CHAPTER 4 AUXILIARY ENGINEERING DIVISION

4–1 Organization and Personnel

The organization and the distribution of personnel of maintenance section and electrical section in Catavi mine are shown in Fig. 4–1, 4–2.

In addition to the above-mentioned personnel mechanics belong to the metallurgy section and are engaged in the repair work and the operation of machine equipment. The number of mechanics is 44 in the Siglo XX section, 78 in the Victoria section and 16 in the Kenko section, making a total of 138 workers.

In Siglo XX maintenance factory, there are 13 compressor operators of the mining section, 30 hoist operators and 25 persons engaged in water supply.

Neither the mining section nor the metallurgy section has electricians, and electrical section managers the electricians.

4–2 Outline of Equipment

The mining equipment and concentration equipment in Catavi mine are shown in Figs. 4–3, 4–4, 4–5 and Table 4–1 ~ Table 4–23.

4–3 Capacity of Main Equipment

4–3–1 Air Compression Equipment

The volume of compressors except Joy 1,000 PS shown in Table 4–24.

The volume of 886 m^3/min is thought to be the theoretical volume, while the actual volume is 886 x 0.85 = 753 m^3/min. This volume covered the production of about 114,000 T/M in 1980, the volume of the Joy 1000 PS, 142 m^3/min, is therefore regarded entirely as surplus volume.

In Matsumine Mine of Dowa Mining Co., Ltd., production is 45,000 T/M and the volume per unit feed ore quantity, this volume is nearly equal to the above-mentioned volume if the volume generated by Joy 1000 PS is excluded.

4–3–2 Winding Equipment

The winding equipment includes seven shafts and two inclines. Except Rampa 620 Incline, all other equipment is used for transporting personnel.

The Rampa 620 Incline hoist equipment is used to wind up ore from levels lower than L650, but the levels lower than L720 have been flooded at present and the hoist is not used. As it will be used in future, the capacity of this incline hoist is mentioned below.

Specification of incline

Winding machine	Winding capacity	7 t
	Rope speed	1.6 m/s
	Drum	Double drum
	Motor	300 PS
Skip	Tare	2,500 Kg
Rope	7″ ϕ 6 x 19	2.41 Kg/m
	Tare	about 530 Kg
Incline	Inclination	55°
	Winding level	L800 → L620
	Winding range	220 m

Winding cycle

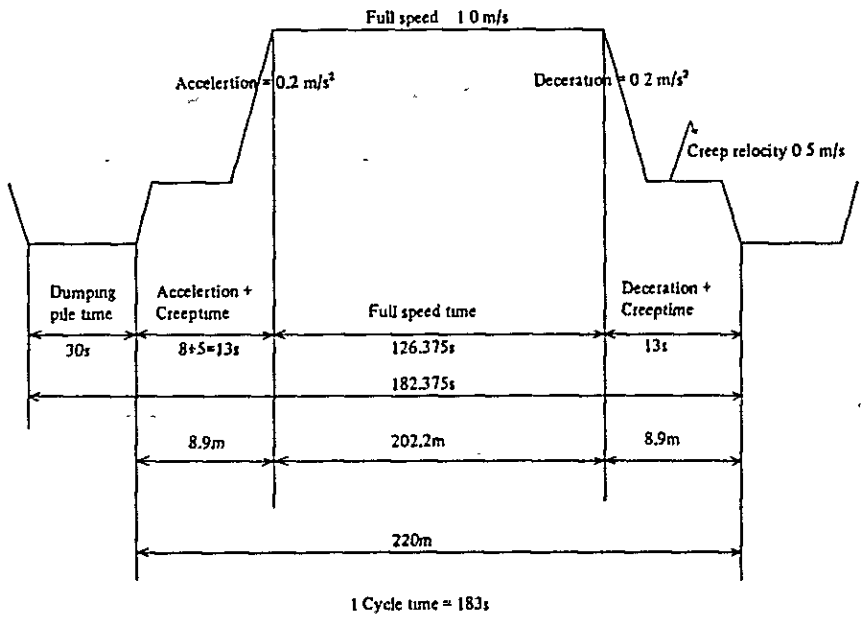


Fig. 4–6 Speed Curve Chart

CORPORACION MINERA DE BOLIVIA
Empresa Minera Catavi

ORGANIGRAMA DEL DEPARTAMENTO SUPERFICIE CATAVI

SUPERINTENDENTE GENERAL

ASISTENTE

5-1 OFICINA SUPERFICIE	BASICO B
Encargado Oficina	1
Secretario "A"	1
Secretario "C"	2
Mecanógrafo	1
Compresorista - L -	2
Correo Interno	1

5-2 OFICINA TECNICA	4
Topógrafo	1
Dibujante Diseñador	1
Dibujante "A"	1
Auxiliar "B"	1

5-3 MAESTRANZA GRAL CAT	89
Jefe Maestranza	1
Sub Jefe Maestranza	1
Encargado Maestranza	1
Auxiliar "C"	1
Secretario "B"	1
Tornero "A"	8
Tornero "B"	4
Fresador	2
Mecánico Espla. Est. Metal.	1
Mecánico Especialista	4
Mecánico Ira. Clase	6
Mecánico 2da. Clase	12
Herrero Ira Clase	2
Soldador Ira. Clase	4
Soldador 2da. Clase	1
Soldador Especialista	1
Taladrista Ira Clase	2
Operador Prensa Hidrául.	1
Operador Cepillador	1
Plomero	3
Despachador "B"	2
Bombero agua potable	7
Tomero agua potable	1
Ayudante Artesano	14
Barredor	1
CUADRILLA VOLANTE	
Mayordomo	1
Jornalero	6

5-4 MAESTRANZA SIGLO XX	127
Jefe Técnico Mecánico	1
Jefe Maestranza Siglo XX	1
Encargado Compresoras	1
Sub Encargado Talleres	5
Encargado Winches	1
Secretaria "A"	1
Secretaria "C"	1
Winchero de Ira.	17
Winchero de 2da.	12
Tornero "A"	3
Tornero "B"	1
Carrocero de Ira.	4
Cepillador	1
Herrero de Ira.	3
Hojalatero de Ira.	1
Mecánico de Ira.	3
Plomero de Ira.	3
Soldador de Ira.	3
Taladrista de Ira.	2
Tornero "C"	2
Carrocero de 2da.	4
Compresoristas Canca	6
Mecánico de 2da.	2
Soldador de 2da.	1
Despachador "B"	1
Encargado Bomb. Catri	1
Bombero Interior Mina	11
Compresorista Int. Mina	1
Herrero de 2da.	1
Juez de Agua Potable	1
Ayudante Winchero	2
Cañerista de 2da.	2
Bombero Ira. agua potable	8
Compresorista Est. Mina	1
Pesador Balanza Mina	2
Ayudante Artesano	14
Cortador Fabrica Tacos	1
Taquero	2

5-6 CARPINTERIA GRAL CAT	31
Encargado Carpintería	1
Sub Encargado	1
Secretario "B"	1
Pintor Especialista	1
Mecánico Ira. Clase	1
Talabartero Ira Clase	1
Despachador "B"	1
Carpintero Ebanista	5
Carpintero Ira Clase	6
Carpintero 2da. Clase	5
Ayudante Artesano	7
Jornalero	1

5-7 CARPINTERIA SIGLO XX	12
Encargado Carpintera	1
Carpintero de Ira.	4
Talabartero de Ira.	1
Carpintero de 2da.	1
Capataz Sierra Concañiri	1
Cortador Collapos	1
Ayudante Artesano	1
Jornalero Varios	2

5-8 GARAJE REPAR. CATAVI	
Encargado Garage	1
Mecánico Especialista	2
Mecánico "A"	2
Mecánico "B"	2
Mecánico 2da. Clase	3
Electricista Ira.	1
Despachador "B"	1
Ayudante Artesano	1

5-9 TRANSPORTES CATAVI	22
Jefe Transportes	1
Auxiliar "C"	1
Chofer "A"	15
Chofer "B"	5

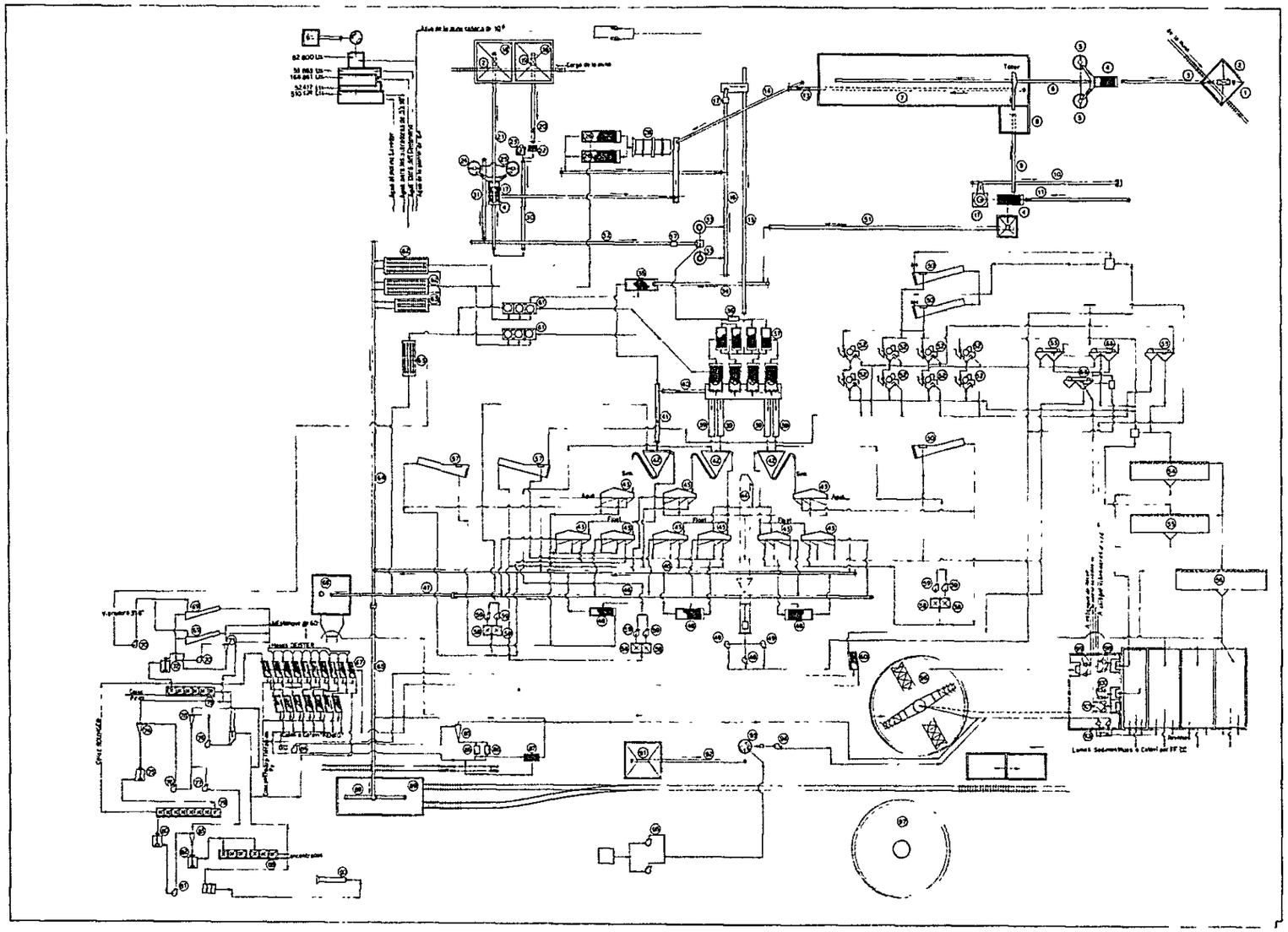
5-10 TRANSPORTES SIGLO XX	16
Jefe de Transportes	1
Chofer "A"	6
Chofer "B"	6
Mecánico 2da. Clase	1
Mecánico "B"	1
Auxiliar "C"	1

5-11 MAESTRANZA CANCAÑI	24
Encargado Maestranza	1
Sub Encargado	1
Secretario "C"	1
Tornero "A"	1
Tornero "B"	1
Reparador Maq. Perfs.	5
Esmerilador	5
Herrero de Ira.	1
Aguzadores	2
Capataz Transp. Matles.	1
Maquinista Transportes	1
Transportes Mina	3
Ayudante Artesano	1

5-12 TALLER VULCANIZAC.	3
Vulcanizador Especialista	1
Mecánico de 2da. clase	1
Ayudante Artesano	1

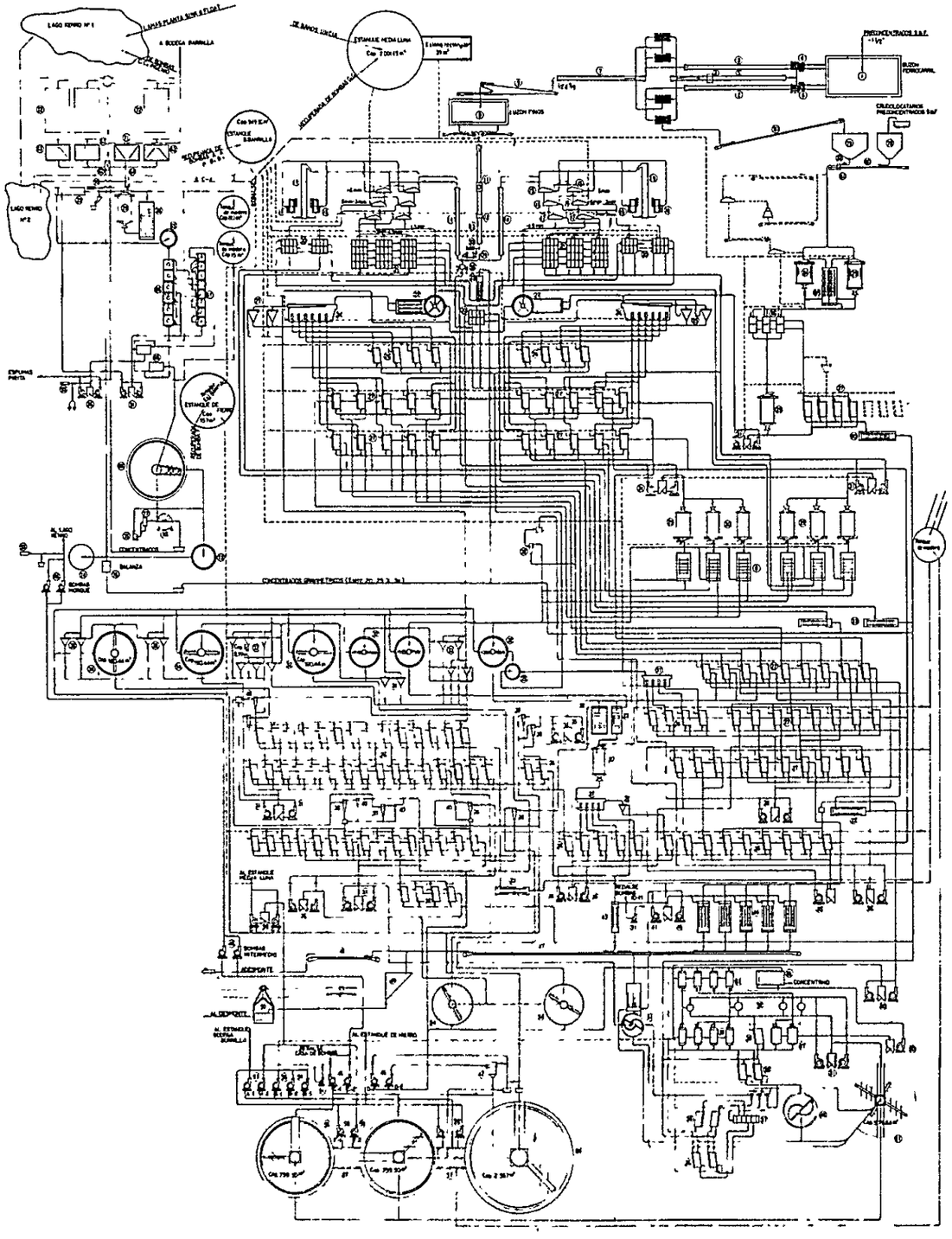
5-13 MAQUINAS PESADAS	20
Encargado Sección	1
Sub Encargado	1
Operador "A"	8
Operador "B"	4
Mecánico Ira. Clase	1
Ayudante Artesano	5

Fig. 4—1 Organization and desposition of personals of mecanic department



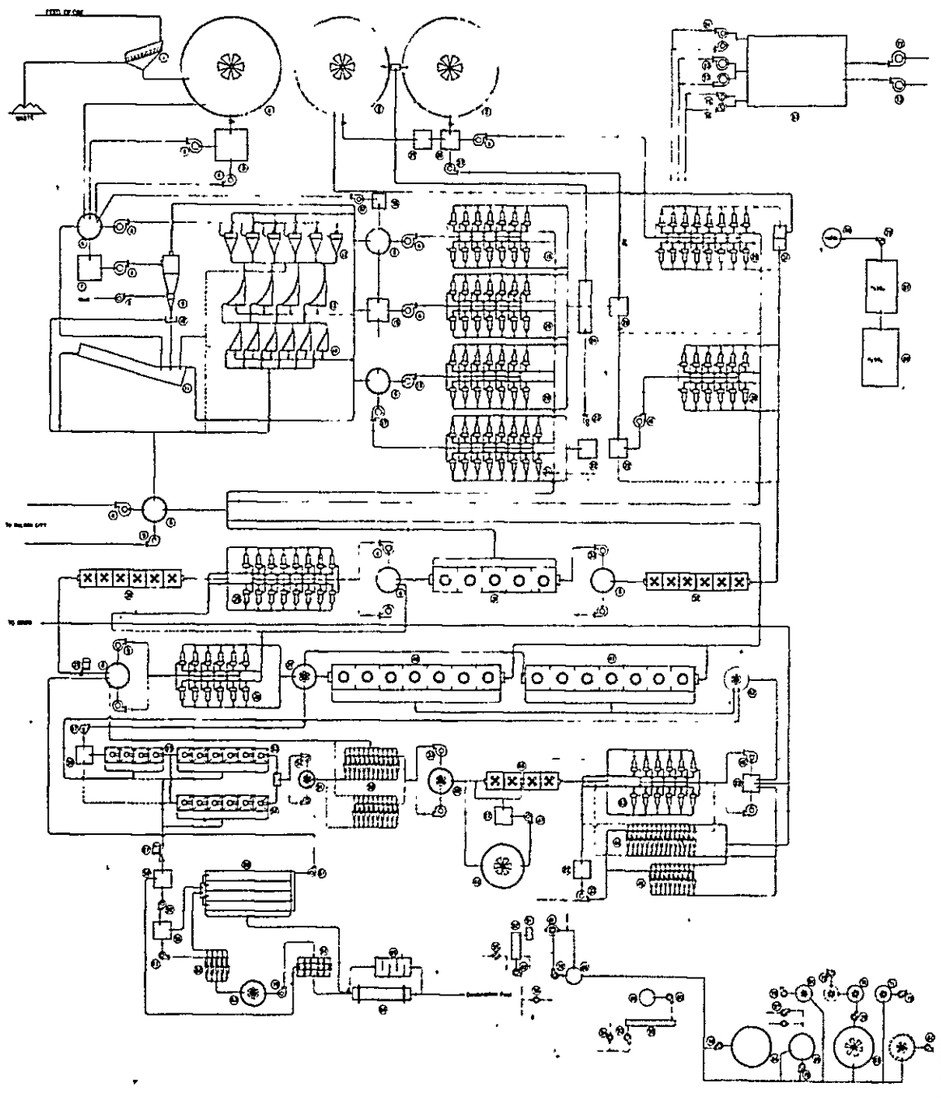
NO	Quantity	Name	Size	H P	NO	Quantity	Name	Size	H P
1	1	Receiver Bin	180T		60	1	Table		2HP
2	2	Apron feeder	48"x6.4m	10+2=20HP	61	6	Flotation macine	42"x42"	6×25HP=45HP
3	1	Belt conveyor	36"x34m	50HP	62	2	Classifier	9'x28'	2×15HP=30HP
4	3	Screen	5'x12'	25HP	63	2	Classifier	6'x18'	2×15HP=30HP
5	2	Gyratorycrusher	13"x46"	100HP×2=200HP	64	1	Belt conveyor	24"x44m	10HP
6	1	Belt conveyor	30"x	50HP	65	1	Belt conveyor	24"x55m	20HP
7	1	Bin	1000T		66	1	Bin		
8	1	Bin			67	17	Table		17×2=34HP
9	1	Belt conveyor	24"x20m	15HP	68	6	Flotation macine	15"	3×25=225HP
10	1	Belt conveyor	24"x31m	15HP	69	2	Spiral Classifier	3'x18'	2×3=6HP
11	1	Belt conveyor	24"x27m	15HP	70	2	Pump (Denver)	5"x3"	2×50=100
12	1	Cone crusher	3'	75HP	71	1	Cyclone	14"	
13	1	Belt conveyor	30"x88m	50HP	72	1	Agitator	6'x7'	30HP
14	1	Belt conveyor	30"x45m	25HP	73	6	Flotation macine	30"	2×40=80HP 4×30=30HP
15	1	Belt conveyor	30"x38m	50HP	74	1	Cyclone	12"	
16	1	Belt conveyor	30"x57m	30HP	75	1	Agitator	3'-6"x4'	55HP
17	3	Merrick scale	36"		76	2	Pump (Wilfley)	6"x4"	2×50=100HP
18	2	Bin	650T		77	1	Pump (Wilfley)	4"x3"	10HP
19	1	Apron feeder	42"x12m		78	8	Cyclone	4"	
20	1	Belt conveyor	36"x209m	15HP	79	8	Flotation macine	18"	4×20=80HP
21	1	Belt conveyor	30"x76m	100HP	80	1	Agitator	4'-5"x5'	4HP
22	1	Grisly deck screen	3'x5'	15HP	81	2	Pump	2"x2"	2×10=20HP
23	1	Jaw crasher	24"x36"	100HP	82	1	Agitator	3'x3'	4HP
24	1	Gyratorycrusher	13"x46"	75HP	83	1	Cyclone		
25	1	Gyratorycrusher	13"x46"	50HP	84	1	Pump (Wilfley)	6"x4"	75HP
26	2	Screen	5'x12'	2×40=80HP	85	1	Cyclone	12"	
27	1	Belt conveyor	30"x23m	10HP	86	2	Table		2×2=4HP
28	1	Scrubber	5'x12'	25HP	87	1	Screen	6'x18'	5HP
29	1	Belt conveyor	24"x31m	10HP	88	1	Belt conveyor	24"x85m	65HP
30	1	Belt conveyor	30"x32m	50HP	89	1	Bin	2200T	
31	1	Belt conveyor	24"x20m	5HP	90	1		300"x6m	15HP
32	1	Belt conveyor	24"x29m	10HP	91	1	Lime hopper		
33	2	Cone crusher	4'	2×200=400HP	92	1	Belt conveyor	15"x	5HP
34	1	Belt conveyor	20"x	5HP	93	1	Agitator		10HP
35	1	Screen	4'x10'	5HP	94	1	Pump (Wilfley)	6"x4"	25HP
36	1	Belt conveyor	36"x4m	10HP	95	2	Pump	6"x6"	2×11.3HP
37	4	Screen	5'x10'	4×10=40HP	96	1	Thickener	60'-0"	5HP
38	4	Screen	5'x16'	4×7.5=30HP	97	1	Thickener	25'-0"	
39	4	Belt feeder	40"x5.5m	4×3=12HP	98	2	Pump (Wilfley)	6"x4"	2×50=100HP
40	1	Belt conveyor	24"x14m	10HP	99	2	Pump (Wilfley)	8"x6"	2×60=120HP
41	1	Belt conveyor	24"x9m	10HP	100	2	Pump (Vacseal)	8"x4"	2×50=100HP
42	4	Sink-Float Separating cone	10"x13"	4×25=100HP	101	2	Pump (Wilfley)	8"x6"	2×50=100HP
43	9	Screen	4'x14'	9×5=45HP	102	2	Pump (Wilfley)	8"x6"	2×50=100HP
44	1	Bucket elevator	x15m	10HP					
45	1	Belt conveyor	24"x	50HP					
46	1	Belt conveyor	24"x44m	30HP					
47	1	Belt conveyor	30"x	25HP					
48	3	Screen	4'x10'	3×5=15HP					
49	3	Pump (Wilfley)	6"x4"	25×3=75HP					
50	3	Spiral Classifier	4'x20'	3×3=9HP					
51	1	Belt conveyor	20"x	10HP					
52	8	Magnetic separator	48"x36"	8×1.5HP=12HP					
53	4	Magnetic separator	48"x60"	4×10HP=40					
54	1	Thickener	30'-0"	5HP					
55	1	Thickener	50'-0"						
56	1	Thickener	50'-0"	5HP					
57	2	Spiral Classifier	4'x30'	2×5=10HP					
58	6	Pump tank							
59	6	Pump (Wilfley)	8"x6"	6×60=360					

