Table 82 Operation Cost Estimation of Process Plant (Bulk)
(The Erdenet Mine Mongolia)

X1,000 US$

No.	Item	Portion	1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	Total
	Classification								Annual Plan									
	Plant Throughput	X1,000t/A	20,500	21,000	22,000	23,000	24,000	25,000	24,839	25,213	25,212	25,444	27,011	27,804	27,803	27,804	29,242	
2	Operation Cost																	
(1)	Electric Power Consumption		24,005	22,201	22,673	23,251	23,922	24,593	24,422	24,819	24,818	25,065	26,729	27,571	27,570	27,571	29,038	378,308
	·Crushing Stage		1,027	1,052	1,102	1,152	1,202	1,252	1,244	1,263	1,263	1,275	1,353	1,393	1,393	1,393	1,465	18,828
	·Grinding stage		12,445	12,749	13,356	13,963	14,570	15,177	15,079	15,306	15,306	15,446	16,398	16,878	16,878	16,879	17,752	228,182
	·Flotation Stage		6,701	4,757	4,674	4,785	4,897	5,008	4,972	5,055	5,055	5,107	5,456	5,632	5,632	5,632	5,952	78,315
	·Filtering & Drying Stage		311	311	311	222	228	233	231	235	235	237	253	262	262	262	277	3,870
	·Reagent Preparation Stage		36	34	33	32	31	30	30	30	30	31	34	35	35	35	38	495
	·Section No. 5 Stage		3,485	3,298	3,197	3,096	2,995	2,893	2,866	2,930	2,929	2,969	3,235	3,370	3,370	3,370	3,814	47,618
(2)	Steaming		3,448	2,691	2,018	1,345	673											10,174
(3)	Liner (Crusher,Mill etc.)		1,312	1,344	1,408	1,472	1,536	1,600	1,590	1,614	1,614	1,629	1,728	1,780	1,780	1,780	1,872	24,058
(4)	Ball (for Mill)		7,035	7,206	7,550	7,893	8,236	8,579	8,524	8,652	8,652	8,731	9,263	9,541	9,541	9,541	10,035	128,385
(5)	Reagent Oil		84	96	100	105	110	114	113	115	115	116	123	127	127	127	133	1,715
(6)	Reagent		6,773	6,411	6,215	6,018	5,821	5,624	5,571	5,695	5,694	5,771	6,289	6,551	6,551	6,551	7,026	92,562
(7)	Water Supply		4,496	4,255	4,125	3,994	3,864	3,733	3,698	3,780	3,779	3,830	4,174	4,348	4,348	4,348	4,663	61,434
	·Fresh Water		2,142	2,028	1,966	1,903	1,841	1,779	1,762	1,801	1,801	1,825	1,989	2,072	2,072	2,072	2,222	29,274
	·Reclaim Water		2,353	2,228	2,159	2,091	2,023	1,954	1,936	1,979	1,978	2,005	2,185	2,276	2,276	2,276	2,441	32,160
(8)	Light Oil		444	412	390	368	347	325	321	328	328	331	351	361	361	361	380	5,408
(9)	Spare Parts		615	615	630	645	660	675	670	681	681	687	729	751	751	751	790	10,332
(10)	Amortization		1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	20,868
(11)	Salary & Wage		1,824	1,801	1,801	1,801	1,801	1,801	2,161	2,161	2,161	2,161	2,161	2,161	2,161	2,161	2,161	30,281
	·Engineer & Technician		234	231	231	231	231	231	277	277	277	277	277	277	277	277	277	3,880
	·Worker		1,570	1,550	1,550	1,550	1,550	1,550	1,861	1,861	1,861	1,861	1,861	1,861	1,861	1,861	1,861	26,068
	·Employee		7	6	6	6	6	6	8	8	8	8	8	8	8	8	8	108
	·Service Worker		14	13	13	13	13	13	16	16	16	16	16	16	16	16	16	225
(12)	Others		9,604	9,629	9,889	10,149	10,409	10,669	10,473	10,631	10,630	10,728	11,389	11,723	11,723	11,723	12,329	161,697
	Operation Cost Total		61,041	58,054	58,191	58,433	58,769	59,105	58,935	59,866	59,864	60,440	64,334	66,305	66,302	66,305	69,878	925,822
	(Unit Cost)	(US$/ton)	2.98	2.76	2.65	2.54	2.45	2.36	2.37	2.37	2.37	2.38	2.38	2.38	2.38	2.38	2.39	2.46

Table 83 INVESTMENT IN MINERAL PROCESSING (WITHOUT PROJECT)

(US$1000)

ITEM		1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	Total
Crushing	Fo.			2,515	1,006												3,521
	Do.			485	194												679
Grinding	Fo.							1,761	1,761								3,521
	Do.							339	339								678
Flotation	Fo.		814	814	814	814											3,256
	Do.		286	286	286	286											1,144
Filtering	Fo.																
	Do.																
Waste Treatment	Fo.			1,316	535												1,850
	Do.			614	405												1,019
Reclaim Water System	Fo.																
	Do.																
Others	Fo.																
	Do.																
Economic Cost Total			1,100	6,030	3,240	1,100		2,100	2,100								15,670
	Fo.		814	4,645	2,354	814		1,761	1,761								12,149
	Do.		286	1,385	886	286		339	339								3,521
Import & Sales Tax																	
Financial Cost Total			1,100	6,030	3,240	1,100		2,100	2,100								15,670
	Fo.		814	4,645	2,354	814		1,761	1,761								12,149
	Do.		286	1,385	886	286		339	339								3,521

Table 84 Operation Cost Estimation of Process Plant (Without)
(The Erdenet Mine Mongolia)

¥1,000 US$

No.	Item	Portion	Annual Plan 1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	Total
	Plant Throughput	¥1,000t/A	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	
2	Operation Cost																	
(1)	Electric Power Consumption		19,907	19,728	19,550	19,378	19,215	19,052	19,052	19,052	19,052	19,052	19,052	19,052	19,052	19,052	19,052	288,234
	·Crushing Stage		852	852	852	852	852	852	852	852	852	852	852	852	852	852	852	12,774
	·Grinding stage		10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	10,320	154,804
	·Flotation Stage		5,557	5,394	5,230	5,067	4,903	4,740	4,740	4,740	4,740	4,740	4,740	4,740	4,740	4,740	4,740	73,548
	·Filtering & Drying Stage		258	243	228	220	220	220	220	220	220	220	220	220	220	220	220	3,372
	·Reagent Preparation Stage		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	451
	·Section No. 5 Stage		2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	43,344
(2)	Steaming		2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	2,859	42,884
(3)	Liner (Crusher,Mill etc.)		1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	16,322
(4)	Ball (for Mill)		5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	5,834	87,506
(5)	Reagent Oil		78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	1,164
(6)	Reagent		5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	5,617	84,255
(7)	Water Supply		3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	3,728	55,921
	·Fresh Water		1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	26,647
	·Reclaim Water		1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	1,952	29,274
(8)	Light Oil		368	325	282	238	195	152	152	221	221	221	221	221	221	221	221	3,479
(9)	Spare Parts		510	495	480	465	450	435	435	459	459	459	459	459	459	459	459	6,943
(10)	Amortization		1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391	20,868
(11)	Salary & Wage		1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	22,692
	·Engineer & Technician		194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	2,907
	·Worker		1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	1,302	19,535
	·Employee		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	81
	·Service Worker		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	168
(12)	Others		7,964	7,730	7,496	7,261	7,027	6,793	6,793	7,168	7,168	7,168	7,168	7,168	7,168	7,168	7,168	108,406
	Operation Cost Total		50,857	50,385	49,914	49,451	48,995	48,539	48,539	49,007	49,007	49,007	49,007	49,007	49,007	49,007	49,007	738,732
	(Unit Cost)	(US$/ton)	2.99	2.96	2.94	2.91	2.88	2.86	2.86	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.90

5-5 Workshop

Based on the survey and diagnosis as already explained, there are several points to be proposed but out of such ideas, those which could be possibly adopted by Erdenet Mine and which are judged to be effective (including the future effects) are selected and proposed as modernization program.

5-5-1 Casting Plant

(1) Introduction of new technology (VRH Method) for production expansion

(Refer to item 5-5-3 for detailed specification and investment cost)

Taking into account the production expansion of Erdenet Mine, the casting plant also has to increase its casting capacity in proportion with such expansion rate. Considering the actual production of the casting plant in 1993 as 5,800 tons/year, it has to be expanded to 6,800 tons/year (17% increase) after 5 years, to 7,200 tons/year (24% increase) after 10 years and to 8,100 tons/year (43% increase) after 15 years on an actual production basis. In order to materialize this production expansion, an installation of facility with the advance new process "VRH (Vacuum Replacement Hardening)" utilizing vacuum pressure in place of the existing CO_2 process is recommended. The introduction program of this VRH is as explained below.

1) Features of the process : This is a new process which adds vacuum pressure to the conventional CO_2 process thereby decreases greatly the consumption of CO_2 gas and water glass which enables to decrease the production cost.

2) Production capacity

The required production quantity even after 15 years is 8,100 tons/year but taking into account the sales outside the mine, the production quantity shall be as described below.

Maximum capacity : 10,000 tons/year

(Possible operating hours per year)

8 hrs/shift x 2 shifts/day x 24 days/month x 12 months = 4,650 hours

(Annual operating hours)

4,650 hours x 0.90 (operating efficiency) = 4,200 hours

(Hourly production capacity)

Based on average of 230 kg per time cycle (230 kg/cycle)

1 hr x 60 min/hr / 5.8 min/cycle x 230 kg/cycle = 2,380 kg

Therefore, the maximum capacity shall be:

4,200 hr/yr x 2,380 kg/hr / 1,000 kg/ton = 10,000 tons/year

3) Advantages of introduction

Significant reduction in CO_2 gas consumption (decreased to 1/6 to 1/20 of the conventional process)

Significant reduction in water glass consumption (decreased to 1/2 to 1/3 of the conventional process)

Shortening of hardening time (decreased to 1/60 to 1/80 of the conventional process)

Decrease of rejected products (by increase of strength and accuracy of the casting mold)

Decrease of production cost (by combined effect of the above)

Shortening of operating time by better deforming of the mold.

Almost 100 % recycling of the sand is possible with the use of a special regenerator.

(2) Measures to maintain existing production capacity (Refer to item 5-5-3 for detailed specification and investment cost)

In order to maintain the present production capacity, it is necessary to renew the following facilities.

1) Renewal of mold forming machine

The existing two sets of small type and two sets of large type machines shall be replaced with the new type in order to improve the working efficiency and accuracy of the mold which will result in improving the production yield.

2) Renewal of shake out machine

The capacity of the existing machine is 3 tons loading but it is overloaded with 5 tons causing frequent troubles which is one of the big factors to decrease the production. This modification aims to prevent the mechanical trouble, to improve the working efficiency, to secure removal of sand and to shorten the working time.

3) Additional installation of shot blast machine

The present requirement is maximum load of 6 tons with one unit. The actual loading capacity of the existing unit is 1.6 tons which is insufficient and therefore, the machine has to be replaced with the one meet the requirement. This will shorten the operating time and improve the operating efficiency.

4) Improvement of working environment

The dust generation in the plant is severe and the working environment is

bad. To prevent this dust generation, bag filters and hoods and other dust collecting devices for the reinforcement of dust collection have to be installed at dust sources.

Blending, drying, kneading and transportation area of casting sand.

Gas collection facility for the gas emitted from the electric furnace during feeding of materials.

Removal of dust generated during cutting of scraps.

Pouring mouth and cast product cleaning area.

(3) Strengthening of quality control (Refer to item 5-5-3 for detailed specification and investment cost)

The control of sand and the control of molten metal are important factors for the quality improvement of product and the following equipment should be introduced for each of them.

1) For control of sand

Analyzer for raw sand control

Silica program of the sand

2) For control of molten metal

Metal component analyzer : This is a radiant-spectro analyzer which can analyze in a short time in front of the furnace and which can be used by an inexperienced operator. Therefore, when the components are not as specified, it can be adjusted immediately at site. The analysis of the metal charged as feed material can also be analyzed in the same way.

Temperature measuring device for molten metal : This can measure quickly and accurately at site the temperature of the metal being melt which

enables temperature control at site.

Weigher for raw materials : This is installed between the hook of the crane and the suspended raw material which can directly measure the weight.

(4) Supply to domestic market (Refer to item 5-5-3 for detailed specification and investment cost)

1) Expansion of the plant to increase sales of cast products

The first thing to be done is the stabilization of production and quality. For this purpose, the aforementioned 5-5-1(1), (2) and (3) should be done. At present, orders received from outside is about 330 tons/year but with the introduction of VRH process, the capability for the sales outside the mine will increase to maximum of about 4,000 tons/year after 5 years. However, for this purpose, the plant has to be expanded for one span (24 meters).

2) Introduction of aluminum die-casting machine

The purpose is for the production of household goods such as pans and automobile parts.

5-5-2 Machining Plant

(1) Introduction of new facilities (Refer to item 5-5-3 for detailed specification and investment cost)

This introduction should be done in order to introduce highly advanced NC machines and to learn the actual situation of the fabricating machines of the developed countries as well as to be able to compete with the foreign competitors in the future.

1) Purchase and training of NC lathe (1 unit)

2) Purchase and training of NC milling machine (1 unit)

3) Purchase and training of NC boring machine (1 unit)

(2) Modification of existing facility for manpower saving (Refer to item 5-5-3 for detailed specification and investment cost)

The modification should be done by installing special sensors and control devices to the existing large size machines to enable one operator to operate several machines (3 to 4 units) instead of present one operator per machines. The machines subject to this modification are a large turning table, boring machine and surface grinder.

1) Turning table (5 units)

2) Boring machine (3 units)

3) Surface grinder (2 units)

(3) Introduction of new equipment for the sales outside

1) Production and sales of automobile parts for domestic use

Interdiction of machines now lacking for this purpose.

Spline broaching machine (1 unit)

Hypoid gear fabrication machine (However, this machine is of very high cost and its introduction should not be done now.)

2) Production and sales of general industrial tools

Training required to learn technology for this purpose.

Heat treatment technology

3) Production and sales of general purpose mechanical parts

There is no lacking equipment for this purpose.

(4) Introduction of machines now lacking in the plant (Refer to item 5-5-3 for detailed specification and investment cost)

Cutting machine for a large diameter materials (1 unit)

Precision boring machine (1 unit)

Automatic fabrication machine of bolts and nuts (1 unit)

5-5-3 Investment Necessary for Modernization

Table 85 shows the investment required for the modernization of Workshop. Also, Table 86 shows the detailed specification and investment schedule. The investment is US$14,767 thousand at financial cost and US$12,341 thousand at economic cost.

Table 85 INVESTMENT IN WORKSHOP

(US$1000)

ITEM	1994								1995								1996							
	Foreign Currency				Domestic Currency			Total	Foreign Currency				Domestic Currency			Total	Foreign Currency				Domestic Currency			Total
	Equip.	Trans.	Other	Sub-T	Insta.	Trans.	Sub-T		Equip.	Trans.	Other	Sub-T	Insta.	Trans.	Sub-T		Equip.	Trans.	Other	Sub-T	Insta.	Trans.	Sub-T	
VRH Facility									2,381	202	190	2,773	476	36	512	3,285								
Mold Forming	194	16		210	19	3	22	233																
Shake-out Machine	219	19	10	247	22	3	25	272																
Shot Blast	400	34		434	40	6	46	480																
Dust Collecting Facility	173	15		188	17	3	20	208																
Dust Collecting Facility	329	28	14	371	33	5	38	409																
Dust Collecting Facility	144	12		156	14	2	17	173																
Dust Collecting Facility	167	14	14	195	17	2	19	214																
Raw Sand Analyzer	43	4		47	4	1	5	51																
Silica Program of Sand	12	1		13	1		1	15																
Metal analyzer	317	27		344	32	5	36	381																
Temperature Measurement	37	3		40	4	1	4	44																
Raw Material Weigher	12	1		13	1		1	15																
Alumi Die Casting Machine									1,097	93	55	1,246	110	16	126	1,372								
NC Lathe	276	23	14	314	28	4	32	346																
NC Milling Machine	400	34	19	453	40	6	46	499																
NC Boring Machine	638	54	29	721	64	10	73	794																
Semi-automation of Turning Table									476	40	171	688	48	7	55	743								
Semi-automation of Boring Machine																	286	24	114	424	29	4	33	457
Semi-automation of Surface Grinder																	190	16	114	321	19	3	22	343
Spline Fabricating Machine	333	28		362	33	5	38	400																
Training on Heat Treatment											54	54				54								
Cutting Machine	133	11		145	13	2	15	160																
Precision Boring Machine									781	66		847	78	12	90	937								
Bolt/Nut automatic Fabricating Machine									381	32		413	38	6	44	457								
Economic Cost Total	3,827	325	100	4,253	383	57	440	4,693	5,116	435	471	6,022	750	77	826	6,848	476	40	229	745	48	7	55	800
Import & Sales Tax						1,038		1,038						1,388		1,388								
Financial Cost Total	3,827	325	100	4,253	383	1,095	1,478	5,730	5,116	435	471	6,022	750	1,465	2,214	8,236	476	40	229	745	48	7	55	800

Gran Total	
Econ'c cost	12,341
Fo.	11,020
Do.	1,321
Fina'l cost	14,767
Fo.	11,020
Do.	3,747

