56.4
%							100	4.3	48.9	19.2	1.1	11	2.9	1.5	3.8	1.1	0.1	6.1									
D/L for Overburden removal																											
D/L 20/90	7296	2480	0	1240	3576	1298	2278	0	526	0	36	1371	290	0	0	0	0	55	36.3	4816	1240	2187	1389	28.8	1298	93.4	27.0
D/L 15/90 N137	7296	824	0	412	6060	5313	747	60	75	0	20	266	79	0	22	0	0	225	87.7	6472	412	420	5640	87.1	5313	94.2	82.1
D/L 10/70 N201	7296	1360	0	680	5256	3750	1506	22	303	27	28	890	48	0	24	0	0	164	71.3	5936	680	1241	4015	67.6	3750	93.4	63.2
D/L 10/70 N492	7296	848	0	424	6024	4590	1434	0	276	0	6	794	67	0	51	0	0	240	76.2	6448	424	1137	4887	75.8	4590	93.9	71.2
D/L 13/50 N61	7296	384	0	192	6720	5503	1217	0	0	0	4	915	100	0	20	0	0	178	81.9	6912	192	1015	5705	82.5	5503	96.5	79.6
Total	36480	5896	0	2948	27636	20454	7182	82	1180	27	94	4236	584	0	117	0	0	862	74.0	30584	2948	6000	21636	70.7	20454	94.5	66.9
%							100	1.1	16.4	0.4	1.3	59.0	8.1	0.0	1.6	0.0	0.0	12.1									
D/L for Waste Dump																											
D/L 13/50 N35	7296	892	0	446	5958	3691	2267	67	166	492	12	532	99	200	0	403	0	296	62.0	6404	446	797	5161	80.6	3691	71.5	57.6
D/L 13/50 N50	7296	352	0	176	6768	3429	3339	52	0	879	0	1811	0	170	0	229	0	198	50.7	6944	176	1811	4957	71.4	3429	69.2	49.4
Total	14592	1244	0	622	12726	7120	5606	119	166	1371	12	2343	99	370	0	632	0	494	55.9	13348	622	2608	10118	75.8	7120	70.4	53.3
%							100	2.1	3.0	24.5	0.2	41.8	1.8	6.6	0.0	11.3	0.0	8.7									

Appendix 3 Specification and Estimated Production

Both Electric Rope Shovels and Draglines, production capacities are estimated. This estimation is based on the condition that the spare parts are supplied properly. Mongolian local conditions are taken into consideration for operating hour and availability. In case of electric rope shovels, a calculation of shovel capacities is conducted.

Table 3.1 Electric Shovel

Type		EKG-8u	EKG-5A	EKG-4.6b	EKG-4y	Total
Make		Russia	Russia	Russia	Russia	
Boom Length	meter	13.3	11.4	10.5	20.6	
Max.Dumping Height	meter	8.6	7.5	6.4	17.5	
Bucket Capacity	cubic meter	8.0	5.0	4.6	4.0	
Weight	ton	364.6	227	197.9	353.3	
Rated Power	kW	630	250	250	520	
Voltage	V	6,000	6,000	6,000	6,000	
Swing Speed	turn/min	2.78	2.8	2.8	2.78	
Cycle time	second	26	25	23	30	
Diameter of wire rope	mm	39	39	39	39	
No. of unit		4	5	4	2	
Price	million Tg.	6.7	5.08	3.8	4.2	
Age (years after made)		3,4,5,6	0,2,5,7,9	0,8,11,1	5,6	
Availability(1992)	%	79.8	89.3	76.3	75.5	
Utilization (1992)	%	68.4	74.5	78.3	60.3	
Assigned Bucket Size	cubic meter	8.0	5.0	4.6	4.0	
Percent Swell	%	26	26	26	26	
Swell Factor		0.79	0.79	0.79	0.79	
Fill Factor		1.03	1.03	1.03	1.03	
Bucket Factor		0.814	0.814	0.814	0.814	
BCM/cycle	BCM	6.5	4.1	3.7	3.3	
Average Swing Angle		120	120	120	120	
Total cycle time	sec	26	25	23	30	
No. of cycle/Op. Hour		138	144	157	120	
BCM/Op.Hour	BCM	897	590	581	396	
Op.Hour/Shift	hour	6.75	6.75	6.75	6.75	
BCM/Op.Shift	BCM	6,055	3,983	3,922	2,673	
Operating Time Factors						
Mech. Elect. Delays	%	80	80	80	80	
Moving & Other Delays	%	75	75	75	75	
Net Operating Time	%	60	60	60	60	
Assigned BCM/shift	BCM	3,633	2,390	2,353	1,604	
Operating Day	day	268	286	290	268	
Scheduled Digging Shift	shift	804	858	870	804	
Assigned BCM/Year	(1000m3)	2,921	2,051	2,047	1,290	
Unit for O/B removal		3	2	1	2	
Maximum capacity	(1000m3)	8,763	4,102	2,047	2,580	17,492

Note:
This estimation is loading capacity.
Transportation means are not considered.

