

Table 100 Income Statement : WITHOUT

(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	143,537	77,535	8,248	0	57,724	23,090	34,634
2	1995	146,153	77,376	10,415	0	58,362	23,345	35,017
3	1996	136,060	76,592	13,277	0	46,191	18,476	27,715
4	1997	128,299	76,468	14,847	0	36,984	14,794	22,190
5	1998	125,175	76,035	15,655	0	33,485	13,394	20,091
6	1999	124,714	75,660	16,384	0	32,670	13,068	19,602
7	2000	125,841	75,742	16,919	0	33,180	13,272	19,908
8	2001	126,273	76,440	17,006	0	32,827	13,131	19,696
9	2002	116,378	77,313	15,900	0	23,165	9,266	13,899
10	2003	116,163	77,494	17,237	0	21,432	8,573	12,859
11	2004	115,401	77,664	18,638	0	19,099	7,640	11,459
12	2005	114,069	78,004	18,261	0	17,804	7,122	10,682
13	2006	114,102	78,043	17,975	0	18,084	7,234	10,850
14	2007	113,210	78,109	18,471	0	16,630	6,652	9,978
15	2008	104,907	78,400	22,949	0	3,558	1,423	2,135
Total		1,850,282	1,156,905	242,182	0	451,195	180,478	270,717

6-3-4 Financial Internal Rate of Return

The financial internal rate of return (FIRR) is calculated by first determining net cash flow, based on cash inflow and cash outflow. Sales and residual value of fixed assets (only items that can be sold) are included in cash inflow. Cash outflow includes capital investment expenses, operating expenses (excluding depreciation) and corporate tax payable. Interest payable is not included in the cash outflow. Based on the asset evaluation or economic evaluation normally applied to mines, the period of calculation has been set at 15 years after the commencement of modernization, though in terms of size of deposits, the mine can continue production well past this time frame.

Tables 101, 102, and 103 show the net cash flow for each case.

The FIRR for modernization investment is calculated by comparison of "with" and "without" scenario. Table 104 shows the IRR calculation in the case of separate production of copper and molybdenum. Table 105 shows the IRR calculation in the case of bulk production of concentrates. These show acceptable profitabilities of 14.04% and 20.12% respectively.

The better profitability of modernization investment in the case of bulk production of concentrates compared with separate production requires explanation. In the case of modernization to implement bulk production of concentrates, although the increase in sales is less than that for separate production, the bulk production of concentrates costs (capital investment and operating expenses) lower.

Under this modernization plan, either of these methods promises good profitability under current conditions. Both of these plans can be ratified for

implementation from economical point of view. If there is to be an emphasis on sales (acquisition of foreign currencies), separate production of copper and molybdenum is recommended. If the emphasis is to be placed on profit, bulk production of concentrates would be preferable.

Table 101 Cash Flow : WITH (Mo/Cu Separation)

		Cash Inflow			Cash Outflow				(US\$1,000)
Year		Sales	Residual	Total (1)	CAPEX	OPEX	Tax	Total (2)	Net C/F (1) - (2)
1	1994	173,570		173,570	78,287	92,589	27,490	198,365	-24,795
2	1995	163,703		163,703	36,542	93,789	20,550	150,881	12,822
3	1996	162,600		162,600	23,082	96,277	17,907	137,266	25,334
4	1997	168,838		168,838	29,660	99,001	17,673	146,334	22,504
5	1998	174,893		174,893	19,018	101,944	17,733	138,695	36,198
6	1999	174,636		174,636	21,047	104,622	16,290	141,959	32,677
7	2000	173,840		173,840	18,258	104,657	15,963	138,878	34,962
8	2001	175,249		175,249	21,433	105,950	16,038	143,421	31,828
9	2002	174,277		174,277	29,275	106,242	15,290	150,807	23,470
10	2003	175,448		175,448	10,619	107,276	15,390	133,285	42,163
11	2004	168,294		168,294	26,224	111,835	10,428	148,487	19,807
12	2005	170,413		170,413	19,933	114,867	10,123	144,923	25,490
13	2006	170,413		170,413	20,792	114,942	10,237	145,971	24,442
14	2007	170,413		170,413	22,362	115,135	9,766	147,263	23,150
15	2008	165,199	25,632	190,831	18,810	115,444	7,266	141,520	49,311

Table 102 Cash Flow : WITH (Production of Bulk Concentrates)

		Cash Inflow			Cash Outflow				(US\$1,000)
Year		Sales	Residual	Total (1)	CAPEX	OPEX	Tax	Total (2)	Net C/F (1) - (2)
1	1994	173,466		173,466	75,882	92,586	27,525	195,993	-22,527
2	1995	164,493		164,493	34,626	89,937	22,572	147,135	17,358
3	1996	160,232		160,232	22,818	90,258	19,560	132,636	27,596
4	1997	165,254		165,254	29,396	90,924	19,671	139,991	25,263
5	1998	170,140		170,140	18,755	91,902	20,058	130,715	39,425
6	1999	169,207		169,207	20,977	92,612	19,135	132,724	36,483
7	2000	167,144		167,144	18,258	92,572	18,329	129,159	37,985
8	2001	168,638		168,638	21,433	93,762	18,469	133,664	34,974
9	2002	167,554		167,554	29,275	94,059	17,665	140,999	26,555
10	2003	167,930		167,930	10,619	95,039	17,460	123,118	44,812
11	2004	160,482		160,482	26,224	99,157	12,546	137,927	22,555
12	2005	164,081		164,081	19,933	101,985	12,905	134,823	29,258
13	2006	164,093		164,093	20,792	102,057	13,015	135,864	28,229
14	2007	164,142		164,142	22,362	102,255	12,553	137,170	26,972
15	2008	159,467	25,632	185,099	18,810	106,129	8,840	133,779	51,320

Table 103 Cash Flow : WITHOUT

(US\$1,000)

Year	Cash Inflow			Cash Outflow				Net C/F (1)-(2)	
	Sales	Residual	Total (1)	CAPEX	OPEX	Tax	Total (2)		
1	1994	143,537		143,537	25,922	77,565	23,090	126,577	16,960
2	1995	146,153		146,153	11,274	77,376	23,345	111,995	34,158
3	1996	136,060		136,060	20,953	76,592	18,476	116,021	20,039
4	1997	128,299		128,299	17,871	76,468	14,794	109,133	19,166
5	1998	125,175		125,175	21,874	76,035	13,394	111,303	13,872
6	1999	124,714		124,714	8,630	75,660	13,068	97,358	27,356
7	2000	125,841		125,841	14,618	75,742	13,272	103,632	22,209
8	2001	126,273		126,273	15,444	76,440	13,131	105,015	21,258
9	2002	116,378		116,378	28,498	77,313	9,266	115,077	1,301
10	2003	116,163		116,163	11,426	77,494	8,573	97,493	18,670
11	2004	115,401		115,401	14,146	77,664	7,640	99,450	15,951
12	2005	114,069		114,069	18,420	78,004	7,122	103,546	10,523
13	2006	114,102		114,102	23,789	78,043	7,234	109,066	5,036
14	2007	113,210		113,210	11,541	78,109	6,652	96,302	16,908
15	2008	104,907	14,767	119,674	12,544	78,400	1,423	92,367	27,307