Fig. 4-3 Flow Sheet of Siglo XX Plant



No	QUANTITY	NAME	SIZE	HP
1	1	Bin	2000 Ton	
2	2	Belt Conveyor	30"×54.99m L 30"×57.86m L	50
3	4	Low Head Screen	4'×10'	20
4	2	Magnetic Separator		
5	1	Belt Conveyor	24"×30.785m L	25
6	2	Roll Crusher	51"×20"	297
7	1	Belt Conveyor	24"×62.454m L	15
8	1	Belt Conveyor	24"×19.2 m L	10
9	1	Bin	2200 Ton	
10	2	Belt Conveyor	20"×90.53m L 20"×6.685m L	10
11	1	Merrick Scale		
12	1	Merrick Scale		
13	1	Belt Conveyor	20"×35.251m L	25
14	2	Belt Conveyor	20"×234.5m L 20"×233m L	30
15	4	Low Head Screen	4'×10'	20
16	4	Low Head Screen	4'×10'	20
17	4	Low Head Screen	4'×10'	225
18	4	Roll Crusher	42"×16"	300
19	2	Bucket Elevator	15"×35m	25
20	8	Jig (DENVER-HILL)	16'×32"	24
21	12	Jig (DENVER-HILL)	16'×32"	36
22	2	Classifier	6'×32"	125
23	6	Classifier	2.4'×16'	32.5
24	4	Classifier Dorrco Type		
25	4	Cone Tank	6'0"	
26	84	Table (DEISTER)		168
27	51	Table (DEISTER)(PLAT-O)		102
28	8	Classifier	6'×20'	175
29	7	Ball Mill	5'×10'	850
30	3	Ball Mill	4'×10'	225
31	14	Pump (WILFLEY)	8"×8" 43 8"×4" 108	636
32	3	Thickener	20'×10"	11
33	16	Cone Tank	10'0"	
34	3	Thickener	30'×10"	8
35	3	Pump (WILFLEY)	6"×3"	65
36	10	Pump (WILFLEY)	6"×4" 49, 3" 16	476
37	3	Classifier (FAMPENWALD)	4'×1'	
38	56	Cyclone	6"	
39	8	Cyclone	4"	
40	24	Cyclone	2"	
41	1	Pump (DENVER)	6"×6"	75
42	2	Cyclones	24"	
43	1	Drag Classifier	25'×16'	25
44	4	Drag Classifier	5'×16'	20
45	1	Hydraulic Classifier	20'0"	1
46	9	Pump	10"×8"	825
47	1	Belt Conveyor	20"×99.644m L	30
48	1	Belt Conveyor	20"×3275m L	10
49	1	Bin	500 Ton	
50	1	Cableway	2000 Ton	
51	1	Thickener	60"×8"	5
52	2	Distributor	4"	
53	8	Table (DENVER-RICKMAN)	6'×6'	3
54	2	Thickener	30'	4
55	1	Thickener	120"×85"	10
56	2	Thickener	75"×7"	10
57	2	Tank (Concrete)	12"×38"×6"	
58	3	Pump (ALLIS CHALMERS)	10"×10"	771
59	7	Pump (ALLIS CHALMERS)	8"×6"	600
60	3	Pump (WILFLEY)	8"×3" 22, 3"×2" 18	13
61	1	Classifier	6'×20'	75
62	1	Winding Machine	980 3/8"×420 3/8"	40
63	3	Hopper	70 Ton	
64	1	Belt Conveyor	30"×515m	2
65	1	Agitator (DENVER)	6'×9'	5
66	6	Flotation Machine	48'×48'	35
67	8	Flotation Machine	28'×28'	20
68	2	Table (PLAT-O)		4
69	1	Thickener	50'×7"	5
70	1	Oliver Filter	6'×8'	10
71	3	Hopper	130 Ton	
72	3	Dryer Light	12'×27.5'	21.9
73	1	Tank	40'×10"	
74	1	Tank	20'×10"	
75	1	Filtrate Pump	2"×1.5"	75
76	1	Washing Machine	10 Ton	
77	1	Vacuum Pump	22"Hg 8"	25
78	1	Bin	500 Ton	
79	1	Bin	750 Ton	
80	2	Belt Conveyor	20"×26.5m L 20"×27.65m L	20
81	1	Merrick Scale		
82	1	Ball Mill	6'×6'	200
83	1	Classifier	5'×18'	5
84	2	Jig	42"×42"	75
85	1	Table (WILFLEY)	63"×86"	03
86	1	Table (SUB-FIN WILFLEY)	83"×9'6"	005
90	1	Classifier	25'×17'	75
91	2	Pump	6"×3"	30
92	1	Magnetic Separator	0.95	
93	4	Automatic Machine		
94	1	Sampling Mill		
95	1	Hydraulic Compressor for Sampling		

Fig. 4-4 Flow Sheet of Victoria Plant



No	Quantity	NAME	SIZE	HP
1	1	Low Head Screen (DOUBLE DECK)	4' × 8	10
2	3	Agitator Tank (DENVER)	32"× 20"H	75×3⁵=225
3	1	Tank (WOOD)	6"× 6'× 6"H	
4	8	Pump (VACSEAL)	8"× 6"	60×8⁵=480
5	3	Pump (VACSEAL)	6"× 4"	50×3⁵=150
6	7	Tank (WOOD)	5"× 6"H	
7	1	Tank (WOOD)	4"×5'×6"H	
8	1	Pump (WARTHINGTON)	3"× 2"	25
9	1	Cyclone (KREBS)	20"	
10	1	Tank (WOOD)	2"× 2.5'× 3.3"H	
11	1	Spiral Classifier (WEMCO)	4' × 24'	5
12	4	Cyclone (PATTERSON)	14"	
13	4	Arch Screen	3'	0.5
14	6	Fixtion Screen	2''	0.5
15	1	Tank (WOOD)	4'×4'×6'	
16	3	Pump (VACSEAL)	6"× 4"	40×3⁵=120
17	1	Pump (VACSEAL)	5"× 8"	50
18	14	Cyclone (DORRCLONE)	4"	
19	14	Cyclone (DORRCLONE)	4"	
20	14	Cyclone (KREBS)	4"	
21	16	Cyclone (KREBS)	4"	
22	5	Tank (WOOD)	3"×3'×4"H	
23	1	Pump (DENVER)	5"× 4"	20
24	1	Tank (WOOD)	10'×15'×1.5"H	
25	1	Tank (WOOD)	3'× 5'× 6'	
26	1	Tank (WOOD)	2.75'× 6'× 5.5"H	
27	1	Pump (DENVER)	6"× 6"	50
28	16	Cyclone (DORRCLONE)	4"	
29	1	Tank	3'×3'× 5'	
30	12	Cyclone (DORRCLONE)	4"	
31	1	Tank (WOOD)	2"×4'×2.5"H	
32	6	Flotation Machine (WEMCO)	#20	20×6⁵=120
33	3	Pump (DENVER)	5"× 4"	40×3⁵=120
34	5	Flotation Machine (WEMCO)	#66	10×5⁵=50
35	16	Cyclone (DORRCLONE)	4"	
36	6	Flotation Machine (WEMCO)	#20	20×6⁵=120
37	1	Auto Sampeing Machine		0.5
38	12	Cyclone (DORRCLONE)	4"	
39	1	Agitator Tank (WEMCO)	5"×6"H	5
40	7	Flotation Machine (WEMCO)	#60	10×7⁵=70
41	7	Flotation Machine (WEMCO)	#60	10×7⁵=70
42	1	Agitator Tank (WEMCO)	5"×6"H	7
43	12	Cyclone (KREBS)	4"	
44	15	Cyclo (PATTERSON)	3"	
45	12	Cyclone (PATTERSON)	3"	
46	4	Flotation Machine (WEMCO)	#20	20×4⁵=80
47	3	Pump (VACSEAL)	2.5"×2"	20×3⁵=60
48	1	Agitator Tank (WEMCO)	10"×10"H	10
49	1	Agitator Tank (WEMCO)	5"×6"H	3
50	12	Cyclone (PATTERSON)	3"	
51	1	Agitator Tank (DENVER)	3"×4"H	2
52	1	Pump (DENVER)	2.5"×2"	10
53	6	Flotation Machine (DENVER)	24"×24"	5×3⁵=15
54	6	Flotation Machine (DENVER)	24"×24"	5×3⁵=15
55	4	Flotation Machine (DENVER)	24"×24"	5×2⁵=10
56	3	Tank (WOOD)	2.5'×2.5'×4"H	
57	1	Auto Sampeing Machine (DENVER)		0.5
58	1	Tank (WOOD)	2.5'×2.5'×3.5"H	
59	1	Pump (VACSEAL)	2.5"× 2"	15
60	1	Thickener	7.3'×20'L×5"H	
61	2	Pump (DENVER)	1.5"×1.25"	3×2 ×6
62	5	Cyclone (PATTERSON)	3"	
63	1	Agitator Tank (TURBOMIXER)	5'×6"H	7.5
64	1	Disk Filter	4'"	0.75
65	1	Thickener	4'L×6'×7"H	
66	1	Rotary Kiln	3'×16'	20
67	1	Pump (DENVER)	5"×4"	30
68	1	Agitator Tank (DENVER)	3'×3"H	2
69	1	Agitator Tank (ALLIS CHALMERS)	10"×10"H	7.5
70	1	Agitator Tank (DENVER)	36"×36"H	1.5
71	1	Agitator Tank (DENVER)	36"×36"H	2
72	1	Pump (ALLIS CHALMERS)	10"× 8"	40
73	3	Pump (ALLIS CHALMERS)	8"× 6"	50×3 ×150
74	1	Pump (DENVER)	5"× 5"	30
75	1	Pump (GOULDS)	3"×1.5"	25
76	1	Pump (GOULDS)	3"× 2"	40
		Pump		
78	1	Pump (WARTHINGTON)	3"× 2"	20
79	8	Pump (WARTHINGTON)	1.5"×1"	7.5×8 ×60
80	1	Pump (WARTHINGTON)	4"× 3"	2
81	1	Vacuum Pump		40
82	1	Pump (WARTHINGTON)	1.25"×1"	7.5
83	1	Tank (CONCRETE)	28.5'×27'×5.6"H	
84	1	Tank (SS+R/L)		
85	1	Tank (SS+R/L)		
86	1	Tank (SS)	10"×16'L	
87	1	Tank (SS)	6.3"× 16.3'L	
88	1	Tank (SS+R/L)	3"×4'H	
89	2	Tank (SS+R/L)	3"×3"H	
90	1	Tank (SS)	1.3"×19'L	
91	1	Moisture Trap (SS)	15"× 3"H	
92	1	Receiver Tank (SS)	2"× 65"H	
93	1	Combustion Installation		0.75
94	1	Root Blower	1"× 1"	5
95	1	Root Blower	1"× 1"	7.5
96	1	Root Blower	3"×3"	15
97	1	Heater		0.5

Fig. 4-5 Flow Sheet of Kenko Plant

Table 4–1 Compressor

Compressor								Motor (Engine)									
Location	Maker	Type	Max Pressure kg/cm²	Cylinder Dia High in	Cylinder Dia Low in	Piston Stroke in	Output Volume m³/min	Type	Output kW	Volt V	Amp	Rev RPM	cos φ	Production Date	Quantity	Note
Cancañirl	Ingersoll Rand	PRL 2	8 8	17.5	30	21	90 7		300	3000	64.5	187.5		1929	2	
Cancañirl	Ingersoll Rand	PRL 2	8 8	21.5	42	27	182 6		620	3000	140 5	150		1929	1	
Cancañirl	Ingersoll Rand	PRL 2	8 8	21.5	42	27	182 6		675	3000	173	150		1929	1	
Cancañirl	Atlas Copco	AR 9	8 4	18 9	31 8	14 5	88 3	(Engine) TRH 348A	428			300		1957	1	
Cancañirl	Atlas Copco	IR 9 1 IR 9 2	8 8	18 7	30 71	10 63	99 1		340	570	410			1978	2	
Cancañirl	JDY	TA 50M-4C					142		750	3000		2970		1980	1	Obstacle
Undergrand Level 383	Ingersoll Rand	PRL 2	7 0	14 0	26 0	16	52 9		185	440		214		1948	1	
Dolores	Ingersoll Rand		8.5	9 0	18 0	10	11.6			440					1	Obstacle
Dolores	Ingersoll Rand		8.5	10 0	20 0	11	14 2			440					1	Obstacle
Dolores	Ingersoll Rand		8.5	10 0	20 0	14	22 0		100	440					1	

Table 4–2 Circulation Pump

Pump								Motor								
Usage	Maker	Type	Size in	Volume m³/min	Lift Head m	Rev RPM	Production Date	Type	Output kW	Volt V	Amp A	Rev RPM	cos φ	Production Date	Quantity	Note
Compressor	General Electric	SIZY8 N1 D	10 x 8	9 1	27	1450		KT51Z 4 55-1500	42	220	137	1470			2	
Compressor		NT80-20	4 x 3						15	550	21 8	2900			2	
Compressor		SO-20	4 x 3						22 5	220	77	2930			1	

Table 4–3 Vertical Shaft

Winding Machine																Motor					
			Wind up range			Wire Rope			Drum			Brake									
Location		Maker	Start	End	Range	Maker	Composition	Dia m/m	Q'ty	Dia %	Width m/m	Common	Emergency	Rope speed	Clutch	Maker	Output kW	Volt. V	Amp A	Rev RPM	Note
			m	m	m																
PRINCIPAL	Vertical Shaft		720	650	70	Japan (Kokoku)	6 x 19	22 2	1	1054 1	1092 2	Manual	Thruster			A Chalmere	56	230		580	
RAMPA	Inclined Shaft	The W.Sequer	800	620	220	USA (Leschen)	6 x 19	25 4	2	1333.5	1079.5	Ditto				G Electric	225	3000			Inclined angle 55°
BI GA	Vertical Shaft		650	411	239	Cage		22 2									94	220	190	580	Case 2 step deck
						Counter Weight		15 9	1	1270	806	Ditto	Thruster								
BLANCA	Vertical Shaft	A Chalmere	411	295	116	Cage		22.2													
						Counter Weight		15 9	1	1041 4	762	Ditto	Ditto			A Chalmere	56	220		575	
RAMPA	Inclined Shaft	Phillie Gear	411	383	50			19 0	1	774 7	463.5	Ditto				A Chalmere	30	230	106	575	
SAN MIGUEL	Vertical Shaft	Norbeng	650	383	267	Germany T.Albert K	6 x 19	22 2	2	1168 4	914 4	Ditto	Thruster		Hydraulic	G Electric	150	3000	20	585	
MISTICO	Vertical Shaft	Phillie Gear	383	125	258	Germany T.Albert K	6 x 19	22 2	2	1701 2	914 4	Ditto	Ditto			Brak Motors	91	440	114	975	
VICTORIA	Vertical Shaft	A Chalmere	530	383	147	Canada (D Granng)	6 x 19	22 2	1	1041 4	762	Ditto	Ditto			A Chalmere	56	230		575	
						Japan (Kokoku)		15 9													
ANIMAS	Vertical Shaft	Phillie Gear	383	50	333	Germany T.Albert K	6 x 19	22 2	2	1701 2	914 4	Ditto	Ditto			A Chalmere	90	440	70	960	

Table 4–4 Drain Pump

Pump								Motor						
Location	Maker	Type	Size in	Volume m³/min	Lift Head m	Output kw	Rev RPM	Type	Output kw	Volt V	Amp A	Rev RPM	Production Date	Quantity
Level 720	A Challmars		8 x 6	0 3	186	75	1450	T F O	75	440	130	1450		
								K	75	440	130	1450		2
Level 683	A Challmars		8 x 6	0 3	186	75	1450	T F.O	75	440	130	1450		
								K	75	440	130	1450		2

Table 4–5 Rock Drill

Stopper			Leg Drill			Sinker		
Maker	Type	Quantity	Maker	Type	Quantity	Maker	Type	Quantity
Gardner Denver	RB-83	124	Atlas Copco	BBD-90	145	Gerdner Denver	S - 55	7
Atlas Copco	BBD-96-W	19	Atlas Copco	RH 656-4W	56	Gerdner Denver	S - 33	4
Falcon	BBD-46-N	1	S I G	PLB-23 CL	24	Atlas Copco	BBC-34-W8	1
Gardner Denver	R-104	3	RUSA	PL-25-L	3			
G I G	PLS-23-95	1						
I Rand	R-38-A	1						
I Rand	JB-38-C	3						
Total		151			178			23

Table 4–6 Fan

Location Level	Location Block Caving		Area	Quantity	Maker	Output HP	Amp. A	Volt V	Rev. RPM	Volume m^3/min	Static Pressure mAq
355	Block	4–D	Laguna	1	General Electric	60	75	440	985	1,133	2
411	"	5–D	Beza	1	Brown Boveri	100	113	440	1,480	1,699	3
446	"	8–B	"	1	General Electric	60	75	440	985	1,133	3
481	"	8–B	"	2	JOY	20	24	440	2,930	566	2
481	"	8–B	"	1	Brown Boveri	150	182	440	1,475	3,398	3
516	"	4	Salvadora	1	"	215	250	440	1,480	3,398	3
516	"	17–A	"	1	JOY	20	24	440	2,930	566	2
516	"	5–D	Siglo XX	1	Brown Boveri	100	118	440	1,475	1,699	3
600	"	3–D	Animas	1	"	150	182	440	1,480	3,398	3
516	Block	4	Salvadora	1	Hitachi	75	92	440	1,450	1,133	
530	Victoria	3–F	Animas	1	Severe Quty	40	50	440	1,760	311	2
551	Block	5–D	Beza	1	Asea	125	150	440	1,480	3,398	3
600	Block	20	Salvadora	1	Donkin	20	26	440	2,920	510	2
600	Victoria	3–F	Animas	1	JOY	20	24	440	2,930	566	2
650	Block	3–D	"	1	General Electric	60	62	440	1,475	1,133	3
650	Reggis		Salvadora	1	"	60	75	440	985	1,133	3
650	Block	4	Buzon	1	(JOY) Austriaco	10	12	440	1,450	170	1
516	"	4	Salvadora	2	Donkin	20	26	440	2,920	510	3
600	Block	3–D	Animas	1		100		440	1,480	1,699	3
Total				21							