Table 86 Detailed Specification and Investment Schedule

Investment Items	Equipment Specifications		Investment Cost		Investment Schedule			
( ) is a ref. to report			(In US$, convert. rate 1$ = 105¥)		Item	1994	1995	1996
1 VRH Facility	1. Production capacity	: 10,000 tons/yr	1. Equipment cost	: $ 2,381,000	1. Determine spec.	——		
(5.5.1-(1))	2. Max. mold size (top & bot.)	: 1,800Wx2,200Lx800H	2. Engineering fee	: $ 133,000	2. Design	——	——	
	3. Product average weight	: 230 kg/piece	3. Training cost	: $ 57,000	3. Proc. & fab.		——	
	4. Time cycle	: 5.8 min./piece	4. Installation cost	: $ 476,000	4. Installation & test		—	
	5. Vacuum pressure	: 10 to 30 Torr	5. Transportation	: $ 238,000				
	6. Layout drawing	: Refer to Att. VI------	Sub-total	$ 3,285,000				
	7. Detailed information	: Refer to Att. VI------						
2 Mold Forming	1. Large Size	: 2 units (VT-1520)	1. Equipment cost	: $ 114,000	1. Determine spec.	—		
Machine	1.1 Max. load	: 4,000 kg	(2 large units)		2. Design	—		
(5.5.1-(2)-1))	1.2 Table dimension	: 1.5 m x 2 m	2. Installation cost	: $ 12,000	3. Proc. & fab.	——		
	1.3 Motor capacity	: 1.2 kW x 2 units	3. Transportation	: $ 11,000	4. Installation & test		—	
	1.4 Detail information	: Refer to Att. VI -----	Sub-total	$ 137,000				
	2. Small Size	: 2 units (VT-1010)	1. Equipment cost	: $ 80,000	1. Determine spec.	—		
	2.1 Max. load	: 1,000 kg	(2 small units)		2. Design	—		
	2.2 Table dimension	: 1 m x 1 m	2. Installation cost	: $ 8,000	3. Proc. & fab.	——		
	2.3 Motor capacity	: 0.32 kW x 2 units	3. Transportation	: $ 8,000	4. Installation & test		—	
	2.4 Detailed information	: Refer to Att. VI -----	Sub-total	$ 96,000				
3. Shake-Out Machine	1. Quantity	: 1 unit (SHO-55U)	1. Equipment cost	: $ 219,000	1. Determine spec.	—		
(5.5.1-(2)-2))	2. Max. load	: 5,500 kg	2. Design fee	: $ 10,000	2. Design	—		
	3. Table dimension	: 2 m x 3 m	3. Installation cost	: $ 22,000	3. Proc. & fab.	——		
	4. Bag filter	: Filtration area 202 m^2	4. Transportation	: $ 21,000	4. Installation & test		—	
	5. Design of accessories	: 1 set	Sub-total	$ 272,000				
	6. Detailed information	: Refer to Att. VI -----						
4. Shot Blast	1. Quantity	: 1 unit (KSB-50)	1. Equipment cost	: $ 400,000	1. Determine spec.	—		
(5.5.1-(2)-3))	2. Max. dimension of work	: 2.5 mø x 3 mH	2. Installation cost	: $ 40,000	2. Design	—		
	3. Max. weight of work	: 5,000 kg	3. Transportation	: $ 40,000	3. Proc. & fab.	——		
	4. Bag filter	: Filtration area 101 m^2	Sub-total	$ 480,000	4. Installation & test		—	
	5. Detailed information	: Refer to Att. VI -----						
5. Dust Collecting	1. Quantity	: 2 units (UDC-818PS)	1. Equipment cost	: $ 173,000	1. Determine spec.	—		
Facility	2. Location	: Blending, drying and	2. Installation cost	: $ 17,000	2. Design	—		
(5.5.1-(2)-4))		kneading of sand	3. Transportation	: $ 18,000	3. Proc. & fab.	——		
	3. Filtration surface area	: 202 m^2/unit	Sub-total	$ 208,000	4. Installation & test		—	
	4. Detailed information	: Refer to Att. VI -----						

6. Dust Collecting Facility (5.5.1-(2)-4))	1. Quantity : 3 units (TDC-44CS) 2. Location : Dust collection at electric furnace 3. Filtration surface area : 440 m^2/unit 4. Detailed information : Refer to Att. VI -----		1. Equipment cost : $ 329,000 2. Design fee : $ 14,000 3. Installation cost : $ 33,000 4. Transportation : $ 33,000 Sub-total $ 409,000		1. Determine spec. 2. Design 3. Proc. & fab. 4. Installation & test			
7. Dust Collecting Facility (5.5.1-(2)-4))	1. Quantity : 1 unit (TDC-55CS) 2. Location : Scrap cutting area 3. Filtration surface area : 550 m^2 4. Detailed information : Refer to Att. VI -----		1. Equipment cost : $ 144,000 2. Installation cost : $ 14,000 3. Transportation : $ 15,000 Sub-total $ 173,000		1. Determine spec. 2. Design 3. Proc. & fab. 4. Installation & test			
8. Dust Collecting Facility (5.5.1-(2)-4))	1. Quantity : 1 units (TDC-66CS) 2. Location : Cast product cleaning area 3. Filtration surface area : 660 m^2/unit 4. Detailed information : Refer to Att. VI -----		1. Equipment cost : $ 167,000 2. Design fee : $ 14,000 3. Installation cost : $ 17,000 4. Transportation : $ 16,000 Sub-total $ 214,000		1. Determine spec. 2. Design 3. Proc. & fab. 4. Installation & test			
9. Raw Sand Analyzer (5.5.1-(3)-1))	1. Object of measurement : Raw sand 2. Measurement items • Moisture content • Air permeability • Contactability • Compression strength and modulus of rupture • Particle size distribution • Kneading test		1. Equipment cost : $ 43,000 2. Installation cost : $ 4,000 3. Transportation : $ 4,000 Sub-total $ 51,000		1. Determine spec. 2. Procurement			
10. Silica Program of Sand (5.5.1-(3)-1))	1. Object of measurement : Casting sand 2. Measurement items • Total viscosity • Carbonaceous material content • Metal content • O-rich content • Flux content • Silica content 3. Detailed information : Refer to Att. VI -----		1. Equipment cost : $ 12,000 2. Installation cost : $ 2,000 3. Transportation : $ 1,000 Sub-total $ 15,000		1. Determine spec. 2. Procurement			

11. Metal Analyzer	1. Quantity	: 1 unit	1. Equipment cost	: $ 317,000	1. Determine spec.	—		
(5.5.1-(3)-2))	2. Object for analysis	: All metal products	2. Installation cost	: $ 32,000	2. Procurement	———	———	
	3. Elements for analysis	: 32 elements	3. Transportation	: $ 32,000				
	4. Detailed information	: Refer to Att. VI -----	Sub-total	$ 381,000				
12. Temperature	1. Quantity	: 3 units (NKH-90)	1. Main body	: $ 6,000	1. Determine spec.	—		
Measurement	2. Measurement items	: Temperature in the	2. Sensor (6 months		2. Procurement	———		
(5.5.1-(3)-2))		melting furnace	consumable)	: $ 29,000				
	3. Measurement range	: 0 to 1,700°C	3. Installation cost	: $ 4,000				
	4. Sensor	: Disposable type	4. Transportation	: $ 3,000				
	5. Detailed information	: Refer to Att. VI -----	Sub-total	$ 44,000				
13. Raw Material	1. Quantity	: 2 units (HS Type)	1. Equipment cost	: $ 13,000	1. Determine spec.	—		
Weigher	2. Measurement items	: Raw material & scraps	2. Installation cost	: $ 1,000	2. Procurement	———		
(5.5.1-(3)-2))	3. Measurement range	: 0 to 2,000 kg	3. Transportation	: $ 1,000				
	4. Detailed information	: Refer to Att. VI -----	Sub-total	$ 15,000				
14. Aluminum Die	1. Quantity	: 1 unit (DC800CL)	1. Main body	: $ 640,000	1. Determine spec.	—		
Casting Machine	2. Mold binding strength	: 800 tons	2. Melting furnace	: $ 190,000	2. Design	———		
(5.5.1-(4)-2))	3. Dies stroke	: 760 mm	3. Molds	: $ 267,000	3. Proc. & fab.	———	———	
	4. Max. product diameter	: 500 mm	4. Training	: $ 56,000	4. Installation & test		—	
	5. Dimension	: 2,480Wx8,530Lx4,100H	5. Installation cost	: $ 110,000				
	6. Weight	: 59 tons	6. Transportation	: $ 110,000				
	7. Melting furnace	: 1 furnace	Sub-total	$ 1,372,000				
	8. Molds	: 3 sets						
	9. Detailed information	: Refer to Att. VI -----						
15. NC Lathe	1. Quantity	: 1 unit (LB15IICR)	1. Equipment cost	: $ 276,000	1. Determine spec.	—		
(5.5.2-(1)-1))	2. Max. size of work	:	2. Training	: $ 15,000	2. Proc. & fab.	———	———	
	3. Revolution of main shaft	: 35 to 4,000 r.p.m.	3. Installation cost	: $ 28,000	3. Installation & test		—	
	4. Dimension	: 1,680Wx2,815Lx1,745H	4. Transportation	: $ 28,000				
	5. Weight	: 4,580 kg	Sub-total	$ 346,000				
	6. Detailed information	: Refer to Att. VI -----						

16. NC Milling Machine (5.5.2-(1)-2))	1. Quantity : 1 unit (8V-NC)		1. Equipment cost : $ 400,000		1. Determine spec.	—		
	2. Rang of table movement :		2. Training : $ 19,000		2. Proc. & fab.	—	—	
	Forward 820mm, side 1,800mm, vertical 600mm		3. Installation cost : $ 40,000		3. Installation & test		—	
	3. Maximum load : 2,500 kg		4. Transportation : $ 40,000					
	4. Dimension : 3,395Wx4,825Lx3,585H		Sub-total $ 499,000					
	5. Weight : 14 tons							
	6. Detailed information : Refer to Att. VI -----							
17. NV Boring Machine (5.5.2-(1)-3))	1. Quantity : 1 unit (BTD-200QE)		1. Equipment cost : $ 638,000		1. Determine spec.	—		
	2. Rang of table movement :		2. Training : $ 29,000		2. Proc. & fab.	—	—	
	Forward 1,000mm, side 700mm, vertical 800mm		3. Installation cost : $ 64,000		3. Installation & test		—	
	3. Dimension : 3,680Wx4,205Lx2,937H		4. Transportation : $ 63,000					
	4. Weight : 14 tons		Sub-total $ 794,000					
	5. Detailed information : Refer to Att. VI -----							
18. Semi-automation of Turning Table (5.5.2-(2)-1))	1. Quantity : 5 units (NC21)		1. Equipment and control panel cost : $ 476,000		1. Determine spec.	—		
	2. Object equipment : Turning table		2. Adjustment at site : $ 171,000		2. Design	—		
	3. NC shaft : 3 shafts		3. Installation cost : $ 48,000		3. Proc. & fab.	—	—	
	4. Control length : 3m and 6m		4. Transportation : $ 48,000		4. Installation & test		—	
			Sub-total $ 743,000					
19. Semi-automation of Boring Machine (5.5.2-(2)-2))	1. Quantity : 5 units (NC21)		1. Equipment and control panel cost : $ 286,000		1. Determine spec.		—	
	2. Object equipment : Boring machine		2. Adjustment at site : $ 114,000		2. Design		—	
	3. NC shaft : 3 shafts		3. Installation cost : $ 29,000		3. Proc. & fab.		—	
	4. Control length : 3m and 6m		4. Transportation : $ 28,000		4. Installation & test			—
			Sub-total $ 457,000					
20. Semi-automation of Surface Grinder (5.5.2-(2)-3))	1. Quantity : 2 units (NC21)		1. Equipment and control panel cost : $ 190,000		1. Determine spec.		—	
	2. Object equipment : Surface grinder		2. Adjustment at site : $ 114,000		2. Design		—	
	3. NC shaft : 3 shafts		3. Installation cost : $ 19,000		3. Proc. & fab.			—
	4. Control length : 3m and 6m		4. Transportation : $ 20,000		4. Installation & test			
			Sub-total $ 343,000					

21.	Spline Fabricating Machine (5.5.2-(3)-1))	1. Quantity 2. Extraction force 3. Fabricating length 4. Fabricating diameter 5. Detailed information	: 1 unit (VUB-7120L) : 7.5 tons : 1,200 mm (Max.) : 410 mmø (Max.) : Refer to Att. VI -----	1. Equipment cost 2. Installation cost 3. Transportation Sub-total	: $ 333,000 : $ 33,000 : $ 34,000 $ 400,000	1. Determine spec. 2. Proc. & fab. 3. Installation & test			
22.	Training on Heat Treatment (5.5.2-(3)-2))	1. Purpose 2. Period 3. No. of trainees	: Training on heat treatment technology of tools in developed country. : 1 month : 2 men	Fee	: $ 54,000	Training period			
23.	Cutting Machine (5.5.2-(4)-1))	1. Quantity 2. Cutting diameter 3. Detailed information	: 1 unit (S-6090) : 700 mmø (Max.) : Refer to Att. VI -----	1. Equipment cost 2. Installation cost 3. Transportation Sub-total	: $ 133,000 : $ 13,000 : $ 14,000 $ 160,000	1. Determine spec. 2. Proc. & fab. 3. Installation & test			
24.	Precision Boring Machine (5.5.2-(4)-2))	1. Quantity 2. Rang of table movement Forward 1,020mm, side 760mm, vertical 800mm 3. Max. boring diameter 4. Positioning accuracy 5. Dimension 4. Weight 5. Detailed information	: 1 unit (6B-D) : : 300 mmø (Max.) : ±0.0015 mm : 2,300Wx3,050Lx2,780H : 8,500 kg : Refer to Att. VI -----	1. Equipment cost 2. Installation cost 3. Transportation Sub-total	: $ 781,000 : $ 78,000 : $ 78,000 $ 937,000	1. Determine spec. 2. Design 3. Proc. & fab. 4. Installation & test			
25.	Bolt/Nut Automatic Fabricating Machine (5.5.2-(4)-3))	1. Quantity 2. Maximum outer diameter 3. Maximum length 4. Forging method 5. Detailed information	: 1 unit (FA-30U) : 100 mmø : 295 mm : Cold rolling : Refer to Att. VI -----	1. Equipment cost 2. Installation cost 3. Transportation Sub-total	: $ 381,000 : $ 38,000 : $ 38,000 $ 457,000	1. Determine spec. 2. Design 3. Proc. & fab. 4. Installation & test			

5-6 Utilities

5-6-1 Electricity

As stated in paragraph 4-4-1 "Electricity" and diagnostic review, the present extreme lack of stable power supply is a critical disadvantage to the stable operation and achievement of production targets. This is a problem to be solved before modernization.

To cope with the situation, a plan is now under progress to install 60,000 kW power generator utilizing excess steam coming from the boilers. As stated in paragraphs 1) to 3), this plan is a very effective and adequate plan. Paragraphs 4) and 5) refer to the advises but we believe they should also be implemented for their advantages and improving the control standards.

1) Scale of power generation

The existing six boilers have a capacity of 75 t/hr. steam generation per unit and three of them are standby units even during winter time. The plan is to install 60,000 kW power generator effectively utilizing the advantages of existing units. It aims to have maximum power generation within the excess capacity of the boilers with minimum investment and the plan is advantageous. The capacity of the power generator is adequate. With the utilization of excess steam from the Erdenet Power Plant, the advantages of this plan will become greater.

From the point of stable supply of electric power, it is better to have bigger power generation capacity but this will require investment for installation of new boilers and decreases the investment advantages.

2) Impact of 60,000 kW power generator

—On average, the electric power cut rate by restriction in 1991 and 1992 was about 20% (20,000 kW). Therefore, the new power generator can make up for this power shortage except at the time of total power failure.

—This new power generator can be used as an emergency power source for the tailing pond pump, which will be put to operation in near future.

—The electric power supply situation of the Central Energy System will be alleviated to some extent.

3) Excess boiler capacity

—Three boilers are in operation in winter and remaining three units are standby. Therefore, when 60,000 kW power is generated, there will be a case when there is no stand by boiler. The full capacity operation will become difficult unless the spare parts become more readily available or sufficient rehabilitation of the plant is done. In order to secure a stand by boiler, it is necessary to expand but with the utilization of excess energy of Erdenet Power Plant, a stand by can be secured without additional installation of a boiler and further, a full capacity operation at 60,000 kW can be done during winter.

4) Proposal to use excess energy from Erdenet Power Plant

(Objectives)

—The Erdenet Power Plant has three 12,000 kW generators. One is a condensing turbine and the other two are back pressure turbines. However, one of the back pressure turbine generators is not in operation because the steam generation is too large for city's steam requirement.

—This turbine generator not in operation could be used and the steam

generated can be turned to hot water to replace a part of hot water used at Erdenet Mine. This would free boiler capacity at the mine and the excess capacity could be used to generate electricity at full capacity. This will result in increase of power generation at Erdenet Power Plant.

(Advantages)

—Erdenet Power Plant can increase the power generation by about 63,600 MWh per year which will result in increase of electric power income.

The investment advantages are referred to in paragraph 7).

—The power plant of Erdenet Mine could increase the electric power generation by 46,000 MWh per year which will result in stable supply of electricity.

5) Modernization of instruments for boiler facilities

The existing instrument facilities were installed at the time of construction and the deterioration is significant and at the same time, supply of spare parts is becoming difficult. It is about the time for renewal. At the same time, when the turbine generator is installed, it is necessary to improve the steam control system and therefore, it is necessary to have centralized control by a computer including the renewal of instruments.

6) Cost estimation for power plant construction program

—Output of generator: 60 MW (30 MW x 2)

—Construction cost: US$77,000,000-

—Unit cost estimation for power generation

- Annual power generation (utilization 80%)

60 x 0.8 x 8,760 = 420,000 MWh

•Electric power at transmission terminal (5% in-plant power)

60 x 0.95 x 0.8 x 8,760 = 400,000 MWh

—Fuel cost (Steam consumption 4 kg/KWH boiler efficiency 88.9%)

•Fuel Kcal per KWH 790 x 4/0.889 = 3,550 Kcal/KWH

(Calorific value of coal 3,800 Kcal/kg)

•Coal consumption 3,550/3,800 = 0.93 kg/KWH

(Unit cost of coal US$25.5/ton)

•Fuel cost 25.5 x 0.93/1.000 = US$0.024/KWH

•Annual fuel cost 0.024 x 420,000 = US$10,080,000/year

—Labor cost

US$1,000/man/year x 40 men = US$40,000/year

—Repair and maintenance cost (2.5% of construction cost)

77,000,000 x 0.025 = US$1,925,000/year

—Depreciation (25 year)

77,000,000 x 0.9/25 = US$2,770,000/year

—Interest payment (Construction cost is all low interest loan of 8%)

77,000,000 x 0.08 = US$6,160,000/year

—Total annual cost US$20,975,000/year

—Unit cost of power generation

20,975,000/400,000 = US$0.0524/KWH

—Rate of each cost to unit cost

•Fuel cost 48.4% •Labor cost 0.2%

•Repair cost 9.2%　　•Depreciation 13.2%

•Interest payment 29.4%

7) Estimation on heat supply program from Erdenet Power Plant

—Outline of program

(Background)

•The Erdenet Mine is planning a construction of power plant in order to solve the electric power insufficiency problem to recover its production as well as to be ready for production expansion. This power plant construction program is to utilize in whole the excess capacity of the boiler facilities and to implement it at minimum investment.