Table 104 Financial IRR : [WITH(Separation) - WITHOUT]

(US\$1,000)

Year	Increase of Cash Inflow			Increase of Cash Outflow				add. NCF (1)-(2)	
	Sales	Residual	Total (1)	CAPEX	OPEX	Tax	Total (2)		
1	1994	30,033	0	30,033	52,365	15,024	4,400	71,789	-41,756
2	1995	17,550	0	17,550	25,268	16,413	-2,795	38,886	-21,336
3	1996	26,540	0	26,540	2,129	19,685	-569	21,245	5,295
4	1997	40,539	0	40,539	11,789	22,533	2,880	37,202	3,337
5	1998	49,718	0	49,718	-2,856	25,909	4,339	27,392	22,326
6	1999	49,922	0	49,922	12,417	28,962	3,222	44,601	5,321
7	2000	47,999	0	47,999	3,640	28,915	2,691	35,246	12,753
8	2001	48,976	0	48,976	5,989	29,510	2,907	38,406	10,570
9	2002	57,899	0	57,899	777	28,929	6,024	35,730	22,169
10	2003	59,285	0	59,285	-807	29,782	6,818	35,793	23,492
11	2004	52,893	0	52,893	12,078	34,171	2,788	49,037	3,856
12	2005	56,344	0	56,344	1,513	36,863	3,001	41,377	14,967
13	2006	56,311	0	56,311	-2,997	36,899	3,003	36,905	19,406
14	2007	57,203	0	57,203	10,821	37,026	3,114	50,961	6,242
15	2008	60,292	10,865	71,157	6,266	37,044	5,843	49,153	22,004

F I R R : 14.04%

Table 105 Financial IRR : [WITH(Bulk) - WITHOUT]

(US\$1,000)

Year	Increase of Cash Inflow			Increase of Cash Outflow				add. NCF (1)-(2)	
	Sales	Residual	Total (1)	CAPEX	OPEX	Tax	Total (2)		
1	1994	29,929	0	29,929	49,960	15,021	4,436	69,416	-39,487
2	1995	18,340	0	18,340	23,352	12,561	-773	35,140	-16,800
3	1996	24,172	0	24,172	1,865	13,666	1,083	16,614	7,558
4	1997	36,955	0	36,955	11,525	14,456	4,877	30,858	6,097
5	1998	44,965	0	44,965	-3,119	15,867	6,664	19,412	25,553
6	1999	44,493	0	44,493	12,347	16,952	6,067	35,366	9,127
7	2000	41,303	0	41,303	3,640	16,830	5,057	25,527	15,776
8	2001	42,365	0	42,365	5,989	17,322	5,338	28,649	13,716
9	2002	51,176	0	51,176	777	16,746	8,399	25,922	25,254
10	2003	51,767	0	51,767	-807	17,545	8,887	25,625	26,142
11	2004	45,081	0	45,081	12,078	21,493	4,906	38,477	6,604
12	2005	50,012	0	50,012	1,513	23,981	5,784	31,278	18,734
13	2006	49,991	0	49,991	-2,997	24,014	5,782	26,799	23,192
14	2007	50,932	0	50,932	10,821	24,146	5,901	40,868	10,064
15	2008	54,560	10,865	65,425	6,266	27,729	7,417	41,412	24,013

F I R R : 20.12%

6-4 Economic Analysis

6-4-1 Cost and Benefits

As mentioned in 6-1, the economic analysis involves factors with a national perspective. It is therefore necessary to consider the application of shadow prices and elimination of transfer items, as mentioned above, in calculating income (benefits) and expenditure (costs) when assessing the internal rate of return (IRR).

Normally, benefits in an economic analysis are perceived as increases in exports or replacements for imports that can be achieved through implementing a project. Erdenet Mine exports its entire copper and molybdenum output. The benefit of modernization in this case will therefore be the increase in exports (increase in sales) resulting from modernization. In our calculation, we interpreted sales and residual value in the financial analysis as benefits of economic analysis.

Turning to costs, from capital investment we deducted import duty and sales tax, which are imposed in the first two years of the modernization plan, as transfer items. Tax on materials imported for operations is not included among operating expenses, on the assumption that payments for imports will be free of tax as long as payment is made out of funds on hand, and there is therefore no need for a deduction.

We assessed shadow prices as follows:

First, for wages, our normal practice is to classify workers into skilled and unskilled, and to apply a shadow wage to unskilled workers. However, under this modernization plan, Erdenet Mine will not reduce its workforce. Instead, we

adopted the principle of offset increase and decrease in the number of employees in each division by transfer of staffs. Total labor costs therefore remain unchanged by modernization, eliminating the need to apply a shadow wage.

For foreign exchange rates, the costs should be classified into those denominated in foreign currencies and those denominated in domestic currency. When converting costs denominated in domestic currency into dollars (for dollar-denominated cash flow analyses like this one), a shadow rate, rather than a market rate, should be applied. However, the Mongolian exchange rate, used for calculating sales and costs, had not been liberalized in the fiscal 1992 accounting year. The official exchange rate was the artificial one of $1\$US = 40 \text{ Tg}$. This rate was not determined by market principles (because a free foreign exchange market did not exist at that time). Furthermore, the artificial rate of that time was a temporary rate, applying only during the transitional period between the former centrally-planned economy and a market economy. For these reasons, it is very difficult to estimate the true rate in this artificial market. (moreover, it will be even more difficult in a market with free competition.) In carrying out this economic analysis, therefore, we shall not use a shadow exchange rate, but the rate of $1\$US = 40 \text{ Tg}$ that is used in the financial analysis.

Applying the above factors, Table 106 (modernization: separate production of copper and molybdenum), Table 107 (modernization: bulk production of concentrates) and Table 108 (scenario without modernization) show economic costs.