Table 3.2 Dragline

Specification and data						
Type		20/90	15/90	10/70	13/50	Total
Make		Russia	Russia	Russia	Russia	
Boom Length	meter	90	90	70	50	
Boom Angle	degree	32	32	32	35	
Operation Radius	meter	83	83	66.5	46.5	
Base Diameter	meter	14	14	9.7	9.7	
Max.Dumping Height	meter	38.5	39.5	27.5	20.5	
Max.Digging Depth	meter	42.5	42.5	35	21	
Bucket Capacity	cubic meter	20	15	10	13	
Weight	ton	1620	1620	650	634	
Rated Power	kW	2500	2100	1380	1380	
Voltage	V	6000	6000	6000	6000	
Swing Speed	turn/min	1.18	1.18	1.58	1.58	
Cycle time	second	63	57	52	52	
Diameter of wire rope	mm	63	57	52	52	
No. of unit		1	1	2	3	
Price	million Tg	45	38	14.8	16.4	
Age (years after made)		8	12	13, 4	6,4,2	
Availability (1992)	%	77.9	81	78.6	84.7	
Utilization (1992)	%	79.4	89	93.1	69.3	
Evaluation of Production capacity						
Assigned Bucket Size	cubic meter	20	15	10	13	
Percent Swell	%	26	26	26	26	
Swell Factor		0.79	0.79	0.79	0.79	
Fill Factor		1.03	1.03	1.03	1.03	
Bucket Factor		0.814	0.814	0.814	0.814	
BCM/cycle	BCM	16.3	12.2	8.1	10.6	
Average Swing Angle		120	120	120	120	
Total cycle time	sec	63	57	52	52	
No. of cycle/Op. Hour		57	63	69	69	
BCM/Op.Hour	BCM	929	769	559	731	
Op.Hour/Shift	hour	6.75	6.75	6.75	6.75	
BCM/Op.Shift	BCM	6,271	5,191	3,773	4,934	
Operating Time Factors						
Mech. Elect. Delays	%	90	90	90	90	
Moving & Other Delays	%	85	85	85	85	
Net Operating Time	%	76.5	76.5	76.5	76.5	
Assigned BCM/shift	BCM	4,797	3,971	2,886	3,775	
Operating Day	day	230	230	251	251	
Scheduled Digging Shift	shift	690	690	753	753	
Assigned BCM/Year	(1000m3)	3,310	2,740	2,173	2,843	
Rehandle ratio	%	62	62	62	62	
Prime BCM	(1000m3)	2,043	1,691	1,341	1,755	
Unit for O/B removal		1	1	2	1	
Total estimated (rehandle 62%)	(1000m3)	2,043	1,691	2,682	1,755	8,171
Assigned BCM/Year	(1000m3)	3,310	2,740	2,173	2,843	
Rehandle ratio	%	30	30	30	30	
Prime BCM	(1000m3)	2,546	2,108	1,672	2,187	
Unit for O/B removal		1	1	2	1	
Total estimated (rehandle 30%)	(1000m3)	2,546	2,108	3,344	2,187	10,185
Total assigned (rehandle 30%)	(1000m3)					8,500

Appendix 4 Estimated Transportation Capacity

Estimation of the transportation capacity is conducted for various kind of mining and transportation systems. Size of the fleet depends on the hauling distance. Five kilometers are applied for the basic distance for the required investment.

First table shows the estimation of a shovel and railway system. Left side shows the estimated capacity of the current system. Right side is the estimation of recommended railway system with FEL.

Second table shows the estimated transportation capacity of 8m3 shovel and 40-ton dump trucks. This system is currently used at Baganuur coal mine. The estimation shows that the calculation by Mining Institute is a reasonable one.

Third table shows the estimated transportation capacity of 8m3 shovel and 50-ton dump trucks. This is the base of Case A of this study.

Fourth table shows the estimated transportation capacity of 12m3 shovel and 80-ton dump trucks. This is the base of Case B of this study.

Fifth table shows the estimated transportation capacity of 8m3 shovel and 40-ton coal trucks. This is the base of coal transportation for every case.

Six table shows the estimated transportation capacity of $16m^3$ shovel and 120-ton dump trucks. This is the base of Case C of this study.

Table 4.1 Shovel and Railway

		Current operation				Proposed system Electric shovel & FEL combination	
Shovel		EKG-8u		EKG-4y		EKG-8u	FEL 10 m3
Bucket Size	m3	8		4		8	10
Maximum Dumping Clearance	meter	8.6		17.5		8.6	4.2
Hinge Pin Height	meter						
Rated Power	HP	630		520		630	700
Material		Rock		Rock		Rock	Rock
Percent Swell	%	25		25		25	25
Swell Factor		0.8		0.8		0.8	0.8
Fill Factor		1.03		1.03		1.03	1.03
Bucket Factor		0.824		0.824		0.824	0.824
BCM per Bucket	BCM	6.6		3.3		6.6	8.2
Weight of Material/BCM	ton	1.9		1.9		1.9	1.9
Weight of Material/Bucket	ton	12.5		6.3		12.5	15.6
Hauler							
Haul Distance	meter	8000	8000	8000	8000	8000	8000
Season		Summer	Winter	Summer	Winter	Summer	Winter
Total Load Time/Fleet	min	70	80	105	120	35	40
Traveling Time	min	42	42	42	42	42	42
Dumping Time	min	24	36	24	36	24	36
Cleaning Time	min	0	15	0	15	0	15
Oil Coating time	min	0	20	0	20	0	20
Another Delay	min	21	21	21	21	21	21
Total Time/Fleet	min	157	214	192	254	122	174
Operating Hour/Shift	min	630	630	630	630	630	630
No.of Fleet/Shift(caluclated)		4.0	2.9	3.3	2.5	5.2	3.6
No.of Fleet/Shift(assigned)		4	2	3	2	5	3
BCM/Fleet	BCM	480	480	480	480	480	480
BCM/Shift	BCM	1,920	960	1,440	960	2,400	1,440
Operation time factors							
Mech. Elec. Delays	%	90	90	90	90	90	90
Moving & Other Delays	%	80	80	80	80	80	80
Net Operating Time	%	72	72	72	72	72	72
Assigned BCM/shift	BCM	1,382	691	1,037	691	1,728	1,037
Scheduled Shift/Summer	Shift	286		286		286	
BCM/fleet in Summer	1,000 m3	395		297		494	
Fleet/Shovel	Fleet	2		2			
BCM/shovel in Summer	1,000 m3	790		594		1,482	
Scheduled Shift/Winter	Shift		286		286		286
BCM/fleet in Winter	1,000 m3		198		198		297
Fleet/Shovel	Fleet		2		2		
BCM/shovel in Winter	1,000 m3		396		396		891
BCM/Year/shovel	1,000 m3	1,186		990		2,373	
No.of Shovel	unit	3		2		2	
BCM/year	1,000 m3	3,558		1,980		4,746	
Total Transportation Capacity	1,000 m3	5,538				4,746	
Assigned capacity	1,000 m3	4,430	Operate 4 unit of 5			4,746	
Rail remove & install	meter	22,150				11,865	
	BCM/meter	200				400	
Note		Shovel EKG-8u 3 unit EKG-4y 2 unit Loco 2 Loco/shovel 8 Loco in total Track 5 tracks				Shovel EKG-8u 2 unit EFL 10 m3 2 unit Loco 3 Loco/shovel + FEL 6 Loco in total Track 2 tracks	