•The back pressure turbine generator (one out of two units) at Erdenet Power Plant is not in operation because the steam consumption of the area is small against the supply quantity. By operating this generator to supply hot water turned from steam to the mine will create an excess capacity of the steam production for hot water at the mine and could contribute to the power generation of the mine. Further, the Erdenet Power Plant will have increase of power generation due to the operation of this back pressure turbine generator thereby could contribute to the stable supply of electric power to the area. This will also lead to stable supply to the mine.

(Plan)

•There is an existing piping between the mine and the Erdenet Power Plant but because of long distance, there will be bigger pressure loss and water supply will become difficult. A booster should be installed.

—Construction cost of booster

US$3,220,000

—Energy available from exhaust gas of back pressure turbine generator of Erdenet Power Plant

(Based on the attached calculation basis.)

500,000 x 10^6 Kcal/year

—Energy used for power generation

500,000 x 10^6 x (790 - 700)/700 = 64,300 x 10^6 Kcal/year

—Power generation volume

64,300 x 10^6/860 x 0.85 = 63,600 MWH/year

—Coal consumption for above power generation (Calorific value of coal: 3,800 Kcal/kg)

63,600 x 10^6/0.88/3,800 = 19,020 tons/year

—Fuel cost of the above (Coal price : US$25.5/ton)

US$25.5/ton x 19,020 tons/year = US$485,000/year

—Operation cost of booster (Unit cost of purchased electricity US$0.051/KWH)

- Electricity consumed

700 KW x 0.8 x 8,760 hr = 4,900 MWH/year

- Electricity cost

US$0.051/KWH x 4,900 = US$250,000/year

- Repair cost US$3,220,000 x 0.025 = US$80,000/year

- Total operation cost US$330,000/year

—Depreciation (15 years)

- US$3,220,000 x 0.9/15 = US$193,000/year

—Interest payment

•US$3,220,000 x 0.08 = US$258,000/year

—Total annual expenditure

US$1,266,000/year

—Income by power generation

•US$0.051/KWH x 63,600 x 0.95 = US$3,081,000/year

—Comparison of income and expenditure

•The profit will be almost US$1,815,000 per year.

•Without implementation of this program, there will be insufficient steam supply for 60,000 KW power generation unless one unit of new boiler is installed at the mine. For the installation of one unit of new boiler, the investment required will be about US$20,000,000.

•Therefore, this program is of a very low investment cost.

(2) Estimation of Electric Power Consumption and Electrical Facilities for Modernization Program

1) Electric power consumption

As shown in Table 87 "Long Term Electric Power Consumption," the maximum power demand is 105,000 kW in 1993. However, with the increase of quantity of treated ores, the electric power consumption will increase to reach maximum power demand of 150,000 kW in 2008.

2) Electrical facilities to meet the increased demand

—The facilities from the substation to the 110 kV transmission line has capacity to accommodate the requirement up to the last year of the program.

—The power distribution facilities for the expansion of mineral processing and mining facilities such as construction of No. 6 plant have to be newly installed.

3) Power supply

—Two units of 30,000 kW generators are to be installed to solve the present unstable supply of power supply and to cope with the increased power demand for the time being.

In a long term, another one unit of 30,000 kW generator may be installed depending on the power supply conditions of Central Energy System.

Table 87

Estimation of Electric Power Consumption (Long Term) 93/09/03

	Feed ore	Minning	Mineral.p	Heat'g.s	Water	Tail'g.pu	misc.	Total	Average	Maximam
	kt	mwh	mwh	mwh	mwh	mwh	mwh	mwh	kw	kw
1993	20,500	14,350	533,000	25,700	153,750		51,000	777,800	88,790	104,459
1994	20,510	14,357	533,260	25,700	153,825	15,383	51,000	793,525	90,585	106,571
1995	20,993	14,695	545,818	25,700	157,448	15,745	51,000	810,405	92,512	108,838
1996	22,006	15,404	572,156	25,700	165,045	16,505	51,000	845,810	96,554	113,592
1997	23,000	16,100	598,000	25,700	172,500	17,250	51,000	880,550	100,519	118,258
1998	24,000	16,800	624,000	25,700	180,000	18,000	51,000	915,500	104,509	122,952
1999	25,009	17,506	650,234	25,700	187,568	18,757	51,000	950,765	108,535	127,688
2000	24,835	17,385	645,710	25,700	186,263	18,626	51,000	944,683	107,841	126,871
2001	25,213	17,649	655,538	25,700	189,098	18,910	51,000	957,894	109,349	128,645
2002	25,213	17,649	655,538	25,700	189,098	18,910	51,000	957,894	109,349	128,645
2003	25,440	17,808	661,440	25,700	190,800	19,080	51,000	965,828	110,254	129,711
2004	26,997	18,898	701,922	25,700	202,478	20,248	51,000	1,020,245	116,466	137,019
2005	27,804	19,463	722,904	25,700	208,530	20,853	51,000	1,048,450	119,686	140,807
2006	27,804	19,463	722,904	25,700	208,530	20,853	51,000	1,048,450	119,686	140,807
2007	27,804	19,463	722,904	25,700	208,530	20,853	51,000	1,048,450	119,686	140,807
2008	29,238	20,467	760,188	25,700	219,285	21,929	51,000	1,098,568	125,407	147,538

Trial Calculation on
Possible Utilization of Exhaust Steam from Back Pressure Turbine of Erdenet Power Plant

Basis of Calculation

1. In order to maintain suitable heating in each area of the plant, the operation is done based on a table which indicates the standard values of the temperature at the outlet of the hot water supply facility and the return water under a certain outdoor temperature.
   The difference between the temperature at the outlet of supply facility and the temperature of return water under each outdoor temperature value based on this table is used for this calculation.
2. Based on the size of the existing piping, the quantity of hot water from Erdenet Power Plant is assumed to be 1,500 t/h.
3. The heat energy from the hot water is calculated from the above temperature difference and the quantity of hot water.
4. The quantity of steam is assumed to be 30 t/h based on the size of the existing piping and the heat energy is calculated based on this quantity.
5. For the trial calculation of heat energy feed program, the actual heat energy feed is used. This actual energy feed is the actual monthly consumption of the mine in the month when the sum of the above items 3 and 4 is higher than the consumption and the sum of items 3 and 4 in the month when this sum is less than the actual consumption.

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Ave.outdoor temp. ℃	-17.1	-14.9	-7.8	0.8	8.5	14.2	15.4	13.7	8.4	0.1	-7.9	-15.1	
Temp.difference sett'g ℃	50.3	47.1	35.6	27	19.6	0	0	0	19.6	27	35.6	47.1	
Heated waterflow T/H	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	
Heat energy of H.W Mcal/H	75,450	70,650	53,400	40,500	29,400	0	0	0	29,400	40,500	53,400	70,650	
Heat energy of steam Mcal/H	18,900	18,900	18,900	18,900	18,900	18,900	18,900	18,900	18,900	18,900	18,900	18,900	
Total heat energy Mcal/H	94,350	89,550	72,300	59,400	48,300	18,900	18,900	18,900	48,300	59,400	72,300	89,550	
Time (hours)	744	696	744	720	744	720	744	744	720	744	720	744	
Heat energy(capacity) 10^3Mcal	70,196	62,327	53,791	42,768	35,935	13,608	14,062	14,062	34,776	44,194	52,056	66,625	
Heat energy (consumotion) 10^3Mcal	73,628	71,906	59,586	47,818	43,141	34,030	13,056	21,263	30,550	51,306	62,653	74,424	
Actual heat energy (feed) 10^3Mcal	70,196	62,327	53,791	42,768	35,935	13,608	13,056	14,062	30,550	44,194	52,056	66,625	499,168

5-6-2 Water

(1) Investigation of Underground Water

At present, there are two water supply sources, which are water from Selenge River (2,400 t/hr. supply) and recycled water from tailing pond (7,800 t/hr. supply). The latter is entirely utilized for mineral processing and boiler water supply and the former is partly used in the plant and also supplied to Erdenet city as the only water source for civic consumption.

The water from Selenge River is pumped for a distance of 60 km to Erdenet city and for a head of 600 meters and for this pump operation, electric power of 10,000 kW (about 10% of total consumption of Erdenet Mine) is consumed.

If there is any trouble with the water supply system, it is anticipated that there will be a big influence not only to the operation of the mine but also the civilian life. To cope with such situation and also to save electricity, it is necessary to look for a second water source near Erdenet city.

Near Erdenet city, to north and to south, there are two rivers running southeast. (Fig. 59.) They are Hangal River and Chingirin River, both of which are branched from Orhon River.

Both areas are based on granite covered with 50 to 60 mm of drift and clay layers. There is a great possibility of this grit layer just above the bedrock forming the layer to hold the shallow underground water. In both areas, the quantity of underground water held, estimated from the catchment area (200 to 300 km^2) and the annual rain fall, is almost equal to the water supplied from the Selenge River.

With the above assumptions, it is recommended to explore underground water by the following procedures.

1) Collection and analysis of hydrological data such as flow of surface water and rain fall.

2) Then conduct an electro-magnetic exploration and analysis of bedrock and underground water passage. For this electro-magnetic exploration, a specific resistivity survey by Time-domain Electromagnetic (TEM) method is deemed to be effective.

3) After specifying the investigation points, drilling is to be conducted. In the drill holes, electrical logging and water injection test are to be conducted to analyze the underground hydrology such as electrical characteristics of the layer and permeability.

4) A simulation on water balance model including the pumping plan should be done after obtaining and combining the above data.

If the underground water quantity estimated from result of above calculation meets the present water consumption, it is recommended to study the possibility of underground dam construction to maximize the utilization of underground water.

The estimated investigation costs (excluding drilling cost) are as follows:

Labor cost	US$	80 thousand
Instruments		30
Traveling expenses		70
Miscellaneous		160
Total		340

(2) Intake and Transportation of Underground Water

The intake of underground water would be a large diameter drilled well.

It is recommended to use a pipe with integrated insulation as the water pipe to be buried underground in order to prevent freezing during winter. This is a new system widely used in the Western world and has following advantages.

—It can be laid for long distance without joints. There is only small leak of water because it has not joints.

—Sufficient strength can be maintained with the material polyethylene and in addition, it can minimize the depth to be buried. This material has no galvanic corrosion.

—The friction factor is small and the diameter of pipe can be minimized which results in low cost including the pipe laying cost.

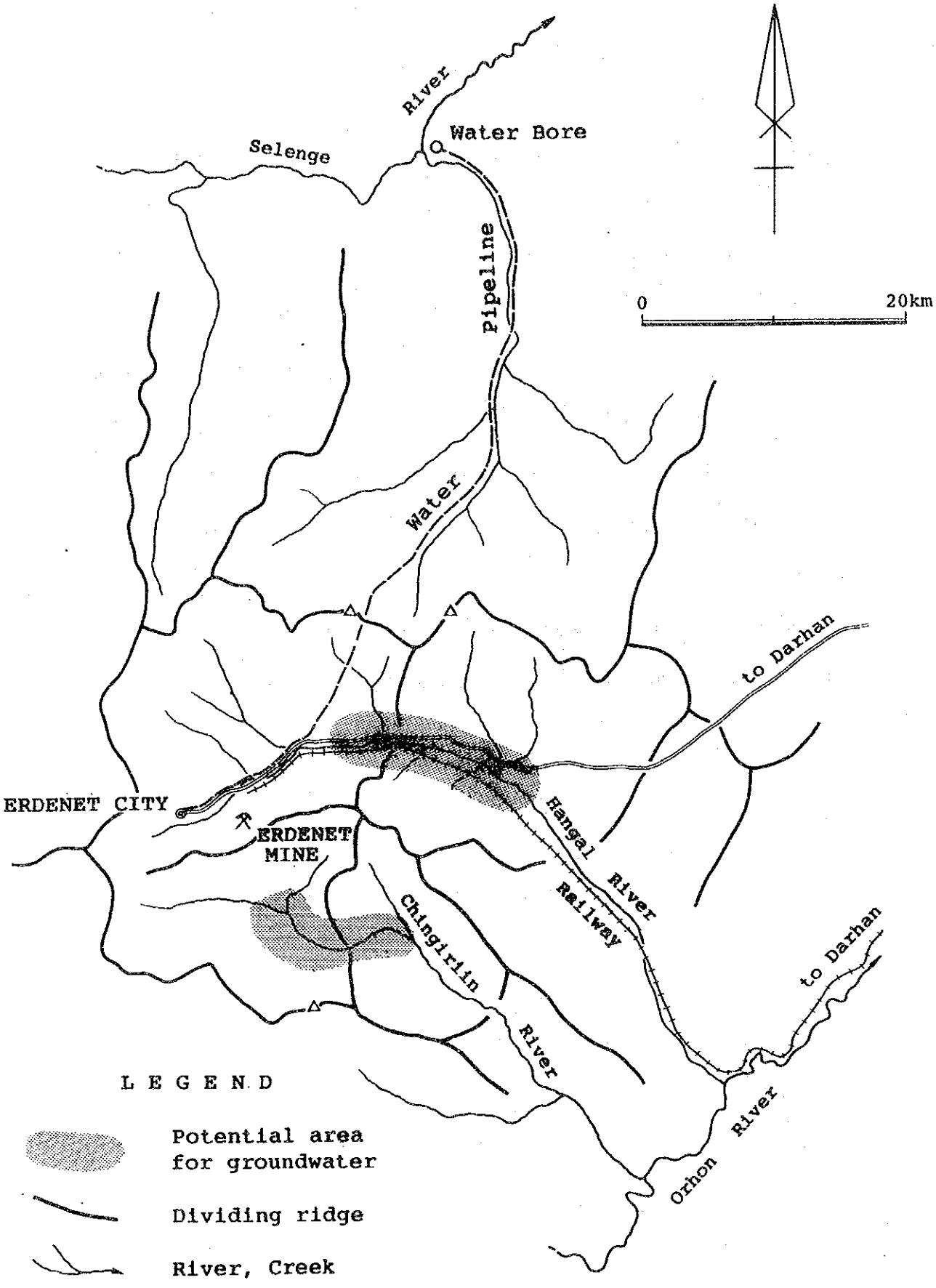


Fig. 59 Drainage System

5-6-3 Other

(1) Modernization of telephone exchanger

The existing cross bar type telephone exchanger is deteriorated and its spare part supply is also becoming difficult. Today, an electronics type digital telephone exchanger is becoming popular. For the modernization of information system, it is preferred to renew and modernize at an early stage.

The subscriber circuits of the existing exchanger is 600 which is insufficient. It is better to have 1,000 circuits with the adaptability to expand.

(2) Improvement of long distance and international calls

—The reason for long waiting time is lack of circuits and manual exchange. Further, it takes time for the payment and the major cause is the latter. The measure to solve this latter problem is the automation of telephone network. Fortunately, in August, 1993, there is a digital telephone exchanger installed at Ulanbaataar for international and long distance calls with the aid from Japan. If the exchanger and the payment system at Erdenet could be improved, a dial call from Erdenet will become possible. In other words, it could be automated. This measure belongs to the policy of Erdenet city but an early implementation is expected.

—Although it depends on the timing of the implementation of above measure, but for the modernization of Erdenet Mine, it is essential to improve the international call system. As an emergency measure, another way has to be studied and implemented. As one of the measures, the following is proposed.

Introduction of communication facility utilizing Inmalsat Satellite.

(Reason of proposal)

•The above satellite communication has already been installed at Tsav Mine in Mongolia with the aid from Japan in 1993 and can be installed easily.

•Not only the dial international call but it can also serve facsimile and other data communications.

•The Intersat station and international automatic telephone station were opened in August, 1993 at Ulanbaataar. By the coordination with this Intersat, a dial call is possible between Erdenet and Ulanbaataar.

(3) Maintenance and reinforcement of communication facility for truck transport control

The transport control of 50 units of ore transport truck is a key point. It is necessary to have communication facility with high performance.

5-6-4 Investment Necessary for Modernization

The equipment items and investment cost (before import and sales taxes) of Utilities are below shown. In view that, as stated before, the construction of 60,000 kw power station should be promoted as another national project and separately from this modernization plan, the corresponding cost, which amounts to US$77 million as shown below, is excluded from the total investment cost in evaluating the feasibility of the plan.

The investment in Utilities is, as shown in Table 88, US$4,907 thousand as financial cost and US$4,106 thousand as economic cost.