Table 106 Economic Costs : WITH (Mo/Cu Separation)

[Capital Expenditure]

(US\$ 1,000)

Year	Mining		Concentrating		Other Section		Replacement		Total Expenditure
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	
1 1994	689	42,184	2,446	8,539	718	5,999	114	3,442	64,131
2 1995	148	9,037	2,334	6,761	1,448	7,541	114	3,442	30,825
3 1996	170	10,426	1,917	6,213	55	745	114	3,442	23,082
4 1997	347	21,217	1,228	3,312	0	0	114	3,442	29,660
5 1998	215	13,147	546	1,554	0	0	114	3,442	19,018
6 1999	246	15,055	483	1,707	0	0	114	3,442	21,047
7 2000	203	12,399	339	1,761	0	0	114	3,442	18,258
8 2001	254	15,523	339	1,761	0	0	114	3,442	21,433
9 2002	413	25,306	0	0	0	0	114	3,442	29,275
10 2003	114	6,949	0	0	0	0	114	3,442	10,619
11 2004	364	22,304	0	0	0	0	114	3,442	26,224
12 2005	263	16,114	0	0	0	0	114	3,442	19,933
13 2006	277	16,959	0	0	0	0	114	3,442	20,792
14 2007	302	18,504	0	0	0	0	114	3,442	22,362
15 2008	245	15,009	0	0	0	0	114	3,442	18,810
Total	4,250	260,133	9,632	31,608	2,221	14,285	1,707	51,633	375,469

[Operation Costs]

(US\$ 1,000)

Year	Financial Costs			Economic Costs
	Total	(Local Costs)	(Foreign Costs)	
1 1994	92,589	37,036	55,553	92,589
2 1995	93,789	37,516	56,273	93,789
3 1996	96,277	38,511	57,766	96,277
4 1997	99,001	39,600	59,401	99,001
5 1998	101,944	40,778	61,166	101,944
6 1999	104,622	41,849	62,773	104,622
7 2000	104,657	41,863	62,794	104,657
8 2001	105,950	42,380	63,570	105,950
9 2002	106,242	42,497	63,745	106,242
10 2003	107,276	42,910	64,366	107,276
11 2004	111,835	44,734	67,101	111,835
12 2005	114,867	45,947	68,920	114,867
13 2006	114,942	45,977	68,965	114,942
14 2007	115,135	46,054	69,081	115,135
15 2008	115,444	46,178	69,266	115,444
Total	1,584,570	633,828	950,742	1,584,570

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

Table 107 Economic Costs : WITH (Production of Bulk Concentrate)

[Capital Expenditure]

(US\$ 1,000)

Year	Mining		Concentrating		Other Section		Replacement		Total Expenditure
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	
1 1994	689	42,184	2,036	7,003	718	5,939	114	3,442	62,125
2 1995	148	9,037	1,983	5,509	1,448	7,541	114	3,442	29,222
3 1996	170	10,426	1,848	6,018	55	745	114	3,442	22,818
4 1997	347	21,217	1,159	3,117	0	0	114	3,442	29,396
5 1998	215	13,147	478	1,359	0	0	114	3,442	18,755
6 1999	246	15,055	468	1,652	0	0	114	3,442	20,977
7 2000	203	12,399	339	1,761	0	0	114	3,442	18,258
8 2001	254	15,523	339	1,761	0	0	114	3,442	21,433
9 2002	413	25,306	0	0	0	0	114	3,442	29,275
10 2003	114	6,949	0	0	0	0	114	3,442	10,619
11 2004	364	22,304	0	0	0	0	114	3,442	26,224
12 2005	263	16,114	0	0	0	0	114	3,442	19,933
13 2006	277	16,959	0	0	0	0	114	3,442	20,792
14 2007	302	18,504	0	0	0	0	114	3,442	22,362
15 2008	245	15,009	0	0	0	0	114	3,442	18,810
Total	4,250	260,133	8,650	28,180	2,221	14,225	1,707	51,633	370,999

[Operation Costs]

(US\$ 1,000)

Year	Financial Costs			Economic Costs
	Total	(Local Costs)	(Foreign Costs)	
1 1994	92,586	37,034	55,552	92,586
2 1995	89,937	35,975	53,962	89,937
3 1996	90,258	36,103	54,155	90,258
4 1997	90,924	36,370	54,554	90,924
5 1998	91,902	36,761	55,141	91,902
6 1999	92,612	37,045	55,567	92,612
7 2000	92,572	37,029	55,543	92,572
8 2001	93,762	37,505	56,257	93,762
9 2002	94,059	37,624	56,435	94,059
10 2003	95,039	38,016	57,023	95,039
11 2004	99,157	39,663	59,494	99,157
12 2005	101,985	40,794	61,191	101,985
13 2006	102,057	40,823	61,234	102,057
14 2007	102,255	40,902	61,353	102,255
15 2008	106,129	42,452	63,677	106,129
Total	1,435,234	574,094	861,140	1,435,234

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

Table 108 Economic Costs : WITHOUT

[Capital Expenditure]

(US\$ 1,000)

Year	Mining		Concentrating		Other Section		Replacement		Total Expenditure
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	
1 1994	359	22,007	0	0	0	0	114	3,442	25,922
2 1995	106	6,512	286	814	0	0	114	3,442	11,274
3 1996	183	11,184	1,385	4,645	0	0	114	3,442	20,953
4 1997	178	10,897	886	2,354	0	0	114	3,442	17,871
5 1998	277	16,941	286	814	0	0	114	3,442	21,874
6 1999	82	4,992	0	0	0	0	114	3,442	8,630
7 2000	144	8,818	339	1,761	0	0	114	3,442	14,618
8 2001	157	9,631	339	1,761	0	0	114	3,442	15,444
9 2002	401	24,541	0	0	0	0	114	3,442	28,498
10 2003	126	7,744	0	0	0	0	114	3,442	11,426
11 2004	170	10,420	0	0	0	0	114	3,442	14,146
12 2005	239	14,625	0	0	0	0	114	3,442	18,420
13 2006	325	19,908	0	0	0	0	114	3,442	23,789
14 2007	128	7,857	0	0	0	0	114	3,442	11,541
15 2008	144	8,844	0	0	0	0	114	3,442	12,544
Total	3,019	184,921	3,521	12,149	0	0	1,707	51,633	256,950

[Operation Costs]

(US\$ 1,000)

Year	Financial Costs			Economic Costs
	Total	(Local Costs)	(Foreign Costs)	
1 1994	77,565	31,026	46,539	77,565
2 1995	77,376	30,950	46,426	77,376
3 1996	76,592	30,637	45,955	76,592
4 1997	76,468	30,587	45,881	76,468
5 1998	76,035	30,414	45,621	76,035
6 1999	75,660	30,264	45,396	75,660
7 2000	75,742	30,297	45,445	75,742
8 2001	76,440	30,576	45,864	76,440
9 2002	77,313	30,925	46,388	77,313
10 2003	77,494	30,998	46,496	77,494
11 2004	77,664	31,066	46,598	77,664
12 2005	78,004	31,202	46,802	78,004
13 2006	78,043	31,217	46,826	78,043
14 2007	78,109	31,244	46,865	78,109
15 2008	78,400	31,360	47,040	78,400
Total	1,156,905	462,762	694,143	1,156,905

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

6-4-2 Economic Internal Rate of Return

In order to calculate the economic internal rate of return, Tables 109, 110, and 111 combine the costs and benefits in the two cases of modernization ("with") and the one case in which modernization is not implemented ("without"). In the financial analysis, we included corporate tax in the costs (cash outflow). However, in the economic analysis, corporate tax is not considered a cost, as it is a transfer item.