Table 4.2 8m³ Shovel and 40 ton Dump Trucks

Haul Distance	meter	2,000	3,000	4,000
Assigned Ave.Speed				
Loaded	km/hour	18	20	22
Empty	km/hour	20	22	24
Total travel time round trip		12.7	17.2	20.9
Fixed time/truck trip				
Spot at Loader	min	1.0	1.0	1.0
Load	min	2.8	2.8	2.8
Turn and Dump	min	1.0	1.0	1.0
Subtotal Fixed Time	min	4.8	4.8	4.8
Total Cycle Time	min	17.5	22.0	25.7
Max truck/loader		4	5	6
Fleet size per loader 75% fleet availability		5	7	8
Ton/trip	Ton	40	40	40
Operating Hour/shift	min	405	405	405
No. of trip/shift	trip	23	18	15
BCM/shift/truck	BCM	920	720	600
BCM/shift/fleet	BCM	3,680	3,600	3,600
Operating time factors				
Mech. Elec Delays	%	90	90	90
Other Delays	%	75	75	75
Net Operating time	%	68	68	68
Assigned BCM/shift/truck	BCM	2,502	2,448	2,448
Sheduled shift/day	shift	3	3	3
Sheduled day/year	day	280	280	280
BCM/Year/Fleet (x 1,000)	BCM	2,102	2,056	2,056
Load by stand-by shovel	day	40	40	40
BCM/Year/Fleet (x 1,000)	BCM	300	294	294
Grand total	BCM	2,402	2,350	2,350

Table 4.3 8m³ Shovel and 50 ton Dump Trucks

Haul Distance	meter	3,000	4,000	5,000
Assigned Ave.Speed				
Loaded	km/hour	18	20	22
Empty	km/hour	20	22	24
Total travel time round trip		19.0	22.9	26.1
Fixed time/truck trip				
Spot at Loader	min	1.0	1.0	1.0
Load	min	1.8	1.8	1.8
Turn and Dump	min	1.0	1.0	1.0
Subtotal Fixed Time	min	3.8	3.8	3.8
Total Cycle Time	min	22.8	26.7	29.9
Max truck/loader		8	9	10
Fleet size per loader		11	12	13
75% fleet availability				
BCM/trip	BCM	26.3	26.3	26.3
Operating Hour/shift	min	405	405	405
No. of trip/shift	trip	17	15	13
BCM/shift/truck	BCM	447.1	394.5	341.9
BCM/shift/fleet	BCM	3,577	3,551	3,419
Operating time factors				
Mech. Elec Delays	%	90	90	90
Other Delays	%	75	75	75
Net Operating time	%	68	68	68
Assigned BCM/shift/truck	BCM	2,432	2,414	2,325
Sheduled shift/day	shift	3	3	3
Sheduled day/year	day	280	280	280
BCM/Year/Fleet (x 1,000)	BCM	2,043	2,028	1,953
Load by stand-by shovel	day	20	20	20
BCM/Year/Fleet (x 1,000)	BCM	146	145	140
Grand total	BCM	2,189	2,173	2,093
Assigned BCM/year		2,000	2,000	2,000

Table 4.4 $12m^3$ Shovel and 80 ton Dump Trucks

Haul Distance	meter	3,000	4,000	5,000
Assigned Ave.Speed				
Loaded	km/hour	18	20	22
Empty	km/hour	20	22	24
Total travel time round trip		19.0	22.9	26.1
Fixed time/truck trip				
Spot at Loader	min	1.0	1.0	1.0
Load	min	2.1	2.1	2.1
Turn and Dump	min	1.0	1.0	1.0
Subtotal Fixed Time	min	4.1	4.1	4.1
Total Cycle Time	min	23.1	27	30.2
Max truck/loader		7	8	9
Assigned truck/loader		6	7	8
Fleet size per loader		8	9	11
75% fleet availability				
BCM/trip	BCM	42.8	42.8	42.8
Operating Hour/shift	min	405	405	405
No. of trip/shift	trip	17	15	13
BCM/shift/truck	BCM	727.6	642	556.4
BCM/shift/fleet	BCM	4,366	4,494	4,451
Operating time factors				
Mech. Elec Delays	%	90	90	90
Other Delays	%	75	75	75
Net Operating time	%	68	68	68
Assigned BCM/shift/truck	BCM	2,969	3,056	3,027
Sheduled shift/day	shift	3	3	3
Sheduled day/year	day	280	280	280
BCM/Year/Fleet (x 1,000)	BCM	2,494	2,567	2,543
Load by stand-by shovel	day	20	20	20
BCM/Year/Fleet (x 1,000)	BCM	178	183	182
Grand total	BCM	2,672	2,750	2,725
Assigned BCM		2,667	2,667	2,667