	Unit: Thousand US$
(1) 60,000 kW (30,000 kW x 2 units) Power Generating Facility	
1) Turbine, generator, substation, instrumentation and accessories	49,000
2) Construction of above	7,500
3) Cooling towers	10,000
4) Generator housing (Steel structure, floor area 2,500 m^2)	5,000
5) Transmission facility (Voltage 110kV, length 500 m, steel tower support)	1,100
6) Modernization of boiler instruments (Centralized control by a computer and upgrading of instruments in general)	4,400

	Total of (1)	77,000
(2)	Reinforcement of Hot Water Supply Facility from Erdenet Power Plant	
	1) Booster facilities	1,510
	(Hot water quantity 1,600 t/hr, pressure boosting 6kg x 2)	
	2) Electrical facility	1,080
	(Voltage 6.6 kV, length of wiring 2,500 m)	
	3) Pump house	200
	4) Instrumentation facility	430
	(Monitoring and pressure remote control facility)	
	Total of (2)	3,220
(3)	Modernization of Telephone Exchanger	600
	(Digital exchanger : subscriber circuits 1,000 telephone units 1,000)	
(4)	Installation of Inmalsat ground station	220
(5)	Reinforcement of Communication Facility for Truck Transport Control	66
	Total of (2) to (5)	4,106

Table 88 INVESTMENT IN UTILITIES

(US$1000)

ITEM	1994								1995								Total		
	Foreign Currency				Domestic Currency			Total	Foreign Currency				Domestic Currency			Total	Foreign Currency	Domestic Currency	Total
	Equip.	Trans.	Other	Sub-T	Insta.	Trans.	Sub-T		Equip.	Trans.	Other	Sub-T	Insta.	Trans.	Sub-T				
Hot Water supply Facility	800	68		868	200	12	212	1,080	1,400	119		1,519	600	21	621	2,140	2,387	833	3,220
Telephone Exchanger	495	42		537	55	7	62	600									537	62	600
INMALSAT Ground Station	200	17		217		3	3	220									217	3	220
Communication Facility	60	5		65		1	1	66									65	1	66
Economic Cost Total	1,555	132		1,687	255	23	278	1,966	1,400	119		1,519	600	21	621	2,140	3,206	899	4,106
Import & Sales Tax						421	421	421						380	380	380		801	801
Financial Cost Total	1,555	132		1,687	255	444	699	2,387	1,400	119		1,519	600	401	1,001	2,520	3,206	1,700	4,907

5-7 Business Management

5-7-1 Financial Control

(1) Accounting Method

The accounting method currently employed at Erdenet Mine is the method generally employed in such countries as Russia. It is a logical accounting method, and the accounts section apparently adheres to the principles and procedures of the method. Erdenet Mine has recently introduced computers to process some aspects of the accounts. However, if the mine intends moving into western markets and attracting foreign investors in the future, adopting an accounting method employed in western countries would appear to be essential.

Without doubt, the adoption of new accounting methods is important for the corporate management of Erdenet Mine. However, such important matters must be examined principally by the government rather than the mine, and new accounting methods should be introduced across the entire nation. If a situation arose in which different companies in Mongolia employed different accounting methods, confusion would result.

The accounting methods currently employed in western countries differ in detail from one country to another. Accordingly, moves are being made to standardize accounting systems internationally. We believe that Mongolia should bring its accounting system into line with these international standards, which have been supervised by an international accounting standards committee. When Mongolia does introduce a new system, it will be need to consult specialists from such organizations as accounting firms in western countries. All managers,

not just people in charge of accounting, will need to be encouraged to deepen their understanding of the accounting methods used in western countries.

(2) Foreign Currency Control

The foreign currency that Erdenet Mine earns from sales is needed by the mine for the purchase of materials, equipment and parts. At the same time, foreign currency is an important national resource for Mongolia, which depends on imports for most essential commodities and pays for them in foreign currency.

As stated above, 48% of the foreign currency earned by Erdenet Mine is being paid to the government, while Erdenet Mine is at liberty to put the remaining 52% to such uses as purchasing parts. This ratio is determined through annual consultations between the government and the mine. Careful considerations will need to be given to future consultations on this issue.

In any industry, a certain minimum reinvestment is necessary each year if production is to be maintained. Care should be taken to ensure that Erdenet Mine retains sufficient foreign currency to purchase materials, equipment and parts. Naturally, temporary circumstances may sometimes force Mongolia to leave Erdenet Mine inadequate foreign currency for reinvestment. However, Mongolia should avoid leaving Erdenet Mine too little money for reinvestment, or even none at all, over long periods; if this happened, an important source of foreign currency — namely, the mine itself— would dry up.

On the other hand, Erdenet Mine should not waste its valuable foreign currency. It does have, for example, unwanted materials and equipment. To avoid being left with dead stock, the entire company must continue to exercise care in placing orders for materials.

(3) Banking

The shortage of liquidity at banks with which Erdenet Mine has business relation which has become a problem, may be considered a temporary phenomenon resulting from confusion in the economy. However, no bank exists that has the capacity, by itself, to support a company like Erdenet, with its domestically outstanding performance. It seems, therefore, that dealings with several banks are necessary. Given the scale of the operation, it is preferable that Erdenet Mine do current business with about five leading domestic banks, at least.

5-7-2 Sales, Procurement and Inventory Control

In order to ensure that funds are applied more efficiently, it is necessary to improve the payment terms for purchased materials. At present, Erdenet Mine places one batch of orders a year, and the items ordered arrive in several deliveries in the course of a year. The mine is often asked to pay about 70% of total sum due in advance. This has placed a major financial burden on the business. Countries with which the mine places orders are numerous, and include Russia, the Czech Republic, Slovakia, China, Finland, Japan and Germany. The explanations for such large advance payments appear to be, in the case of companies in the former Soviet bloc, poor cash flow, and, in the case of Western companies, poor creditworthiness on the part of the mine.

The mine will have to change to a system of paying for goods on receipt. Import letters of credit should make this possible. If the mine can obtain import letters of credit from major overseas banks at which the mine has deposits, this will improve the credit rating of the business and the mine will be able to secure more advantageous terms of payment.

(1) Sales

Table 92 is a draft sales plan.

In the past, copper smelters in the former Soviet bloc needed a supply of concentrates from Erdenet Mine to meet the ore needs of that economic group. Former member nations of the Soviet Union will remain significant importers in the future.

However, copper is an international commodity, and circulates freely around the world. Undoubtedly, concentrates from Erdenet Mine will flow to

Asian countries, such as Japan and China, as well as other nations.

Two factors that will particularly compel exports to countries outside the former Soviet bloc, and to Asian nations especially, are production difficulties at smelters in Russia and Kazakhstan, which are expected to result from rising concern about environmental and safety issues as well as from aging plant, and delays in collecting payment for the concentrates in hard currency.

Over the long term, copper consumption is expected to increase in Asia, and the mine should not neglect this region.

In a free-market economy, the quality of concentrates is important. In particular, copper containing arsenic and mercury is unpopular for environmental reasons.

① Significant aspects of concentrate sales

Traditionally, base metal prices and demand have widely fluctuated in response to market conditions. The outbreak of war or labor disputes affecting leading mines has had an immediate effect on producers. It follows that, if Erdenet Mine wishes for stable management, it must secure reliable customers and smelters of custom ores.

The mine must therefore address the following issues:

— Meeting its obligation to produce a steady supply

— Ensuring consistent quality

— Observing international commercial practice in the settlement of payments for concentrates

Additionally, we recommend that the mine monitor transport in order to reduce losses of concentrates, contamination by foreign matter and other

problems.

② Negotiating conditions of sale

In negotiating selling conditions, it is not normal practice for one party always to secure an advantage. Conditions of sale are agreed between purchaser and vendor on the basis of the prevailing state of the market around the world. The mine must study the global standards after examining treatment charges (T/C), refining charges (R/C), and penalty factors and always observe them.

When Western nations draw up contracts for the sale of ore, they usually employ a method of reducing the impact of price fluctuations, namely hedging.

— Conclude a long-term contract, to run for about five years, for half the annual output of concentrates, and set conditions of sale, such as T/C and R/C.

— Once every two years, negotiate the sale of half the remaining output (one-quarter of annual output), setting conditions on the basis of the prevailing state of the market.

(2) Introduction of statistical inventory control

A shortage in inventory, such as parts for heavy machinery, causes a major impediment to production. The mine has experienced a fall in production because of delays in procuring parts.

However, excess inventory stretches available funds. The mine must effect inventory control on the smallest possible budget.

We should like to emphasize that at Erdenet Mine the most important factors in inventory control are knowledge of the frequency of withdrawal (i.e. use) of items from stock, and of the lead time between placing an order and taking delivery.

At the materials supply depot, a diverse range of materials, equipment, parts and so forth are appropriately categorized. Their codes, quantity in hand and location are already stored on computer. Adding the factors involved in drawing up orders would complete a statistical inventory program. Effectively, a statistical inventory control system is already partially in place.

If the mine relies heavily on the former Soviet Union economy bloc countries for supplies, it will be difficult to predict delivery lead times, and this is a matter for concern. It is therefore important to increase the number of suppliers whose lead times can be forecast, evaluate their delivery times, quality and prices and establish a system by which the mine will be able to select suppliers from tenderers.

If inventory in warehouses at production sites is controlled by a central computer at the materials supply depot, the system will be further strengthened, leading to a reduction in the quantity of dead stock.

As computers are already widely used at the mine, we should like to recommend that the mine consider more progressive computerized material requirement planning (MRP). MRP, which takes into account delivery times and the quantity of materials required, and results in several orders being placed, will achieve a reduction in the costs of materials purchased and an improvement in financial management and labor productivity in a free market economy. (Fig. 60)

The value of MRP is that it makes it possible to order items in such a way so as to avoid either shortages or excesses. Computers process a large amount of information on inventory movements. If Erdenet Mine manages to achieve economies and efficiencies in its use of foreign currency, this will release more

hard currency for other industrial sectors in Mongolia, which in turn will have a significant effect on the Mongolian economy.

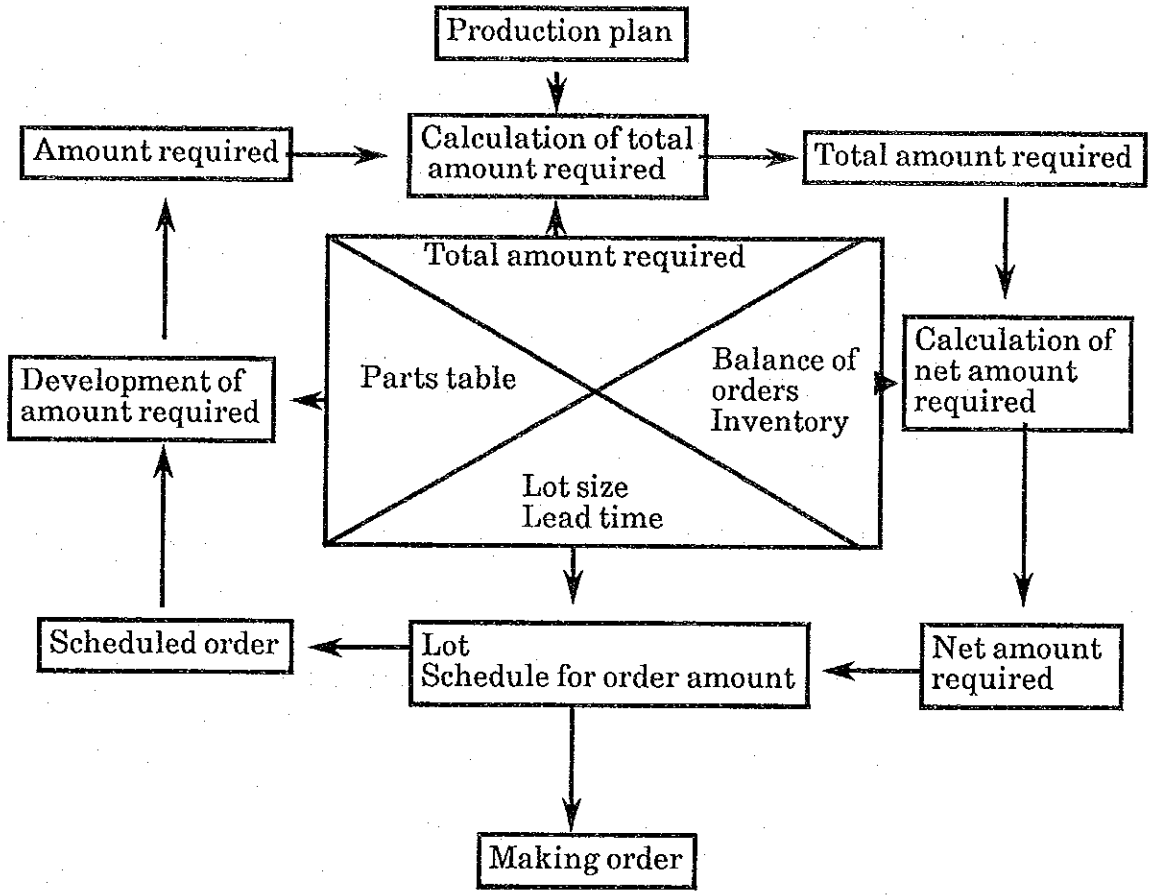


Figure 60 MRP Processing Flowchart

5-7-3 Organization, Personnel and Labor Management

(1) Improvement plan for organization

The development of Erdenet Mine created the third largest city in Mongolia on a once uninhabited plain, and established an economic zone based on a single mining city. A traditionally agricultural and stock raising region became involved in the mining economy. For Mongolia to adapt to modern social changes, such as the nation's shift to a market economy, we should like to propose that the mine examine a measure to expand its business operations by separating part of its operation and making it independent.

Basic guidelines for implementing plans to set up a separate company are as follows:

— The division that is separated and becomes independent must have autonomous management to suit its aims and objectives. The company must be profitable in the open market. Transactions between companies must take place at prevailing market prices.

— However, management policies must be drawn up by Erdenet Mine itself. This point should be observed.

— Employment conditions, salaries and personnel management must accord with the practices of Erdenet Mine. The new company must avoid the confusion that is liable to arise when it is founded. However, the new company must also introduce a system that passes on to managers and other employees the benefits of their performance. We recommend that Erdenet Mine introduce incentives that will give employees of the new company a sense of unity and an awareness of results.

— The separate companies must be privatized.

we should like to recommend the following specific measures:

① Make the livestock-related division independent

— Cattle farming is a traditionally plank in the Mongolian economy, and this is therefore an area in which Mongolia is strong. A separate company would expand this operation into a more industrialized livestock business.

— While maintaining steady supplies to employees of Erdenet Mine, which is the company's original term of reference, the new company would promote sales of its products to other customers.

— The new company should make possible a modern lifestyle, to replace the traditional Mongolian nomadic way of life, with, for example, solar housing and modern communications. It should make available the tools of a civilized way of life without destroying traditional culture.

② Make the closing factory independent

— There is a large demand for clothing among the general population.

— As Mongolians acquire a new sense of values, their tastes in clothing will diversify. The independent company would, as part of its management, employ designers to produce clothes based on new concepts. The focus would have to shift from quantity to quality.

— The separate company would increase the participation of women in the workforce, and make effective use of part-time workers. The new company would draw on excess labor in neighboring areas. In these ways, the company would be able to reduce costs.

③ Make the construction group of the building and repairs division

independent

— If Erdenet Mine implements its modernization plan, it will be investing in an increased number of construction projects.

— The city of Erdenet is expanding, and demand for both buildings and improved infrastructure is expected to grow. The new company would be able to expand its business to meet this new demand.

— Erdenet Mine is distinguished among Mongolian domestic companies for its experience in the use of heavy construction machinery and in maintenance, design and related fields. The new company would be able to draw upon the resources of other divisions of Erdenet Mine. It would have the potential to grow into an organization offering a comprehensive range of construction services.

— The new company should have the goal of ultimately becoming a construction business serving the entire nation.

④ Separate the daily necessities supply service as an independent distribution or retail company.

— Erdenet Mine has a reliable system for supplying materials, which operates efficiently. Using the expertise accumulated within the company, the new company would expand beyond Erdenet into other cities.

— It would be effective if the new company used a network of import and export operations, information from overseas offices and special arrangements with distributors.

— By acquiring expertise in the service industry, in which experience is lacking in Mongolia, and anticipating market changes, the new company would be able to expand its operations in the future.

We should like to propose that the above four divisions are separated as separate companies, and privatized.

A number of measures might be adopted for the shareholding of capital in the new companies. For example, Erdenet Mine itself could hold a minimum 51% stake, with the balance of ownership in the hands of individual employees, companies in the city and companies within the same corporate group. These new companies must, as they grow, observe the management policies of Erdenet Mine and the targets set by the group of companies. At the same time, the new companies must grow in competition with one another on free market principles.

(2) Improvements in personnel control and labor-management control, including salaries

It is important to combine adequately the application of management resources and vision to the management of companies.

Management resources include people, goods, money, information, time and technology. The most important of these are human resources and wages policies.

Based on the present situation, questions of personnel and labor-management relations to which Erdenet Mine should now attend include:

— Obtaining the highly skilled staff needed for its operations

— Creating conditions that will attract first-class new staff to the mine and attract first-class engineers to remain with the company for long periods

— Eliminating all unnecessary impediments to the deployment of staff in accordance with production targets and management goals; promoting greater circulation and leveling of staff between divisions; allocating surplus personnel to

new businesses (i.e. divisions which are formed into separate companies). Appropriate deployment of staff is the first step towards achieving a reduction in costs.

We should like to make the following specific proposals for achieving the above:

① Centralize personnel and labor-management administration, to facilitate total control.

Designate the staff personnel sections as general staff and administer centrally such matters as employment, dismissals, promotion, overseas study, pay and labor conditions.

This move is expected to result in appropriate deployment of staff, fair evaluation of individual employees' ability, greater movement of personnel between divisions and appropriate staffing over the company as a whole. Existing personnel sections at production sites should remain. This division must come within the general staff framework. At the same time, the division must accept recommendation from production sites. A matrix organization (two line manager system) must be employed only in this division. While building on the strengths of the current organization, overall divisional control by general staff must be strengthened. The general staff should deal with the wage system and aim at centralization of the wage and personnel systems.