Table 4–7 Rocker Shovel

	Maker	Type	Location					Total
			Animas	Laguna	Salvadora	Beza	SigloXX	
1	Eimeo	12 - B		1	1		2	4
2	Eimeo	22 - B					4	4
3	G. Denver				1	2	1	4
4	A. Copco	LN - 50		1	1	3	1	6
5	A. Copco	A. V. O	1					1
6	Rusa	PPW-18	5	1		7	8	21
			6	3	3	12	16	40

Table 4–8 Mine Car

	Capacity (t)	Location					Total
		Animas	Laguna	Salvadora	Beza	SigloXX	
1	0 65	1	1	2	1	2	7
2	0.75	9	26	16	8	20	79
3	1.70	47	23	25	57	17	169
4	2 00				5	39	44
5	3.30		11				11
6	5.00					130	130
		57	61	43	71	208	440

Table 4–9 Locomotive

No.	Capacity (t)	Animas	Laguna	Salvadora	Beza	SigloXX	Extracción 650	Under Repair	Total
1	10						11		11
2	8		1			2		6	9
3	7		1					1	2
4	6					1			1
5	4	6	2	2	9	3			23
6	2.5	1						6	7
7	1.5	1	4	2	3	2			12
8	Battery	1	3	4	2	4			14
	Total	9	11	8	14	12	11	13	79

Table 4–10 Rectifier

Location	Maker	Type	Capacity KW	Volt. v	Amp. A	Note
SigloXX	Ohio Brass		150	250	500	
Under Ground L 383			50	250		

Table 4–11 D.C. Generator

Motor							Generator					Quantity
Location	Maker	Type	Out Put KW	Volt. V	Amp. A	Rev. R P M	Maker	Type	Capacity	Volt. V	Amp A	
Under Ground L411			75	250	300				82.5	3,000		1

Table 4–12 Compressor

Location	Maker	Compressor							Motor (Engine)							Quantity	Note
		Type	Max. Pressure kg/m²	Cylinder High in	Dia Low in	Piston stroke in	Output f³/min	Volume m³/min	Maker	Type	Output (kW)	Volt V	Amp. A	Rev RPM	Production Date		
Siglo XX	Gardner Denver	Screw							G ELECTRIC		263	380	486	1450		1	Water Cooling Pump 2 sets
Siglo XX	Inger Soll Rand	XLE	7	13.5	23	10	1672	47 4			177	440				1	
Siglo XX	Inger Soll Rand		7	14 5	26	16	1866	52.9			188	440		214		1	
Victoria	Ingersollrand	XRE									188	440		273		1	
Victoria		K.T 346									34	3000	8.7	725		1	
Victoria		Screw									22	220	75	965		1	
Victoria	Atlas Copco	XA. 350 TOP	8.5					21		(Engine)						1	

Table 4–13 Incline

Winding Machine						Motor						Quantity	Note
Location	Maker	Drum Dia.	Drum Width	Drum Quantity	Wire Rope Dia	Maker	Type	Output kW	Volt V	Amp. A	Rev RPM		
Victoria		780	600	2	20			45	440		720	1	

Table 4–14 Generator

Generator							Engine							Quantity	Note
Location	Maker	Type	Capacity kW	Volt. V	Amp A	Rev RPM	Maker	Type	Output kW	Volt. V	Amp. A	Rev RPM	Production Date		
Victoria		B 514 A	90	220/110	294	1560			90			1560		1	

Table 4–15 Belt Conveyor

Location	Belt Width mm	Belt Length m	Motor							Quantity	Note
			Maker	Type	Output kW	Vol. V	Amp A	Rev RPM	Production Date		
Victoria	500	21 4			4	220	15.3	720		1	Loading to flat car

Table 4–16 Dredger

Pump							Engine							Quantity	Note
Location	Maker	Type	Size in	Capacity T/Hr	Lift Head m	Rev RPM	Maker	Type	Output KW	Volt V	Amp A	Rev RPM	Production Date		
Kenko			10 x 10	150~200		540	Caterpillar	D 343	292			2000		1	

Table 4–17 Cable Way

Location	Usage	Wire rope dia m/m		Motor				Quantity	Note
		Guide	Traction	Output HP	Volt. V	Amp. A	Rev. RPM		
SigloXX		38/28	16	75	220		985	1	
		28	16	30	720		720	1	
Victoria		38/28	16	75	440		960	1	

Table 4–18 Belt Conveyor

Location	Belt Width	Motor				Quantity	Note
		Output HP	Volt. V	Amp. A	Rev. RPM		
SigloXX	20	20	220	60	960	1	
	20	20	220		1450	1	
	20	20	220			1	
	20	15	220	52	730	1	
Victoria	20	15	440	21.5	720	1	
	20	25	440	31	1475	1	

Table 4–19 Pump

Location	Pump		Motor				Quantity	Note
	Type	Size	Output HP	Volt. V	Amp. A	Rev RPM		
Victoria	Volute	$4^B \times 4^B$	50	440	58	1470	1	
	Volute	$4^B \times 4^B$	50	440		1450	1	

Table 4–20 Hydraulic Power Station

Location	Water Wheel			A. C. Generator						Production Date	Quantity	Note
	Type	Head m	Rev RPM	Type	Output KW	Amp. A	Volt. V	Frequency ∞	COS ϕ			
Lupi Lupi	Pelton	131	375	ATB-15-350 375 Form	280	88	2300	50	0 8	1926	4	
Chaquri	Francis	40	750	KH	350	110	2300	50		1926	3	
	Francis	40	750	ATP-8-125-750 Form PP	100	24	3000	50		1926	1	

Table 4–21 Diesel Power Station

Location	Engine			A. C. Generator						Production Date	Quantity	Note
	Type	Out Put KW	Rev. RPM	Type	Output KW	Amp. A	Volt. V	Frequency ∞	COS ϕ			
Miraflores		224	167	ATI-36-280M -167 Forms	224	52	3100	50	0.8	1930	1	
		1000	167	ATI-36-1250 M-167 Forms	1000	72.1	10000	50		1930	1	
		256	167	ATI-36-320M -167 Forms	256	59.6	3100	50		1930	3	

Table 4–22 Water Pump

Pump								Motor						Quantity
Location	Maker	Type	Size in	Volume m^3/min	Lift Head m	Output kW	Rev RPM	Type	Outpt kW	Volt. V	Amp A	Rev RPM	Production Date	
Catiri	KSB Alemana	OMOPELO WR-WL	8 x 6	8.3	400	188	1170		188	3000		1170		1
Catiri	KSB Alemana	OMOPELO H A.K	8 x 6	8	400	233	1500	BROWN BOVERI MAHA 184 CW	233	3000	47	1500	1973	1
Catiri	CSB Arzentina	OMOPELO WL-125	8 x 6	5	300	370	2970	SIEMENS	370	3000	86	2970	1979	1
Concreto	KSB Alemana	OMOPELO WL-80	4 x 4	0 75	500	150	2920	SIEMENS-ALUS	150	3000	36 7	2970	1964	2
Blanca	ALDRICH			0.34	200	18			22 22	220	31	720		2
Sauta	Worthing Tor		6 x 6	2 085	140	113	2950	U.S Electric Motor	113	440	170	2960		2
Sauta	Sulzer	HZ 102-7401	8 x 6	3.4	185	148	2980	Ruhrtorf/Rott T—	200	440	240	2980	1979	1
Baños Uncia			6 x 5					U.S Electric Motor	113	440	17.4	2970		1
Baños Piscina			6 x 6 4 x 6						38	220/440		865		2
Baños Catavi			8 x 6	2 25	145	75	1500		75	220/440	125 5	1500		1
Ventilla	KSB Alemana	OMOPELO H A K 125/3	6 x 6 6 x 5	2 25 2.25	140 140	88	1460 1455		85	220	280	1465		2
Sentenario	K.S B	H A K 125/3EE	6 x 5	2.25	140	100	1465		110	440	174	1485		1
Sentenario	A Challmars	MM-2	4 x 3	1.8	122	113	2960		113	440	174	2975		1
Sentenario	Worthingtor	N C B-1011		1 1	45	15			15	440		2850		1
Sink A. Float	A Challmars		8 x 6	0 3	186	80	1450	T I O K	56 56	440 440	92 92	1450		2
Maraca	Pitz	4608	4 x 3	1	260	110	2970		110	440	176 3	2970		1
Maraca	Crane	DC-555645	3 x 2	0 8	120	45	2900		45	440	176 3	2950		1
Catavi			6 x 6						38	440		865		2

Table 4–23 Sub-Station

Location	First Volt. V	Secondly Volt V	Capacity kW
Siglo XX	66,000	10,000	8,800

Table 4–24 volume of compressors

	Ingersoll	Ingersoll	A. Copco	A. Copco	Ingersoll	Total
Volume m^3/min	90.7 x 2	182.6 x 2	88.3	99.1 x 2	52.9	886
Output PS	400 x 2	1,725	459	460 x 2	250	4,154

Time per cycle is about 183 sec.

Capacity

The quantity of lifted ore per cycle is:

$7{,}000 / \sin 55^\circ \sim (2{,}500 + 530)/\sin 55^\circ = 4{,}846$ Kg

The number of cycles per hour is:

$3{,}600 \div 183 = 19$ times/hr

Hence, the capacity is:

$4{,}846 \times 19 = 92{,}000$ Kg/hr

Assuming that operating time per shift is six hours, the capacity is:

$92{,}000 \times 6 = 552{,}000$ Kg/shift

Since all the other shafts have small sectional area, the size of cages is restricted to about 1 mW x 1.5 mL and method of reloading different materials is employed instead of loading a tube on the cage directly when used for transporting materials. The capacity of the shafts is sufficient for transportation of materials at present, but it is clear that the method is inefficient.

Although there is restriction of the tunnel, if the winding equipment can lift materials about 4 m long, the efficiency of winding can be improved substantially and the number of shafts can be reduced.

4–3–3 Crushing of Siglo XX Sink and Float Plant

There are four #6 gyratory crushers and one 24" x 36" jaw crusher installed as primary crushing equipment, but two #6 gyratory crushers are now out of order, the actual capacity is therefore the capacity of two #6 gyratory crushers and one 24" x 36" jaw crusher.

There are two 4' cone crushers installed as secondary crushing equipment.

The usual capacity of crushers is shown in Table 4–25, Table 4–26 and Table 4–27.

Table 4–25 #6 Gyratory Crusher

Set in	2	2 1/2	3	3 1/2	4	4 1/2
Capacity T/H	35	40	47	56	67	80

Table 4–26 24" x 36" Jaw Crusher

Set in	3	4	5
Capacity T/H	50	60	70

Table 4–27 4' Cone Crusher

Set in	1/2	5/8	3/4	1	1 1/4	1 1/2
Capacity T/H	70	90	110	135	150	165

The value is the capacity when the apparent specific gravity is taken to be 1.6. The flow chart is shown in Fig. 4–7.

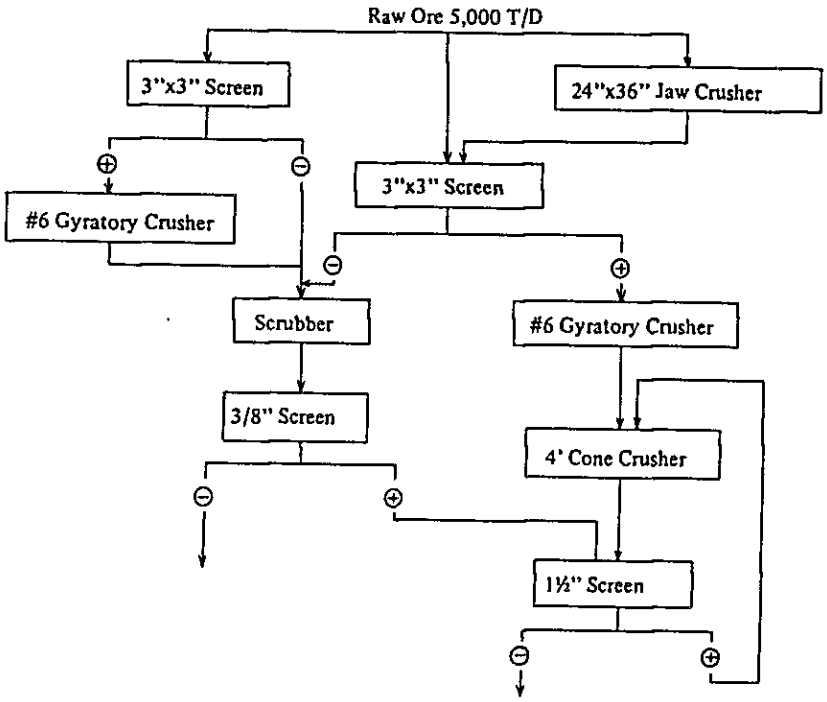


Fig. 4–7 Flow Sheet of Siglo XX Sink and Float Plant

If 3" x 3" screening is halved, the feed quantity of the #6 gyratory crushers is:

$$5{,}000 \text{ T/D} \div 24 \text{ H/D} \div 2 = 105 \text{ T/H}$$

Since there are two gyratory crushers, the capacity of one gyratory crusher is 52.5 T/H.

The feed quantity for the cone crusher is 52.5 T/H and as there is the same amount of repeated quantity and there are two cone crushers, capacity per unit is 52.5 T/H.

As the feed quantity for #6 gyratory crusher is 52.5 T/H and its capacity is 47 T/H, the capacity is insufficient and the shortfall is supposed to be covered by the 24" x 36" jaw crusher.

In the case of the cone crusher, the feed quantity is 52.5 T/H while its capacity is 165 T/H, so one unit cone can cover the quantity.

Actually, as there are four #6 gyratory crushers and one 24" x 36" jaw crusher as primary crushing equipment, the capacity of the equipment, considering that one #6 gyratory crusher is a spare one to be used at the time when another is being repaired, is therefore:

$$47 \times 3 + 50 = 191 \text{ T/H}$$

4–3–4 Scrubbing Equipment of Siglo XX Sink and Float Plant

Concerning the capacity of scrubbers, the capacity in Fukazawa concentration shop of Dowa Mining Co., Ltd., is about 7′ϕ x 12′L and 150 T/H, and that in Matsumine concentration shop is about 8′ϕ x 18′L and 300 T/H.

The disposal quantity per m^3 in Fukazawa concentration shop is:

$$150 \div (\pi \times 2.1^2 \times 3.6/4) \approx 12.0 \text{ T/H}$$

and that in Matsumine concentration shop is:

$$300 \div (\pi \times 2.4^2 \times 5.4/4) \approx 12.3 \text{ T/H}$$

The scrubber in the Siglo XX Sink and Float Plant is 5′ϕ x 12′L, its disposal capacity is therefore supposed to be:

$$12 \times \pi \times 1.5^2 \times 3.6/4 \approx 76 \text{ T/H}$$

Accordingly, a part of the ore is not passed through the scrubber as seen in the flow sheet. To handle the total quantity, 210 T/H, a scrubber at about 8′ϕ x 15′L is required.

4–3–5 Sink-float Separation of Siglo XX Sink and Float Plant

At Siglo XX Sink and Float Plant, the feed size, 9.5 mm ~ 38 mm, is almost the same as that in the Mascot Plant, but the precipitation quantity is higher by 50%. The size of the conical heavy-media separator is 10′, or 78 ft^2 area. There are three separators, but one of them having problems, the remaining two are in operation at present. When it is assumed that the capacity of the conical heavy-media separator is proportionate to its area and is inversely proportionate to the precipitation quantity, the capacity is,

$$136 \times 78/60 \times 0.142/0.5 = 50 \text{ T/H}$$

Table 4–28 Capacity of Conical Heavy-media Separator

The capacity of two separators is 100 T/H, a little short of the feed quantity, 134.2 T/H. However, if all the three separators are operated, there will be no problem.

Table 4–28 Capacity of Cone type Sink and Float Separator

Plant	Ore Kind	Cone Diameter f	Cone area f^2	Feed Size mm	Disposal quantity per a hour	Disposal quantity per a hour cone $1f^2$ t/h	Settling ore quantity per a hour t/h
Mascot	Pb, Zn	9	60	10 ~ 38	136	2.27	19.3
Eagle Pitcher	Pb, Zn	9	60	6 ~ 22	181	3.17	35.2
Ashio	Cu	6	27	5 ~ 15	30	1.11	11.4
Hitachi	CuS	7	37	5 ~ 30	40 ~ 50	1.08 ~ 1.35	24.6

4–3–6 Crushing of Victoria Mill Plant

2,086 T/D of ore transported from Siglo XX Sink and Float Plant crushed with roll crushers.

The flow chart of the equipment is shown in Fig. 4–8.

The capacity of the roll crushers is as follows:

$T = 60 \times R \times \pi \times D \times W \times S \times G$

T = capacity per seven hours

R = number of revolution per minute, 57"ϕ : 92 RPM, 42"ϕ : 81 RPM

D = roll diameter, 57"ϕ : 1.448 m, 42"ϕ : 1.067 m

W = roll width, 57"ϕ : 0.508 m, 42"ϕ : 0.406 m

S = roll space, 57"ϕ : 0.0127 m, 42"ϕ : 0.006 m

G = specific gravity, $1.6 \times 0.6 = 0.96$ T/m^3

Fig. 4–8 Flow Chart of Victoria Mill Plant

The capacity of the 57"ϕ x 20"W roll crusher is:

$T = 60 \times 92 \times \pi \times 1.448 \times 0.508 \times 0.0127 \times 0.96 = 155$ T/H

The capacity of the 42"ϕ x 16"W roll crusher is:

$T = 60 \times 81 \times \pi \times 1.067 \times 0.406 \times 0.006 \times 0.96 = 38$ T/H

Feed quantity from 1/2" x 1/2" screen to 57"ϕ x 20"W roll crusher is 87 T/H and yet it is net feed quantity; two crushers are installed, but one crusher can sufficiently cover the quantity.

There are four 1/2" x 1/2" screens, one of which is for feeding the mill. Even if the feed quantity to the 6 mm screen is 87 T/H, as its net feed quantity enters the 42"ϕ x 16"W roll crushers, four 42"ϕ x 16"W roll crushers have sufficient capacity.

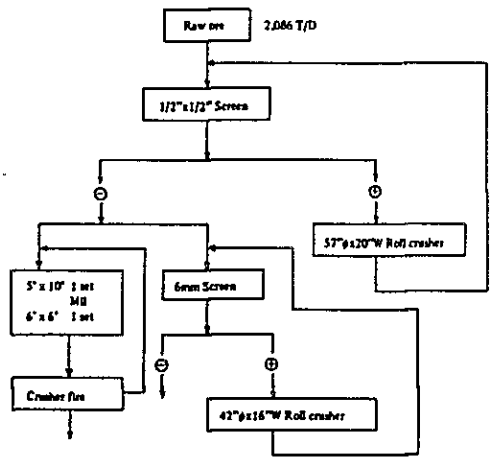


Fig. 4–8 Flow Sheet of Victoria Mill Plant

4–3–7 Dredger of Kenko Mill Plant

The dredger has one volute pump for dredging and a 365 PS. Diesel engine driving a hydraulic pump as the power source for a hydraulic cylinder which ascends and descends the suction pipe of the pump and a winch for operating the ship.

The capacity of the volute pump is 150 T/H – 200 T/H, and as the concentration of slurry is 50%, its capacity per day is:

$$(150 - 200) \times 0.5 \times 24 = 1,800 - 2,400 \text{ T/D}$$

Since the feed quantity of concentration is 1,000 T/D, the capacity of the volute pump is sufficient.

Actually, the mill plant of 1,000 T/D is processing only 39,000 T on an average annually since 1977. The reason for this is the deterioration of the capacity of the dredger. Its cause is the dredger trouble and the fact that a concentration of 50% cannot be maintained. To maintain the concentration of 50%, smooth operation of the ship and dredging to very deep levels are required, which are thought to be very difficult.

At present, there is a plan to purchase a new dredger, but it will be necessary to investigate its capacity, performance, etc., thoroughly.

4–3–8 Water Supply Equipment

There are so many intake places of the water supply equipment that a pump is installed in each place, and operators run the pumps in three shifts.

The procedures of water intake are shown in Fig. 4–9, and specifications are shown in Table 4–29.

1) Sauta

At the time of survey, the dam was empty, the upstream flow rate was measured to be 2.82 m^3/min and the pumped up quantity was about 1.2 m^3/min.

To pump up at the flow rate of 2.82 m^3/min, the capacity of equipment including one pump of 3.4 m^3/min, two pumps of 2.085 m^3/min and the piping is sufficient. In practice only, one pump is operated and pumped up quantity is only 1.2 m^3/min. This is because the performance of the pump is very low.

2) Ventilla

The flow rate is 1.89 m^3/min, and when compared with the performance of the pump there, the equipment there can pump up the entire quantity with one pump. In fact, the entire quantity of flow is pumped up.

3) Catavi

This is a pump station pumping up water stored by a dam and the upstream flow rate is 0.9 m^3/min. Except the pumps of capacity of 5 m^3/min, the capacity of motors of other pumps is too low.

There is no problem in the capacity of equipment to pump up only the quantity of water flowing into the dam, but as the diameter of the pipe is too small compared with the capacity of pumps, loss of head becomes bigger so a pump of 5 m^3/min capacity is pumping up only about 3 m^3/min. In addition, as the capacity of motors is too low, a pump of 8.3 m^3/min capacity can pump up only 2.5 m^3/min and a pump of 8 m^3/min capacity, about 3 m^3/min.

The actually pumped up quantity is thought to be about 1 m^3/min.