Table 4.5 8m³ Shovel and 40 ton Dump Trucks

Haul Distance	meter	3,000	4,000	5,000
Assigned Ave.Speed				
Loaded	km/hour	18	20	22
Empty	km/hour	20	22	24
Total travel time round trip		19.0	22.9	26.1
Fixed time/truck trip				
Spot at Loader	min	1.0	1.0	1.0
Load	min	1.3	1.3	1.3
Turn and Dump	min	1.0	1.0	1.0
Subtotal Fixed Time	min	3.3	3.3	3.3
Total Cycle Time	min	22.3	26.2	29.4
Max truck/loader		9	11	12
Assigned truck/loader		7	9	10
Fleet size per loader		9	12	13
75% fleet availability				
BCM/trip	BCM	20.6	20.6	20.6
Operating Hour/shift	min	405	405	405
No. of trip/shift	trip	18	15	13
BCM/shift/truck	BCM	370.8	309	267.8
BCM/shift/fleet	BCM	2,596	2,781	2,678
Operating time factors				
Mech. Elec Delays	%	90	90	90
Other Delays	%	75	75	75
Net Operating time	%	68	68	68
Assigned BCM/shift/truck	BCM	1,765	1,891	1,821
Sheduled shift/day	shift	3	3	3
Sheduled day/year	day	280	280	280
BCM/Year/Fleet (x 1,000)	BCM	1,483	1,588	1,530
Assigned BCM/year (x 1,000)	BCM	1,500	1,500	1,500

Table 4.6 16m³ Shovel and 120 ton Dump Trucks

Haul Distance	meter	3,000	4,000	5,000
Assigned Ave.Speed				
Loaded	km/hour	18	20	22
Empty	km/hour	20	22	24
Total travel time round trip		19.0	22.9	26.1
Fixed time/truck trip				
Spot at Loader	min	1.0	1.0	1.0
Load	min	2.6	2.6	2.6
Turn and Dump	min	1.0	1.0	1.0
Subtotal Fixed Time	min	4.6	4.6	4.6
Total Cycle Time	min	23.6	27.5	30.7
Max truck/loader		6	7	8
Fleet size per loader		8	9	11
75% fleet availability				
BCM/trip	BCM	70	70	70
Operating Hour/shift	min	405	405	405
No. of trip/shift	trip	17	14	13
BCM/shift/truck	BCM	1,190	980	910
BCM/shift/fleet	BCM	7,140	6,860	7,280
Operating time factors				
Mech. Elec Delays	%	90	90	90
Other Delays	%	75	75	75
Net Operating time	%	68	68	68
Assigned BCM/shift/truck	BCM	4,855	4,665	4,950
Sheduled shift/day	shift	3	3	3
Sheduled day/year	day	280	280	280
BCM/Year/Fleet (x 1,000)	BCM	4,078	3,919	4,158
Load by stand-by shovel	day	20	20	20
BCM/Year/Fleet (x 1,000)	BCM	291	280	297
Grand total	BCM	4,369	4,199	4,455

Appendix 5 Outline of BWE System

Bucket Wheel Excavator with Belt Conveyor system

1 System Operation

A BWE is illustrated on Figure. A rising belt conveyor is to follow the 3000 m long horizontal conveyor and a short extensible conveyor on the bench. At the end of rising conveyor, waste is discharged onto belt conveyors which are connected to the spreaders. The spreader discharges waste and a dozer operates the waste to make flat. Both of the face conveyor and the dumping conveyor can be shifted by a dozer sideward.

2 Specification of BWE system

The excavating capacity of the BWE assumed in this study is 4.0 million BCM per year.

A conveyor belt width is 1,400 m/m and the speed is 3.5 meter/sec.

The specification of O&K BWEs Nos. 1382-86 are shown on Table and the derails are attached as reference.

(1) BWE

Both booms are raised and lowered by means of hydraulic cylinders.

(2) BW (Belt Wagon)

The recommendable BWE and BC system is shown on Fig 5.1.

Table 5.1 Specification of a BWE Mode

Basic detailes (some values rounded off)		Model
Dimensions & Speeds		
Bucket Wheel (BW) Doameter, D	m	9.1
Bucket Volume, I,	liter	640
Ring Space Volume,	liter	320
Nominal Bucket Volume,		
In = I1 + 0.5 I2	liter	800
Number of Buckets,z		14
Number of Intercutters		Nil
Discharges per min., s	high speed	80
	low speed	65
Cutting Speeds, m/s	high speed	2.7
	low speed	2.2
BW Drive Motors	kw	700/700
Basic Digging Force, tonnes high speed		22.5
(n = 0.85)	(KN)	220
	low speed	27.5
	(KN)	270
Swell Factor	OB	1.4
Belt Speed	m/s	4.5
Max. Height to BW Centre	m	13.5
BW Cutting Depth below BWE Bench	m	1.2
Outreach to BW Centre. BW at BWE Bench	m	15.5
Outreach of Discharge Boom (horiz.)		25.0
Average Ground Pressure	KPa	95
Mass. CRS	tonnes	560
Outputs		
Theoretical Output, Qthn	lcm/h	3,100 (low speed)
Rated effective Outputs, Qe (Annual Average)	bcm/h	1,050