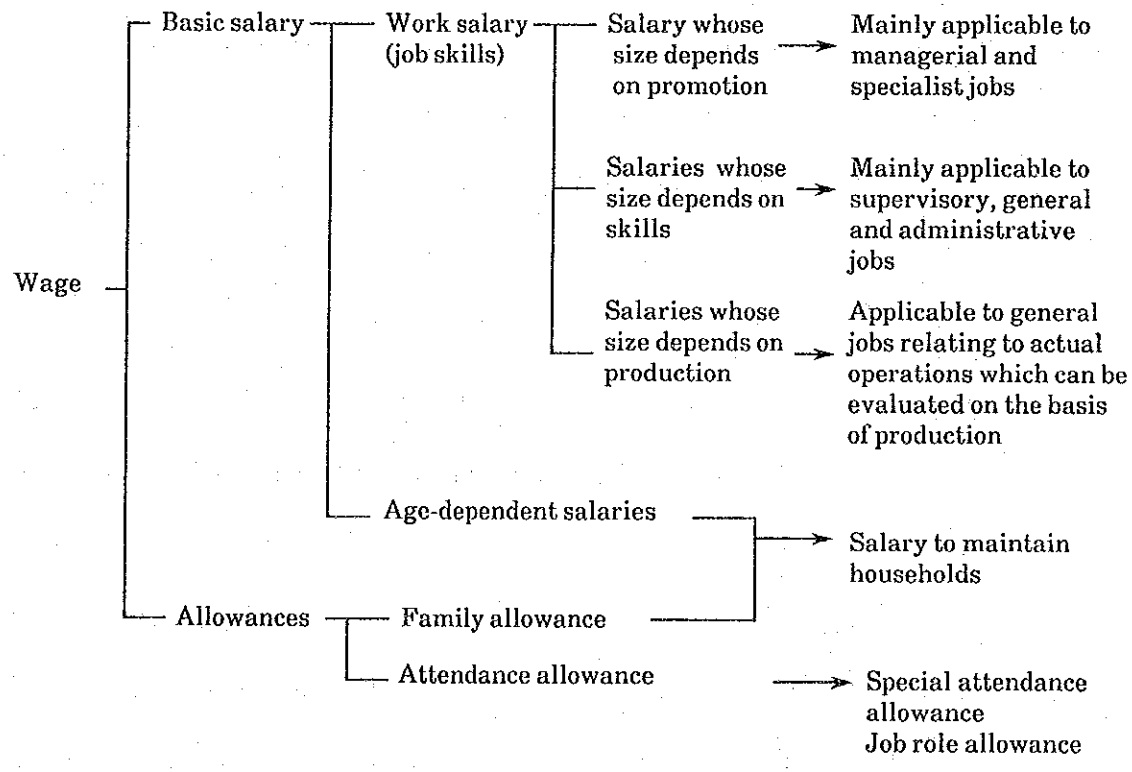
② Proposals for the revision of the wage system

Wages are the means of livelihood for workers. Maintenance of adequate wage levels is vital. This is an important aspect of a company's production costs, and strict control is therefore necessary.

Revising, and in particular standardizing, wages at Erdenet Mine will have a major impact on other industries in Mongolia. The issue must therefore be handled with care. We cannot make proposals for specific wage standards or wages for each job skill. We should like to offer one basic system that might serve as a reference model for Erdenet Mine in designing its wages system.

— A specimen model of a wages system

It is preferable to adopt a simple, logical wages system that satisfies both the principle of wages having a value equivalent to labor and the principle of wages providing a livelihood. the factors to be used in determining the salary for each job must be determined for each job cluster on the basis of an analysis of each job.



On the basis of this job function analysis, a job function criteria table, job

skills table, promotion criteria table, production evaluation criteria table and so forth should be prepared. For example, the job skills table must cover all job groups (control, supervision, specialization, general jobs etc.). On the vertical axis should be job skill levels graded 1-10), and along the horizontal axis titles (1-10 or 15 titles, depending on the years of skill). Tables may have 100-150 ranks.

— Determination of basic pay (job rate + pay for age)

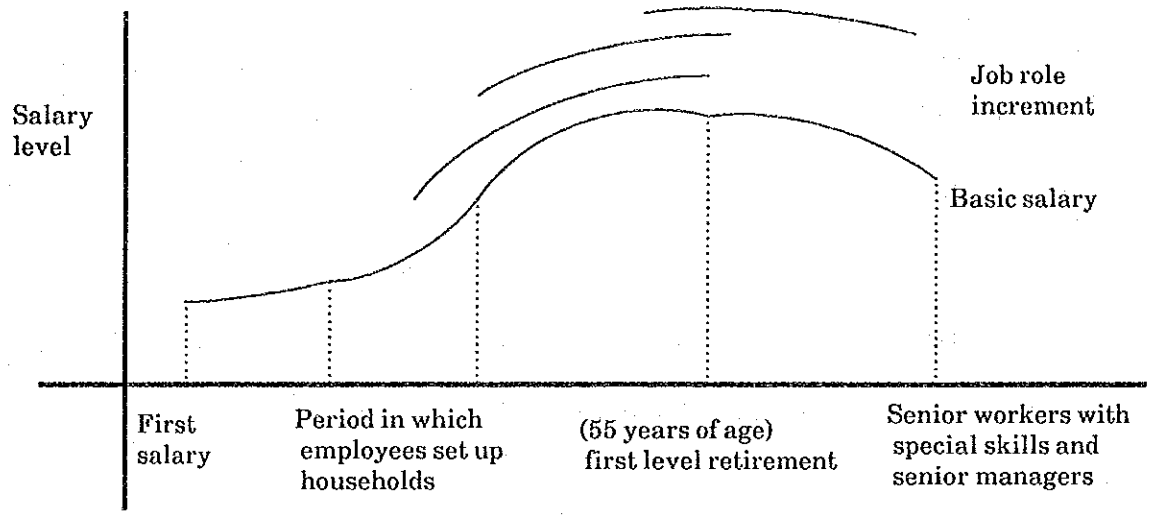
The basic pay rate comprises a job rate and an age component.

When an employee sets up a household, expenses are incurred in establishing his or her lifestyle. It is also natural that there should be a difference in salary between young and middle-aged workers. In determining salaries, the age component figures significantly for young employees. On the other hand, it is better to establish a variable pay scale to reflect skill for middle management and instructor positions, and variable scales depending on promotion for management and specialist positions.

When it is difficult to correct differences in age or experience through this basic pay (job rate + pay for age), a job role increment is added to the basic pay rate.

The job role increment is aimed mainly at managers. However, it should not be a salary that simply reflects the difference between categories of jobs. The job role increment should take into consideration an assessment of results, tertiary educational qualifications and so forth. production-dependent salaries apply in locations of production operations, where output can be quantified. It is important to add meaning to the pay rate by making it both remuneration for results and an incentive to greater productivity, and not merely remuneration for

achieving a target output.



— Study of theoretical livelihood expenses

In drawing the curve of promotion of basic salary, it is necessary to secure minimum living costs at each age.

Amidst the political, economic and environmental changes, it is necessary to study theoretical living costs, so that new inequalities do not arise.

(3) Education and staff training

① Education and training

The most important factor in resource management is obtaining staff. It is essential to train staff, and accumulate the human resource capacity to achieve company targets.

Education and training must involve not only the education of workers directly involved in operations, but also the education and training of staff in senior positions, such as managers and supervisors. Staff training should include the following:

— Improving skills → general skilled workers, administrative staff

— Improving managerial and supervisory capacity, to ensure cooperation among workers → middle managers and supervisors

— Improving managerial capacity for supervising the overall operations of the organization → senior managers and administrators

② Setting up a training center for workers with special skills

Engineers should, in principle, be university graduates. Recruiting engineers from the former Soviet Union used to be relatively easy, but we hear that that has now changed.

The education system in Mongolia has been changing since 1990. It is not easy to obtain first-class young staff within the country.

Mining technology has advanced, with the introduction of new heavy machinery, computers and so on. In addition, new staff are needed in such areas as management technology, to enable Erdenet Mine to participate successfully in the market mechanism.

For Erdenet Mine to train its own workers in order to meet these needs, we propose the establishment of a training center for workers with special skills. Our suggestion includes the following proposals:

— Specialist fields: about 20 workers; geology, mining, mineral processing, machinery, electricity, civil engineering, finance, management etc.

— Curriculum: in a two-year program, workers will acquire language and computer skills in addition to a more general education.

— Educational policies: training will be not only for workers who are well versed in specialist fields at Erdenet Mine, but also for staff of other companies in

the Erdenet group and from the city of Erdenet. These workers will be sent to study overseas.

— Obligations on completion of training: on completion of their training, these workers will be assigned to the sites of actual operations. They will be transferred to other workplaces as the need arises, and thus accumulate experience.

— Expected side effects: training will foster company loyalty. While trained workers will be pursuing their individual careers, communications between them will become facilitated. This will create a friendly environment in which communications will improve between divisions and sections.

5-7-4 Privatization

With Mongolia shifting, as a country, to a market economy, privatization is very important. As already mentioned, considerable progress in this regard has been seen, mainly in medium and small companies. Here, we should like to consider privatization of Erdenet Mine as one measure to improve management of the mine.

(1) Method of privatization

Privatization by the coupon method is intrinsically effective. This method, which has been used in Mongolia and several other former Soviet bloc countries, involves transferring state-owned companies to citizens free of charge. It has achieved a certain measure of success. However, privatizing a huge company like Erdenet Mine by the same process would have a major impact on the nation's finances. It would also raise fears of accelerated inflation. Privatization by the coupon method is therefore difficult to contemplate.

Privatization through the government acquiring sales revenues is the most realistic option. One practicable method would be to make the targeted companies into joint shareholding companies, and release their shares gradually onto the stock market.

Possible purchasers of these shares are Mongolian citizens (domestic capital) and foreigners (foreign capital). The sale of shares to foreigners would lead to the introduction of foreign capital into the relevant business. The matter therefore requires careful examination. This problem should also be considered from the perspective of other issues, such as the importance of the companies to the nation and future development policies.

Unless new mines are to be opened, it is difficult to imagine the sale to overseas interests of a mine such as Erdenet Mine, which has achieved successful management and development. The most realistic option for Erdenet Mine, therefore, is the sale of shares in the mine to Mongolian citizens.

(2) Conditions for successful privatization

For the successful privatization of a large company such as Erdenet Mine, we consider the following conditions essential:

① The establishment of a fully functioning domestic stock market

② An adequate accumulation of domestic capital

③ The development of a domestic banking system

The medium of sale of shares to citizens, namely the stock market, must be functioning satisfactorily. Moreover, citizens must have accumulated enough capital to purchase the shares and, if they have not, there must be a banking system capable of providing the necessary capital from its own financial resources.

In recent years, Mongolia has established a stock exchange and implemented banking reforms. the nation's economic foundation has accordingly improved. However, it seems that it will take a little while for the national economy to fulfill these three conditions.

(3) Our proposals for privatization of Erdenet Mine

As mentioned above, given the current state of the Mongolian economy, it will take some time for the financial environment to allow the privatization of Erdenet Mine through sale of shares. In practice, therefore, it is not yet possible to privatize large companies like Erdenet Mine.

If privatization were forced on the company under current conditions, shares would be forcibly sold. This would lead to a fall in share value and, therefore, the value of the company would significantly fall. It must be understood that, in a market economy, the value of a company is determined by the share price on the stock market, no matter what figure a preliminary asset evaluation has arrived at. Even in Japan, where there is a major stock market, shares in large companies are carefully released in stages, as happened when NTT was privatized, with consideration paid to the effects of releasing these shares onto the stock market. The privatization of NTT could provide a good case study of the privatization of huge companies like Erdenet Mine.

In the light of the foregoing, we should like in conclusion to propose a partial, not total, privatization of Erdenet Mine. In the preceding section, 5-7-3, we put forward proposals for the separation of four divisions (livestock, closing, construction, and other) and their establishment as separate companies. We advise privatizing these four companies, and carefully monitoring the market, with a view to the eventual privatization of Erdenet Mine itself.

(4) Significant aspects of privatization

With privatization, it is usual to look rigorously for improved efficiency. It frequently happens that staff numbers decline. If the privatization of Erdenet Mine led to unemployment, the city of Erdenet would find it difficult at present to employ the unemployed workers. Any privatization must therefore be preceded by suitable measures, such as redeployment of staff, to prevent large numbers of workers becoming unemployed.

Furthermore, the interests of different social groups in privatization

conflict with one another. Before privatization, it is essential that the process be examined by representatives of different social groups, such as government, management and labor union. Privatization must take a form that will be beneficial for everyone concerned.

5-7-5 Other

(1) Introduction of QC circle activities

Workers on the front-line of production processes possess skills and knowledge about the operations of facilities and production systems. However, they tend to be unaware of problems because they are bored with the monotonous repetition of operations (although it was this repetition that made them skilled) and being involved in only a limited range of tasks each day.

For example, if we look at the loading of ore in open cut mining, shovel operators, truck drivers and road repair workers are each responsible for carrying out a single process in close cooperation with each other. The individual operations are monotonous, however, and also involve a certain, constant amount of tension. If problems are caused by lack of attention, the damage will be great. If the penalty is large, it will cause a deterioration in worker morale thereby lead to a decrease in efficiency.

Quality control (QC) circle activities encourage workers to discuss daily small steps which groups of a few workers can take to improve their tasks. This will improve the efficiency of the overall process and is designed to have a greater beneficial effect on product quality.

QC circle activities comprise one control method which has succeeded in eliminating the monotony from operations, while making the most of allocated operations, and encouraging workers to develop pride as technicians and awareness about their responsibilities. This is sure to improve product quality and safety.

(2) Rationalize design using computers

The Engineering Design Division's main tasks include designing new facilities within the mine, producing drawings for renovation and improvement and producing quantity charts. To assist in these tasks, we would like to propose that a computer-aided design (CAD) system be introduced.

The division is responsible for a broad array of design work, in a wide range of fields, including construction, civil engineering, machinery, electricity and pit design. To complete designs in each of these fields manually is to be behind the times.

Computers today are user-friendly tools used in virtually every industry. CAD systems are often used for drawing. Some examples of the functions and characteristics of CAD systems are:

- They allow easy and accurate drafting based on hand-drawn plans.
- It is possible to synthesize more than one drawing, allowing designers to do more creative work.
- Design revisions can be input into the quantity chart as data for quick processing.

As the above examples show, CAD systems improve the productivity of a range of design operations, including the drafting and production of quantity charts. The quality of drawings are accurate and tidy to look at. Such systems are therefore vastly superior to plans drawn manually. The drawings can be also be stored on floppy disks.

When we examine the capabilities of CAD systems, the introduction of two CAD units to the Engineering Design division will enable the division to carry

out operations that would take about 15 personnel to complete by hand.

The CAD systems will also produce markedly superior end results, in the selection of applications, the set up of large drawing plotters and color printing. At present, we have no information on models which use Mongolian or Russian displays. If we may be permitted to recommend an English version, we would suggest Auto CAD Release 12J.

Training in the use of CAD should only take between three and six days if the trainee has basic computing knowledge. We would like to recommend either that the mine sends trainees to the supplier or that Erdenet Mine invites trainers to provide instruction.

The estimated costs of CAD system are as follows (Table 89):

Table 89 Cost of CAD system (US$1,000)

Items	Quantity	Amount
Personal computer main frame	2	18
Color display	2	10
Software	2	17
Plotter	1	9
Accessories	1 set	3
Subtotal		57
Transport charges		3
Total (economic cost)		60
Import and sales taxes		15
Final total (financial cost)		70

(3) Fringe Benefits

Fringe benefits can be defined as health insurance and employee pension insurance — which are both national systems — as well as employee housing, medical care, insurance, work uniforms, as well as cultural, sports and recreational facilities, all of which, in the West at least, the company provides.

Welfare means that when the national policies are lacking, the company provides supplementary benefits to compensate for the low salaries. In this regard, the environment of Erdenet Mine enjoys substantial advantages over other regions as the Mine offers significantly better welfare than other regions.

Although the Mongolian economy is expected to experience temporary chaos, it will stabilize in the future and achieve growth. If employees' sense of value diversify, fringe benefits will cover not only material benefits but also insurance and lifelong benefits. Some examples of such fringe benefits include:

—For a safe and healthy and life →Good health is essential if employees are to do their jobs with a feeling of security.

To ensure this, the Mine should implement regular medical checkups for all employees and their families for the purposes of medical control. The mine should also provide education on public health.

— For asset formation and life planning → In order to assist in life planning while employees are still working for the mine, the mine should encourage employees to save and should also institute an employee stock-sharing plan.

— In order to ensure a comfortable life after retirement → In combination with the nation's pension scheme, the mine should set up comprehensive lifelong

welfare policies including an industrial pension scheme, and a post-retirement medical insurance system.

— To promote a company culture → The mine should help set up sports clubs. The mine should also create a strong unity among employees through international and external activities.

However, we would like to add that excessive protection of employees may result in increased risk for management.

5-8 Modernization Implementation Plan

The modernization plan principally comprises Erdenet Mine's 15 year, long-term production plan. We also proposed rationalizing processes and expanding and modifying equipment and facilities.

However, this is merely one of the several alternative production plans.

The mid- and long-term management plan focuses on the company's strategies. Therefore, when it comes to the actual investment, Erdenet Mine should select items which the mine gives high priority to, while maintaining a strong grasp of cash flow, such as the mine's profitability and the procurement of funds. The modernization plan is divided into two items: items which should be urgently taken and those that should be taken based on long-term strategies, as described below.

5-8-1 Investment Plan and Schedule

(1) Matters which should be implemented urgently

① Satisfy electricity demand

To do this, the mine should take the following measures:

— Construct a power generation station at Erdenet Mine.

The mine itself would receive priority for the electricity generated there.

— The scale of the power generation station would be 60,000 kw.

— In building the power station, take fund procurement and national energy policies into account by choosing either to make the plant exclusively for the benefit of Erdenet Mine or having Erdenet Mine buy electricity from the station as part of the energy system. Therefore, the cost of power station construction is not included in this investment plan.

② Eliminate shortages in equipment, materials and parts.

— Return the production of equipment, materials, and parts made locally at Erdenet Mine to normal levels.

To do so, invest in improving the workshop.

— Sort out priorities given to each imported item and carefully control the allocation of funds.

③ Prevent skilled workers from retiring.

— In order to hold on to vital human resources, it will be necessary to improve employment conditions and expand job function or improve treatment to different standards.

④ Avoid shortages in foreign and domestic currencies.

As purchased parts will be often be paid for in dollars, the government's

allocation of foreign currencies must be adjusted.

Discuss the selection of such systems as fund payment systems with domestic financial institutions in order to avoid delays in payment and other unnecessary problems.

⑤ Guaranteeing safety in the workplace.

Preventive measures against occupational diseases must be drawn up. The mine must take, as an urgent stopgap measure, steps to prevent workers from absorbing fine dust by distributing masks.

(2) Items implemented based on long-term strategies.

① Renew production facilities

— When antiquated equipment or equipment whose effective life has passed continues to be used, production will be impeded. For example, breakdowns will cause a loss in production, the cost of parts' acquisition will increase and a greater number of repair staff will be required. This situation must be revised.