Next, by calculating the difference between "with" and "without," we obtained from Table 112 an EIRR of 26.75% for the case of separate production of copper and molybdenum. An EIRR of 40.17% for bulk production of concentrate is also obtained from Table 113. These modernization plans both show extremely high profitability, as can be judged by the comment, "The project is said to be economically feasible if the EIRR is at least 12% for the World Bank, 8% for USAID, 10% for the Asia Development Bank and 7% for Japan." (Note).

(Note) "New F/S: Theory and Practice for the Implementation of Development Projects" January, 1980, Masamitsu Toriyama

Table 109 Cost/Benefit : WITH (Mo/Cu Separation)

(US\$1,000)

Year	Benefit			Costs			Net Bnft. (1)-(2)	
	Sales	Residual	Total (1)	CAPEX	OPEX	Total (2)		
1	1994	173,570		173,570	64,131	92,589	156,720	16,850
2	1995	163,703		163,703	30,825	93,789	124,614	39,089
3	1996	162,600		162,600	23,082	96,277	119,359	43,241
4	1997	168,838		168,838	29,660	99,001	128,661	40,177
5	1998	174,893		174,893	19,018	101,944	120,962	53,931
6	1999	174,636		174,636	21,047	104,622	125,669	48,967
7	2000	173,840		173,840	18,258	104,657	122,915	50,925
8	2001	175,249		175,249	21,433	105,950	127,383	47,866
9	2002	174,277		174,277	29,275	106,242	135,517	38,760
10	2003	175,448		175,448	10,619	107,276	117,895	57,553
11	2004	168,294		168,294	26,224	111,835	138,059	30,235
12	2005	170,413		170,413	19,933	114,867	134,800	35,613
13	2006	170,413		170,413	20,792	114,942	135,734	34,679
14	2007	170,413		170,413	22,362	115,135	137,497	32,916
15	2008	165,199	25,632	190,831	18,810	115,444	134,254	56,577

Table 110 Cost/Benefit : WITH (Production of Bulk Concentrates)

(US\$1,000)

Year	Benefit			Costs			Net Bnft. (1)-(2)	
	Sales	Residual	Total (1)	CAPEX	OPEX	Total (2)		
1	1994	173,466		173,466	62,125	92,586	154,711	18,755
2	1995	164,493		164,493	29,222	89,937	119,159	45,334
3	1996	160,232		160,232	22,818	90,258	113,076	47,156
4	1997	165,254		165,254	29,396	90,924	120,320	44,934
5	1998	170,140		170,140	18,755	91,902	110,657	59,483
6	1999	169,207		169,207	20,977	92,612	113,589	55,618
7	2000	167,144		167,144	18,258	92,572	110,830	56,314
8	2001	168,638		168,638	21,433	93,762	115,195	53,443
9	2002	167,554		167,554	29,275	94,059	123,334	44,220
10	2003	167,930		167,930	10,619	95,039	105,658	62,272
11	2004	160,482		160,482	26,224	99,157	125,381	35,101
12	2005	164,081		164,081	19,933	101,985	121,918	42,163
13	2006	164,093		164,093	20,792	102,057	122,849	41,244
14	2007	164,142		164,142	22,362	102,255	124,617	39,525
15	2008	159,467	25,632	185,099	18,810	106,129	124,939	60,160

Table 111 Cost/Benefit : WITHOUT

(US\$1,000)

Year	Benefit			Costs			Net Bnft.	
	Sales	Residual	Total (1)	CAPEX	OPEX	Total (2)	(1)-(2)	
1	1994	143,537	143,537	25,922	77,565	103,487	40,050	
2	1995	146,153	146,153	11,274	77,376	88,650	57,503	
3	1996	136,060	136,060	20,953	76,592	97,545	38,515	
4	1997	128,299	128,299	17,871	76,468	94,339	33,960	
5	1998	125,175	125,175	21,874	76,035	97,909	27,266	
6	1999	124,714	124,714	8,630	75,660	84,290	40,424	
7	2000	125,841	125,841	14,618	75,742	90,360	35,481	
8	2001	126,273	126,273	15,444	76,440	91,884	34,389	
9	2002	116,378	116,378	28,498	77,313	105,811	10,567	
10	2003	116,163	116,163	11,426	77,494	88,920	27,243	
11	2004	115,401	115,401	14,146	77,664	91,810	23,591	
12	2005	114,069	114,069	18,420	78,004	96,424	17,645	
13	2006	114,102	114,102	23,789	78,043	101,832	12,270	
14	2007	113,210	113,210	11,541	78,109	89,650	23,560	
15	2008	104,907	14,767	119,674	12,544	78,400	90,944	28,730

Table 112 Economic IRR : [WITH(Separation) - WITHOUT]

(US\$1,000)

Year	Increase of Benefit			Increase of Costs			Net Bnft. (1)-(2)	
	Sales	Residual	Total (1)	CAPEX	OPEX	Total (2)		
1	1994	30,033	0	30,033	38,209	15,024	53,233	-23,200
2	1995	17,550	0	17,550	19,551	16,413	35,964	-18,414
3	1996	26,540	0	26,540	2,129	19,685	21,814	4,726
4	1997	40,539	0	40,539	11,789	22,533	34,322	6,217
5	1998	49,718	0	49,718	-2,856	25,909	23,053	26,665
6	1999	49,922	0	49,922	12,417	28,962	41,379	8,543
7	2000	47,999	0	47,999	3,640	28,915	32,555	15,444
8	2001	48,976	0	48,976	5,989	29,510	35,499	13,477
9	2002	57,899	0	57,899	777	28,929	29,706	28,193
10	2003	59,285	0	59,285	-807	29,782	28,975	30,310
11	2004	52,893	0	52,893	12,078	34,171	46,249	6,644
12	2005	56,344	0	56,344	1,513	36,863	38,376	17,968
13	2006	56,311	0	56,311	-2,997	36,899	33,902	22,409
14	2007	57,203	0	57,203	10,821	37,026	47,847	9,356
15	2008	60,292	10,865	71,157	6,266	37,044	43,310	27,847

E IRR : 26.75%

Table 113 Economic IRR : [WITH(Bulk) - WITHOUT]

(US\$1,000)

Year	Increase of Benefit			Increase of Costs			Net Bnft. (1)-(2)	
	Sales	Residual	Total (1)	CAPEX	OPEX	Total (2)		
1	1994	29,929	0	29,929	36,203	15,021	51,224	-21,295
2	1995	18,340	0	18,340	17,948	12,561	30,509	-12,169
3	1996	24,172	0	24,172	1,865	13,666	15,531	8,641
4	1997	36,955	0	36,955	11,525	14,456	25,981	10,974
5	1998	44,965	0	44,965	-3,119	15,867	12,748	32,217
6	1999	44,493	0	44,493	12,347	16,952	29,299	15,194
7	2000	41,303	0	41,303	3,640	16,830	20,470	20,833
8	2001	42,365	0	42,365	5,989	17,322	23,311	19,054
9	2002	51,176	0	51,176	777	16,746	17,523	33,653
10	2003	51,767	0	51,767	-807	17,545	16,738	35,029
11	2004	45,081	0	45,081	12,078	21,493	33,571	11,510
12	2005	50,012	0	50,012	1,513	23,981	25,494	24,518
13	2006	49,991	0	49,991	-2,997	24,014	21,017	28,974
14	2007	50,932	0	50,932	10,821	24,146	34,967	15,965
15	2008	54,560	10,865	65,425	6,266	27,729	33,995	31,430

E IRR : 40.17%

6-5 Sensitivity Analysis

The calculations were made in the above financial and economic analyses after estimating the most likely figures for the various assumptions (economic variables). We call this scenario (the most likely scenario) the "base case."