Sources: Continuous Surface mining, 1987 PTBA, Indonesia

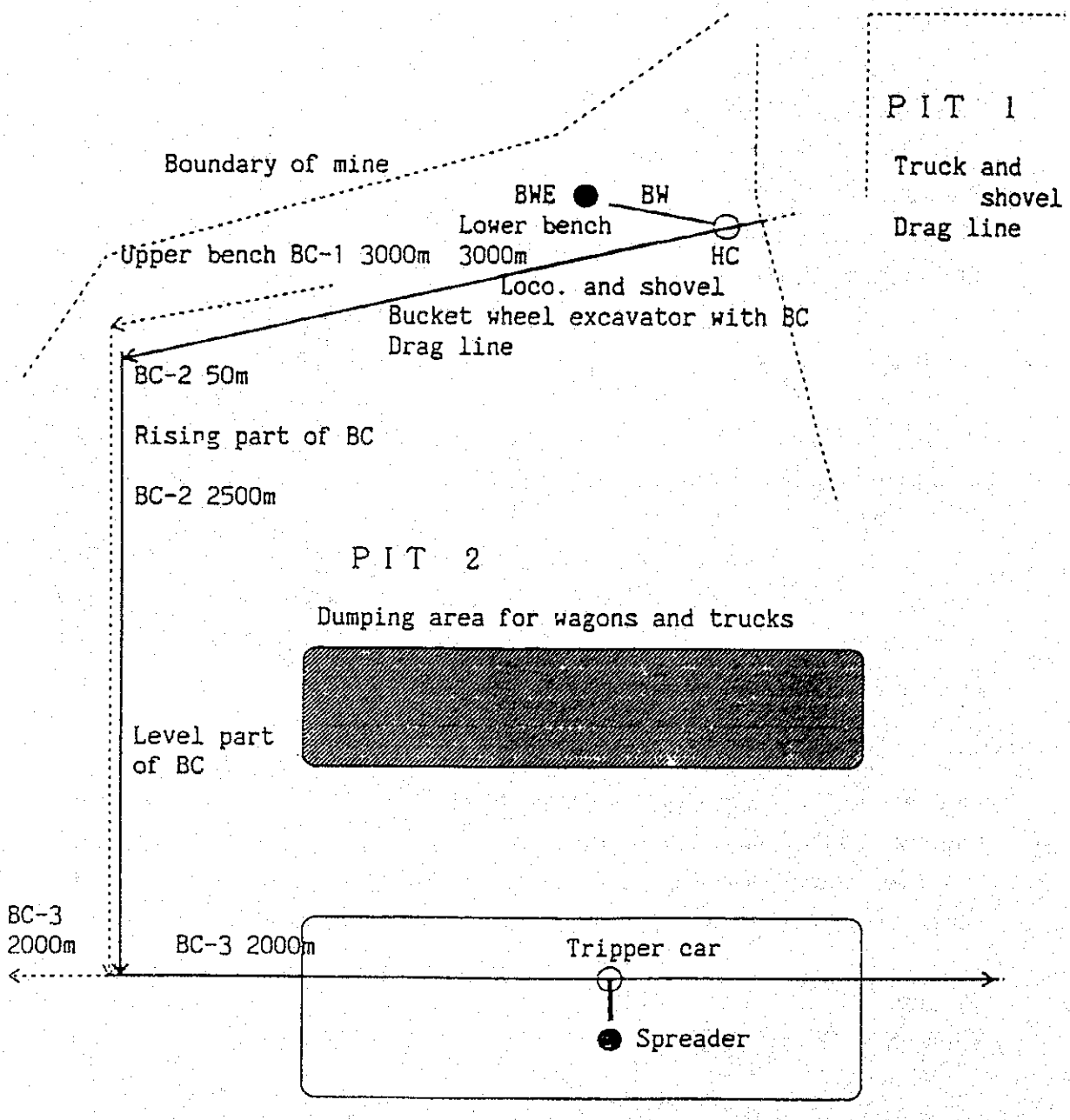


Figure 5.1 Outline of BWE System

Appendix 6 Five Year Plan of Bench Advance

1 Purpose and Criteria of This Study

1.1 Purpose of this study

The purpose is to check how Baganuur Coal Mine can regain the delayed stripping work with new mining equipment.

1.2 Current situations of Pit 1 and Pit 2

Inclined average angles of each bench are as follows:

Table 6.1 Current Benches Inclination

Location of bench section*		Average angle (degree)	Remark
Pit 1	VII	7.5	
	VI	8.0	
	V	30.0	Delayed Strip
	IV	11.0	
	III	13.0	
	II	n.a	
Pit 2	40	11.0	
	50	7.0	
	60	11.0	
	70	8.0	
	80	10.0	
	90	14.0	
	100	9.0	
	110	8.0	
	120	7.0	
	130	11.0	
	140	14.0	
	150	22.0	Delayed strip
	160	24.0	do
	170	38.0	do
	180	35.5	do
	190	18.0	do
	200	16.0	
	210	25.0	

Note: * The location is shown on the figure 1.

The table shows that stripping work of the area of Section 150 - 210 is much delayed comparatively.

1.3 Criteria of this study

The design criteria are as follows:

(1) Study Area

The study is carried out on one pit which covers Pit 1 and Pit 2 (Pit 5 is excluded). Then, assuming that the Pit 5 coal production is 0.6 m.t/y, the one pit coal production is fixed to be 5.4 m. t/y.

(2) Estimation of the delayed stripping work of the Pit

Based on the actual production results at the end of 1993, the delayed stripping work can be estimated to be about 13,000,000 BCM compared to the Russia F/S plan.

Calculation of the delay is as follows:

Basic data (refer to Tables 3.2 "Design Capacity of Baganuur Coal Mine", 3.3 "Production Record of Baganuur Coal Mine", and 3.4 "Overburden Removal of Baganuur Coal Mine" in this text)

According to the F/S plan (1985) by Russia, the mining activity from 1981 to 1993 was only for Seam 2a (Pit 1 and Pit 2). However, actual mining operation has been carried out at Seam 2 (Pit 5) as well. Therefore, in order to study the delayed excavation work, the comparison of actual operation and F/S plans is necessitated to be based on the same coal production.

Because the total coal production record to the end of 1993 was 29,133,000 t, excavation work planned by the F/S equivalent to the coal quantity was calculated with proportional allocation method as follows:

- The planned coal production to the end of 1992 was 28,300,000t.
  Then the difference of coal production to that is 833,000t (29,133,000t - 28,300,000t).
- Because the planned coal production in 1993 was 6,000,000t and the excavation work (including coal) was 21,670,000 BCM, the proportional allotment was calculated as follows:

  21,670000 BCM × 833,000t / 6,000,000 = 3,009,000 BCM

- Because the planned excavation work (including coal) to the end of 1992 was 98,129,000BCM, the total excavation work is:

  98,129,000 + 3,009,000 = 101,138,000 BCM

- After all, the delayed excavation work can be estimated as follows:

  101,138,000 - 88,131,000* = 13,007,000 BCM

* Total excavation record (including coal) to the end of 1993.