4) Concreto, Blanca

One pump is meeting the requirement there and the pipe diameter is balanced with the capacity of the pump.

5) Siglo XX

One pump pumps up the entire quantity, 0.9 m^3/min, and there is no problem in the capacity of equipment, but for the strange fact that the specification of the pump tells that its capacity is only 0.3 m^3/min.

6) Baños Uncia

The entire quantity, 0.9 m^3/min, is pumped up now, there is therefore no problem in capacity, but the specification of the pump is not clear. The capacity of the motor is 113 KW, but the work to be done requires 0.9 m^3/min x 79^{mH}, accordingly, a motor of 20 KW can sufficiently perform the work and the capacity of the equipment is too large.

7) Centenario

Submerged pumps are used for pumping up 1.26 m^3/min and the specifications of the pumps correspond to the quantity. However, in the case of pumps other than the submerged pumps, the pipe diameters are too small for the specification of the pumps, therefore, loss of head is increased and the actual amount delivered is estimated to be a little more than 1.26 m^3/min although their capacity is larger.

8) Maraca

The entire quantity of flow, 0.354 m^3/min, is pumped up, and the pumps and the pipe diameters still have surplus capacity.

Table 4–29 Capacity of Supply Water Pump

Intake Pump Station	PH	m^3/min Volume	m Actual Lift Head	Piping		Pump				Calculated Value		
				m Size	m Range	m^3/min Volume	m Lift Head	kw Out Put	Quantity	m^3/m Lift Volume	m Loss Head	m Total Lift Head
Sauta	8.01	2.82	60	8	6990	2.085	140	113	2	2.82	71	131
										2.085	35	95
						3.4	185	148	1	3.4	103	163
Ventilla	6.3	1.89	135	8	2.040	2.25	140	85	2	1.89	9	144
						8.3	400	188	1	0.9	13	186
						8	400	233	1	2.5	104	277
Catiri	7.6	0.9	173	6	3.270	5	300	370	1	3	151	324
Concreto	7.6		373	4	2.350	0.75	500	150	2	0.75	47	420
Blanca	7.6		185	3	1.500	0.34	200	18	2	0.34	23	208
Siglo XX	2.9	1.02	19	8	260	0.3	186	80	2	1.02	1	20
Baños Uncia	7.36	0.9	58	6	5.000			113	1	0.9	21	79
Sentenario	4	1.26	25	4	50	1.13	45	15	1	1.26	3	28
						2.25	140	110	1			
Sentenario	4	1.26	120	8	6.955	1.8	122	113	1	1.26	14	134
						0.8	120	45	1			
Maraca	5.9	0.354	55	4	4.500	1	260	110	1	0.354	20	75
Piscina Catavi	2.78	2.01	7	6	35			38	2	2.01	1	8
Baños Catavi			44	6	480	2.25	145	75	1	2.25	13	57
Tomas Ventilla	8.18	0.174		2	5.000							

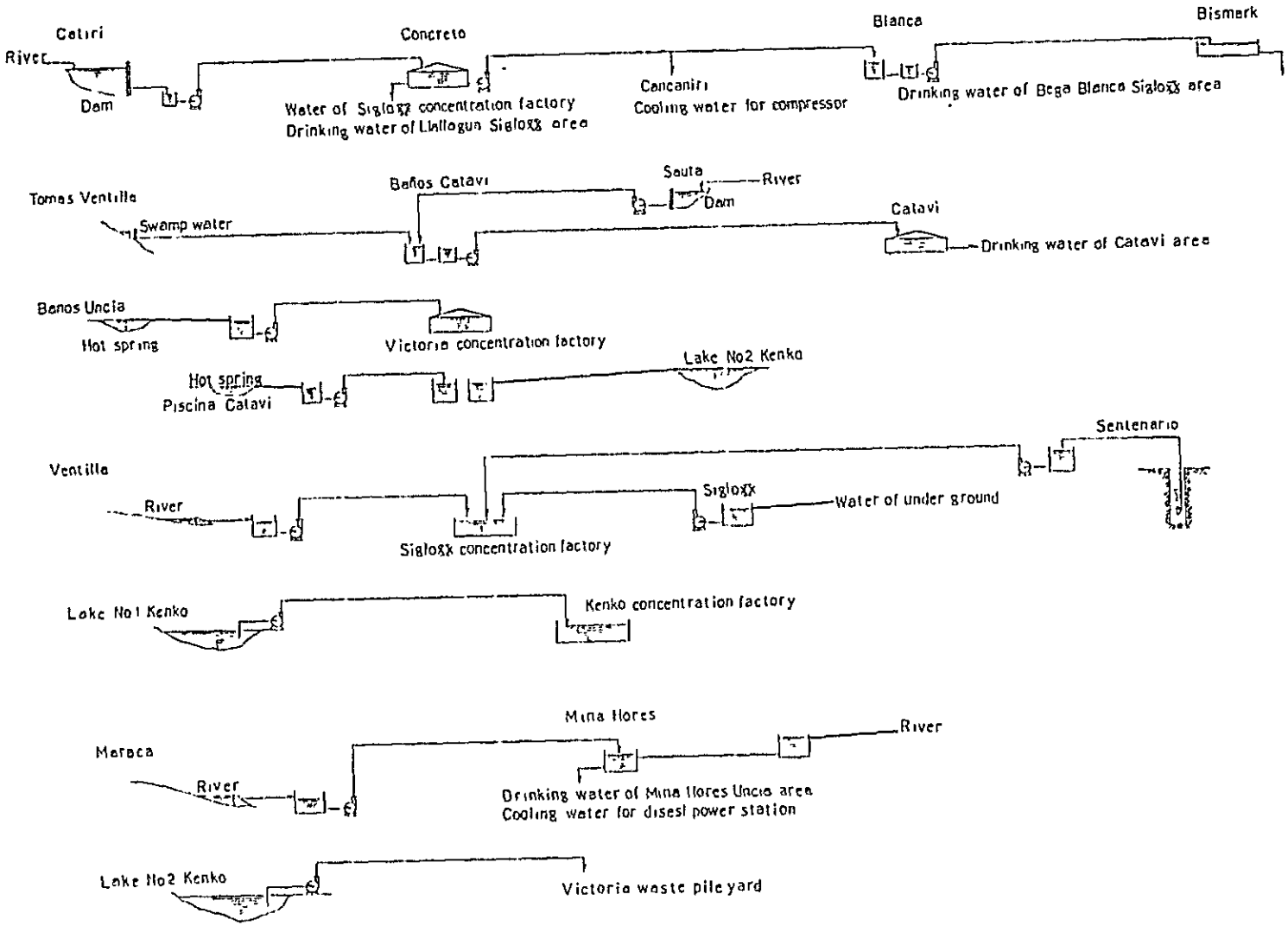


Fig. 4–9 Water supply sistem

9) Piscina Catavi

Although the specification of pumps is not clear, the entire quantity of flow is pumped up at present, and as a capacity of 5 KW is sufficient for the motor, the motor of 38 KW now used is too large.

10) Baños Catavi

The pumps relay the entire quantity of flow at Santa, 1.2 m^3/min, and that at Tomas, Ventilla, 0.174 m^3, and from the specification of pumps and the pump diameters, the pumping up capacity of the equipment is thought to be about 52.5 m^3/min which is too large.

The quantity of water used in Japan at a mill plant carrying out mainly heavy-media separation is, on the average, about 1.8 m^3 of supplemented water and about 7.3 m^3 of circulated water per ton of crude ore and that at a shop mainly carrying out flotation it is about 2 m^3 of supplemented water and about 4.6 m^3 of circulated water.

Compared with this, in Siglo XX sink and float plant, the quantity of supplemented water excluding that of Catiri is only 1.2 m^3, and is still insufficient even when that of Catiri is added. The quantity should be increased by the amount, it is falling short and the shop is actually partly out of service on account of the shortage of water supply.

At Victoria mill plant, the quantity of water supply except that from Lake No. 2 Kenko is 2 m^3 and is quite enough.

Kenko mill plant uses the water of Lake No. 1 Kenko and it seems that there is no problem there.

The quantity of drinking water used by mine houses is about 10 m^3/M per household. In Catavi mine, there are 15,576 households, the quantity of drinking water is therefore,

$$15{,}576 \times 10 \div 30 \div 24 \div 60 = 3.6 \text{ m}^3/\text{min}$$

On the other hand, even when Catiri intake water is fully used as drinking water, pumped up water quantity is about 2.628 m^3/min. This value seems to be the lowest limit even if the fact that people there rarely take a bath and their standard of living is low is taken into account.

4–3–9 Dump for Tailing and Slime

The flow chart of tailing and slime is shown in Fig. 4–10.

In dump except Lake Kenko, tailing and slime are dumped on the surface and they have not been washed away even in the rainy season. For dumping the matter is transported by a cable way and belt conveyors and processed with bulldozers.

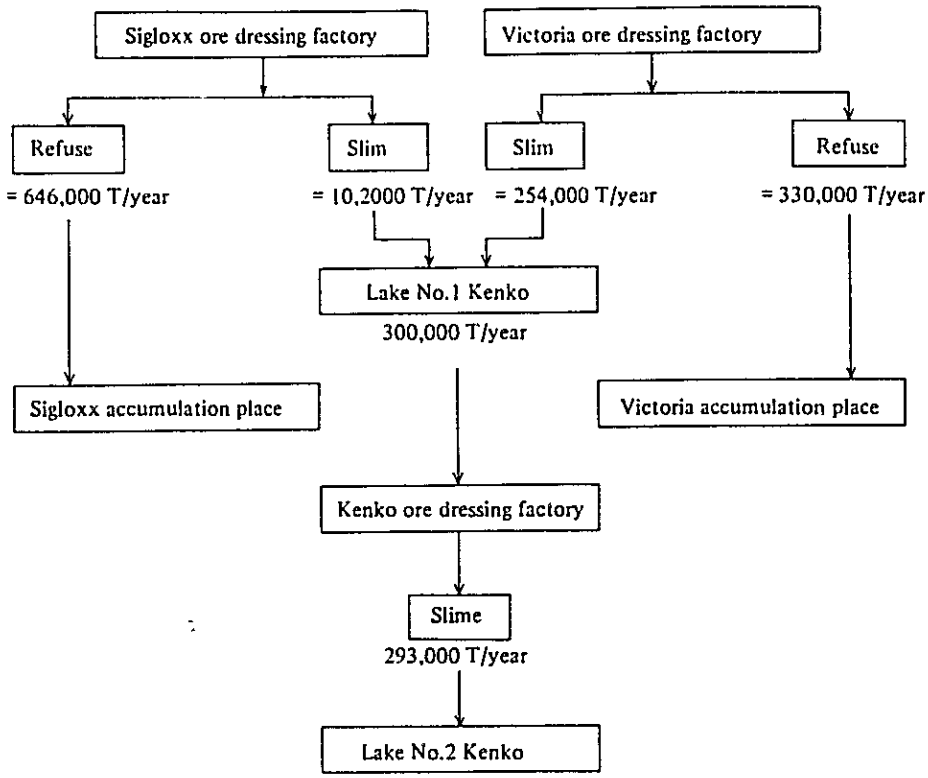


Fig. 4–10 Flow Sheet of Slime and Tailing

The capacity of the dumps is large enough if the present method of dumping is continued, if only the cable way is extended. There are sufficient places which can be used as dumps if the method of transporting by trucks and shovels is adopted.

Minimum required capacity of the cable way is as follows.

$330{,}000 \div 12 \div 28 \div 24 = 41$ T/H

The capacity of the cable way whose rope speed is 120 m/min, bucket volume 0.65 T and bucket interval 50 m is:

$120 \div 50 \times 0.65 \times 60 = 93.6$ T/H

Accordingly, its capacity is more than twice the required capacity.

Concerning Lake Kenko, when the two factories process 1,000 T/D, their full capacity, the quantity of slime dumped into Lake No. 1 Kenko is 264,200 T/year, while the actual quantity processed is 300,000 T/year, so that there is no problem.

In Lake No. 2 Kenko, about 293,000 T/year will be dumped. On the assumption that its capacity is 300,000 T, its life is about one year. Accordingly, the problem of the slime accumulation place will occur very soon when Kenko mill plant is operated at its full capacity.

4–4 Maintenance

The equipments which require maintenance from time to time in Catavi mine include winding equipment, air compression equipment, drainage equipment, ventilation equipment, Siglo XX sink and float plant, Kenko mill plant, water equipment non-utility generation equipment etc.

Only in mill plants, machines which require performed who transport and repair them belong to each metallurgy section, but all other such machines belong to the work shop Electricians all belong to electrical section and that section is in charge of maintenance of all the electrical equipment.

There are patrols who check the underground equipment such as the winding equipment, drain equipment, etc., to some extent. Periodic inspections of the winding equipment such as measurement of ropes, etc., are carried out.

Compressors are all operated in the first shift, and in the second shift, only those for blowing are operated and others are checked and repaired.

In the concentration sections, there are only the operators of machines such as cable ways, dredgers, etc., and repairers; and inspection is not carried out.

The state of operating the machines and instruments in the mill plants is as follows.

1. There are many roller conveyors whose rollers do not move, gears and roller chains which are not lubricated, roller stands which have no fixing bolts.
2. There are many screens and tables whose V-sheaves are of a size different from the proper one and machines which do not have sufficient number of V-belts.
3. The crankshaft bearing metal of Akins classifier is badly worn and even its tank vibrates.
4. There are cracks in the bases of gyratory crushers and the counter shaft is rotating eccentrically.
5. The cables of trippers are hanging down over.
6. The anchor bolts of roll crushers are broken, the crushers therefore have practically

no anchor bolts.

7. The temperature of pump metals is abnormally high.

8. There are many cases where the center of the motor is not aligned with that of the machine.

9. Ore collect at apron feeders, belt conveyors, mills, etc., to such an extent that the motor shafts of these machines are rotating in the ore.

The above are only noticeable examples, and even when such states are found, workers regard them quite normal, leaving the states as they are. Accordingly, those who are in charge of machines are repairing the machines in the mill plants everyday, but there are considerable number of machines out of service.

Another problem about maintenance is the parts control. Parts which can be obtained immediately in Japan require a minimum of four months to be obtained, and some parts requiring longer delivery time take one or two years. Accordingly, proper inventory control is a very important subject.

At present, there are machines which have not been operated over one year because of lack of parts, while there are parts which have not been used for years.

As mentioned above, something like maintenance work is being carried out merely in a part of the mining sections, but in other sections, no maintenance work is carried out.

4–5 Rate of Operation

The capacity of equipment in Catavi mine except additional facilities, such as the hospital, schools, dwellings, etc., is 22,085 Kw, while electric power consumption is on the average 9,711 Kw and 12,140 Kw in maximum.

The electric power consumption includes those of the hospital, schools, dwellings, etc., and the latter is about 60 Kw.

Accordingly, the average rate of operation of the equipment is,

$$(9{,}711 - 60)/22{,}085 \times 100 = 43.7\%$$

and the maximum rate of operation is,

$$(12{,}140 - 60)/22{,}085 \times 100 = 54.7\%$$

The average electric power generation of the hydraulic power stations was 1,622 Kw in 1978, 1,171 Kw in 1979 and 835 Kw in 1980, and its rate of operation was 74.7% in 1978, 54% in 1979 and 38.5% in 1980. The rate of operation of the hydraulic power stations is falling year by year.

4–6 Maintenance Factories

There is a head office of the maintenance section including the room of superintendent and the technical office, factories include Cancañiri carpentry factory, and Siglo XX transportation in Siglo XX area, Catavi maintenance factory, Catavi carpentry factory, automobile factory, Catavi transportation, heavy machine factory and rubber factory in Catavi area.

Disposition of persons in the factories is shown in Fig. 4–1.

1) Cancañiri maintenance factory

This factory is located at the material transportation entrance of 411 level, having 24 employees who are engaged mainly in the repair of rock drills.

The kinds of shops included are the shops for forging, casting and finishing and the shop for repairing locomotives. Rods, levers, chisels, bits, etc. are produced in the forging shop. In the casting shop, the casting of gun metal bushings only is carried out. The finishing shop, has lathes, drills, grinders, etc., and operations such as the production of through bolts and bushings, regrinding of bits, etc., are carried out.

The members of transportation squad are engaged in the repairing of locomotives.

2) Siglo XX maintenance factory

This factory is located at the entrance of 650 level, the main haulage level of the plant, and the production and the repair of the parts of mining equipment and ore dressing equipment are carried out.

The members of the factory consist of 9 compressor operators including a foreman, 32 winding machine operators including a foreman, 21 members of mine water and drinking water supply and 2 ore measurers, 64 in total, and as one member is dispatched to the mining section and is working there, the actual number of members of this factory is 63 persons

The kinds of shops are forging and finishing shops and the shop for repairing ore tubs. The equipments include nine lathes the largest one being 44"ϕ x 110"L, three drilling machines including one radial drilling machine, one surface grinder, two screw cutting lathes, four cutting machines including sawing machines, two electric hammers, one air hammer, grinders, etc.

The production of parts and the repairing work of winding machines, compressors, fans, pumps and tubs, and the production of parts and the repairing work of the belt conveyors, screens, crushers, crusher fires, pumps, etc., of Siglo XX sink and float plant are carried out.

3) Siglo XX carpentry factory

This factory is located at the same place as Siglo XX carpentry factory, provided with

one sawing machine, one drilling machine, one lathe, one universal woodworking lathe, two milling machines and one fret sawing machine, and is producing underground ladders, the brake shoes of winding machines, core cases, cabinets, desks, chairs, doors, etc.

4) Siglo XX transportation

This is located in Siglo XX area and its business is to drive automobiles.

5) Catavi maintenance factory

This factory is located next to the ore receiving place of Victoria mill plant.

The actual number of personnel of the factory is 74, excepting eight who are in charge of drinking water and operate pumps in Catavi area and seven patrol members.

The equipments of the factory include 17 lathes, the largest of which is a 92"ϕ x 236"L, five drilling machines, three milling machines, two cutting machines including a sawing machine, two screw cutting lathes, two presses, one furnace, one electric power generator, one air hammer, welders, etc.

The large parts of the machines used in Catavi mine, i.e., mill shells, gears, screens, pumps, roll crusher tires, conveyor pulleys, etc., and most of the small and medium size machines are produced in this factory.

6) Catavi carpentry factory

This factory is located at the same place as Catavi maintenance factory and has two lathes including one universal woodworking lathe, five cutting machines including sawing machines, two grinders, one wood planing machine, one drilling machine, one welder, etc.

The tables and gutters of the mill plant, the desks, chairs, cabinets, doors, etc., of schools and company houses are produced here.

7) Automobile factory

This factory is located at the same place as Catavi maintenance factory and repairs all the automobiles of Catavi mine.

8) Catavi transportation office

This is located at the same place as Catavi maintenance factory and takes charge of driving the automobiles.

9) Heavy machine factory

This factory is located at the same place as Catavi maintenance factory and takes charge of operating and repairing the heavy machinery.

10) Rubber factory

This factory is located at the same place as Catavi maintenance factory and takes

charge of the maintenance work of rubber pump-impellers, casings, liners, etc.

4–7 Electrical Installation

Concerning the electrical installation, the present state of power receiving facilities, power stations, distribution facilities and loads was found out based on the data of present survey in the mine and data submitted by Catavi mine, and the capability of power supply, electric power consumption, etc., are investigated based on the result.

4–7–1 Power Receiving Facilities and Power Station

The electric power for Catavi mine is supplied by the installation of a total capacity of 16,327.5 KVA consisting of 11,000 KVA by the power receiving facilities installed in Siglo XX, 2,837.5 KVA by the hydraulic power station and 2,490 KVA by the thermal power station. The outline of the installation is shown in Table 4–30.

Table 4–30 *Capacity of Receiving and Generation Power*

Facility	Type of equipment	Capacity (KVA)	Number	Voltage (kV)	Installation Site
Power receiving	Receiving transformer	3,500	1	66KV/10KV	Siglo XX
Facilities	"	7,500	1	"	"
	(Subtotal)	11,000			
Hydraulic	Water-wheel generator	350	4	2.3	Lupi-Lupi
Power station	"	437.5	3	"	Chaquiri
	"	125	1	3	
	(Subtotal)	2,837.5			
Thermal	Diesel engine generator	280	1	3	Miraflores
Power station	"	1,250	1	10	"
	"	320	3	3	"
	(Subtotal)	2,490			

The thermal power generating facilities (Diesel engine generators) are operated only during in emergencies and do not operate otherwise usually.

4–7–2 Power Distribution Facilities

Power that is transformed from 66 Kv to 10 Kv by the power receiving facilities is distributed through switch gear and supplied to feeders. The names of feeders and the capacities of transformers are shown in Table 4–31.

Table 4–31 Capacity of Transformers of Electric Distribution

Feeder symbol	Feeder name	Number of transformers	Capacity of transformer (kVA)
F_2	Ingenio Catavi	8	6,217
F_3	P. Sink & Float, Fundicion	7	4,665
F_4	Mina Auxiliar	5	1,625
F_5	Compresras Cancañiri	12	6,370
F_6	Salvadora Concreto	1	750
F_7	Bunbas Cativi	1	1,500
F_8	Alumbrado Compto, Villareoel	1	332
-	(Total)		(21,459)

The system of the power receiving facilities, power distribution facilities and power stations is shown schematically in Fig. 4–11 Single Line Connection Diagram.

4–7–3 Electrical Load

Loads in Catavi mine are mainly compressors, pumps, belt conveyors, flotation machines, ventilation fans, etc. The lists of facilities are shown in Fig. 4–3 ~ Fig. 4–5 and Table 4–1 ~ Table 4–23.

The number of loads and installed capacities grouped by place or the kind of machines are shown in Table 4–32 below.