However, in practice, not all the variables will necessarily agree with our estimates. It is therefore possible that project profitability will be very different. The purpose of sensitivity analysis is to look what effects such fluctuations in variables will have on the project.

Here, we conduct a sensitivity analysis on copper prices and operating expenses, both of which will have a relatively major impact on this modernization plan.

First, for copper prices, we used £1,400MT (real price remains unchanged over 15 years) based on the London LME as at the end of November, 1992 in the base case. When we look at the changes in prices (converted into dollars for the past five years), a level about 10% lower than this is the lower limit. Furthermore, as mentioned, price fluctuations in the future are expected to be in line with inflation (in other words, real prices will remain unchanged). Therefore, we conduct the sensitivity analysis with a 10% fluctuation in copper prices (see Sensitivity Analysis (1) -- Table 114).

As regards operating expenses, we used figures calculated by each division based on the fiscal 1992 figures in the base case. We made the calculations on the assumption that all costs will increase in line with inflation. However, an increase in real costs (an increase in costs greater than inflation) is conceivable. The sensitivity analysis (2) (See Table 115) shows calculations based on the

assumption that, in addition to fluctuations in copper prices, the level of operating expenses will uniformly rise 10% in each fiscal year.

Based on the results of the above analysis, it is clear that fluctuations in copper prices will have a major effect on the project's economics. To ensure that the modernization plan is profitable in the future, management will need to be flexible to the level of copper prices.

The situation created in the sensitivity analysis (2), where both copper prices and operating expenses affect the economy of the project adversely, is the worst conceivable scenario. However, even in this case (especially with the method of bulk production of concentrates) we can see that IRR is not so bad.

Based on an overall judgment from a financial and economic perspective, we can conclude that this modernization plan is profitable enough to be able to respond to a certain number of changes in conditions.

Table 114 Sensitivity Analysis(1): Base case

Copper Price (£/MT)		FIRR(%)		EIRR(%)	
		Separation	Bulk	Separation	Bulk
-10%	1,260	7.38	13.14	13.22	24.69
ベース	1,400	14.04	20.12	26.75	40.17
+10%	1,680	20.31	26.94	40.87	58.02

Table 115 Sensitivity Analysis(2): 10% rise of operation cost

Copper Price (£/MT)		FIRR(%)		EIRR(%)	
		Separation	Bulk	Separation	Bulk
-10%	1,260	3.18	11.49	6.67	20.43
ベース	1,400	11.23	18.24	20.87	35.38
+10%	1,680	17.59	25.00	34.41	51.87

7 Conclusion and Recommendation

7. Conclusion and Recommendation

The primary aim of the proposed modernization plan is to stabilize mining operations over the 15 years beginning 1994 and to achieve forecast sales (foreign currency revenue) and profit.

To do so, we set the target amount of copper in the concentrate at 120,000 tons/year. Given the mining conditions, a fall in the grade of crude ore and investment in the addition and modification of facilities, we plan for a 50% increase in the amount of crude ore mined, from 20 million to 30 million tons per annum.

The amount of investment required over 15 years to implement this plan is \$342 million under the method of separating copper and molybdenum (the separation method) and \$337 million for the mixed concentrate method (the bulk method). Financial and economic analysis on the investment amount and anticipated income show outstanding results, indicating that the plan is feasible.

The internal financial rate of return of this plan is 14% for the separation method and 20% for the bulk method. Both cases exceed the assumed interest rate (5%) on invested borrowings. Therefore, these projects are profitable.

For the Mongolian nation, the internal economic rate of return was 27% for the separation method and 40% for the bulk method, showing very high levels.

These levels far exceed the 10% to 12% that international institutions use as criteria to determine the appropriateness of projects. Thus, the project can be considered to hold great benefits for Mongolia's economic development.

As for the selection of the concentrate production method: if more importance is placed on Mongolia's foreign currency income, the separation

method should be adopted. Alternatively, if the company wishes to seek greater profits, it should choose the bulk method. This choice must be up to the Mongolians.

Some of the forecast values in this plan are uncertain. In actually making the investment, we hope that a more detailed examination will be made to ensure that prudent measures are adopted.

In implementing the modernization plan we should like to raise the following as matters requiring attention.

(1) The first priority in investment should be to secure a steady supply of electricity. Because this is extremely important, it is necessary to quickly build a power generation plant in Erdenet in line with national energy policies. Under this plan, our conclusion is that the country invests in building the power generation plant and Erdenet buys electricity from the plant.

Investment in modernization should be directed at the addition and modification of machinery and equipment needed for production activities, the introduction of new processes and other areas. We have calculated the costs of mining equipment, mineral processing facilities and machine tools using western prices. However, as Mongolia lacks information on the specifications and prices of western equipment, we would like the mine to obtain more detailed information in the future.

(2) With regard to the amount of investment required in the first two years: we based our economic and financial analysis on the precondition that investment would be wholly financed by borrowings. About 30% of the investment needed to execute this modernization plan comes in the first two years. Further, because

economic conditions in the Mongolian economy are expected to remain severe, we believe that it would be most realistic for the mine to appropriate the amount of investment required to modernize in the first two years from overseas loans.

In this case, investment from the third year will be appropriated from the Mine's funds on hand (namely, funds generated by the Mine's profits). However, as such funds are an important source of foreign currency for Mongolia, and given the nation's financial conditions, investment should be made while conducting careful investigation at a national level.

(3) In terms of overall management, as Mongolia is currently shifting from a socialist to a market economy, the country must correct the weaknesses inherent in the previous system. The underlying principle of a market economy is free competition. To withstand free competition, productivity must be constantly improved and efforts must be made to reduce costs and improve quality.

Here, we propose that improvements in the following aspects of production and management be taken as key examples: the accounting system, personnel and wage policies, simplification of the organization, appropriate allocation of personnel, sales conditions, automation of operational control, concentrate quality control and the quality of the mine's products. In particular, to increase the feeling of employee unity with the company, and to access qualified workers, the mine must continue to provide training on skills, control, safety and other aspects. The mine must never cease to train its human resources.