(3) Basic parameter for regaining delayed stripping work of Pit 1 and Pit 2.

Average thickness and dip of coal seam

	Thickness	Dip
Seam 3-1	13.9m	10°
Seam 2a	17.2m	10°

Average thickness of 84m

interburden Seam 3-1 - Seam 2a

Average depth of Seam 2a roof 57m

(end, 1997)

Depth of oxidized Seam 3 15m

Bench length 4,000m

Table 6.2 Excavation capacity in 1994

1,000 BCM

	Pit 1		Pit 2		Sub-total	Remark
D/L	15/90	2,100	20/90	2,500	4,600	
			10/70	1,700	1,700	
80 ton truck			3 Fl	8,000	8,000	
Railway			2 Fl	4,000	4,000	Include 2 dozers and 2 FELs
40 ton truck, dump	1 Fl	1,500	1 Fl	1,500	3,000	
40 ton truck, Coal			2 Fl	3,500	3,560	
Others		840		1,000	1,840	
Tatal		4,440		22,260	26,700	Total excavation capacity

The excavation capacity of 3,200,000 BCM/y which is allocated on Pit 5 is excluded (refer to 1.3.(1) Study Area).

(4) Coal seam to be excavated

Seam 2a and Seam 3-1 are to be excavated in this study (Seam 2 is excluded).

2. Prospect of 5-Year Stripping Work from 1998 - 2002

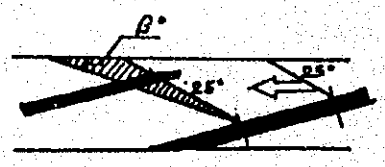
The average inclination angle of benches was presumed to be 25° at the end of 1997. Then, how much the bench can exceed the 25° line was studied. The results are shown on Table 6.3 and Figure 6.2.

Table 6.3 "Five Plan of Bench Advance" indicates the following conclusions:

Table 6.3 Five Year Plan of Bench Advance

Items	1998	1999	2000	2001	2002
Coal production, Total (x1000 t)	4,400	5,400	5,400	5,400	5,400
Seam 2a	4,400	5,400	3,846	2,986	2,986
Seam 3-1	-	-	1,554	2,414	2,414
Total (x1,000 BCM)	3,410	4,186	4,186	4,186	4,186
Seam 2a	3,410	4,186	2,981	2,315	2,315
Seam 3-1	-	-	1,205	1,871	1,871
Excavation Work (x1,000BCM) (including coal)	26,700	26,700	26,700	26,700	26,700
O.B / I.B. Removal (x1,000BCM)	23,290	22,514	22,514	22,514	22,514
S/R	5.3	4.2	4.2	4.2	4.2
Excess Capacity across the 25 Inclination Line(x1,000BCM)*	6,787	5,871	10,795	19,400	26,761
Coal Bench Advance (m)	50	61	43	34	34
Accumulated (m)	-	112	154	187	221
Top Bench Advance (m)	119	69	85	90	78
Accumulated (m)	119	188	273	363	441
Average Inclination of (degree) Bench, end of the year	18.8	20.6	18.9	16.6	15.5

* Hatching area of the right hand figure of section.



(1) The excavation capacity planned by the study team has enough capacity to regain the delayed stripping work, even though rate of the top bench advancement gets slower in the second year (1999) comparatively. To regain the delayed stripping work can be attained in 2001.

(2) Excavation of Seam 3-1 plays an important role to suppress the increase of strip ratio.