Table 4–32 Motor Capacity

Place or kind of machine	Number of facilities	Installed capacity (kW)
Siglo XX sink and float plant	184	3,717
Victoria mill plant	342	5,242
Kenko mill plant	121	1,830
Cancañiri (Compressors)	8	4,041
Cancañiri (Pump)	5	137
Maintenance factories	71	600
Casting factories	1	1,440
(Subtotal)	(732)	17,007

Winding machines	9	848
Ventilation fans	21	1,054
Water supply pumps	25	2,576
Drainage pumps	4	300
Motor-driven generator for locomotives	1	75
Rectifier for locomotives	1	225
(Subtotal)	(61)	5,078
Total	793	22,085

4–7–4 Power Consumption and Estimation of Maximum Demand

Power consumption in Catavi mine in five years from 1976 to 1980 is shown in Table 4–33. To compare the capability of power supply with power consumption, the mouth experiencing the maximum power consumption in each year was founded out and the maximum power demand was estimated as shown in Table 4–34 below.

Table 4–34 Power Consumption and Maximum Demand Estimated

Month, Year	Power consumption (kwh/D)	Average power (kw)	Maximum demand (kw)
April 1976	236,046	9,835	12,294
August, 1977	244,429	10,185	12,731
April, 1978	234,364	9,765	12,206
June, 1979	228,287	9,512	11,890
April, 1980	222,251	9,260	11,575

(The estimated value of the maximum demand was calculated on the assumption of 24 hours operation per day and 80% load factor)

4–7–5 Consideration, Investigation and Proposals about Electric Installations

1) Investigation of power consumption versus power facilities

As seen in Table 40–30 showing the capabilities of power receiving facilities, hydraulic power stations and thermal power station, the sum of the capabilities of the power receiving facilities and the hydraulic power stations is 13,837.5 kva (since power factor is 80%, the capability of the power receiving facilities is 8,800 kw, that of the hydraulic power station is 2,270 kw and their sum if 11,070 kw), while the average of the maximum power consumption in the past five years is 12,140 kw, surpassing the capability of the power facilities. The shortage has been covered by operating the thermal power station with the capability of

2,490 kVA (1,992 kw).

When the thermal power station is regarded as emergency facilities, there is a problem in future increase in loads compared with the capability of the existing power facilities.

If the demand factor in Catavi mine is supposed for reference, the capacity of facilities in Table 4–31 is 22,085 kw, while the maximum power consumption in Table 4–34 is 12,140 kw, accordingly, the demand factor is 55%, which is almost the same as that in Japan.

4–8 Casting Factory

This is the largest casting factory in Republic of Bolivia and produces the machines and parts of not only Catavi mine but all the mines under the control of COMIBOL.

The factory is located at the lowest level of Victoria mill plant, and its equipment includes sand blasting booths and shot blasting booths, sand recovery equipment, environmental dust collecting equipment etc., in addition to a 3 t/charge and a 1 t/charge furnace.

The capability of the factory is 200 T/H at present, while all the mines under the control of COMIBOL require the products of about 400 T/H, accordingly, the capacity of the factory is enough for Catavi mine alone, but for all COMIBOL, it is about a half of the required capacity.

The factory produces all the different kinds of mine equipments, and the materials of the products include various materials such as cast iron, cast steel, manganese steel, alminum, gun metal, babbit metal, etc.

The settlement of account of the factory shows a profit on a self-paying basis and the factory has the elements of an independent enterprise, but it has no inspection mechanism and often supplies defective products, accordingly, blow holes are sometimes found after machining and the products have to be thrown away.

Therefore, it is necessary to introduce a quality control system and check materials and products.

To supply all the products required by all the mines under the control of COMIBOL, a plan to double the production of the factory is in progress and will soon be put into practice.

4–9 Consideration and Proposals

Problems about the mine equipments seem from the standpoint of mine service section are as follows.

Table 4–33 CONSUMPTION FIGURE OF ELECTRIC POWER FOR CATAVI MINE (Annual 1976–1980)

		January	February	March	April	May	June	July	August	September	October	November	December	Total
1976	Hydrauric Power Station		1,110,290	1,614,580	1,424,500	1,473,000	513,500	1,470,240	1,424,420	1,380,380	1,411,580	1,204,260	208,950	13,235,700
	Thermal Power Station	117,030	10,260	–	–	–	790	–	1,880	–	1,570	–	–	131,530
	Power Company	5,841,800	4,751,200	4,278,600	4,994,800	5,097,600	3,456,400	5,287,200	5,442,200	5,701,000	5,772,400	5,614,200	6,556,400	62,793,800
	Total	5,958,830	5,871,750	5,893,180	6,419,300	6,570,600	3,970,690	6,757,440	6,868,500	7,081,380	7,185,550	6,818,460	6,765,350	76,161,030
	Average Hydrauric	–	1,652	2,170	1,978	1,980	713	1,976	1,915	1,917	1,897	1,672	281	
	do. Thermal	157	15	–	–	–	–	–	2	–	2	–	–	
	do. Power Co.	7,852	7,070	5,751	6,937	6,852	4,801	7,107	7,315	7,918	7,759	7,798	8,812	7,168
	do Total	8,009	8,737	7,921	8,915	8,832	5,515	9,083	9,232	9,835	9,658	9,470	9,093	
1977	Hydrauric P.S	–	19,960	1,071,540	673,840	1,200,060	1,504,020	1,530,600	1,058,640	349,440	327,620	817,420	537,020	9,090,160
	Thermal P.S	–	–	–	–	7,730	–	140,910	158,490	153,150	188,020	192,670	136,850	977,820
	Power Company	6,489,000	5,953,600	6,110,400	6,183,200	5,884,400	5,668,200	5,905,800	5,782,400	6,162,000	6,211,200	5,547,200	5,911,400	71,808,800
	Total	6,489,000	5,973,560	7,181,940	6,857,040	7,093,190	7,172,220	7,577,310	6,999,530	6,664,590	6,726,840	6,557,290	6,585,270	81,876,780
	Average Hydrauric	–	29	1,440	936	1,613	2,089	2,057	1,423	485	440	1,135	722	
	do. Thermal	–	–	–	–	11	–	190	213	213	253	268	184	
	do. Power Co.	8,722	8,554	8,213	8,588	7,909	7,872	7,938	7,772	8,558	8,348	7,704	7,945	8,175
	do. Total	8,722	8,583	9,653	9,524	9,533	9,961	10,185	9,408	9,256	9,041	9,107	8,551	
1978	Hydrauric P.S	589,880	1,579,000	1,765,970	1,634,400	1,566,760	1,435,920	1,521,880	1,433,100	731,560	1,111,500	842,720	–	14,212,680
	Thermal P.S	44,330	128,850	147,360	126,870	157,740	160,330	110,740	3,000	–	–	–	–	879,220
	Power Company	5,486,000	4,241,200	4,944,000	5,269,672	5,212,310	5,093,482	5,204,986	5,244,600	5,766,000	5,203,200	5,383,200	6,446,400	63,495,050
	Total	6,120,210	5,949,050	6,857,320	7,030,942	6,936,810	6,689,732	6,837,606	6,680,700	6,497,560	6,314,700	6,225,920	6,446,400	78,586,950
	Average Hydrauric	793	2,350	2,374	2,270	2,106	1,994	2,045	1,926	1,016	1,494	1,170	–	
	do. Thermal	59	192	198	176	212	223	149	4	–	–	–	–	
	do. Power Co.	7,374	6,311	6,645	7,919	7,006	7,074	6,996	7,049	8,008	6,994	7,477	8,665	7,248
	do. Total	8,226	8,853	9,217	9,765	9,324	9,291	9,190	8,979	9,024	8,488	8,647	8,665	
1979	Hydrauric P.S	–	310,000	463,000	362,930	1,179,770	1,235,520	1,250,260	1,265,580	1,168,700	1,320,020	1,238,280	902,550	10,691,610
	Thermal P.S	9,410		–	–	1,430	65,380	54,570	65,150	47,760	48,280	900	17,210	310,090
	Power Company	6,227,400	5,205,600	6,086,000	5,826,200	5,571,768	5,547,702	5,737,400	5,255,600	5,314,200	5,654,600	3,737,400	5,535,000	65,698,870
	Total	6,236,810	5,515,600	6,549,000	6,189,130	6,747,968	6,842,602	7,042,230	6,586,330	6,530,660	7,022,900	4,976,580	6,454,760	66,700,570
	Average Hydrauric		461	622	504	1,579	1,716	1,680	1,701	1,623	1,774	1,720	1,213	
	do. Thermal	13	–	–	–	2	91	73	88	66	65	1	23	
	do. Power Co.	8,370	7,746	8,180	8,092	7,489	7,705	7,112	7,064	7,381	7,600	5,191	7,440	6,928
	do Total	8,383	8,707	8,802	8,596	9,070	9,512	9,465	8,853	9,070	9,439	6,912	8,676	
1980	Hydrauric P.S	12,600	20,760	1,060,350	1,301,420	1,055,140	982,680	769,840	945,310	850,270	319,645	–	–	7,318,015
	Thermal P.S	58,790	58,400	3,370	18,100	–	–	–	78,830	–	45,280	21,190	3,410	387,370
	Power Company	5,993,400	5,292,200	5,586,200	5,348,000	5,636,200	5,670,000	4,881,600	5,123,000	5,809,600	6,306,400	5,806,400	6,042,200	67,495,200
	Total	6,064,790	5,371,360	6,649,920	6,667,520	6,691,340	6,652,680	5,651,440	6,147,140	6,659,870	6,671,325	5,827,590	1,045,610	75,100,585
	Average Hydrauric	17	30	1,425	1,808	1,418	1,365	1,035	1,271	1,181	430	–	–	
	do. Thermal	79	84	45	24		–	–	105	–	61	29	5	
	do Power Co.	8,056	7,604	7,508	7,428	7,576	7,875	6,561	6,886	8,069	8,476	8,065	8,121	7,684
	do. Total	8,152	7,718	8,938	9,260	8,994	9,240	7,596	8,262	9,250	8,967	8,094	8,126	

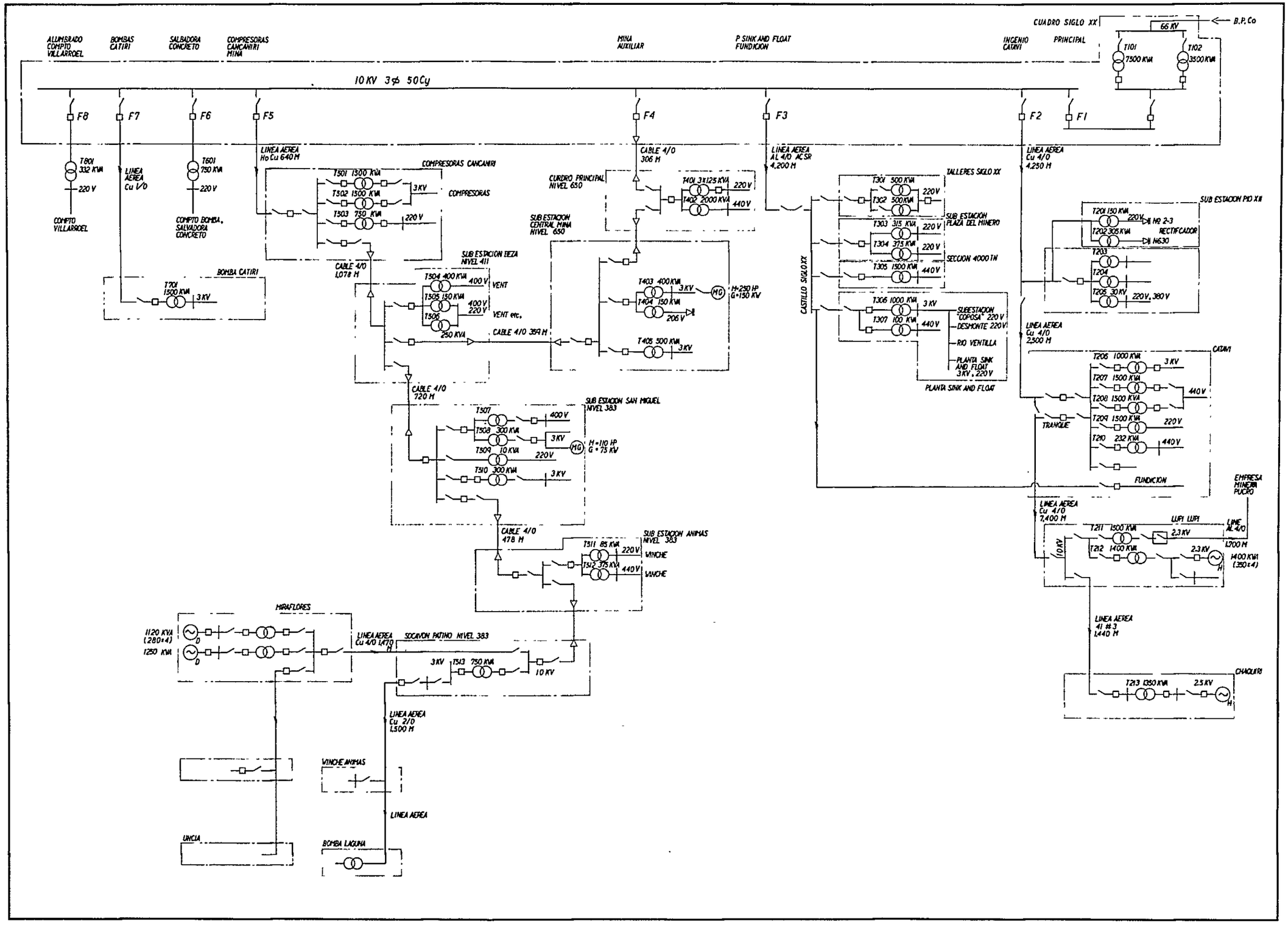


Fig. 4-11 One Line Diagram for the Cotavi Mine

4–9–1 Deterioration of Equipment

Much of the equipment in Catavi mine is old. For example, Lupi-Lupi and Chaquiri hydraulic power stations were constructed in 1926, Milaflores power station was down in 1930, four of the eight compressors in Cancañiri were produced in 1929 and one of them was down in 1957, the date of production of three compressors in Dolores is not clear, but they seem to have been manufactured in about 1930. In concentration equipment, the production dates of most of the machines except those of Kenko mill plant are not clear, but they seem to be those of thirty years ago.

Since many machines have deteriorated as mentioned above, several machines were renewed recently, i.e., two 340 kw Atlas Copco compressors made in 1978, one 750 kw Joy compressor made in 1980; and in the concentration section, one Allis Chalmers #6 gyratory crusher and one Symons 3′ cone crusher were renewed recently. Although renewal was started two or three years ago, renewed machines form only a small part of the equipment and most of them have surely passed their durable years.

Such deterioration results in the following.

1) The frequency of mechanic trouble is very high.
2) Parts of the machines are not produced by their manufacturers.
3) In the case of common trouble of machine, it can be repaired by changing parts, but in the case of such an old machine, the entire machine must be overhauled and the time taken for repair is very long.

The best measure is to carry renewal forward systematically. From financial conditions, renewal has to be continued for a long time.

In effecting this renewal plan, it is necessary to take various managerial problems into account, envisage a desirable future figure and proceed to the target instead of simply renewing the same kind of machines.

For example, in the case of the receiving and crushing equipments at Siglo XX sink and float plant, the width of the apron feeder for bin drawout is 700 mm and the size of the gyratory crusher for primary crushing is small for (#6), accordingly, 7 – 8″ size grizzlies are used over the bin. Ore feeded from stopes includes many large blocks owing to the method of exploitation, so that "grizzly-over" occurs frequently and those blocks are manually loaded in trucks and disposed as tailing.

In spite of the existence of such a problem, the #6 gyratory crushers are renewed mechanically for the same size ones without thinking about this problem. In this case, it

is necessary to make a plan to install a large jaw crusher at the time of renewal, remodel the bin next and then renew the apron feeder to solve the above-mentioned problem.

To cope with deterioration during renewal, perfect maintenance work including preventive maintenance must be carried out to reduce the frequency of trouble.

4–9–2 Maintenance

The biggest problem is a fact that no maintenance work is carried out actually. An important point is how to introduce an effective maintenance work system.

During the present survey someone expressed an opinion that, in the case of concentration work, systematic repairing work employing maintenance could never be carried out because of 28-day operation. In the case of a Japanese mine, the capability of equipment is planned on the basis of the operation days setting aside the number of days for repair as a matter of course. The operation days have been 25 until a recent date, and at present, it is 23.

In Catavi mine, the number of operation days is set to 28, and a method to prepare spare machines is used to cope with trouble. However, it requires much money to have spare machines, so that only auxiliary machines can be prepared in reserve.

Large costly machines except the scrubbers of Siglo XX sink and float plant have sufficient capacities for 25-day operation, so that it is necessary to reduce the number of operation days to 25 at maximum.

Next, the mining department and the concentration department must be provided with maintenance sections. The work of the maintenance section includes check work and repair work. The number of members who carry out the check work may be small, but they must guess even the interior states of machines which cannot be seen, so that experienced competent persons are needed.

The study of the maintenance section is, not only for repair at times of sudden breakdown, but also:

1) Patrol check work and oiling work.
2) Deciding the time to repair.
3) Preparation of materials and parts.
4) Planning of periodic repairs.
5) Preparation for periodic repairs.
6) Recording of the date, states, the method of repair for periodic repairs, and the date,

states, causes and the method of repair of daily troubles.

By carrying out these, the system of maintenance work can be established.

The purpose of the maintenance work may include the reduction of the time taken to repair, but its most important point is to prevent loss caused by the suspension of the operation of the factory on account of troubles. Therefore, the maintenance section is an indispensable section in such a large scale mine as Catavi mine.

4–9–3 Water Supply and Drain Treatment

Geographical feature around Catavi mine is such that, including water from River Catavi, River Ventilla, River Sauta, etc., effluent from Lake No. 2 Kenko and even sewage all flow into Lake Lupi-Lupi.

Above all, the concentration sludge of Locatario and the effluents from Leke No. 2 Kenko reduce the pH value of the water of Lake Lupi-Lupi and accelerate the erosion of the turbines of Lupi-Lupi and Chaquiri hydraulic power stations.

As mentioned before, Catavi mine itself is suffering from the shortage of water supply and uses many water supply pumps and also operators.

It is necessary to supply clean water into Leke Lupi-Lupi to prevent the erosion of the water turbines of the power generators, and further, install large pumps by Lake Lupi-Lupi to supply water to the whole mine.

1) Drain-treating equipment should be installed at the outlet of the effluents of Lake No. 2 Kenko.

This equipment consists of a hopper of slaked lime, an agitation tank for the draw-out equipment, pH meter, etc. The quantity of slaked lime is adjusted according to the state of the draw-out feeder. The equipment may be a simple one to discharge the liquid produced by agitating the original contaminated water with slaked lime directly into the river.

2) The drinking water equipment in Uncia Milaflores area may be used as it is.

3) Concerning drinking water for Catavi area, pumps which can pump up water to Catavi should be installed by Santa, but the existing piping can be used unchanged. Only the water from Tonas and Ventilla must be relayed at Catavi and pumped up to Catavi tank. The pipe between Baños and Catavi must be newly installed.

4) Water from Catiri should be used only as drinking water. A pump which can pump up water from Catiri to Blanco must be installed, but the existing piping can be used unchanged.

5) A pump station should be constructed by Lake Lupi-Lupi, installing new piping to

Bimarck, to supply all the water required for concentration, mining, etc.

As shown in Fig. 4–12, the above-mentioned pumps should be of the automatic operation type to save labor.

4–9–4 Electric Installation

1) Investigation of power consumption related to power facilities

As seen in Table 4–31 showing the capabilities of the power receiving facilities, hydraulic power stations and the thermal power station, the sum of the capacity of the power receiving facilities and the hydraulic power stations is 13,837.5 kva (since power factor is 80%, the capability of the power receiving facilities is 8,800 kw, that at the hydraulic power stations is 2,270 kw their sum is 11,070 kw), while the average of the maximum power consumption in the past five years is 12,140 kw, surpassing the capability of the power facilities. The shortage has been covered by operating the thermal power station with the capability of 2,490 kva (1,992 kw).

When the thermal power station is regarded as an emergency facility, there is a problem in future increase in loads compared with the capacity of the existing power facilities.

2) Consideration about distribution facilities

Concerning the distribution facilities, the capacity of the equipment and the power of each feeder could not be grasped accurately, therefore, thorough investigation should be carried out at the time of future survey (quantitative survey).

It seems that there are some places where machines have to be stopped on account of voltage drop, it is therefore necessary to reduce voltage drop by increasing the distributed voltage, providing power condensers for terminal equipments, etc.

3) Consideration about power stations

As mentioned before, the thermal power station should be regarded as emergency equipment to be operated for a short time as a rule, so that they should not be relevant to the subject of the normal capability of power facilities. Concerning the hydraulic power stations, there were few periods in the past when they supplied their rated output. Accordingly, it is necessary to carry out the proper maintenance of the hydraulic power stations so that their rated output can be generated and electric power cost can be reduced by reducing receiving power.