— In renewing mining-related machinery, rely chiefly on large western models and reduce the total number of units.

② Invest in additional facilities and rationalization.

— Improve the capacity to meet increased processing at mineral processing facilities.

— Introduce new items to the workshop, such as VRH and machine tools equipped with NC functions.

— Enhance communications facilities (INMARSAT)

— Increase the number of computers (CAD systems, etc.)

③ Upgrade test, research and analysis facilities.

— Upgrade the central laboratory facilities.

This will enhance support systems for mineral research, environmental measurement, quality control and other functions.

④ Take measures to reduce energy consumption

— Explore a second source of water supply in the area neighboring Erdenet with an aim of reducing the amount of electricity used and energy costs.

The study for this second water source should be implemented as a project with overseas assistance.

⑤ Investment in environmental conservation

As a measure to prevent air pollution, set up a Cottrell precipitator for the boiler flue gas. However, the investment required is large, so that this project must be implemented in line with the construction of the power generation station.

⑥ Improvements in control, organization and other areas.

— The plan to set up separate companies must be implemented while maintaining a balance with management status and the privatization program.

— Reorganizing the company will require no additional funds.

Reorganization should be implemented after agreement has been obtained from all divisions and sections concerned and by choosing the time when the effects will be clearly felt.

⑦ Establish a training center for skilled workers.

(3) Schedule

Fig. 61 and Table 90 show an investment implementation plan and a list of investment items. The amount is a total, and includes transportation charges for machinery and equipment purchased from abroad.

In implementing the modernization plan, a focus should be placed on fund-raising for the investment required in the first two years. As self-financing for that purpose seems not to be sufficient to cover the required amount of capital, the Erdenet mine will have to ask for the assistance from international financial agencies. The modernization plan must be implemented as quickly as possible, because the delay in initiating the plan means so much lowering of the mine's capacity to make such investment.

Figure 61 INVESTMENT IMPLEMENTATION PLAN
(1) MINING and MINERAL PROCESSING

ITEM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1. Mining Machinery (Purchase/Renewal)															
Rotary Drill	4 units			1				4			1				4
Power Shovel	4 units			1											
Bulldozer	1 unit	8	2	3	1		8	3	4	2	2	9	4	4	2
Motor Grader	3 units				4				4				4		
Dump Truck	10 units	3	3	7	1	10	3	5	9	3	12	4	5	9	3
2. Mineral processing(New installation/Reinforcement)															
Crushing															
Renewal of Cone Crusher			═══	═══											
Grinding															
AG Mill/Ball Mill of No.6 Sec.					═══	═══									
Process water for AG Mill					═══	═══									
Renewal of Ball Mill(No.1-No.4)							═══	═══							
Flotation															
Inst. of No.6 Section	═══														
Renewal of No.1-No.4		═══	═══	═══	═══										
Expansion of No.5						═══									
Filtering & Drying															
Ceramic Filter	═══														
Reinf. of Compressor		═══	═══	═══											
Crane	═══														
Waste Treatment															
Reinf. of Slurry Pump			═══	═══											
Step Banking of Waste Dam			═══	═══											
Water Reclaiming															
Recl. Water System	═══														
Pipe			═══	═══											
Miscellaneous															
Reagent Storehouse	═══														
Lime Handling Equip't	═══														
Lime Storehouse	═══														
Research Apparatus	═══	═══	═══	═══											

Figure 61 INVESTMENT IMPLEMENTATION PLAN
(2) UTILITIES·WORKSHOP·OTHERS

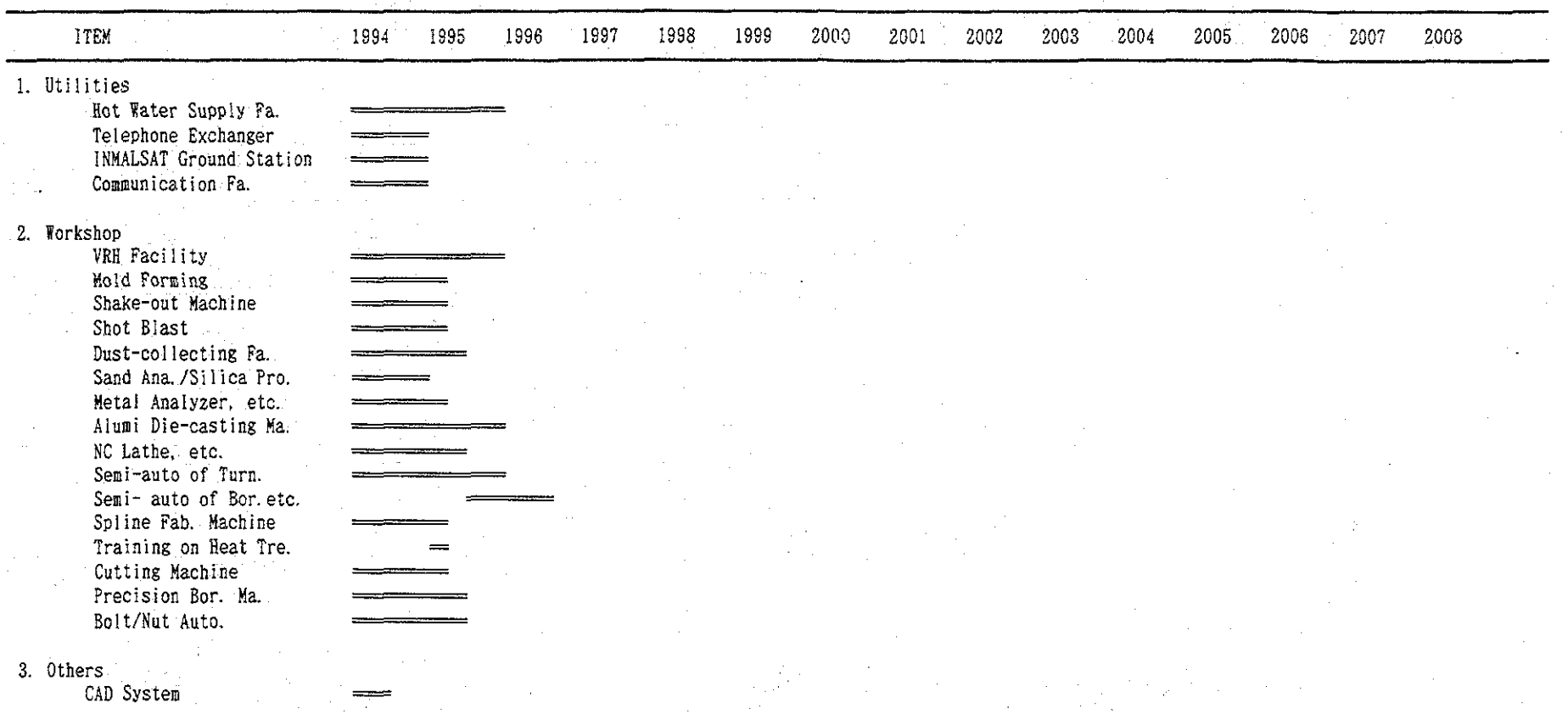


Table 90 LIST OF TOTAL INVESTMENT COST (1)---MINING AND MINERAL PROCESSING

(US$1000)

ITEM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
1. Mining																
Rotary Drill	5,276			1,319	1,583			5,672			1,319	1,583			5,672	22,424
Power Shovel	21,844		5,461	5,461	6,553		1,638	1,638	6,553		1,638	1,638	6,553		1,638	60,615
Bulldozer	529	3,439	814	1,343	1,384	651	3,622	1,343	1,750	1,791	1,180	4,151	1,465	1,872	1,913	27,247
Motor Grader	966		290		1,288		386		1,288		386		1,288		386	6,278
Dump Truck	14,258	5,746	4,032	13,440	2,554	14,650	6,954	7,123	16,128	5,272	18,144	9,005	7,930	16,934	5,645	147,815
Total(economic cost)	42,873	9,185	10,597	21,563	13,362	15,301	12,600	15,776	25,719	7,063	22,667	16,377	17,236	18,806	15,254	264,379
Import & Sales Tax	10,546	2,259														12,805
Total(financial cost)	53,419	11,444	10,597	21,563	13,362	15,301	12,600	15,776	25,719	7,063	22,667	16,377	17,236	18,806	15,254	277,184
2. Mineral Processing																
Crushing																
Cone Crusher Renewal			3,000	1,200												4,200
Grinding																
AG, Ball Mill for No.6 Sec.					500	1,600										2,100
Process Water					500	370										870
No. 1-4 Ball Mill renveal							2,100	2,100								4,200
Flotation																
A. Mo/Cu Separation																
No.6 section	6,100	4,200														10,300
No.1-4 Renewal		1,100	1,100	1,100	1,100											4,400
No.5 expansion						220										220
B. Bulk																
No.6 section	4,154	2,859														7,013
No.1-4 Renewal		837	837	837	837											3,348
No.5 expansion						150										150
Filtering																
Ceramic Filter	2,000	750														2,750
Compressor Reinforcement		1,200	1,000	631												2,831
Crane for Concentrate	500	331														831
Waste Treatment																
Slurry Pump Reinforcement			1,330	340												1,670
Waste Dam Step Banking			600	600												1,200
Water Reclaiming																
Reclaim Water System	1,630	500														2,130
Reclaim Water No.3 Pipe			1,000	671												1,671
Miscellaneous																
Reagent Storehouse	100	740														840
Lime Handling Equipment	330															330
Lime Storehouse	25	75														100
Research Apparatus	300	200	100													600
Total(economic cost)																
A. Mo/Cu Separation	10,985	9,096	8,130	4,542	2,100	2,190	2,100	2,100								41,243
B. Bulk	9,039	7,492	7,867	4,279	1,837	2,120	2,100	2,100								36,834
Import & Sales Tax																
A. Mo/Cu Separation	2,135	1,690														3,825
B. Bulk	1,751	1,377														3,128
Total(financial cost)																
A. Mo/Cu Separation	13,120	10,786	8,130	4,542	2,100	2,190	2,100	2,100								45,068
B. Bulk	10,790	8,869	7,867	4,279	1,837	2,120	2,100	2,100								39,962

Table 90 LIST OF TOTAL INVESTMENT COST (2)---UTILITIES, WORKSHOP AND OTHERS

(US$1000)

ITEM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
1. Utilities																
Hot water Supply Facilities	1,080	2,140														3,220
Telephone Exchanger	600															600
INMMALSAT Ground Station	220															220
communication Facilities	66															66
Total(economic cost)	1,966	2,140														4,106
Import & Sales Tax	421	380														801
Total(financial cost)	2,387	2,520														4,907
2. Workshop																
VRH Facilities		3,285														3,285
Mold Forming	233															233
Shake out Machine	272															272
Shot Blast	480															480
Dust Collecting Facility	1,004															1,004
Sand Analyzer/Silica Program	66															66
Metal Analyzer, etc.	440															440
Alumi Die Casting Machine		1,372														1,372
NCLathe, etc.	1,639															1,639
Semi-Auto. of Turning Table		743														743
semi-auto.of B.Machine, etc.			800													800
Spline Fabricating Machine	400															400
Training on Heat Treatment		54														54
Cutting Machine	160															160
Precision Boring Machine		937														937
Bolt/Nut Auto- Fab. Machine		457														457
Total(economic cost)	4,694	6,848	800													12,342
Import & Sales Tax	1,038	1,388														2,426
Total(financial cost)	5,732	8,236	800													14,768
3. Others																
CAD System	60															60
Total(economic cost)	60															60
Import & Sales Tax	15															15
Total(financial cost)	75															75
Gran Total																
Economic Cost																
A. Mo/Cu Separation	60,578	27,269	19,527	26,105	15,462	17,491	14,700	17,876	25,719	7,063	22,667	16,377	17,236	18,806	15,254	322,130
B. Bulk	55,632	25,665	19,264	25,842	15,199	17,421	14,700	17,876	25,719	7,063	22,667	16,377	17,236	18,806	15,254	317,721
Financial Cost																
A. Mo/Cu Separation	74,733	32,986	19,527	26,105	15,462	17,491	14,700	17,876	25,719	7,063	22,667	16,377	17,236	18,806	15,254	342,002
B. Bulk	72,403	31,069	19,264	25,842	15,199	17,421	14,700	17,876	25,719	7,063	22,667	16,377	17,236	18,806	15,254	336,896

5-9 Recommendations on Pollution Control and Working Environment Improvement

The measures which are deemed best at the present stage to solve the problems which were pointed out based on the diagnosis inspection of Chapter 4-6 are explained below.

Further, the measuring and analysis system which will be the basis for the pollution control and environmental improvement with the preparation of required equipment is referred to in paragraph 5-9-5.

5-9-1 Air Pollution Control

(1) Dust removal from boiler exhaust gas

The major components in the exhaust gas from the coal burning boiler are SiO_2, FeO, CaO and other elements, with minimal content of hazardous heavy metals. Therefore, the dust concentration limitation for a boiler of 150,000 m^3/hr. capacity in Japan is less than 250 mg/m^3.

Normally, dust removal from the exhaust gas from a coal burning boiler in Japan is done by a dry type electrostatic precipitator (ESP) installed immediately after the boiler and the gas is deducted to less than 100 mg/m^3.

At Erdenet Mine where a standard Russian type boiler is used, a venturi scrubber which also functions as a gas cooler, is installed immediately after the boiler for dust removal but as already stated, the gas is exhausted to atmosphere at a dust concentration higher than 500 mg/m^3.

At present, there are two units of boilers out of six units are in continuous operation. The dust removal countermeasure would be as follows.

a. Installation of two units of wet type ESP at the inlet of 100 meters high stack, each unit of ESP serving three units of boilers.

b. Installation of two units of dry type ESP, each unit serving three units of boilers, replacing the scrubber which is now installed immediately after the boiler.

Specifications of each ESP and rough cost estimation for one unit of ESP are described below.

Specifications	Unit	a. Wet Type	b. Dry Type
Inlet Gas Volume	$Nm^3/hr.$	120,000	
Inlet Temperature	°C	60	250
Inlet Dust Content	g/m^3	0.5	5
Outlet Dust Content	mg/m^3	50	100
Pressure Loss	mmAq	50	50
Rough Cost Estimate	US$	3,000,000	5,000,000

Both types of ESP have specific advantages and disadvantages. It is necessary to conduct a survey for a specific design of the ESP and our recommendation at the moment is as follows.

—For a fundamental solution, introduction of a dry type ESP mentioned in paragraph b. is preferable.

—To solve the problem for the time being, introduction of wet type ESP mentioned in paragraph a. costs less and could be easily introduced.

However, for the operation of the boiler, there is a plan now to install a new power generating plant and this issue has to be considered carefully taking into account this new plan.

(2) Dust removal from and recovery of Cu concentrate dryer exhaust gas

At present, a test is conducted together with a research for setting of conditions to introduce a special high pressure filtering machine in the mineral processing section and if this research is successful, the moisture content in de-watered concentrate may possibly be reduced to below 10%. If this is materialized, as already stated in modernization program of mineral processing,

the oil burning rotary dryer itself will become unnecessary and this problem can be solved without any trouble together with energy saving problem.

The above countermeasure requires high investment and long time. For the time being, therefore, strict and proper operation control of the dryer, including reinforcement of the present measuring and monitoring of dust concentration in the exhaust gas, should be conducted with an aim of maintaining the proper level of moisture in the concentrate. With this measure, the emission of black smoke is expected to greatly decrease.

5-9-2 Waste Water Treatment

We think that there is no problem for the time being.

Data (operation data, equipment specifications, regulation limits) obtained at site are shown in the attachment.

The improvement of analysis and measuring systems which are now missing for the accurate and quick implementation of pollution control measures are referred to in paragraph 5-9-5.

5-9-3 Dust Generation from Tailing Dam (Figure 50)

The dust concentration limit for the dust containing more than 50% of free silica (SiO_2), such as residue form mineral processing, is less than 0.25 to 0.96 mg/m3 as indicated in Table 50. An environment wherein "you cannot see the face of others" which occurs in March to May is estimated to be several times this level and therefore, it is necessary immediately to take some measure to prevent dust generation and improve the situation by spring of 1994.

There are following three alternatives and the basic idea is to wet or cover the dust sources at area C of Figure 50 (2,300mW x 300mL).

a: To wet this area C, the water level in the dump yard may be raised from time to time or water may be sprayed using a tank truck. The latter is more practical and also requires less cost. In both cases, however, the rise of water level may cause a problem of stability of dike. So, the verification in this respect will be required.

b: A removable sprinkler system may be installed and spray water from the nearby circulation pump room. The cost is estimated to be US$1 million.

c: Coating material such as mortar cement may be sprayed to coat the surface. In March, about 5 to 10 mm thickness concrete could be sprayed to prevent dust generation. It will cost much if the coating of the entire surface is done at one time and to decrease the surface area, it is one idea to used the discharge part half by half in June to October. In any case, with the cost of cement at about US$50/ton, the annual cost requirement will be about US$100 to 200 thousand.

There is no firm assurance but for a short term, we recommend case a) and

for a long term, case c). It is better to test the method in a small scale before actual implementation.

The time of dust generation may be forecast through past experience and if a possible measure can be taken before such time, it may be possible to prevent dust generation with not so high cost.

5-9-4 Improvement of Working Environment

The greatest cause of labor disease in each working area of Erdenet Mine is pneumoconiosis caused by inhaling suspended dust. (Figure 53)

The concentration of free silica is comparably high at mine site and mineral processing plant (crude ore > 50%), in casting plant (casting sand > 70%) and dump yard (tailing > 60%). The particle size of the dust is few microns which is worst for the pneumoconiosis. (Under 7 microns is inadequate.) An example of comparison between tolerable dust concentration in Japan and the actual situation at Erdenet Mine is shown in Table 50.

The best way to improve this situation is to prevent generation of dust from each source. The only way to do this is to maintain and control well the ventilation systems and water spraying systems in each area.

The second way is the use of dust mask by the operators to prevent inhaling of dust. In Japan, it is legally mandatory to use this mask under strict control of Safety Regulations for Metal Mining Industry and Pneumoconiosis Act. The employer is obliged to prepare these masks and force the operators to use them and the operators are obliged to wear them.