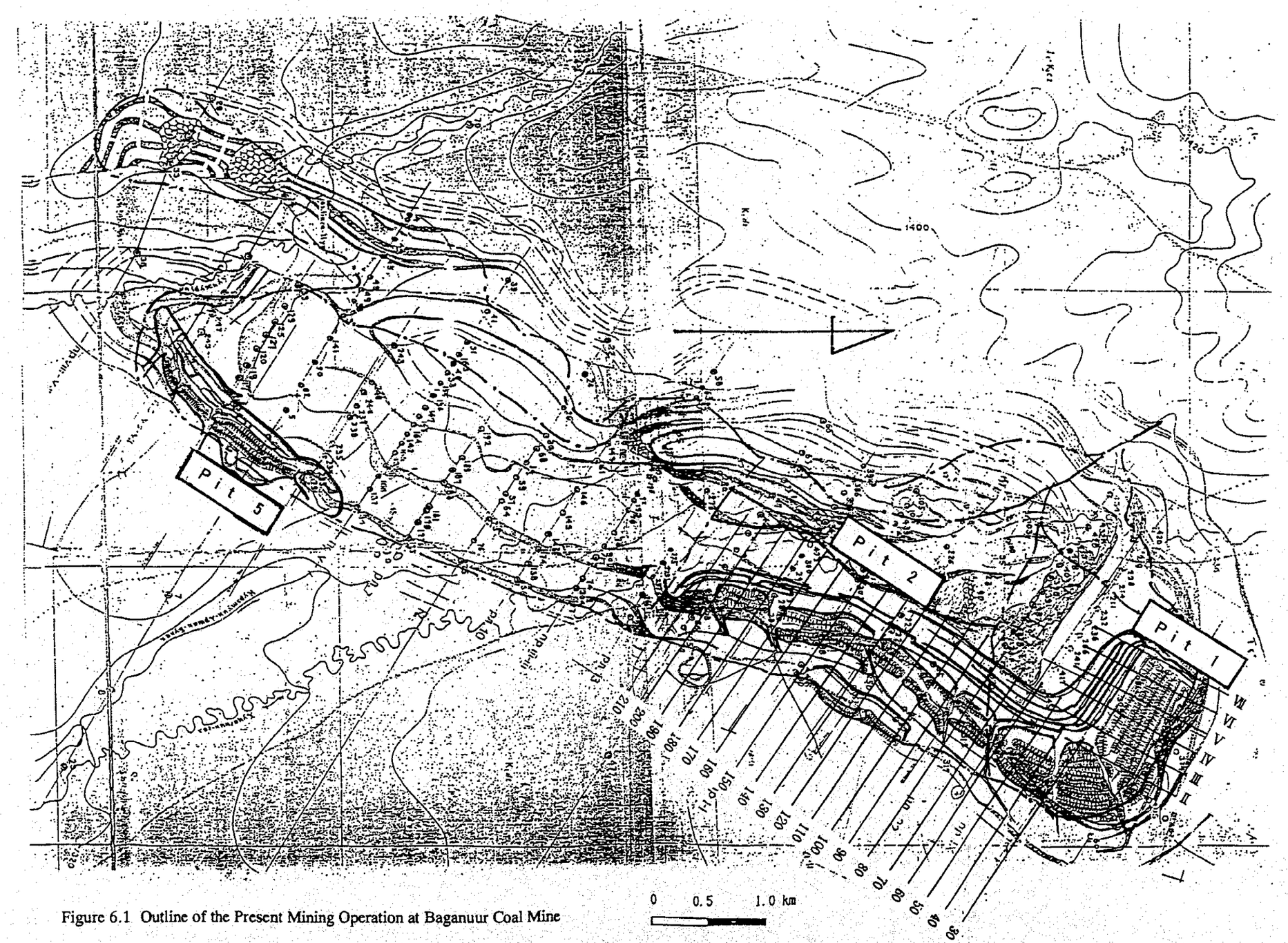


Figure 6.1 Outline of the Present Mining Operation at Baganuur Coal Mine

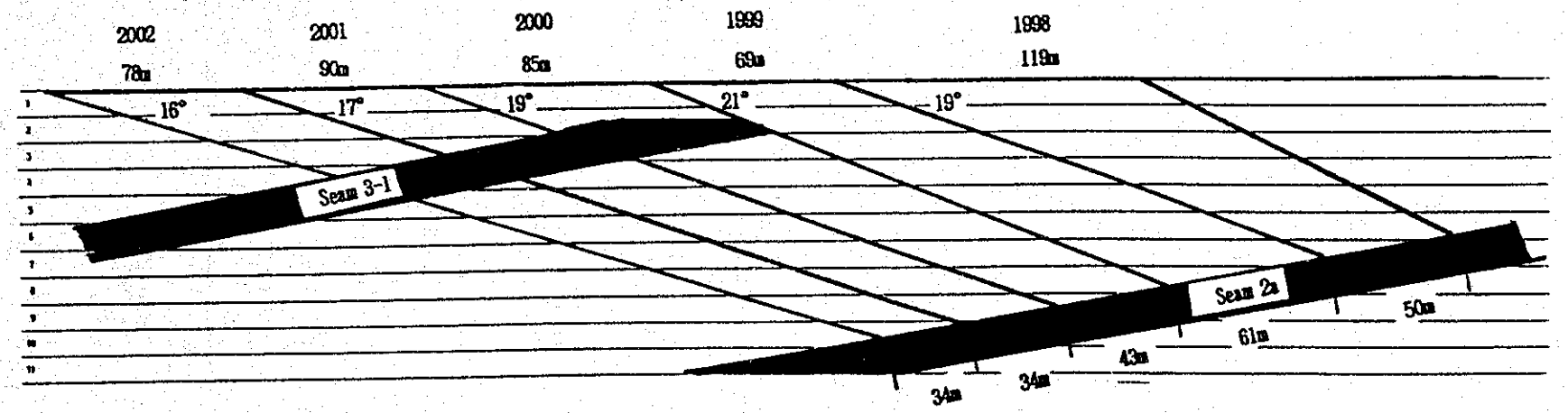


Figure 6.2 Schematic Bench Advance for 5 Years

Appendix 7 Salary and Wage Variance

Table 7.1 Salary and Wage Variance Data

		1993 (Budget)	1993 (Actual)			
Coal (1,000t)		4,000	2,848.2			
Over burden (1,000BCM)		13,000	9,680			
TBCM	(1,000BCM)	① 16,100	② 11,888	②/①	1−②/①	
				0.7384	③ 0.2616	
						Varianc Factor ④/③
Engineer	(men)	178	170	0.9551	④ 0.0449	0.17
	(1,000Tg/year)	40,659.0	35,304.6	—	—	—
	(1,000Tg/man・year)	228.42	207.67	0.9092	④ 0.0908	0.35
Adm. Clerk	(men)	63	62	0.9841	④ 0.0159	0.06
	(1,000Tg/year)	8,754.0	7,959.6	—	—	—
	(1,000Tg/man・year)	138.95	128.38	0.9239	④ 0.0761	0.29
Skilled	(men)	1,191	1,156	0.9706	④ 0.0294	0.11
	(1,000Tg/year)	240,343.7	203,650.4	—	—	—
	(1,000Tg/man・year)	201.8	176.17	0.8730	④ 0.0127	0.49
Unskilled	(men)	94	89	0.9468	④ 0.0532	0.20
	(1,000Tg/year)	10,812.8	6,414.1	—	—	—
	(1,000Tg/man・year)	115.03	72.07	0.6265	④ 0.3735	1.43
Total	(men)	1,526	1,477	—	—	—

Note: No change in salary and wage rates happened in 1993.