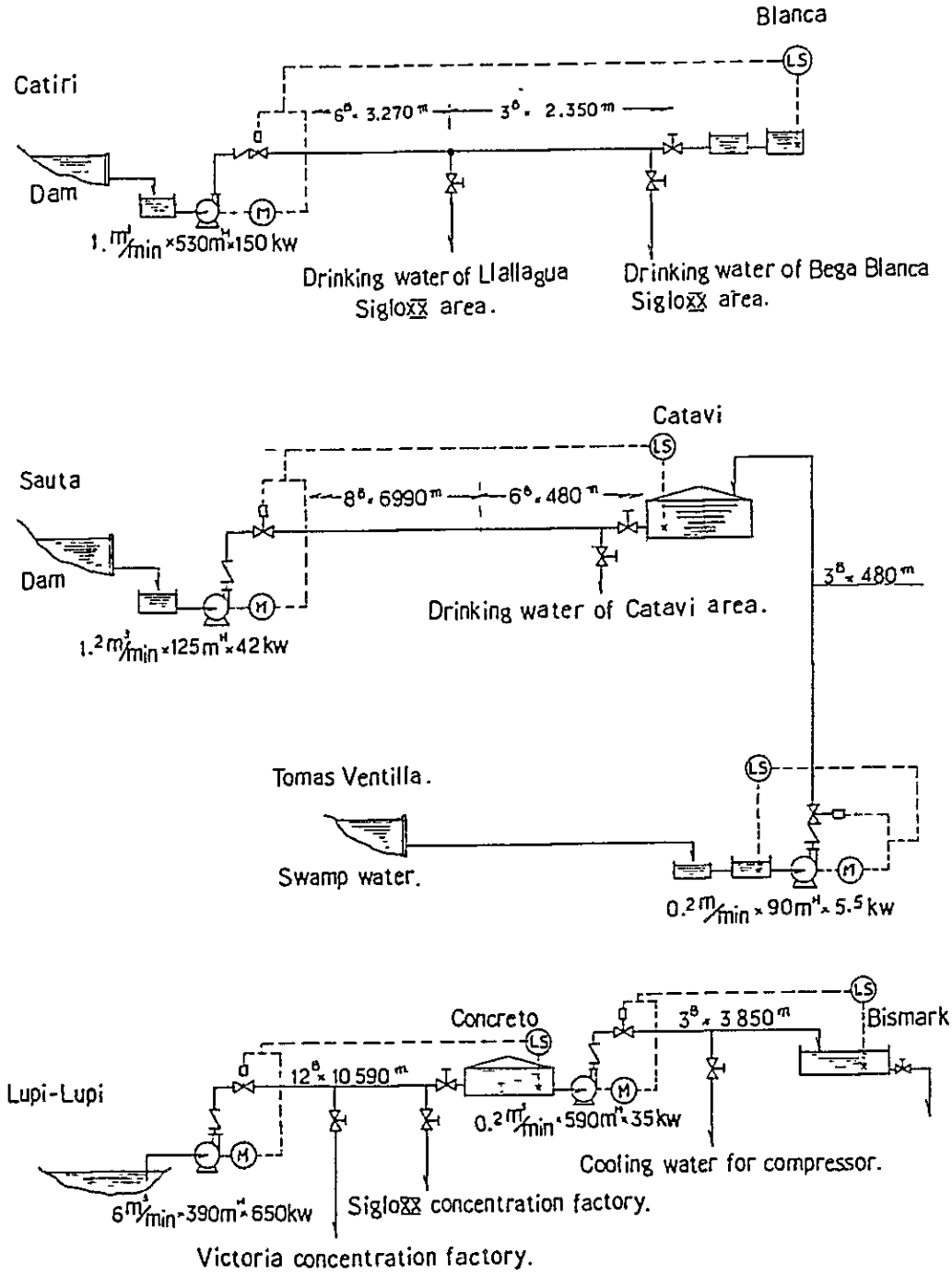


Fig. 4—12 Aremedy of water supply sistem

CHAPTER 5. ADMINISTRATION DIVISION

5–1. Mine Cost

Catavi mine adopts group, item, factor and process cost accounting systems for cost control. But designation of item is too theoretical to meet realities. Furthermore, the cost control organization does not necessarily match the business management organization. The cost control setup is not a satisfactory one. Although all departments prepare various cost control materials, they fail to organize such materials for effective use.

5–1–1 *Business Management and Cost Control System*

As illustrated in Table 5–1, the overall Catavi mine organization is under the control of general manager and the submanager. Other than the staff, specialized jobs are divided by job site or business category into five division – mining, dressing, surface work, electricity and administration. Overall cost accounting item as shown in Table 5–2, is divided into seven groups – mining, sink-float separation, dressing, surface work, electricity, administration, other business and ore purchase. Each group is comprised of cost categories and item. The number of items total more than 300, indicating excessively detailed classification of job orders. The large number of items are not well organized, leading to difficulties in cost control.

For example, the business management organization has no division to supervise ore purchase. Within the mining division, Explotacion Locatarios, Veneros and Lamas undertake registration of ore sellers and mining management for acceptance by Metallurgy division and Barilla Bodega. In charge of liquidation are the sales department and Liquidación minerales office. In the cost control organization, they are considered independent groups. Their costs and part of expenses for the manager's and submanager's offices are included into the direct transfer and direct ore purchase costs. Although ore analysis facilities are put under direct control of the submanager, they are incorporated into an surface supplementary division in terms of cost calculation.

There are no problems with factor-by-factor classification in which common factors such as direct and indirect personnel expenses, equipment expenses and electricity charges are used.

5–1–2 Process Costing

Costs, calculated in accordance with the above mentioned procedures, are tabulated every month and every year for reporting to the head office. As illustrated in the table, 5–3 production cost consists of six groups – mining, sink and float separation, dressing, energy and support service, management and ore purchase. The group of "others" is divided into four subgroups of casting plants, investments in fixed assets, medical affairs and others. "Other costs" are classified by factor. Energy and support service group costs are distributed to other groups and part of management and medical costs are transferred to relevant groups. Thus each group's costs are calculated. The cost table indicates production income as well as direct production costs, and group-by-group, factor-by-factor and other breakdowns, providing all the information to look through Catavi mine's costs comprehensively.

5–1–3 Mine Cost

On the basis of the above illustrated total cost table, a group-by-group breakdown of monthly average costs for 1978 – 1981 (Table 5–6) is prepared. Each group's costs per ton of ore have been increasing sharply year by year as shown below:

Table 5 – I Organization of Catavi Mine

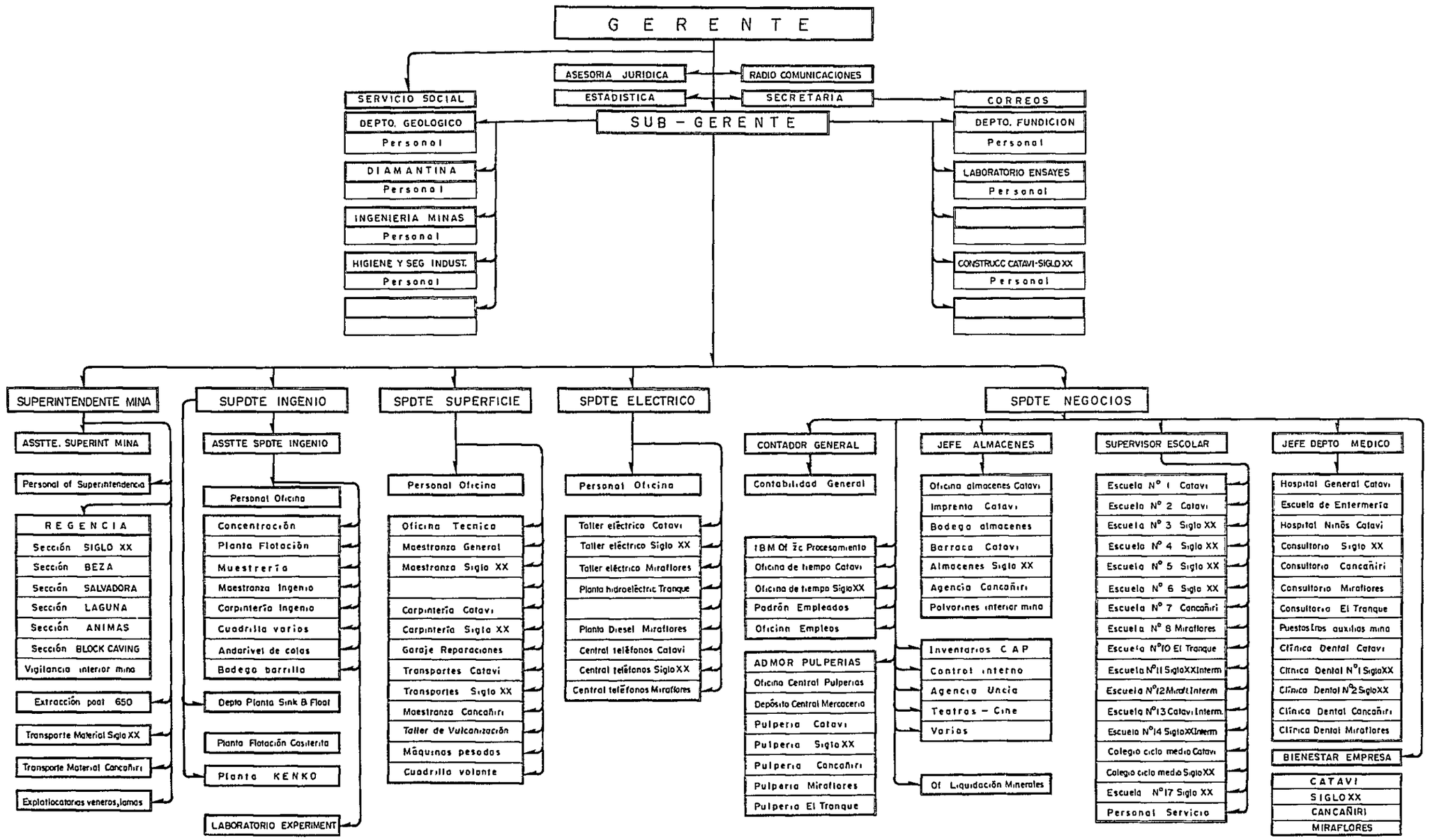


Table 5–2. Catavi Mine's Cost System by Group and Item (1)

Code Number				Name of Item			
	Class				Large Item	Medium Item	Small Item
Group	Large	Medium	Small	Group			
1	30	00	01–07	Mining	Control, management		Supervisory office, overall underground station
							each underground station.
		00	09–19				Block caving management.
	31	01	01–10		Prospecting, Develop-	Prospecting	In and outside of mine drilling, survey, mine,
					ment preparation,		block caving
					mining, underground		Evaluation, placer.
					transport		
		02	01–04			Mine development (Vein)	Tunnel
		03	01–06			Mine development (others)	Tunnels, pits, pit bin, in mine
							Auxiliary tunnels, ventilation and drainage tunnels
		04	01–07			Working face preparation	Working faces
		10	01–08			Working face mining	Working faces, Bismarck vein
		16	01–04			Underground trans-	Each means of transport (trolley, battery loco,
						port	winding, and man power
		20	01		Underground main-	Air shaft pit bin	Air shaft, bin in mine
		21	01		tenance	All tunnels	All tunnels

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
		22	01–05	Mining			Shaft, incline, ventilation operation and maintenance, lift winding operation and maintenance, water and air pipe installment and maintenance, collap and rehabilitation.
		23	01				Drainage operation and maintenance.
		25	01–05			Indirect service	Tunnel heating and lighting, cap lamp charging, underground guard.
	32	02	01–12		Block caving		Block caving.
		02	01–72				Block caving ventilation and dust control.
	33	01	01–02		Ore transport		No. 650 level transportation, trolley transport.
	34	01	01–02		Ore purchase		Independent contractor, non-independent contractor.
		01	03				Dump extraction.
	95	00	01			Depreciation	
		03	01			Ore a/c adjustment	
		05	01			Technical guidance introduction	
	35	01			Block caving preparation		

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
2	41	00	00	Metallurgy	S&F Plant direct costs	Management	
		01	00			Ore acceptance	
		02	00–01			Crushing	First crushing, second crushing.
		03	00–01			Classification	Classification, transport.
		04	00–04		Sink-float separation	Sink-float	Sink-float, classification, water classification, transport, pump.
		05	00–02			Water recirculation	Water recirculation and purification, silicon iron recall, others.
		06	00			Tailing treatment	Tail acceptance and transport.
		07	00			Bin maintenance	Depreciation of a 4,000-ton ore bin.
	42	01	00–03		Maintenance		Water, ditch and pipe maintenance, compressed air, lubrication oil.
		01	04–06			Indirect service	Heating and lighting, tests, sampling analysis.
	43	01	00–01		Transport for Mill Plant		Railways, trucks.
	45	01	00–03		Tin ore flotation		Flotation, classification, pump, others.
		02	10–13		Hole man table		Classification, pump, table, others.
	95	00	02			Depreciation	
		03	02			Ore a/c adjustment	

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
3	40	00	01–02	Metallurgy	Management and supervision		Supervisory office, management.
	44	01	00		Direct cost	Ore acceptance	
		02	00–12			Crushing, classification, transport	First-third crushing, classification I and II, transport, lift transport.
		04	01–05			Dressing	Gib, table.
		05	00–01			Classification	Water classification, classification IV.
		06	00–01			Concentration, water recall	Thickener, water recall and purification.
		08	00			Dressing	
		09	00			Dressing pump	
		10	00			Others	
		11	00			Flotation plant for sink-float concentrate	
		12	00			Plant for purchased ore	
	46	01	00–06		Indirect cost	Maintenance	Water, ditch and pipe maintenance, mobile service group, lubrication oil, ventilation, construction.
		02	01–04			Others	Heating and lighting, tests, sampling analysis.
	47	00	00–01			Transport	Tailing acceptance and transport.

Code Number				Name of Item			
Group	Large	Class Medium	Small	Group	Large Item	Medium Item	Small Item
3	48	00	00	Metallurgy	(Works for concentrate)		
		01	00–01				Concentrate drying, weighing, others.
		02	00			Shipment lot sampling analysis	
	24	00	00		Laboratory		
	95	00	03			Depreciation	
		03	03			Ore a/c adjustment	
	60	01	01–03		Verification plant	Management	Manager, management office, depreciation.
		02	01–03			Mining	Dredger, piping and fittings, agitation, vibration.
		03	01–03			Classification	Classification I and II, pumps.
		04	01–10			Dressing	Sulfurization flotation, cyclone, pump, others
		05	01–03			Works for concentrate	Concentration, evaporation, drying, weighing, transport.
		06	01–04			Maintenance, service	Water, piping, lubrication oil, others.
		07	01–05				Heating and lighting, sampling analysis, tests, tailing pump, others

Table 5–2. Catavi Mine's Cost System by Group and Item (2)

No. 1

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
4	23	00	00	Auxiliary Engineering	Laboratory		
	25	01, 02	0		Construction	Catavi, Siglo XX	
		03	00			Gravel, sand and stone output	
	50	01	00–01		Management and supervision		Supervisory office, technical office.
	51	00, 01	00–01		Construction and smithery	Catavi, Siglo XX	Workshop, smithy.
	52	00, 01	00		Wood processing	Catavi, Siglo XX	Wood processing works.
	53	00, 01	00		Automobile repair	Catavi, Siglo XX	Car repair works.
	54	01, 02	00–01		Transport by automobile	Catavi, Siglo XX	Ordinary automobile, large automobile
		03	00–01		Transport by automobile	Personnel Transport	(truck, dump, etc.). Catavi, Siglo XX.
	55	01	00–05		Rock drill		Hoses, rock drill repairs, drill steel, grinding, rods.
	56	01	00–01		Compressor		Catavi, Siglo XX
	57	01	00–01		Heavy machines		Tire regeneration works, heavy transport. equipment repair works.
	60	00	01–02		Management and supervision		Supervisory office, management.
	61	00, 01	00		Electricity	Catavi, Siglo XX	Electricity works.
	62	01	00–01		Power generator	(diesel)	Catavi and Miraflores plants.
	63	01	00–01		Power station	(hydro)	Lupi-Lupi and Chaquiri plants.
	64	01	00–01		Power purchase		Power purchase, voltage transformation, relay station.

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
5	10	00	00	Administration	Manager's office		
	14	00	00		Mail, telegram		
	15	00	00		Statistics office		
	16	00	00		Inspector		
	20	00	01		Submanager's office		
	21	00	00		Geology	Geology office	
	21	01–04	00			Geological survey, drilling, sampling small mine survey	
	22	00	00		Mining technology		
	25	04–07	00			Mine road maintenance, housing office, company house and school maintenance	
	26	00–04	00		Health and security	Mining, concentration management	
	65	01	00–02		Telephone		Catavi, Siglo XX, Miraflores.
	70	00	01–04		Labor		Labor management office, security, mine police, social plan of COMIBOL.
	71	00	00		Labor management office		
	72	00	00–07		Welfare	Catavi	Welfare office, company house heating and lighting, cleaning, housing office, maintenance, company house maintenance, guard.

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
5		00	10–17	Administration		Siglo XX	Welfare office, company house heating and lighting, cleaning, housing office, maintenance, company house maintenance, guard.
		00	20–22			Cancañiri	ditto
		00	25–28			Miraflores	ditto Patiño entry guard.
		02	01–02			Culture activities sports	Catavi, Siglo XX
		03	01–02			Water service	Catavi, Siglo XX
	73	00–01	01–02		Social service		Social service office, Catavi, Siglo XX labor union.
	74	00–10	01–04		Education service		Education management office, training, feeding, school maintenance, school-wise service.
	75	00	00		Administration division	Health control	
	81	00	00–01		Management and supervision		Supervisory office, accounting.
	82	00	00		Machine accounting		IBM
	84	01–03	00		Immigrant-labor management	Catavi, Siglo XX, immigrant-labor management office	
	86	01–07	00		Materials	Warehouse accounting, printing house, Catavi warehouse, wood warehouse, Siglo XX warehouse, Cancañiri office, mine powder magazine	

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
5		08	00–04	Administration		Firewood supply	Mining and dressing divisions, departments, casting works warehouse office.
	88	01–07	00		Pulperia	Accounting, head office warehouse, Pulperia	Catavi, Siglo XX, Cancañiri, Miraflores, El Tranque.
		08	00–01			Meat	Meat supply, Uncia refrigeration
	90	00	00		Clearance control	Clearance control office	
	91–92	00	00		Inner management, branch offices		
	95	02	00			Head office loan expense	
6	00	00	01	Others	Construction suspense account		Construction suspense account (by name).
	01	02	00			Catavi casting factory	
	01	03	01–05			Movie theaters	Catavi, Siglo XX, Cancañiri, Miraflores, El Tranque
	01	06	00			Poultry farm	
	02	01–04	00			Fixed assets (by each accounting)	
	03	01–03	00			Construction material output, material transport goods, clearance adjustment a/c	

Code Number				Name of Item			
	Class						
Group	Large	Medium	Small	Group	Large Item	Medium Item	Small Item
6	04	01–11	00	Others	Hospitals, clinics	Hospitals, clinics	
		12–13	00			Maintenance	
		14	00			Family allowance management	
	05	00	01–02		Others		Other mines, personal advances.
	49	00–15	00		Ore purchase	Veneros, Locataries, Lamas Cooperativas	

Table 5–3 Monthly Average Cost of Production (1981.6)