(4) At present, we consider it premature to privatize the entire mine. However, the issue should be kept in mind for the future.

The mine should aim to separate businesses which have little connection to

mining operations and make them independent new companies. These companies should then be privatized and allowed to grow in an environment of free competition. In doing so, the mine should aim at strengthening companies which come under its aegis.

We would also like to propose that the mine establish a system under which other divisions accept relocated personnel. This system should be put in place in future, when the organization is simplified.

(5) The mine should adopt a corporate philosophy of carrying out fair business activities. So that the Mine can gain credit and a positive evaluation on an international level, it should continue to carry out sound management in the future. At the same time, we consider that the mine should ensure that it takes into sufficient consideration such matters as environmental conservation, employees' health and continued employment.

Appendix

Appendix 1 Bibliography

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Appendix 2 Data from the Mongolian Side

1. Data related to Geology and Mineral Exploration

- (1) Ore block plan at 1400-1460m level
- (2) Cost of Geology Department
- (3) Geological map of Erdenet Mine area(1:25,000)
- (4) Geological map of Erdenet area
- (5) Topographic map of Erdenet Mine and neighborhood
- (6) Layout of plant & facilities(1:10,000)
- (7) Medium-term mineral exploration plan
- (8) Cross section of ore reserve computation
- (9) A sample of ore block computation
- (10) Summary of ore reserve computation
- (11) Location map of drill holes
- (12) Geological map of Erdenet Mine and neighborhood(plane)
- (13) Geological map of Erdenet Mine and neighborhood(cross section)
- (14) Organization chart of Geology Department
- (15) Summary of ore reserve computation of central ore body

2. Data related to Mining

- (1) Production cost of mining
- (2) Long-term mining plan
- (3) Check list of machinery maintenance
- (4) List of drilling specifications
- (5) Results of dilution
- (6) Specifications of explosive charging
- (7) Comparative table between plans and results
- (8) Working records of rotary drills
- (9) Purchase and depreciation of bulldozers
- (10) Purchase and depreciation of power shovels
- (11) Working records of dump trucks
- (12) Working records of bulldozers
- (13) Grade of crude ore
- (14) Organization chart of Mining Department

- (15) Working records of power shovels
- (16) Sampling of crude ore and feed grade
- (17) Present operating pit design
- (18) Open pit mining plan
- (19) Open pit design
- (20) Summary of five-year mining plan
- (21) Summary of drilling powder analysis
- (22) Distribution diagram of results of drilling powder analysis

3. Data related to Mineral Processing and Laboratory

- (1) Plant operation table(annual & monthly)
- (2) Plant operation cost table
- (3) Equipment list of No.5 section
- (4) Wage table
- (5) Organization and personnel table
- (6) Renewal plan of plant equipment(1993-1997)
- (7) Long-term production plan(1993-2010)
- (8) Annual periodical maintenance plan(1992)
- (9) General layout of Erdenet Mine
- (10) Flow sheet of crushing & grinding stage of No.5 section
- (11) Material balance sheet for grinding and water
- (12) Vertical section of tailing pipe line
- (13) Technical instruction for Cu-Mo ore of dressing plant
- (14) Method of raising the containing ratio of chalcopyrite
- (15) Test report on upgrading of Cu concentrates
- (16) Research laboratory equipment list
- (17) List of research theme(1992-1993)
- (18) Report on mineralogical study
- (19) Analytical values of Cu concentrate(yearly average,1990-1992)
- (20) Analytical values of Cu conc. as of May, 1993
- (21) Mineralogical study results on bulk flotation tailings
- (22) Equipment and materials for processing test already ordered
- (23) Central labotratory's long-term research theme

4. Data related to Workshop

- (1) List of products
- (2) Time study list
- (3) List of machinery and equipment life
- (4) Production yield rate list
- (5) Raw materials list
- (6) Organization and personnel table
- (7) List of causes of inferior products
- (8) Table of product standards
- (9) Production cost table
- (10) Production by kind
- (11) Heat treatment data

5. Data related to Utilities

- (1) Electric power consumption records
- (2) Day load curve of electric power
- (3) Table of electric power transmission & distribution loss
- (4) Table of average load to each transformer
- (5) Diagram of transmission and distribution line
- (6) Records of power stoppage and restriction
- (7) List of electric motors of more than 20kw
- (8) Average load of electric powers of more than 20kw
- (9) Monthly consumption of steam and hot water
- (10) Diagram of steam and hot water piping
- (11) Standards for deciding the temperature of hot water
- (12) Coal analysis table
- (13) Piping diagram of steam, water and hot water in the boiler room
- (14) Water balance diagram
- (15) Route of water pipe and specifications
- (16) Characteristic curve of water pumping

6. Data related to Environment

- (1) Meteorological data of Erdenet city
- (2) Text of air pollution control law

- (3) Spec. and operation data on the equipment for boiler waste gas
- (4) Spec. and operation data on the equipment for drier waste gas
- (5) Foundry ventilation system and data
- (6) Standards for potable water
- (7) Standards for draining of waste water from the plant
- (8) Operation data on sewage treatment plant(monthly average of '92)
- (9) Specifications of sewage system
- (10) analysis data on sewage discharged into Orhon river
- (11) Data on work places environment
- (12) List of occupational diseases
- (13) Measurement data on work place environment(dust, Co)
- (14) Comprehensive program for environmental improvement
- (15) List of analytical equipment for environmental measurement
- (16) List of analytical equipment of Central laboratory
- (17) List of analytical equipment to be reinforced

7. Data related to Financial and Economic Analysis

- (1) Average wage table by profession and section
- (2) List of the number of employees by profession and section
- (3) Changes of wages and number of employees by profession
- (4) List of employees by Mongolian/Russian and section
- (5) Balance sheet(1992)
- (6) Profit and loss statement(1992)
- (7) List of fixed assets(1992)
- (8) Changes in business results for the last five years
- (9) Production cost by section and factor(Jan. 1992-Jan. 1993)
- (10) Production cost by product(1992)
- (11) Production cost by product(1991/1992)
- (12) Changes in production cost by factor
- (13) Table of depreciation rate
- (14) New forms of book-keeping
- (15) Profit and dividend plan for 1993
- (16) Investment plan for 1993
- (17) Production plan for 1993

- (18) List of main articles procured
- (19) Sales records by destination and sales plan for 1993
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- (22) Export and import records(1988-1992)
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- (24) Mineral resources law(draft as of March, 1993)
- (25) Resolution No.170 referring to privatization
- (26) Privatization law
- (27) Customs Act
- (28) Banking Act
- (29) Petroleum law
- (30) Foreign investment law
- (31) List of ODA to Mongolia

8. Data related to Management

- (1) Labor law
- (2) Organization chart of Transportation Department
- (3) Items of design drawing
- (4) Organization chart of Railway Department
- (5) List of vehicles
- (6) Vehicle load rates
- (7) Details of service of Repair Division
- (8) Organization chart of Repair Division
- (9) Work place environment analysis
- (10) Statistics of labor disasters
- (11) Shipping control of Cu concentrate
- (12) Copy of labor contract with Russian employees