The dust filtering efficiency of the masks are as high as 99.9% compared with about 50% or less of existing simple type mask and the breathing resistance is less than 10 mm H_2O (total) which makes it easy to work. (Table 51 "Performance of Each Type of Dust Mask")

Three kinds of dust masks were brought to the mine and presented as samples (all of them were manufactured by K company in Japan).

In order to prevent further occurrence of pneumoconiosis, we propose to

start with immediate distribution of dust masks to all operators and oblige them to wear the masks. From the humanity point of view, this should be done immediately.

The trial calculation of required quantity and cost is as follows.

—Personnel to wear dust masks at Erdenet Mine and the type of proper mask (3 kinds)

•Supervisors and staff 1,100 men

General purpose mask

•Operators at dust environment 1,500 men

Dust environment mask

•Operators wearing face shield 400 men

Shield mask

Out of total 6,800 employees, about 44% are exposed to dust (nearly the same as the results of a normal mine).

—Quantity of dust mask required and its cost (for 2 years)

It is necessary to prepare for replacement of masks and make up of consumable such as filters. Based on the above figure, 10,000 masks are required in 2 years and it will cost about US$520,000.

We recommend to study the utilization of foreign aid for the implementation of the above measure.

5-9-5 Analysis and Measuring Systems for Environmental Pollution Control

This subject was taken up as an important matter requiring urgent solution during the site survey and the problems and countermeasures are explained below.

(1) Exchange of Idea between Japanese Experts and Erdenet's Engineers

In the process of promoting survey, a meeting was held to exchange opinion between the Japanese experts in charge of mineral research, mineral processing, pollution and environmental control and the engineers of Erdenet Mine in charge of analysis and measurement for chemical analysis center, energy department (pollution control) and technical department (labor hygiene).

In this discussion, a frank opinion was exchanged on the analysis and measuring organization, its role, number of personnel (engineer and operator), flow of work, and existing equipment and instrument for analysis and measuring system at Erdenet Mine. The Japanese side also explained the prevailing conditions in Japan and presented catalogues and brochures of typical and advanced equipment used in Western countries..

(2) Inspection of Analysis and Measuring Facilities and Problems

The Japanese experts visited the analysis and measuring facilities of energy department, technical department and chemical analysis center. The following problems were found out.

— In the initial stage of operation 15 years ago, the engineers from former USSR and East Europe stayed at the site for about one year to give technical supervision, but after their return, the operation had been left in the hand of

Erdenet Mine.

— The analysis and measuring facilities are made in former USSR or East Europe and they are of old types. Erdenet Mine wish to purchase latest equipment but the budget has not been materialized yet. Even the spare parts are not enough and it is difficult to operate these facilities correctly and efficiently.

— Due to the above situation, they are disturbed in their collaboration not only with the pollution and environmental control but also with the production side and technical development. Particularly, the reliability and quantity of data required for pollution control and environmental improvement are insufficient and cannot establish an adequate countermeasures.

— The independence of each section is quite high and communication is not enough and therefore, they are fully occupied to maintain the technical standard and not reached a situation to improve it. (The technology control is under the control of chemical analysis center.) The concerned personnel are well aware of the situation but the improvement has not been done due to several reasons.

(3) Modernization of measuring and analysis equipment for environmental pollution control

In the course of above discussion, a list of required analysis and measuring equipment and that of the existing equipment were presented by Erdenet Mine.

The list includes equipment for production control and quality control which highlights the great insufficiency of measuring and analysis equipment throughout the entire mine.

Table 91 shows the list of measuring and analysis equipment (draft)

together with the objectives of measurement or analysis. They are required for pollution control and environmental improvements which are urgent problems to be solved. The list is based on one of our experiences at non ferrous metal mines in Japan.

It is also necessary, aside from the equipment, to invite experts or to have training for technology transfer. This will improve the technical standards of entire measuring and analysis system of overall Erdenet Mine.

We believe some of the problems could be solved with the implementation of the above modernization measures. We recommend this program to be implemented by utilizing the foreign aid just like the case of dust masks.

—The measuring and analysis equipment for pollution control and environmental improvement consists of 29 items and the purchase cost is estimated to be US$2,760,000.

—The concerned engineer of Erdenet Mine has 14 years of actual experience and therefore, we think they can exhibit sufficiently the results of training with only short period of training and supervision.

Table 91 List of Analysis, Measuring Equipment Necessary for Anti-Pollution and Working Environmental Control

No.	Name & Type	Q'ty	Reference
1	Ion Meter (Table Type, IM-40S)	3 sets	Waste Treatment
2	PH Meter (Table Type + Potable Type)	3 sets	
3	Electronic Balance (AEG-320 + EB-630SW)	3 sets	
4	Liquid Gravity Meter (DA-310)	2 sets	
5	Microscope with Camera for Biology and Metal	2 sets	
6	Dust Meter (Potable Type)	2 sets	
7	High + Low Volume Sampler	2 sets	Dust
8	Noise Meter System with Recorder	2 sets	
9	Lux Meter (Potable)	2 sets	
10	Vibration Meter (VM-51)	2 sets	
11	Gas Analyzer (Potable Type) with Detector Tube	2 sets	SOx, NOx, Etc.
12	NOx Analyzer (NOA-7000)	1 set	Low Content
13	Soil Analyzer (DR-2000)	1 set	Heavy Metal
14	Particle Size Analyzer (SA-CP4)	1 set	Dust
15	Gas Chromatography (GC-14B)	1 sets	Smell, SOx
16	Atomic Absorption Spectrometer (AA-6500/AA-6500G)	2 sets	Low Content
17	Sequential Plasma Spectrometer (ICPS-1000-IV)	1 set	High Speed
18	X-Ray Fluorescent Spectrometer (SXF-1200)	1 set	Solid
19	X-Ray Diffractometer	1 set	F-SiO2, Etc.
20	Liquid Chromatography (LC-10A)	2 sets	Organics
21	Thermal Analyzer (DTA-50 + TGA-50II)	1 set	
22	Electric Furnace (KM-600)	1 set	Small Test
23	Forced Convection Oven (FV-430)	2 sets	Drying
24	Distillation Apparatus for F, CN	2 sets	
25	Pure Water Maker (GS-100)	1 set	Chemical Analysis
26	Refrigerator for BOD Analysis	2 sets	
27	Non-destructive Inspection Apparatus Ultrasonic Flaw Detector	1 set	
28	Glassware for Analysis (Buret, Pipet, Beaker, etc.)	1 set	
29	Spare Parts for aboves	1 set	for 2 years

6 Financial and Economic Analysis

6. Financial and Economic Analysis

6-1 Financial and Economic Analysis

The major objective of this modernization plan is, as mentioned in the preceding sections, to maintain a continuing inflow of foreign currency. To this end, it is proposed to increase mining to maintain the production quantities of metallic copper, and the investment for the plan was estimated (on the assumption that the real price of metallic copper will remain steady).

Investment with the above objective should not only fulfill its original objective of acquiring foreign currency, but also ensure a certain degree of profitability. If not, and the significant investment for the plan is not covered by an increase in profit, an overall loss of foreign currency will ensure. The "Financial analysis" and "Economic analysis" will evaluate the profitability of the modernization plan, and are executed in accordance with certain procedures.

"Financial analysis" views the project from the perspective of a company, and is conducted to maximize profit from the project. In calculating revenues and expenses, the assets invested and assets produced are evaluated based on market prices, and profitability is calculated.

"Economic analysis" views the project from the perspective of a nation. Emphasis is placed on the nation's optimum economic growth or the achievement of economic efficiency through the optimum allocation of resources. In the "Economic analysis," revenues are replaced by "benefits" accrued, and expenditures by "costs." The following factors generally apply:

Tax, subsidiaries and so forth are merely a transfer of funds between a company and the nation. As these funds are offset on the national level, such

"transfer items" are not included in the "costs" or "benefits." The calculation of "costs" and "benefits" is not based on market prices as in the case of "financial analysis," but utilizes so-called "economic prices" for calculation. For instance, international prices are used for foreign trading assets, on the principle that in comparison with domestic market prices, international prices are determined by conditions closer to free competition, and that international prices contain fewer price distortions. For the same reasons, modified exchange rates and wages for calculation purposes, known as "shadow exchange rates" and "shadow wages," are utilized.

Therefore, it is necessary to conduct both "Financial analysis" and "Economic analysis," from the perspective of a company and the nation respectively, and if the indices of profitability obtained from these analyses reach a certain level, then the project will be adopted.

6-2 Analysis Method

6-2-1 Internal Rate of Return

In carrying out financial and economic analysis, attention should be paid to the project's balance of cash, and calculations should be based on the computation of cash inflow and outflow. Internal rate of return (IRR) is normally used as an index of profitability. IRR is a discount rate at which the net present value (NPV) of projects equals to zero. NPV is defined as:

Project NPV = Total present value of future cash inflow – Total present value of future cash outflow

= Total present value of future net cash flow.

The greater the IRR, the discount rate at which the net present value of the project is 0, the higher the profitability of the project. This IRR is called Financial IRR (FIRR) or Economic IRR (EIRR), as appropriate to the analysis situation.

6-2-2 "With" and "Without"

In evaluating projects, the principle of "with" and "without" is observed. To begin with, comparison is made between the case where the project is implemented, a "with" scenario, and the case where the project is not implemented, a "without" scenario. Next, increases in the costs and benefits and then profitability are calculated.

In this project, the "with" and "without" cases are defined as:

With: Modernization of the mine is implemented in accordance with the proposals. The mine increases crude ore production to a level that will enable annual production of 120,000 tons of copper metal. Here the following two cases are examined; separating copper and molybdenum as in the past and selling copper concentrate as bulk without separating these (the sales of molybdenum not included).

Without: Modernization of the mine is not implemented, and annual production of crude ore is maintained at 17 million tons.

6-3 Financial Analysis

6-3-1 Production and Sales

The production and sales amounts that serve as the basis for the calculation of revenues or benefits for the project use the figures in the production plan in Section 5. Tables 92, 93, and 94 show the sales volumes in the case of modernization with separate production of copper and molybdenum, the case of modernization with bulk production of concentrates, and the case where modernization is not implemented ("without"), respectively.

In any event, the mine will be forced to extract lower grades of ore. Therefore, it is anticipated that the unit price for copper concentrate will continue to fall each year. As previously mentioned, we assume that real copper prices (allowing for inflation) will remain unchanged in the future. It is therefore necessary to increase the amount of production in order to maintain the acquisition of foreign cash through sales. In the "without" scenario, as the production amount does not increase, sales amount will gradually fall.

In calculating sales and unit price of concentrate, the following assumption is used.

[Assumption for calculating sales]

Copper:	LME settlement 1,400£/MT flat (price set on the last day of November, in the year when the first field survey was conducted)
Silver:	$3.76/TOZ
Molybdenum:	$2.5/0.1% MO Pure

T/C: $100/t

R/C: 10c/lb

PP: at 90c/lb ± 10%

Exchange rate: 1£ = US$1.55

Transport costs by route: As per the following:

(Unit: US$/1 ton of concentrate)

	Proportion of sales	Domestic transport costs	Overseas transport costs	Total	Recorded in the cost	Deduction from sales
Russia(Urals)	40%	4	24	28	4	24
Kazakhstan (Balkhash)	35%	4	40	44	4	40
Japan and other	15%	4	68	72	72	0
China	10%	11	43	11	11	43

Table 92 SALES (Mo/Cu Separation)

ITEM	Unit	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
(1) Cu Concentrate																
Production	DMT	370,666	383,902	389,064	412,549	436,911	446,841	450,926	465,022	472,404	484,070	473,431	495,697	495,697	495,697	493,850
-ditto-	WMT	411,851	426,558	432,293	458,388	485,457	496,490	501,029	516,691	524,893	537,856	526,034	550,774	550,774	550,774	548,722
Sales Volume	DMT	370,110	383,326	388,480	411,930	436,256	446,171	450,249	464,325	471,695	483,344	472,721	494,953	494,953	494,953	493,109
by country	WMT															
Russia		164,740	170,623	172,917	183,355	194,183	198,596	200,412	206,676	209,957	215,142	210,414	220,310	220,310	220,310	219,489
Kazakhstan		144,148	149,295	151,303	160,436	169,910	173,772	175,360	180,842	183,713	188,249	184,112	192,771	192,771	192,771	192,053
China		41,185	42,656	43,229	45,839	48,546	49,649	50,103	51,669	52,489	53,786	52,603	55,077	55,077	55,077	54,872
Japan, etc.		61,778	63,984	64,844	68,758	72,818	74,474	75,154	77,504	78,734	80,678	78,905	82,616	82,616	82,616	82,308
Total		411,851	426,558	432,293	458,388	485,457	496,490	501,029	516,691	524,893	537,856	526,034	550,774	550,774	550,774	548,722
Unit Price (CIF)	$/t	470.37	431.25	422.86	415.16	407.62	399.75	392.17	384.26	376.68	369.12	361.58	353.75	353.75	353.75	345.53
Price of Conc. (CIF)	US$1000	174,089	165,310	164,272	171,018	177,828	178,356	176,573	178,419	177,676	178,411	170,927	175,088	175,088	175,088	170,385
Freight(Deducted from sales)																
Russia (24$/t)	US$1000	3,954	4,095	4,150	4,401	4,660	4,766	4,810	4,960	5,039	5,163	5,050	5,287	5,287	5,287	5,268
Kazakh (40$/t)	US$1000	5,766	5,972	6,052	6,417	6,796	6,951	7,014	7,234	7,349	7,530	7,364	7,711	7,711	7,711	7,682
China (43$/t)	US$1000	1,771	1,834	1,859	1,971	2,087	2,135	2,154	2,222	2,257	2,313	2,262	2,368	2,368	2,368	2,360
Sales Amount	US$1000	162,599	153,410	152,211	158,229	164,284	164,503	162,595	164,004	163,032	163,405	156,251	159,721	159,721	159,721	155,076
(2)Mo Concentrate																
Produc'n=Sales vol.	DMT	3,849	3,611	3,645	3,722	3,722	3,555	3,945	3,945	3,945	4,225	4,225	4,225	4,225	4,225	4,000
-ditto-	WMT	4,277	4,012	4,050	4,136	4,136	3,950	4,383	4,383	4,383	4,694	4,694	4,694	4,694	4,694	4,444
Unit Price (CIF)	$/t	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,557	2,557	2,557	2,557
Price of Conc. (CIF)	US$1000	11,074	10,389	10,487	10,708	10,708	10,228	11,350	11,350	11,350	12,155	12,155	10,805	10,805	10,805	10,229
Freight (24$/t)	US$1000	103	96	97	99	99	95	105	105	105	113	113	113	113	113	107
Sales Amount	US$1000	10,971	10,293	10,389	10,609	10,609	10,133	11,245	11,245	11,245	12,043	12,043	10,692	10,692	10,692	10,123
Total Sales	US$1000	173,570	163,702	162,600	168,838	174,893	174,636	173,839	175,248	174,276	175,448	168,293	170,413	170,413	170,413	165,199
Freight (to be calculated as cost)																
Russia, Kazakh(4$/t)	US$1000	1,253	1,296	1,313	1,392	1,473	1,505	1,521	1,568	1,592	1,632	1,597	1,671	1,671	1,671	1,664
China(11$/t)	US$1000	453	469	476	504	534	546	551	568	577	592	579	606	606	606	604
Japan, etc. (72$/t)	US$1000	4,448	4,607	4,669	4,951	5,243	5,362	5,411	5,580	5,669	5,809	5,681	5,948	5,948	5,948	5,926
Total	US$1000	6,154	6,372	6,457	6,847	7,250	7,414	7,483	7,716	7,838	8,033	7,857	8,225	8,225	8,225	8,194

Table 93 SALES (Bulk)

ITEM	Unit	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
(1) Cu Concentrate																
Production	DMT	370,514	386,986	395,223	422,405	450,851	464,613	468,822	483,398	491,071	503,483	492,464	515,625	515,625	515,625	513,353
-ditto-	WMT	411,682	429,984	439,137	469,339	500,946	516,237	520,913	537,109	545,634	559,426	547,182	572,917	572,917	572,917	570,392
Sales Volume	DMT	369,958	386,405	394,630	421,771	450,175	463,916	468,119	482,673	490,335	502,728	491,725	514,852	514,852	514,852	512,583
by country	WMT															
Russia		164,673	171,994	175,655	187,736	200,378	206,495	208,365	214,844	218,254	223,770	218,873	229,167	229,167	229,167	228,157
Kazakhstan		144,089	150,495	153,698	164,269	175,331	180,683	182,320	187,988	190,972	195,799	191,514	200,521	200,521	200,521	199,637
China		41,168	42,998	43,914	46,934	50,095	51,624	52,091	53,711	54,563	55,943	54,718	57,292	57,292	57,292	57,039
Japan, etc.		61,752	64,498	65,870	70,401	75,142	77,435	78,137	80,566	81,845	83,914	82,077	85,937	85,937	85,937	85,559
Total		411,682	429,984	439,137	469,339	500,946	516,237	520,913	537,109	545,634	559,426	547,182	572,917	572,917	572,917	570,392
Unit Price (CIF)	$/t	470.27	430.11	421.28	412.80	404.28	395.78	388.10	380.43	372.76	365.09	357.41	349.74	349.77	349.86	342.15
Price of Conc. (CIF)	US$1000	173,981	166,197	166,250	174,105	181,995	183,610	181,677	183,624	182,777	183,538	175,748	180,065	180,078	180,127	175,381
Freight(Deducted from sales)																
Russia (24$/t)	US$1000	3,952	4,128	4,216	4,506	4,809	4,956	5,001	5,156	5,238	5,370	5,253	5,500	5,500	5,500	5,476
Kazakh (40$/t)	US$1000	5,764	6,020	6,148	6,571	7,013	7,227	7,293	7,520	7,639	7,832	7,661	8,021	8,021	8,021	7,985
China (43$/t)	US$1000	1,770	1,849	1,888	2,018	2,154	2,220	2,240	2,310	2,346	2,406	2,353	2,464	2,464	2,464	2,453
Sales Amount	US$1000	162,495	154,200	153,998	161,010	168,019	169,207	167,144	168,638	167,554	167,930	160,482	164,081	164,093	164,142	159,467
(2)Mo Concentrate																
Produc'n=Sales vol.	DMT	3,849	3,611	2,187	1,489	744										
-ditto-	WMT	4,277	4,012	2,430	1,654	827										
Unit Price (CIF)	$/t	2,877	2,877	2,877	2,877	2,877										
Price of Conc. (CIF)	US$1000	11,074	10,389	6,292	4,284	2,140	0	0	0	0	0	0	0	0	0	0
Freight (24$/t)	US$1000	103	96	58	40	20	0	0	0	0	0	0	0	0	0	0
Sales Amount	US$1000	10,971	10,293	6,234	4,244	2,121	0	0	0	0	0	0	0	0	0	0
Total Sales	US$1000	173,466	164,493	160,231	165,255	170,140	169,207	167,144	168,638	167,554	167,930	160,482	164,081	164,093	164,142	159,467
Freight (to be calculated as cost)																
Russia, Kazakh(4$/t)	US$1000	1,252	1,306	1,327	1,415	1,506	1,549	1,563	1,611	1,637	1,678	1,642	1,719	1,719	1,719	1,711
China(11$/t)	US$1000	453	473	483	516	551	568	573	591	600	615	602	630	630	630	627
Japan, etc. (72$/t)	US$1000	4,446	4,644	4,743	5,069	5,410	5,575	5,626	5,801	5,893	6,042	5,910	6,187	6,187	6,187	6,160
Total	US$1000	6,151	6,423	6,553	7,000	7,467	7,692	7,762	8,003	8,130	8,335	8,153	8,536	8,536	8,536	8,499