	CLASES DE COSTO	I Mina	II Pre-Concentrat	III Ingenio	IV Energias Servicios Auxiliares	V Adminst.	VII Compra Conc. Export.	Costos Netos de Produccion	VI-01-02 Fundicion	VI-00, VI-02 Inversion Activo Fijo	VI-04 Admin. Sanidad	VI-01-03,06 VI-03, 05 Otros Costos	Total
1	Sueldos y Jornales	57,548 85	27,724 65	40,455.93	68,019 01	116,331 16	14,946.40	325,026 -	11,921.68	7,161.52	62,853.13	14,287.82	421,250.15
2	Sobretiempos	5.23	728.44	61.24	91.13	3,852 68	90.71	4,829 43	74 98	13,520 52	714.19	930.15	20,069 27
3	Contratos Interior Mina	90,556 52	–	–	–	–	–	90,556.52	–	7,423 77	–	3,447.32	101,427.61
4	Contratos Exterior Mina	3,110 05	2,080 33	2,265 06	2,862 42	1,477.38	9.87	11,805.11	12,345.93	838 48	–	607.07	25,596 59
5	Bonos	85,991.73	23,780.74	34,743.55	36,968.47	66,824 04	1,642.78	249,951.31	8,352 82	4,939 41	19,303 12	6,059,52	288,606.18
6	Incentivo Asistencia	12,529.06	3,732.79	5,559 51	5,890 36	7,882.57	245.24	35,839.53	992,24	1,071.30	2,281.62	547.82	40,732.51
							(16,935 -)	(718,007.90)					
8	Perdidas Pulperias	170,211.47	33,392 36	48,161.97	79,689.36	131,604.74	16,107.82	479,167.72	27,180.36	17,124.17	48,505.41	20,724.87	592,702.53
9	Aporte Patronal	44,031.13	8,646.38	12,436.75	20,646.98	35,103 08	3,212.95	124,077.27	7,055.20	4,478.54	12,551.44	5,339.88	153,502.33
10	Seguro Enf. y Mat. 9%	19,452.32	3,820.12	5,493 88	9,122 16	15,522.35	1,407.13	54,817.96	3,115.74	1,979.05	5,545.66	2,358 95	67,817.36
11	Alsg. Fami 4% y Subsidio Hogar 5%	17,121.39	3,361.41	4,830 66	8,029.45	13,567 02	1,340.54	48,250 47	2,744 03	1,746 51	4,879.17	2,072.88	59,693.06
12	Foundos Para Vivienda 2%	4,882.51	958 67	1,379.-	2,289.51	3,896.52	352.33	13,758.54	782 57	496.75	1,391 67	592.05	17,021.58
13	Prevision Para Indeminizacion	44,464 62	8,730 82	12,560.36	20 850.92	35,506.40	3,185.91	125,299.03	7,136.34	4,522.64	12,673.51	5,392.64	155,024 16
14	Prevision Aguinaldo	61,526 01	12,081.-	17,379.76	28,851 90	49,122.71	4,417.22	173,378.60	9,874.92	6,258.45	17,536.48	7,461.69	214,510 14
15	Otras Cargas Sociales	17,026.10	3,097.96	4,552.74	9,580 43	15,032 28	716 68	50,006.19	2,187.18	928.61	3,873 74	1,997.26	58,992.98
	Total Labor	628,456.99	132,135.67	189,880 41	292,892.10	495,722.93	47,675.58	1,786,763.68	93,763.99	72,489.72	192,109.14	71,819.92	2,216,946.45
18	Materiales	167,323.80	120,849.78	171,916.36	180,720.07	40,946 87	5,791.63	687,548.51	89,380.14	119,192 25	4,081.77	163,425.72	1,063,628.39
19	Drogas e Instrumental Qururgico	9.23	–	9.74	14 16	335 80	–	368 93	16 88	17.96	15,226.46	73,104.30	88,734 53
20	Maquinarias y Equipo Activo Fijo	–	–	–	–	–	–	–	–	146,030 23	–	–	146,030.23
21	Fuerza Motriz Comprada	182 45	242.32	2,221.78	180,469 73	16,179 63	749.60	200,045.51	919.87	883.38	15,934 91	3,992.21	221,775.88
22	Eletes Pagados a Particulares	(3,788 05)	41,773 09	21,001.61	(4,459 93)	7,244 41	5,022.43	66,793.56	6,718.26	24,263.70	1,330.10	2,341.84	101,941.10
									493.64				
23	Gastos de Viaje	172 88	74.66	305 82	774 35	6,688.91	–	8,016.62	65 27	291.92	7,656 15	124.76	16,154 72
24	Administracion Pulperias				–	(5,516.04)	–	(5,516 04)		–	–	–	(5,516 04)
25	Seguros			2.20	–	1,145 52	–	1,147.72		–	5 56	–	1,153 28
26	Alovi Leres	(10 65)			(51.44)	11,064 58	137.70	11,140.19		377.10	672 52	6,543.79	18,733.60
27	Gastos de Representacion				–	277.54	–	277.54		18.81	–	(18 81)	277.54
28	Donaciones y Asignaciones	20.14	3 67	2,326.59	98 07	14,526.97	20 06	16,955 50	5,185.25		(329.38)	18.81	21,870.18
29	Honorarios				146.47	(747.11)		(600 64)			6,637.70	–	6,037 06
30	Publicidad y Suscripciones					179.44		179.44	–	–	–	–	179.44
31	Correos, Cables y Telegramas					47.23		47.23				94 26	141.49
32	Reparaciones Varias				(126 48)	222.35		95.87			200 46	0 88	297.21
33	Impuestos, Papel y Timbres			0.41	0.34	287.19		287.94	1.01		5.78	(1,867.61)	(1,572.88)
34	Cargos Diferidos	28,052 21	1,620 36	(1,620.35)	–			28,052 22				–	28,052 22
	Total Varios	191,962.01	164,563 88	196,164 16	357,585.34	92,883 29	11,721.42	1,014,880.10	102,780.32	291,075.35	51,422.03	247,760 15	1,707,917.95
36	Depreciaciones	35,898.97	4,416 87	6,758 55	32,840 32	8,321.11	8.77	88,244 59	4,453.62		3,748 05	1,557.25	98,003 51
37	Compra de Minerales	32,496.28	–			(354.42)	812,481.79	844,623 65				–	844,623 65
38	Ajuste de Minerales	247,854.45	44,608.72					292,463 17				–	292,463.17
39	Gastos Adm. of Central y Agencias												
40	Gastos Financieros					350,523 57		350,523.57				–	350,523.57
41	Contribuciones Especiales C.M.B.									153.55			
42	Servicios Tecnicos Recibidos	7.80	1,967.29	2,760 28	(2,328.48)	1,766.12	246.13	4,419.14	494.74	18,644.19	234 67	–	23,946.29
		316,257.50	50,992 88	9,518 83	30,516 84	360,256.38	812,736 69	1,580,274 12	4,948.36	18,797.74	3,982 72	1,557.25	1,609,560.19
	Distribucion Cal. Radrillos	28,678 32	6,172.79	400 58	78 82	63.55	–	30,394 06	625.49	2,254.28	25.40	(33,220 33)	78 90
	Distribucion Samidad, Educacion					(79,873.53)	18,977.44	(60,896 09)			(18,492.47)		(79,388 56)
	Distribucion de Servicios Auxil.	168,797.56	112,833 49	156,163.21	(681,067.46)	140,358 70	5,063 80	(97,850 70)	13,970.08	19,186 08	15,866 64	48,828 71	0 81
	Transpaso A of Central								(216,088 20)	(403,802.68)	(244,913.24)	(336,745.35)	(1,201,549.47)
		1,334,152.38	461,698.71	552,127.19	0 64	1,009,411.32	896,174.93	4,253,565 17	0 04	0.49	0 22	0.35	4,253,566.27

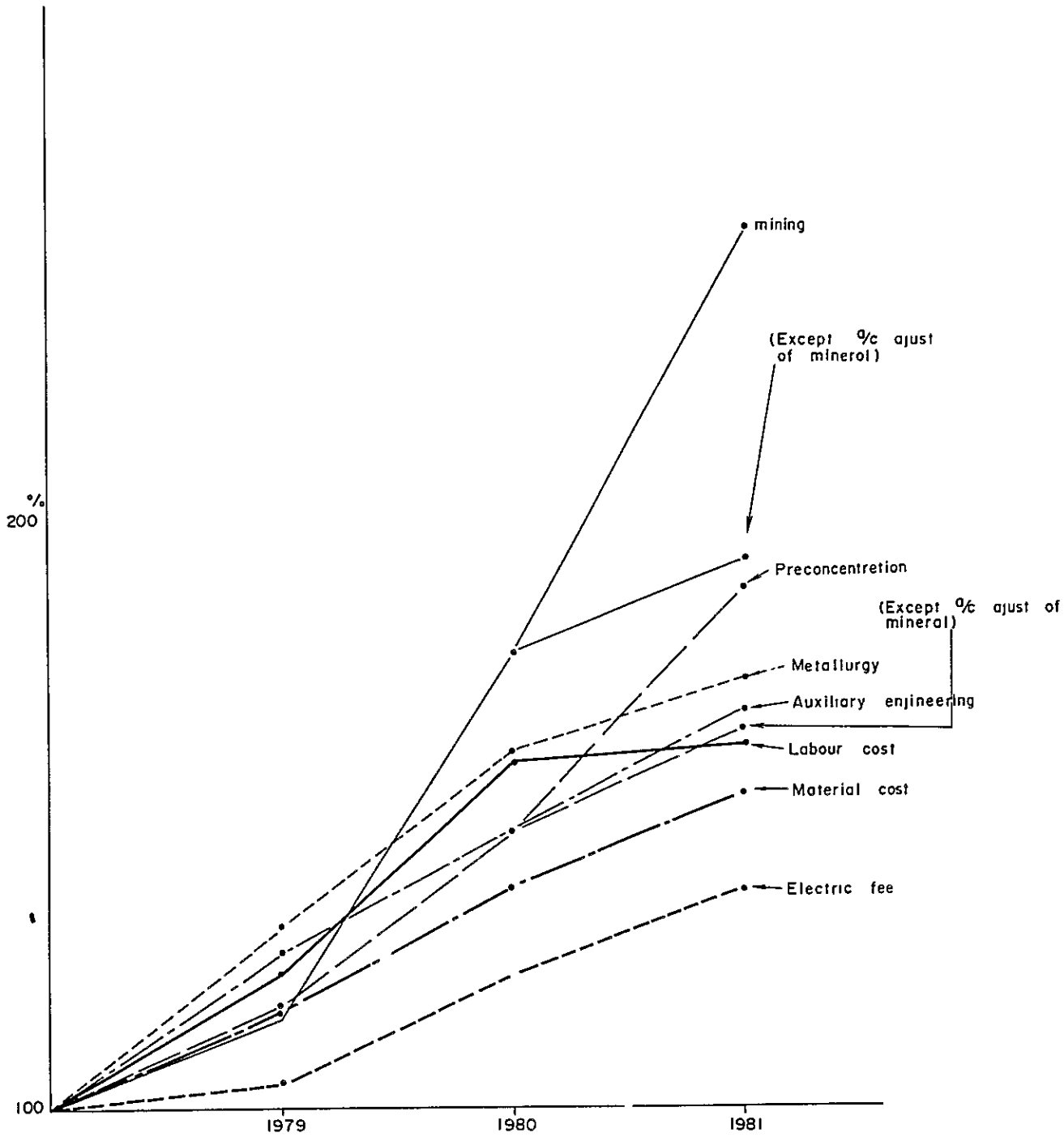


Fig. 5-1 Rate of rising cost

Table 5–4 Cost after Distributed Indierct Costs

	1978		1979		1980		1981	
Group	$/T	Index	$/T	Index	$/T	Index	$/T	Index
Mining	5.4	100	6.5	120	9.4	174	10.7	235
Sink-float separation	2.3	100	2.8	121	3.3	143	4.3	187
Concentration	5.4	100	7.0	130	8.5	157	(9.4)	(174)
Total	23.0	100	19.6	130	37.2	162	42.9	183

Table 5–5 Consts before Distributed Indirect Costs

	1978		1979		1980		1981	
Group	$/T	Index	$/T	Index	$/T	Index	$/T	Index
Mining	4.4	100	5.5	116	7.8	177	10.9	248
Sink-float separation	1.7	100	2.0	118	2.5	147	3.2	188
Concentration	3.9	100	5.1	131	6.2	160	(6.7)	(172)
Engineering	1.5	100	1.9	127	2.2	147	(2.5)	(167)
Total	21.0	100	27.2	130	34.4	167	38.4	183

Note: Figures in parentheses are estimated ones.

Table 5–6 Group-by-Group Breakdown of Monthly Average Cost for 1978 – 1981

	Group	1978 Processed Ore (tons)	1978 Value ($1,000)	1978 $/T	1979 Processed Ore (tons)	1979 Value ($1,000)	1979 $/T	1980 Processed Ore (tons)	1980 Value ($1,000)	1980 $/T	1981 Processed Ore (tons)	1981 Value ($1,000)	1981 $/T
Total Cost	Mining	123,336^{T}	671.8	5.4	114,877^{T}	749.4	6.5	113,758^{T}	1,064.0	9.4	104,706^{T}	1,334.2	12.7
	Sink-float separation	119,339	276.2	2.3	105,552	291.8	2.8	108,065	359.5	3.3	108,313	461.7	4.3
	Concentration	59,026	318.7	5.4	59,932	419.8	7.0	59,455	507.5	8.5	(59,000)	552.1	(9.4)
	Service		–			–			–			–	
	Management	(123,336)	748.4	(6.1)	(114,877)	867.5	(7.6)	(113,758)	1,037.7	(9.1)	(104,706)	1,125.2	(10.7)
	Ore Purchase	SNF 262,786^{Lbs}	819.5	(3.1)	258,849^{Lbs}	1,074.0	4.1	305,269^{Lbs}	1,267.1	4.2	263,227^{Lbs}	932.7	3.5
	Total	123,000^{T}	2,834.6	23.0	115,000^{T}	3,402.5	29.6	114,000^{T}	4,235.8	37.2	105,000^{T}	4,405.7	42.0
Total Cost / Mine Cost	Mining	123,336	538.8	4.4	114,877^{T}	589.5	5.1	113,758^{T}	891.6	7.8	104,706	1,136.7	10.9
	Sink and float	119,339	207.9	1.7	105,552	213.8	2.0	108,065	264.8	2.5	108,313	345.7	3.2
	Dressing	59,026	227.9	3.9	59,932	302.7	5.1	59,455	369.9	6.2	(59,000)	392.8	(6.7)
	Service	(301,701)	441.7	(1.5)	(280,361)	525.1	(1.9)	(281,278)	604.7	(2.2)	(272,019)	683.3	(2.5)
	Management	(123,336)	396.0	(3.2)	(114,877)	498.4	(4.3)	(113,758)	598.6	(5.3)	(104,706)	596.6	(5.7)
	Ore Purchase	262,786	774.3	2.9	258,849	1,001.7	3.9	305,269	1,192.0	3.9	263,227	872.3	3.3
	(Sub Total)	(123,000)	(2,586.6)	(21.0)	(115,000)	(3,131.2)	27.2	(114,000)	3,921.6	34.4	(105,000)	(4,027.4)	38.4
Total Cost	a/c Distributed Service and Other Costs	(123,000)	Δ 49.3	(2.0)	(115,000)	Δ 57.6	(2.4)	(114,000)	Δ 65.6	(2.8)	(105,000)	Δ 67.5	(3.6)
	a/c Distributed Welfare and Management Costs		Δ 41.6			Δ 55.8			Δ 66.9			Δ 61.4	
	Head Office Expense		114.7			132.9			148.4			152.4	
	Transferred Head Office and Other Expenses		22.2			27.6			19.4			4.4	
	Financial Costs		202.0			224.2			278.9			350.6	
	Total	SNF Lbs 806,474	2,834.6	3.5	SNF Lbs 722,661	3,402.5	4.7	SNF Lbs 725,637	4,235 8	5.8	SNF Lbs 645,331	4,405.9	6.8

Note: 1. Process ore amount figures for 1978 – 1980 are from Catavi's "Informe Annual 1980." Figures for 1981 are from "Mining Output Data 1981," but figures for Dressing in parentheses are estimated ones.

2. Cost figures for 1978 – 1980 are from Catavi's annual financial statements and figures for 1981 (average for January – June) are from IBM/Catavi and Accountant/Catavi data.

Table 5–7 Factor-by-Factor Breakdown of Monthly Average Costs for 1978 – 1981

(Value Unit: $1,000)

		Factor	1978		1979		1980		1981			
			Value	Index	Value	Index	Value	Index	Value	Index	Proportion	Growth Rate
Mine Costs	Personnel Expenses	Wage	255.3	100	277.3	109	238.3	93	235.3	92		
		Overtime Allowance	80.1	100	110.4	138	93.3	116	87.3	109		
		In-Pit Piece Wage	73.4	100	94.7	129	99.9	136	93.1	127		
		Out-of-Pit Piece Wage	17.1	100	30.1	176	19.7	115	16.6	97		
		Special Allowance	68.6	100	88.8	129	325.7	475	249.9	364	6	7
		Temporary Employment Promotion Allowance	31.1	100	47.0	151	36.7	118	35.9	115		
		(Sub Total)	(525.6)	100	(648.3)	123	(813.6)	155	(718.1)	137	(19)	(8)
		Loss of Allocated Goods	197.5	100	262.2	133	363.6	184	479.1	243	12	11
		Social Security	202.5	100	229.1	113	222.4	110	290.9	144		
		Reserve for Retirement Allowance	88.5	100	103.3	117	117.6	133	125.3	142		
		Reserve for Christmas Allowance	97.1	100	128.9	133	234.3	241	173.4	179		
		(Sub Total)	(1,585.6)	100	(723.5)	124	(937.9)	160	(1,068.7)	182	(27)	(19)
		(Total)	1,111.2	100	1,371.8	123	1,751.5	158	1,786.8	161	46	27
		Supply	470.4	100	548.6	117	647.2	138	719.1	153	18	10
		Electricity	130.0	100	136.5	105	159.8	123	178.1	137	5	2
		Others	102.4	100	119.4	116	118.4	116	123.4	121	3	1
		Ore Purchase	766.7	100	974.0	127	1,158.2	151	844.5	110	122	3
		Ore Adjustment a/c	Δ 55.2	100	Δ 91.6	166	3.2	Δ 6	290.9	Δ526	7	14
		Group Distribution	Δ 90.9	100	Δ113.5	125	Δ132.5	146	Δ132.5	146	Δ3	Δ2
		Depreciation	61.1	100	72.6	119	83.3	136	88.2	144	2	1
		Total	2,495.7	100	3,017.8	121	3,789.1	152	3,898.5	156	100	56
		Transferred Head Office Expenses	338.9	100	384.7	114	446.7	132	507.4	150		
		Grand Total	2,834.6	100	3,402.5	120	4,235.8	149	4,405.9	155		

Especially, the mining division's increase from 1980 onwards is far more conspicuous than other groups' rises. Following is a cost increase trend based on a factor-by-factor breakdown of monthly average costs from 1978 – 1981 (Table 5–8):

Table 5–8 Cost Increase Rate

	(1978)	(1979)	(1980)	(1981)
Direct Personnel Expenses	100	123	155	137
Indirect Personnel Expenses	100	124	160	161
(Loss of Allocated Goods)	(100)	(133)	(184)	(243)
Supply Expenses	100	117	138	153
Electricity Expenses	100	105	123	137
Total	100	121	152	156

The increase of direct personnel expenses is attributable primarily to payment of 40.8 dollars per person in December 1979 and 163.2 dollars in 1980 in bonus under a government ordinance. Indirect personnel expense rose due to an increased differential loss resulting from inflation and a freeze on prices of four rationed items (meat, bread, sugar and rice). It is also attributed to revision of social insurance rates in 1981.

The increase of supply and electricity expenses resulted from rising prices of imported equipment amid worldwide inflation, electric power rate hikes and rising power consumption (100–105–108 for 1978–1980). But it is important that personnel expense accounts for about 50 percent of the overall cost increase.

An abnormal price of ore a/c adjustment in 1981 for mining and sink and float separation usually served to boost the overall cost increase rate. But the rise of personnel and supply expenses is a primary factor behind the cost rise. A decreased operation ratio for mining and sink and float separation is also one of the factors.

5–1–4 Profit and Loss of Production and Sale

Catavi mine prepares ore-wise production income statements. They are tabulated in "Catavi mine's production income (Table 5–9)." The mine posted a monthly average loss of 1.37 million dollars in 1980. In January – June 1981, the monthly average loss increased to 2.11 million dollars due to decreased quotation, reduced production and increased production costs. Fundamentally, the swelling loss is attributable to a decline in ore quality, or scarcity of ore deposits.

The table indicates indirect production scored a higher earning rate than direct production.

If ore purchase conditions are taken into account, however, such relationship cannot exist in nature.

Table 5-10 is a tabulation of monthly ore purchase statements. The purchase price is the mine bank's purchase quotation (an international price minus refining expense) minus 7–14 percent of management expense and 50 percent of Regalia. The deduction of the partial Regalia, though discontinued after a recent Regalia revision, is still retained as an exception of COMIBOL.

In 1981, the quoted ore sale price averaged 5.45 dollars per pound against a purchase price of 4.47 dollars per pound. The gap amounted to 231,000 dollars plus 118,000 dollars in Regalia exemption plus 104,000 dollars in management expenses, 453,000 dollars which should have absorbed sales costs, including Regalia, and corporate management expenses. But Table 5–9 indicates sales expenses alone totaled 462,000 dollars. Even if 10 percent of 12 TMF in ore purchases from Uncia office and the trade union is taken into account, the corporate management costs cannot be absorbed. Despite this, a profit is set aside. (Note: this problem is detailed in consideration of the support service division)

Table 5–11 on Production Income of COMIBOL and Catavi, tabulated on the basis of COMIBOL's financial data, indicates a gap between production earning of the mine of COMIBOL and Catavi, but no large difference between their final profit or loss. As shown in the table, Catavi accounts for 16 percent of overall production income of COMIBOL, 22 percent of cost and 20 percent of taxes. In 1980, it accounted for 56 percent of loss of COMIBOL. Sales income of COMIBOL and Catavi are illustrated in Table 5–12. Until 1979, production profit and loss had been calculated by adjusting production income with the ore inventory clearance account. Since 1980, however, shipments or arrivals at concentration works have been subjected to sales calculation. As a result, sales value has declined.