9. Miscellaneous data

- (1) Report on the development of Mongolian copper industry
- (2) Technical & economic basis for the construction of copper smelter
- (3) World Bank Report(Mining Sector)

Appendix 3 List of People Interviewed

(1) Steering Committee

Name	Office
H. Naranhuu	Director of Foreign Investment Department Ministry of Trade & Industry (MTI)
L. Tserenjav	Deputy Director Foreign Investment Department, MTI
L. Nasanbuyan	Assistant of Director Foreign Trade Policy Department, MTI
B. Doeddorj	Expert, Economic Cooperation Department National Development Department
D. Jigjid	Officer, Asia & African Division Ministry of External Relations
Z. Prefnanzado	Adviser Ministry of External Relations
C. Dashdorj	Officer Ministry of Finance
B. Dalai	Senior Officer, Mining Department Ministry of Geology and Mineral Resources
N. Alгаа	Senior Metallurgical Engineer, Mining Dept. Ministry of Geology and Mineral Resources
D. Odongua	Officer Foreign Trade Policy Department, MTI
Y. Enhchuluun	Investment Promotion Official Foreign Investment Department, MTI
J. Suvdaa	Officer Foreign Investment Department, MTI
B. Chimgee	Coordinator Foreign Investment Department, MTI

(2) Erdenet Mine

Name	Post/Department
S. Otgonbileg	General Director
R. D. Arustamov	First Deputy General Director
G. Sharhuu	Deputy General Director
T. Sanjii	Deputy General Director
D. Nyamaa	Deputy General Director Director for Economical Affairs
G. D. Apazov	Deputy General Director Director for Production & Technical affairs
D. Adaya	Ex-General Manager, Production & Technical Department
S. Gezegt	General Manager, Production & Technical Department

Name	Post/Department
L. Khukhuu	Ex-General Manager, Energy Department
Ganhujag	General Manager, Energy Department
S. Ganjargal	Chief, Mining Division
S. Davaanyam	Chief, Mineral Processing Division
Baatarhuu	Chief, Test & Research Division
G. Sanduijav	Chief Geologist, Geological Division
Ononhuu	Manager, Ulaanbaataar Office (Ex-Chief, Transportation Division)
G. Sodnomdorj	Chief, Transportation Division
Jamvajants	Chief, Railway Division
D. Galbaatar	Manager, Health & Cultural Center
B. Tsogtsaihan	Chief, Work Shop Division
Batchuluun	Chief, Boiler Division
Chinbat	Chief, Electric Division
Sharavdorj	Chief, Water Division
Batsaihan	Chief, Stockbreeding Division
Handsuren	Manager, Accounting Division
Kiriyarov	General Manager, Economic Division
Galbaatar	Manager, Economic Division
Purevdorj	Manager, Financial Division
Zorigt	Ex-Manager, Commercial & Sales Division
Amarbat	Manager, Commercial & Sales Division
Dimitrov	Manager, Equipment Supply Division
Tuvdendorj	Manager, Quality Control Division
Amgalan	Manager, Legal affairs Division
Togooche	Manager, Personnel Division
D. Erdenedalai	Chief Engineer, Production & Technical
B. Baatarchuluun	Ex-Manager, Ulaanbaataar Office

(3) Central & Local Government

Name	Office
G. Oyuntchimeg	Officer, Foreign Trade Policy Department, MTI
Saija	Deputy General Director, The Inspectorate of Hygiene and Epidemiology
D. Lkhagvasuren	Director-General, Employment Department, Ministry of Population Policy and Labor
Eredenchimeg	Officer, Labor Relation Department, Ministry of Population Policy and Labor
B. Ochbadrakh	Deputy Chairman, State Commission for Privatization
D. Bailykhuu	Adviser, State Commission for Privatization
T. Batnasan	Director, Ministry of Finance
G. Zinaamyadar	First Deputy Director General, Department of State Taxation
T. Oyunbileg	General Director, Department of Mines, Ministry of Geology and Mineral Resources
D. Batbold	Officer, Foreign Affairs Div., Ministry of Nature and Environment
T. Sukubaatar	Chief of Department for International Co-operation, Ministry of Fuel & Energy
Amarsaikhan	Deputy Director General, Customs General Administration
Ishdorj	Chief, Market & Conjuncture Dept., MTI
Hongorzul	Officer, Market & Conjuncture Dept., MTI
Altontulga	Deputy Director, Foreign Trade Policy Department
Odongua	Officer, Foreign Trade Policy Department
Gerelchuluun	Secretary, State Commission for Privatization
Ayua	General Director, Dept. for External Economic Relations, Ministry of Finance
Dashdorj	Officer, Dept. for External Economic Relations, Ministry of Finance
Odongua	Director, International Dept., The Bank of Mongolia
Batsandag	Deputy Director, Department of Mines, Ministry of Geology and Mineral Resources
Ganbold	deputy Director, Dept. of Industrial Policy, MTI
Jatambaa	Deputy Mayor of Erdenet City