Table 94 SALES (Without Project)

ITEM	Unit	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
(1) Cu Concentrate																
Production	DMT	306,085	318,470	294,551	310,147	301,875	301,875	301,875	302,968	341,550	338,197	335,661	335,661	335,661	332,873	343,829
-ditto-	WMT	340,094	353,856	327,279	344,608	335,417	335,417	335,417	336,631	379,500	375,774	372,957	372,957	372,957	369,859	382,032
Sales Volume	DMT	305,626	317,993	294,109	309,682	301,422	301,422	301,422	302,513	341,038	337,690	335,158	335,158	335,158	332,373	343,313
by country	WMT															
Russia		136,038	141,542	130,912	137,843	134,167	134,167	134,167	134,652	151,800	150,310	149,183	149,183	149,183	147,944	152,813
Kazakhstan		119,033	123,849	114,548	120,613	117,396	117,396	117,396	117,821	132,825	131,521	130,535	130,535	130,535	129,451	133,711
China		34,009	35,386	32,728	34,461	33,542	33,542	33,542	33,663	37,950	37,577	37,296	37,296	37,296	36,986	38,203
Japan, etc.		51,014	53,078	49,092	51,691	50,313	50,313	50,313	50,495	56,925	56,366	55,944	55,944	55,944	55,479	57,305
Total		340,094	353,856	327,279	344,608	335,417	335,417	335,417	336,631	379,500	375,774	372,957	372,957	372,957	369,859	382,032
Unit Price (CIF)	$/t	464.80	458.29	458.34	411.08	411.13	411.18	411.23	411.29	339.32	339.38	339.43	339.49	339.59	339.49	307.13
Price of Conc. (CIF)	US$1000	142,054	145,733	134,802	127,304	123,924	123,939	123,954	124,420	115,721	114,604	113,764	113,782	113,816	112,837	105,443
Freight(Deducted from sales)																
Russia (24$/t)	US$1000	3,265	3,397	3,142	3,308	3,220	3,220	3,220	3,232	3,643	3,607	3,580	3,580	3,580	3,551	3,668
Kazakh (40$/t)	US$1000	4,761	4,954	4,582	4,825	4,696	4,696	4,696	4,713	5,313	5,261	5,221	5,221	5,221	5,178	5,348
China (43$/t)	US$1000	1,462	1,522	1,407	1,482	1,442	1,442	1,442	1,448	1,632	1,616	1,604	1,604	1,604	1,590	1,643
Sales Amount	US$1000	132,566	135,860	125,671	117,690	114,566	114,581	114,596	115,028	105,133	104,120	103,358	103,377	103,410	102,518	94,784
(2)Mo Concentrate																
Produc'n=Sales vol.	DMT	3,849	3,611	3,645	3,722	3,722	3,555	3,945	3,945	3,945	4,225	4,225	4,225	4,225	4,225	4,000
-ditto-	WMT	4,277	4,012	4,050	4,136	4,136	3,950	4,383	4,383	4,383	4,694	4,694	4,694	4,694	4,694	4,444
Unit Price (CIF)	$/t	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,557	2,557	2,557	2,557
Price of Conc. (CIF)	US$1000	11,074	10,389	10,487	10,708	10,708	10,228	11,350	11,350	11,350	12,155	12,155	10,805	10,805	10,805	10,229
Freight (24$/t)	US$1000	103	96	97	99	99	95	105	105	105	113	113	113	113	113	107
Sales Amount	US$1000	10,971	10,293	10,389	10,609	10,609	10,133	11,245	11,245	11,245	12,043	12,043	10,692	10,692	10,692	10,123
Total Sales	US$1000	143,537	146,153	136,060	128,299	125,175	124,714	125,841	126,273	116,378	116,162	115,401	114,069	114,103	113,210	104,907
Freight (to be calculated as cost)																
Russia, Kazakh(4$/t)	US$1000	1,037	1,078	998	1,050	1,023	1,022	1,024	1,027	1,156	1,146	1,138	1,138	1,138	1,128	1,164
China(11$/t)	US$1000	374	389	360	379	369	369	369	370	417	413	410	410	410	407	420
Japan, etc. (72$/t)	US$1000	3,673	3,822	3,535	3,722	3,623	3,623	3,623	3,636	4,099	4,058	4,028	4,028	4,028	3,994	4,126
Total	US$1000	5,085	5,288	4,893	5,151	5,014	5,014	5,015	5,033	5,672	5,618	5,576	5,576	5,576	5,530	5,710

6-3-2 Financial Expenses

Tables 95, 96, and 97 show forecast financial expenses for the project. The tables show capital investment and operations expenses. Capital investment consists of investment for modernization enabling the mine to increase production, and expenses for replacement of existing facilities. The expenses for replacement are estimates based on fiscal 1992 results. Even if modernization is not implemented, a certain amount of investment will still be required to sustain the current production. The total capital investment over the 15 year period will be $257 million. To implement modernization, investment of $395 million will be required for the separate production of copper and molybdenum, while investment of $390 will be required for the bulk production of concentrate.

Once modernization is implemented operating expenses will increase significantly, particularly in the Milling Division, mainly as a result of the increase in electricity charges resulting from increased production. (In the Erdenet Modernization Project, the construction of a new power station is a core requirement, and although it would be a separate project, we have calculated appropriate charges for electricity purchased from the new power station, based on its construction costs. Such expenses are included in operating expenses.)

Table 95 Financial Costs : WITH (Mo/Cu Separation)

[Capital Expenditure]

(US$ 1,000)

Year		Mining	Concentrating	Other Section	Replacement	Total
1	1994	53,419	13,120	8,192	3,556	78,287
2	1995	11,444	10,785	10,757	3,556	36,542
3	1996	10,596	8,130	800	3,556	23,082
4	1997	21,564	4,540	0	3,556	29,660
5	1998	13,362	2,100	0	3,556	19,018
6	1999	15,301	2,190	0	3,556	21,047
7	2000	12,602	2,100	0	3,556	18,258
8	2001	15,777	2,100	0	3,556	21,433
9	2002	25,719	0	0	3,556	29,275
10	2003	7,063	0	0	3,556	10,619
11	2004	22,668	0	0	3,556	26,224
12	2005	16,377	0	0	3,556	19,933
13	2006	17,236	0	0	3,556	20,792
14	2007	18,806	0	0	3,556	22,362
15	2008	15,254	0	0	3,556	18,810
Total		277,188	45,065	19,748	53,340	395,342

[Operation Costs]

(US$ 1,000)

Year		Mining	Concentrating	Other Sector	G&A, Transport	Total Costs
1	1994	15,750	59,650	7,081	10,108	92,589
2	1995	15,816	60,566	7,081	10,326	93,789
3	1996	15,870	62,915	7,081	10,411	96,277
4	1997	15,847	65,272	7,081	10,801	99,001
5	1998	16,022	67,637	7,081	11,204	101,944
6	1999	16,171	70,002	7,081	11,368	104,622
7	2000	16,231	69,908	7,081	11,437	104,657
8	2001	16,249	70,950	7,081	11,670	105,950
9	2002	16,421	70,948	7,081	11,792	106,242
10	2003	16,620	71,588	7,081	11,987	107,276
11	2004	17,026	75,917	7,081	11,811	111,835
12	2005	17,500	78,107	7,081	12,179	114,867
13	2006	17,575	78,107	7,081	12,179	114,942
14	2007	17,770	78,105	7,081	12,179	115,135
15	2008	18,108	78,107	7,081	12,148	115,444
Total		248,976	1,057,779	106,215	171,600	1,584,570

(note) Conversion Rate : 1US$ = 40.0Tg.

Table 96 Financial Costs : WITH (Production of Bulk Concentrates)

[Capital Expenditure]

(US$ 1,000)

Year		Mining	Concentrating	Other Section	Replacement	Total
1	1994	53,419	10,790	8,117	3,556	75,882
2	1995	11,444	8,869	10,757	3,556	34,626
3	1996	10,596	7,866	800	3,556	22,818
4	1997	21,564	4,276	0	3,556	29,396
5	1998	13,362	1,837	0	3,556	18,755
6	1999	15,301	2,120	0	3,556	20,977
7	2000	12,602	2,100	0	3,556	18,258
8	2001	15,777	2,100	0	3,556	21,433
9	2002	25,719	0	0	3,556	29,275
10	2003	7,063	0	0	3,556	10,619
11	2004	22,668	0	0	3,556	26,224
12	2005	16,377	0	0	3,556	19,933
13	2006	17,236	0	0	3,556	20,792
14	2007	18,806	0	0	3,556	22,362
15	2008	15,254	0	0	3,556	18,810
Total		277,188	39,958	19,673	53,340	390,160

[Operation Costs]

(US$ 1,000)

Year		Mining	Concentrating	Other Sector	G&A, Transport	Total Costs
1	1994	15,750	59,650	7,081	10,105	92,586
2	1995	15,816	56,663	7,081	10,377	89,937
3	1996	15,870	56,800	7,081	10,507	90,258
4	1997	15,847	57,042	7,081	10,954	90,924
5	1998	16,022	57,378	7,081	11,421	91,902
6	1999	16,171	57,714	7,081	11,646	92,612
7	2000	16,231	57,544	7,081	11,716	92,572
8	2001	16,249	58,475	7,081	11,957	93,762
9	2002	16,421	58,473	7,081	12,084	94,059
10	2003	16,620	59,049	7,081	12,289	95,039
11	2004	17,026	62,943	7,081	12,107	99,157
12	2005	17,500	64,914	7,081	12,490	101,985
13	2006	17,575	64,911	7,081	12,490	102,057
14	2007	17,770	64,914	7,081	12,490	102,255
15	2008	18,108	68,487	7,081	12,453	106,129
Total		248,976	904,957	106,215	175,086	1,435,234

(note) Conversion Rate : 1US$ = 40.0Tg.

Table 97 Financial Costs : WITHOUT

[Capital Expenditure]

(US$ 1,000)

Year		Mining	Concentrating	Other Section	Replacement	Total
1	1994	22,366	0	0	3,556	25,922
2	1995	6,618	1,100	0	3,556	11,274
3	1996	11,367	6,030	0	3,556	20,953
4	1997	11,075	3,240	0	3,556	17,871
5	1998	17,218	1,100	0	3,556	21,874
6	1999	5,074	0	0	3,556	8,630
7	2000	8,962	2,100	0	3,556	14,618
8	2001	9,788	2,100	0	3,556	15,444
9	2002	24,942	0	0	3,556	28,498
10	2003	7,870	0	0	3,556	11,426
11	2004	10,590	0	0	3,556	14,146
12	2005	14,864	0	0	3,556	18,420
13	2006	20,233	0	0	3,556	23,789
14	2007	7,985	0	0	3,556	11,541
15	2008	8,988	0	0	3,556	12,544
Total		187,940	15,670	0	53,340	256,950

[Operation Costs]

(US$ 1,000)

Year		Mining	Concentrating	Other Sector	G&A, Transport	Total Costs
1	1994	11,979	49,466	7,081	9,039	77,565
2	1995	12,059	48,994	7,081	9,242	77,376
3	1996	12,141	48,523	7,081	8,847	76,592
4	1997	12,222	48,060	7,081	9,105	76,468
5	1998	12,382	47,604	7,081	8,968	76,035
6	1999	12,463	47,148	7,081	8,968	75,660
7	2000	12,544	47,148	7,081	8,969	75,742
8	2001	12,756	47,616	7,081	8,987	76,440
9	2002	12,990	47,616	7,081	9,626	77,313
10	2003	13,225	47,616	7,081	9,572	77,494
11	2004	13,437	47,616	7,081	9,530	77,664
12	2005	13,777	47,616	7,081	9,530	78,004
13	2006	13,816	47,616	7,081	9,530	78,043
14	2007	13,928	47,616	7,081	9,484	78,109
15	2008	14,039	47,616	7,081	9,664	78,400
Total		193,758	717,871	106,215	139,061	1,156,905

(note) Conversion Rate : 1US$ = 40.0Tg.

6-3-3 Profit and Loss Account

Tables 98, 99, and 100 show profit and loss is forecasts based on the income and expenditure outlined. All cases show a declining trend in profit, partly due to depreciation costs. Utmost priority is given to the maintenance of the foreign cash acquisition and not to the maintenance of the profit ratio. However, it may be necessary to focus on future changes and take measures to improve profitability when necessary.

When comparing total figures, profit over the 15 year period will considerably improve if modernization is implemented, for both separate production of copper and molybdenum and bulk production of concentrate.

Major assumption in calculating financial expenses and profit and loss is:

[Assumtion for Calculating Financial Expenses and Profit and Loss]

Foreign exchange rate: US$1 = 40.0 Tg (official rate at end of 1992)

Future inflation: Not taken into consideration

Fund raising: It is assumed that all the funds necessary for the modernization in the first two years (1994 and 1995) will be raised by loans from international financial institutions (thereafter, the investment will be made from funds on hand).

Loan conditions: Interest rate 5.0% p.a.
Period: 15 years (including grace period 5 years)

Import tariffs: At present, there are tax exemption measures for foreign-capital joint ventures, such as Erdenet

Mine. However, the Tariff Law, as revised in January 1993, will impose a 15% import duty and a 10% sales tax, a total tax of 25%, on imports that Erdenet Mine buys in case they are financed by loan. Therefore, we assume that materials and equipment used for the investment in modernization in the initial two years will be taxed.

Income tax rate: 40%

Table 98 Income Statement : WITH (Mo/Cu Separation)

(US$ 1,000)

Year		(a) Sales	(b) Ope.costs	(c) Depreci'n	(d) Interest 5.0%	(e) Prft bf tx	(f) Tax 40%	(g) Net Income
1	1994	173,570	92,589	10,299	1,957	68,725	27,490	41,235
2	1995	163,703	93,789	13,711	4,828	51,375	20,550	30,825
3	1996	162,600	96,277	15,813	5,741	44,769	17,907	26,861
4	1997	168,838	99,001	19,912	5,741	44,184	17,673	26,510
5	1998	174,893	101,944	22,876	5,741	44,332	17,733	26,599
6	1999	174,636	104,622	23,547	5,741	40,726	16,290	24,435
7	2000	173,840	104,657	23,693	5,582	39,908	15,963	23,945
8	2001	175,249	105,950	24,261	4,944	40,094	16,038	24,056
9	2002	174,277	106,242	25,505	4,306	38,224	15,290	22,934
19	2003	175,448	107,276	26,028	3,668	38,476	15,390	23,086
11	2004	168,294	111,835	27,360	3,030	26,069	10,428	15,641
12	2005	170,413	114,867	27,847	2,392	25,307	10,123	15,184
13	2006	170,413	114,942	28,125	1,754	25,592	10,237	15,355
14	2007	170,413	115,135	29,746	1,116	24,416	9,766	14,649
15	2008	165,199	115,444	31,112	478	18,165	7,266	10,899
Total		2,561,786	1,584,570	349,835	57,023	570,358	228,143	342,215

Table 99 Income Statement : WITH (Production of Bulk Concentrates)

(US$ 1,000)

Year		(a) Sales	(b) Ope.costs	(c) Depreci'n	(d) Interest 5.0%	(e) Prft bf tx	(f) Tax 40%	(g) Net Income
1	1994	173,466	92,586	10,170	1,897	68,813	27,525	41,288
2	1995	164,493	89,937	13,467	4,660	56,429	22,572	33,858
3	1996	160,232	90,258	15,549	5,525	48,900	19,560	29,340
4	1997	165,254	90,924	19,627	5,525	49,178	19,671	29,507
5	1998	170,140	91,902	22,567	5,525	50,146	20,058	30,087
6	1999	169,207	92,612	23,231	5,525	47,839	19,135	28,703
7	2000	167,144	92,572	23,377	5,372	45,823	18,329	27,494
8	2001	168,638	93,762	23,945	4,758	46,173	18,469	27,704
9	2002	167,554	94,059	25,189	4,144	44,162	17,665	26,497
19	2003	167,930	95,039	25,712	3,530	43,649	17,460	26,189
11	2004	160,482	99,157	27,044	2,916	31,365	12,546	18,819
12	2005	164,081	101,985	27,531	2,302	32,263	12,905	19,358
13	2006	164,093	102,057	27,809	1,688	32,539	13,015	19,523
14	2007	164,142	102,255	29,430	1,074	31,383	12,553	18,830
15	2008	159,467	106,129	30,778	460	22,100	8,840	13,260
Total		2,486,323	1,435,234	345,426	54,904	650,759	260,304	390,456