Table 7.2 Salary and Wage Variance

Case	Short & Long			Non Railway
	I	II	III	IV
	Existing Improvement	Existing additional	Additional Expansion	Existing - Railway + Truck & Shovel
TBCM Standard Norm (10^3BCM)	17,300	18,489	11,411	18,489
Standard Number of Workers				
Engineers	180 + 2 →	182	52	146 (180 - 47 + 13)
Adm. clerks	63 + 1 →	64	18	60 (63 - 7 + 4)
skilled	1,262 +17 →	1,279	362	1,015 (1,262 - 339 + 92)
Unskilled	87 + 1 →	88	25	75 (87 - 18 + 6)
Total	1,592 +21 →	1,613	457	1,296 (1,592 - 411 + 115)
TBCM Performance (10^3BCM)	X	X	X	X
Variance Factor	$\left[A = \frac{X-17,300}{17,300}\right]$	$\left[A = \frac{X-18,489}{18,489}\right]$	$\left[A = \frac{X-11,411}{11,411}\right]$	$\left[A = \frac{X-18,489}{18,489}\right]$
Engineers		(1+0.17A) × (1+0.35A)		
Adm. clerks		(1+0.06A) × (1+0.29A)		
skilled		(1+0.11A) × (1+0.49A)		
Unskilled		(1+0.20A) × (1+1.43A)		

Appendix 8 Economic and Financial Evaluation

1. Conceptual Methodology and Terminology of DCF Analysis.

The discounted cash flow analysis is an analytical method used in economic evaluation, which is based on the concepts of the time value of money with a compound interest rate. The methodology and terminology are briefly illustrated here.

Terminology

Compound interest is generally accepted approach today for calculating accrued interest or return on investment in time value of money calculations. In handling the time value of money, a thousand togrog in hand today has greater value than a thousand togrog at some future time because a thousand togrog in hand today can be put to work now in a bank account or other investments, to accrue interest or return on investment. What currently pervading in Mongolia is "inflation", which is defined as persistent rise in the prices of a consumer price index type basket of goods and services. This inflation is also a compound interest factor but works inversely when accounting for the effect of inflation on purchasing power. For example, 7% compound interest will double capital in ten years but 7% inflation will cut the purchasing power of currency in half in ten years. Under this situation, therefore, an effective interest is zero.

The term "discount" is generally considered to be synonymous with "present worth" in economic evaluation work. The future value that is projected to be accrued from the investment of togrog today at a specified compound interest rate is equal to the sum of the accrued interest and the initial togrog (principal) invested. The concept of present worth is just the opposite of compounding.

The term "cash flow" is used to refer to the net inflow or outflow of money that occurs during a specified operating period. Inflows of money from revenues and savings, minus outflows of money for expenditures such as operating costs, income taxes and capital expenditures, equal the project cash flow for a given period .

Simple Example of DCF Analysis

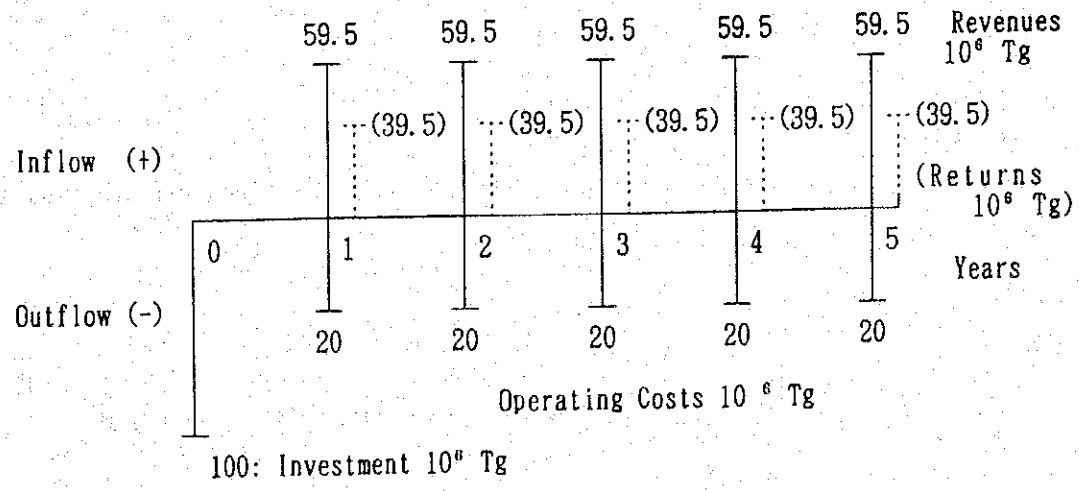
(1) Compound interest

Interest is paid each year on the principal in the account at the beginning of the year. For year one the principal is P and interest is Pi which gives P(1+i) accumulated at the end of year one. Therefore, in year two, the principal P(1+i) draws interest of P(1+i)i, which gives a total value of $P(1+i)^2$ accumulated at the end of year two. The final value accrued at the end of year "n" is given as $F = P(1+i)^n$

Then, the future value can be converted into the present value at a compound discount rate of "i".

Present value $P = F \div (1+i)^n$

(2) Internal rate of return (IRR)



※Time value of money here is expressed in constant Tg at year 0.

IRR is given in the following equation.

$$IRR : \sum_{t=1}^{n} (It - Ot) / (1 + d)^t = 0$$

Where, n = a project period (year)
t = year "t " from the beginning of the project
It = cash inflow at year "t"
Ot = cash outflow at year "t"
d = discount rate equal to internal rate of return (to be calculated)
Return = Revenue - Operating costs

then,

$$-100 + \frac{(59.5 - 20)}{(1 + d)} + \frac{(59.5 - 20)}{(1 + d)^2} + \frac{(59.5 - 20)}{(1 + d)^3} + \frac{(59.5 - 20)}{(1 + d)^4} + \frac{(59.5 - 20)}{(1 + d)^5} = 0$$

d = 0.28, IRR = 28%

If a debt financing cost is 10%, this investment by using debt is profitable because an internal rate of return is greater than a financing cost.

(3) Net present value

How much profit can be gained from this investment is calculated by using a net present value (NPV) method. Assuming an accounting interest rate of 10%,

then,

$$NPV = \frac{39.5}{(1 + 0.1)} + \frac{39.5}{(1 + 0.1)^2} + \frac{39.5}{(1 + 0.1)^3} + \frac{39.5}{(1 + 0.1)^4} + \frac{39.5}{(1 + 0.1)^5} - 100$$

= 149.736 - 100

= 49.736 (10^6 Tg): (net present value of return).