Appendix IV
Site Survey
Photographs



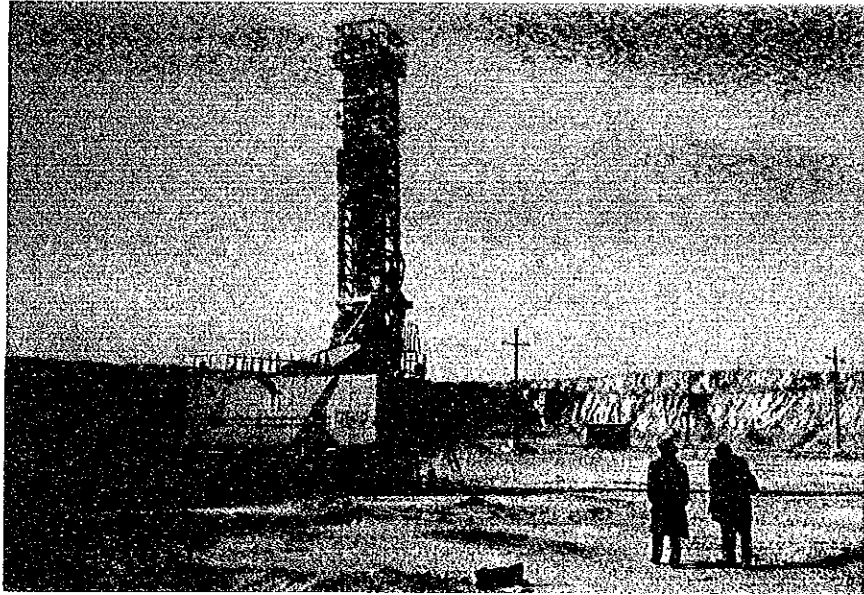
Meeting with Steering Committee



Meeting with Staff of the Erdenet Mine



A-11 Exchange of Memorandum



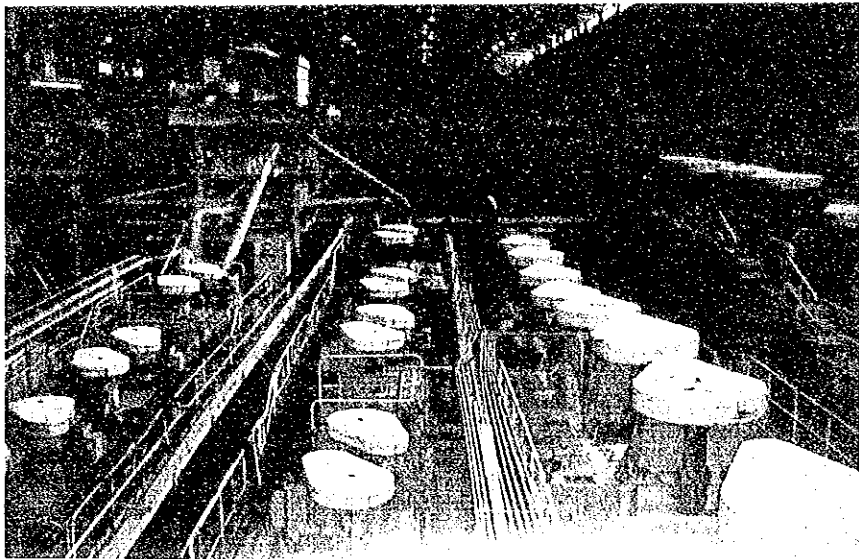
Rotary Drill



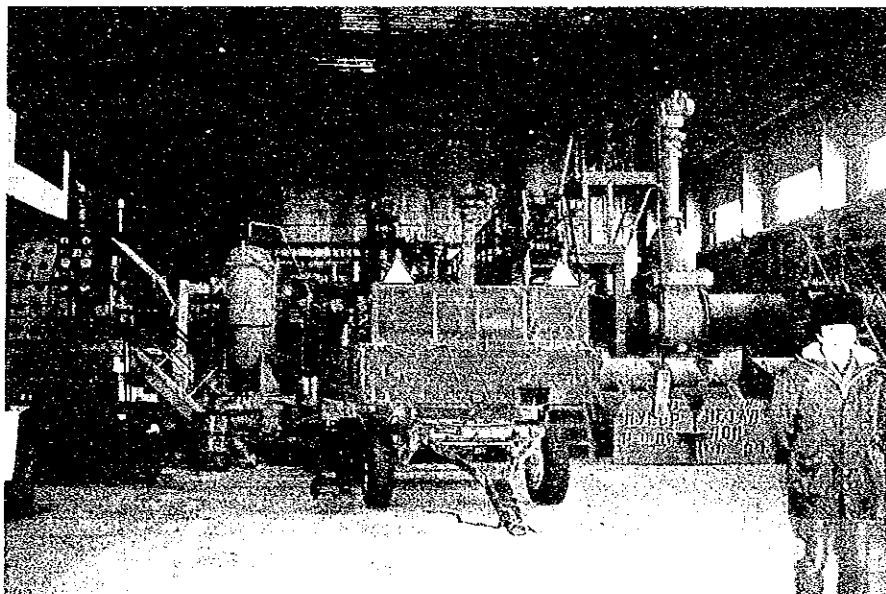
110t Dump Truck



A Scene of Blasting

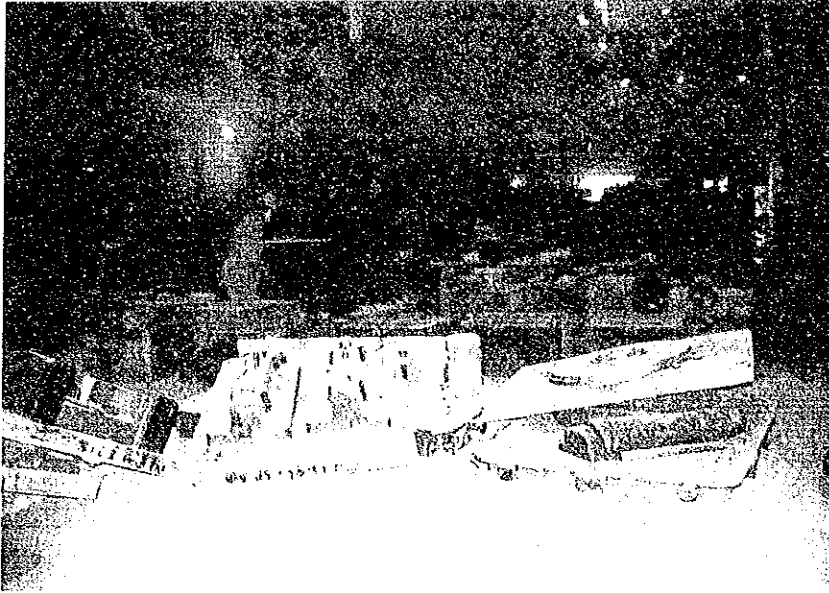


Flotation Machines of Unit No.5



Booster Pump for Discharge of Tailing

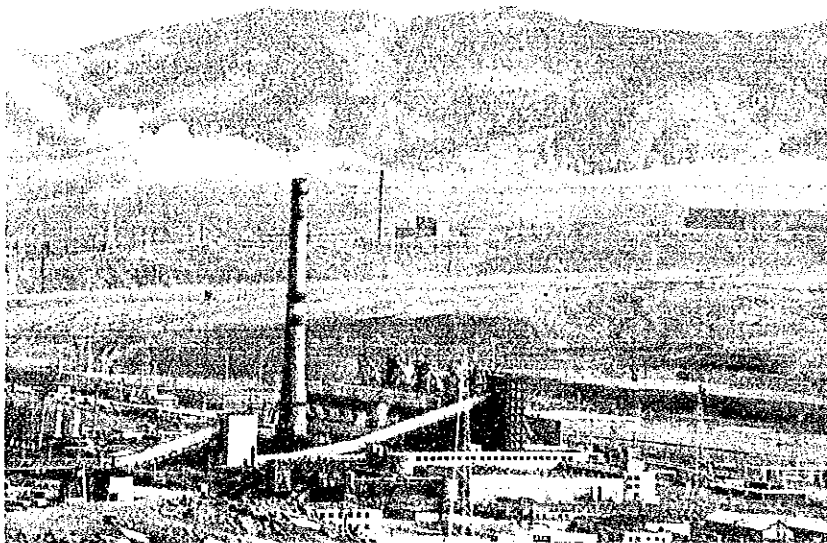




Casting Plant
(Casting Section)



Casting Plant
(Lathe Work
Section)



Power Plant (front)
and Boiler Facility (back)

JICA