Table 5–9 Catavi Mine Production Income

No. 1

Class		1980 (Monthly Average)				1981 (Monthly Average for Jan. – Jun.)				81/80 %
		Direct Production	Indirect Production	Total	%	Direct Production	Indirect Production	Total	%	
Production	Dry Tons	515.^{T}048	335.^{T}443	850.^{T}490	Proportion of Indirect Production 42%	486.^{T}148	279.^{T}834r	765.^{T}982	Proportion of Indirect Production 41%	
	Grade %	37.02	41.28	38.70		35.65	42.67	38.21		
	Metal Content	196.^{T}076	138.^{T}468	329.144		173.^{T}320	119.^{T}398	292.^{T}718		
	(Metal Content in Pounds)	(420.368)	(305.269)	(725.637)		(382.104)	(263.227)	(645.331)		
	(Quotation)	6.87$^{\$}$	6.90	6.88		5.44	5.45	5.44		
	Value	1,000$ 2,887.6	2,106.8	4,994.4		1,000$ 2,077.4	1,435.5	3,512.9		
Production Costs	Wage	222.8	15.5	238.3		221.6	13.7	235.3		
	Overtime Allowance	94.4	0.9	93.3		86.0	1.3	87.3		
	Mine Contract Wage	99.9	–	99.9		93.1	–	93.1		
	Surface Contract Wage	19.6	0.1	19.7		16.5	0.1	16.6		
	Special Allowance	323.3	2.4	325.7		248.3	1.6	249.9		
	Temporary Employment Promotion Allowance	36.4	0.3	36.7		35.6	0.3	35.9		
	(Sub Total)	(794.4)	(19.2)	(813.6)	16	(701.1)	(17.0)	(718.1)	20	88
	Loss of Allocated Goods	349.9	13.7	363.6	7	463.0	16.1	479.1		132
	Social Security	215.9	6.5	222.4		283.9	7.0	290.9		131
	Reserve for Retirement Allowance	114.2	3.4	117.6		122.1	3.2	125.3		
	Reserve for Christmas Allowance	228.6	5.7	234.3		169.0	4.4	173.4		
	(Sub Total)	(908.6)	(29.3)	(937.9)	19	(1,038.6)	(30.7)	(1,068.7)	30	114
	Total	1,703.0	48.5	1,751.5	35	1,739.1	47.7	1,786.8	50	102
	Material	640.1	7.1	647.2	13	712.5	6.6	719.1	20	111
	Electricity	159.8	–	159.8	3	178.1	–	178.1	5	111
	Contract Transport	45.9	3.1	49.0		52.6	5.0	57.6		
	Business Trips	9.5	0.1	9 6		8.0	–	8.0		
	Pulperia	(3.7)	–	(3.7)		–	–	–		
	Insurance Premium	2.7	–	2.7		12.1	–			
	Rental	11.3	0.1	11.3						
	Business Entertainment	0.1	0.0	0.2				–		
	Support	17.9	–	17.9		–	–	16 6		
	Remuneration	1.6	–	1.6		16.6 (0.4)	0.0	(0.4)		
	PR and subscriptions	0.2	–	0.2		–		–		
	Communications	0.1	–	0.1		–		–		
	Maintenance	0.1	–	0.1		0.1		0.1		
	Taxes and Public Charges	(0.0)	–	(0 0)		0.3		0.1		
	Others	28.6		28.6		28.1		28.1		
	Total	914.2	10.4	924.6	19	1,008.0	11.7	1,019.7	29	110

Table 5–9 Catavi Mines Production Income

No. 2

Class		1980 (Monthly Average)				1981 Monthly Average for Jan. – Jun.)				81/80 %
		Direct Production	Indirect Production	Total	%	Direct Production	Indirect Production	Total	%	
Production Costs	Depreciation	83.3	0.0	83.3		88.2	0.0	88.2		
	Ore Purchase	25.9	1,132.3	1,158.2	23	32.5	812.0	844.5	24	13
	Ore Adjutment a/c	3.2	–	3.2		290.9		290.9		
	Distributed Support	(71.3)	5.7	(65.6)		(76.2)	5.1	(71.1)		
	Transferred Management	(85.1)	18.2	(66.9)		(79.9)	18.5	(61.4)		
	Accepted Technical Guidance	10.4	0.3	10.7		4.2	0.2	4.4		
	CMB Distribution	8.7	–	8.7		–	–	–		
	Head Office Expenses	148.4	–	148.4	3	152.4	–	152.4	4	103
	Finance	228.0	50.9	278.9	6	314.0	36.6	350.6	10	126
	Rental fee of Concession	–	0.8	0.8	31	–	0.9	0.9		
	Total	351.5	1,208.2	1,559.7		726.1	873.3	1,599.4	46	103
Total		2,968.7	1,267.1	4,235.8	85	3,473.2	932.7	4,405.9	125	104
Sells Costs	Regalia	(664.6)	Proportion of Indirect Production 30%			190.6	Proportion of Indirect Production 21%			
	Domestic Transport Loading					47.2				
	Marine Transport					55.3				
	Refining					455.2				
	Others					5.6				
Total		1,282.7	850.4	2,133.1	43	753.9	461.9	1,215.8	35	57
Balance (Loss) Profit		(1,368.8)	(10.7)	(1,374.5)	(28)	(2,149.7)	40.9	(2,108.8)	(60)	(153)

Table 5–10 Summery of Production of Locatarios, Veneros, Lamas

10^3 USS/	1980 (Ene.-Dic./Promedio)				1981 (Ene.-Jun./Promedio)			
	LLocatario	Veneros	Lamas	Total	l Locatario ı	Veneros	Lamas	Total
T M S	214.^{t}097	107.^{t}525	40.^{t}190	361.^{t}812	178.^{t}354	104.^{t}657	35.^{t}888	318.^{t}899
LEY (%)	37.85	34.90	18.90	34.87	35.58	35.34	18.99	33.63
T M F	81.040[9]	37.524[2]	7.594[1]	126.159	63.449[8]	36.982[6]	6.814[8]	107. 247[2]
				5.99 US$				4.47 US$
Ganado 100 %	1,090.9	496.1	77.8	1,664.8	636.3	371.6	50.7	1,058.6
Descuento 7%	65.3	–	–	65.3	44.5	–	–	44.5
" 14	–	48.9	7.5	56.4	–	52.2	7.1	59.3
" 15	26.0	–	–	26.0	–	–	–	–
" 22	–	32.3	5.4	37.7	–	–	–	–
Regalia 100%	289.5	109.2	22.6	421.3	139.7	80.6	15.4	235.7
" (Devolución) 50%	+144.8	+54.6	+11.3	+210.7	69.8	40.3	7.7	117.8
Ganado Net	854.9	360.3	53.6	1,268.8	521.9	279.1	35.9	836.9
C.N.S.S	* 13.3	–	–	13.3	13.4	–	–	13.4
Edificación Eocolar	* 8.0	3.5	0.5	12.0	5.2	2.8	0.3	8.3
Impuesto Rento	* 11.3	6.0	1.0	18.3	8.8	5.2	0.8	14.8
12% S/D.L	19.0	13.7	2.3	35.0	–	–	–	–
Consejo Nal, Vivienda minera 3%	* 2.4	1.1	0.2	3.7	1.6	0.8	0.1	2.5
Materiales	* 3.9	0.7	0.0	4.6	4.9	0.7	0.0	5.6
Transporte	–	0.0	–	0.0	0.2	0.0	–	0.2
Pulpería	* 11.8	–	–	11.8	15.4	–	–	15.4
Sereno	* 3.6	–	–	3.6	3.7	–	–	3.7
Retencion Judicial	* 1.2	0.0	0.0	1.2	1.0	0.0	0.0	1.0
Garantía	* 78.5	34.4	9.2	122.1	50.2	27.7	6.5	84.4
Analisis Quimico	–	–	0.2	0.2	0.0	–	0.2	0.2
Varios	* 4.2	2.0	1.5	7.7	3.4	1.5	1.1	6.0
Anticipos	* 25.2	–	–	25.2				
Total Deducir	182.4	61.4	14.9	258.7	107.8	38.7	9.0	155.5
Saldo Recibir	672.5	298.9	38.7	1,010.1	414.1	240.4	26.9	681.4

Table 5–11 Production Income of COMIBOL and Catavi

(Value Unit: $1,000)

Class	1979			1980		
	COMIBOL	Catavi	%	COMIBOL	Catavi	%
Income on Production	426,408	62,346	15	428,969	61,972	14
refining expense	Δ88,527	Δ9,803	11	Δ98,493	Δ8,553	9
Production Income	337,881	52,543	16	330,476	53,419	16
Production Costs						
Personnel Expenses: Wage	37,151	7,270	20	44,377	9,157	21
Loss at Pulperia	13,486	2,940	22	18,375	4,092	22
Social Security	26,026	5,174	20	33,086	6,462	20
(Sub Total)	(76,663)	(15,384)	(20)	(95,838)	(19,711)	(21)
Material Expense	29,919	6,449	22	37,246	7,621	20
Expenses: Electricity	6,880	1,637	24	8,633	1,917	22
Contract Transport	1,377	546	40	1,540	573	37
Ore Purchase	39,143	11,697	30	45,931	13,908	30
(Direct Shipment Ore)	(34,036)	(11,377)		(43,869)	(13,597)	
(Mined Ore)	(1,649)	(320)		(1,847)	(311)	
(Others)	(3,458)	–		(215)	(–)	
Others	4,308	752	17	5,452	726	13
Ore Adjustment a/c	Δ2,253	Δ1,099	47	846	39	5
Volatilization	661	–	–	827	–	–
(Sub Total)	(50,116)	(13,533)	(27)	(63,229)	(17,163)	(27)
(Depreciation)	7,194	847	12	7,876	974	12
Total	163,892	36,213	22	104,189	45,469	22
General Management Costs	10,815	1,927	18	11,471	2,014	18
Sales Costs	13,136	1,040	8	14,863	1,303	9
Financial Costs	16,115	2,690	17	28,015	4,260	15
Current Income	133,923	10,673	8	71,938	373	1
Taxes	105,089	20,053	19	82,001	16,216	20
Special Account	17,679	Δ 5,332	Δ30	3,455	176	5
Bonus for Profit Distribution	8,307	512	6	15,025	2	0
Net Income or Loss	2,848	Δ 4,560	Δ160	Δ28,543	Δ16,021	56
(Monthly Production Income)	(237)	(Δ 380)		(Δ2,378)	(Δ1,335)	

Table 5–12 Profit and Loss of Selling of COMIBOL and Catavi Mine

(1,000 US$)

ITEM	1978			1979			1980		
	COMIBOL	Catavi	%	COMIBOL	Catavi	%	COMIBOL	Catavi	%
Ventas	378,738	58,458	15	426,408	62,346	15	352,782	54,995	16
Menos Gastos Realizacion	83,836	9,646	12	88,527	9,803	11	72,857	7,035	10
Ventas Netas	294,946	48,812	17	337,881	52,543	16	279,925	47,960	17
Costo Mina de Ventas	135,701	29,948	22	163,892	36,213	22	164,076	40,511	25
(Depreciacion del Activo Fijo)	(6,040)	(706)	(27)	(7,194)	(847)	(27)	(7,876)	(974)	(27)
Utilidad Bruta	159,245	18,864	12	173,989	16,330	9	115,849	7,449	6
Gastos Admin. Centraly Agencia.	9,075	1,727	19	10,815	1,927	18	11,471	2,014	18
Gastos de Realizacion	14,428	1,043	7	13,136	1,040	8	10,248	980	9
Ajuste en Operaciones							9,193	1,571	17
							8,958	914	10
Gastos Financieros	14,238	2,288	16	16,115	2,690	17	19,057	3,346	18
Utilidad en Operacion	121,504	13,806	11	133,923	10,673	8	56,922	Δ1,376	Δ2
Ingresos. Egresos Varios	11,334	180	2	17,679	(Δ)5,332	Δ30	3,455	176	5
Ajuste en Operaciones									
Gestiones Anteriores	1,785	(Δ) 969	Δ54	Δ10,333	(Δ)1,285	12	(Δ)4,131	(Δ).408	17
Utilidad del Ejercicio	108,385	14,595	13	126,577	17,290	14	57,598	(Δ)1,144	Δ2
Impositivos	90,750	17,910	20	105,089	20,053	19	72,542	14,653	20
Participacion S/Utilidades	5,713	3	0	5,749	–	–	15,025	2	0
Prima Legal	2,384	477	20	2,558	512	20	–	–	–
Utilidad o Perdida net	9,538	Δ3,795	Δ40	13,181	Δ3,275	Δ25	Δ29,969	Δ15,799	53

The "cost or market" method is adopted for concentrate ore inventory valuation instead of the actual cost method. According to the "cost or market" method, sales in 1980 are given as 9.19 million dollars, of which Catavi accounts for 1.57 million dollars. From the viewpoint of the actual cost method, an unrealized loss is taken into account. But no large difference exists between production and sales profit or loss. For reference, Table 5–13 for sales details and Table 5–14 showing the balance sheet have been prepared. It should be noted that even if a net income is posted before tax, taxation could result in a net loss. This is because that taxes are considerably high. Before tax, 1980 gross income is almost balanced with expenses if without modification by concentrate ore inventory valuation.

5–1–5 Distribution of General Management and Financial Expenses

Catavi bears about 18 percent of COMIBOL's general management and financial expenses every year. General management expenses are distributed to each mine according to its proportion in overall fixed assets. As shown in Table 5–13, Catavi accounts for around 9 percent of COMIBOL's total fixed assets. Thus Catavi is exempted from 50 percent of its share of general management expenses. (For example, 62 million dollars for construction of Palca, Machacamarca, volatilization plants etc.)

Each mine's share of total working assets serves as the standard for distribution of financial expenses. Due consideration is given to such distribution, which could affect each mine's income and even mine-by-mine bonus for employees, making it difficult to alter the standard. Catavi first distributes to each ore section the transferred financial expenses' part corresponding to 4.5 percent of ore purchase payment, and then, the remaining part of the expenses is allocated to the Victoria concentrate ore and the cassiterite concentrate in accordance with each ore's proportion in overall production costs. In the cost statement, the transferred expenses are incorporated into ore purchase and management expenses.

5–1–6 Other Matters

Support service group expenses are distributed to production and other groups in accordance with the scale of work and support services involving each group, making Catavi's accounting considerably complicated.

Catavi's accounting system does not cover process-wise or product-wise cost statements.

Expenses for survey visits to Catavi by personnel of the head office and branch are also transferred to Catavi's cost statement, although they are small. The expenses are included in

technical guidance acceptance expense (Servicios Technicos Recibidos) and the special contribution (Constribución Especiales C.B.M.)

The result of a survey on Catavi mine's costs has thus been outlined. To summarize, a decline in the grade of ore, coupled with international and domestic inflation, has served to boost costs of Catavi mine. Primarily, the mine has to improve its cost control setup to achieve the original purpose of the cost system.

5–2 Support Service Group

Catavi mine's support service group may be roughly divided into three subgroups – technical support service of the Superintendencia Electrica, management support service of the Superintendencia de Negocios, and staff support service of the manager's and submanager's president's offices.

The manager's and sub manager's offices, which have no function as a staff section, belong to the support service group. Therefore, in this report, the service group is divided into two subgroups – technical and management service. The technical service subgroup consists of the Superintendencia Superficie and Electric as well as geology, drilling, mining technology, industrial sanitation, security, casting plant, analysis and construction work sections. The management service subgroup covers social service, communications and statistics sections under the manager's direct control as well as the Superindendencia de Negocios with supervises a materials warehouse, accounting, computers, ore purchase accounting, monthly wage registrations, day workers' attendence, employment, distribution stations, schools, medical affairs, theaters and welfare (company houses).

Of the two subgroups, this report is to deal only with the management service subgroup.

As to the technical service subgroup, we must note that casting plants, which receives casting orders from other mines as well under control of the head office, are independent from the Superintendencia Superficie and under direct control of the manager. It should also be pointed out that construction work is under direct control of the submanager, while a telephone exchange office belongs to the Superintendencia Electrica.

5–2–1 Store House

The materials warehouse department, with the director serving as a supervisor, involves the Catavi office, printing office, material warehouse, wood processing works, Siglo XX

Table 5—13 Detail of Sales of COMIBOL and Catavi Mine

Item		1978			1979			1980		
		COMIBOL	Catavi	%	COMIBOL	Catavi	%	COMIBOL	Catavi	%
Toneladas Metaricas Netas	MT	54,787.3	11,212.9	20	48,844.0	10,250.2	21	38,955.0	8,237.0	21
Ley Sn	%	36.77	39.15	106	36.33	38.37	106	38.96	41.85	107
Toneladas Metaricas Finas	MT	20,147.9	4,389.7	22	17,747.7	3,933.6	22	15,179.2	3,447.4	23
Precio P/Libra Fina	US$	6.1064	6.0405	99	7.1545	7.1893	100	7.1513	7.2360	101
Valor Mercado	10^3US$	271,235	58,458	22	279,933	62,346	22	239,917	54,995	23
Otros Minerales										
Toneladas Metaricas Netas ETAS	MT	113,587.7			93,087.2			60,901.5		
" " Finas Sn	"	1,295.5			1,246.2			733.5		
Pb	"	12,646.5			9,549.5			7,575.9		
Zn	"	38,638.8			30,244.5			17,917.0		
Cu	"	2,733.1			1,753.2			1,024.1		
Ag	"	177.3			148.5			108.0		
Wo	"	988.6			1,216.9			1,258.9		
Bi	"	304.7			374.3			42.4		
Cd	"	107.8			88.3			55.8		
Sb	"	–			–			672.5		
Total Valor Mercado	10^3US$	107,479			145,836			112,865		
Deduccion por Merma		3,244	129	4	2,400	103	4	3,036	457	15
Gastos de Fundicion		54,323	6,845	13	51,333	6,892	13	35,100	4,320	12
Descuento en Cont. Fino		23,800	2,247	9	32,433	2,409	7	31,587	1,681	5
Gastos Uapios Enexterior		2,079	405	19	2,079	390	19	3,069	573	19
Gastos Pag. P/CMB		390	20	5	282	9	3	65	4	6
Total (10^3 US$)		83,836	9,646	12	88,527	9,803	11	72,857	7,035	10
		(22.1%)	(16.5 %)		(20.8 %)	(15.7 %)		(20.7 %)	(12.8 %)	
INGRERO NET		249,946	48,812	17	337,881	52,543	16	279,925	47,960	17

Table 5—14 Balance Sheet of COMBOL and Catavi Mine

Item	1978			1979	1979		1980		
	COMIBOL	Catavi	%	COMIBOL	Catavi	%	COMIBOL	Catavi	%
Activo Disponible	94,360	10,429	11	108,292	8,177	8	49,914	6,025	12
Activo Inventario	114,782	12,473	11	137,172	17,158	13	152,650	18,743	12
(Existensia de Minerales)	(34,956)	(3,092)	(9)	(40,042)	(6,465)	(16)	(51,920)	(6,972)	(13)
Otros Activos Corrientes	9,713	981	10	16,735	1,108	7	22,448	1,596	7
Activo Fijo	159,569	15,883	10	184,722	17,492	9	220,425	20,065	9
(Depreciacion Acumulada)	(Δ79,049)	(Δ9,830)		(Δ86,498)	(Δ10,703)		(Δ93,347)	(Δ11,675)	
Inversiones	4,178	—	—	5,515	—	—	7,948	—	
Otros Activos Fijos	1,123	—	—	1,045	—	—	885		
Gastos Diferidos	9,364	2,008	21	12,452	2,246	18	21,457	2,146	10
Total	393,089	41,774	11	465,933	46,181	10	475,727	48,575	10
Pasivo Corriente	119,859	1,988	2	185,330	2,547	1	153,603	2,558	2
(Prestamo Corto Plazo)	(35,721)			(67,336)			(32,086)		
Pasivo No Corriente	117,450	—		102,035	—		162,953	—	
(Prestamo a Largo Plazo)	(117,450)			(102,035)			(162,953)		
Prevision (P' Indemnizacion)	36,474	5,143	14	31,624	4,937	16	41,595	7,053	17
Capital Pagado	79,797	38,438	29	87,910	41,972	26	109,857	54,758	33
Reserva de Capital	29,971			45,853			37,689		
Utilidad o Perdida (Δ) Ejercicio En Gestion	9,538	Δ3,795		13,181	Δ3,275		Δ29,969	Δ15,794	
Total	393,089	41,774	11	465,933	46,181	10	475,727	48,575	10

warehouse, Cancañiri Branch and mine powder magazine. Its personnel consists of 55 monthly wage earners and 58 daily wage earners.

Inventories at the materials warehouse in 1980 are as follows:

The stock-output ratio has been dropping gradually. Inventories stands at an equivalent of nine to 10 months of consumption. Inventories at the end of 1980 consisted of 8,840,000 dollars worth of general materials, 1,320,000 dollars worth of machinery and 350,000 dollars worth of idle goods. The proportion of idle goods was 3 percent. Fresh supply in the year aggregated 20,700 tons or about 70 tons a day.

The comparatively larger increase in inventories and the existence of idel goods may be inevitable because Catavi in the inland nation of Bolivia depends on imports for most of machinery supply. But powder, fuels and fat can be and are procured efficiently. If goods in transit, including those for COMIBOL's central warehouse in Oruro, are taken into account, the mine's inventories standing at an equivalent of nine to 10 months of consumption are deemed excessive. Although some problems may exist with procurement procedures, inventories should be reduced to an equivalent of six months consumption. Detailed consideration must be given to the inventories to find the real necessity of the reduction.

The relationship between the warehouse output value and management costs is illustrated below:

Table 5–17 Warehouse Output Value and Management Costs (Unit: $1,000)

	Monthly Average		
	1979	1980	1981
Output Management Costs	931.4	1,168.2	* 1,254.7
Personnel Expenses	25.8	32.6	33.9
Material Expenses	1.8	1.4	2.5
Other Expenses	1.3	1.4	1.2
Distribution	1.6	1.8	2.0
Total	30.5	37.2	39.6
Management Costs Output	3.27%	3.18%	3.16%

* An estimate based on the cost statement.

The ratio of the management costs to a total of fresh supply and output was 1.6 percent for 1979 and 1.5 percent for 1980. The above table is prepared to look into realities, although it would be better to compare the management costs with a total of fresh supply and output. At present, fresh supply and output slips are processed by computers. For their evaluation, the monthly moving-average cost method and the monthly average method are used.

Table 5—15 Inventories in Value at Materials Warehouse (Unit: $1,000)

Inventory Item	Inventories at End of 1979	1980 Fresh Supply	1980 Dispatch	Inventoried at End of 1980	Stock-Output Ratio
Medical Supplies	325.0	948.0	961.4	311.6	32%
Dressing Reagents	685.7	712.3	831.9	566.1	68
Powder	155.1	2,302.4	2,384.3	73.2	3
Electric Appliances	515.7	385.7	388.8	512.6	132
Mine Electric Locomotives	602.6	120.3	214.6	508.3	237
Rock Drills	402.7	1,182.4	369.7	1,215.4	329
Crushing and Grinding Machines	768.2	524.2	791.2	501.2	63
Pumps	447.0	533.5	530.9	449.6	85
Pipes	378.9	513.7	220.3	672.3	305
Casting Plant Equipment	713.9	1,115.6	1,082.1	747.4	69
Timber	172.6	537.9	422.7	287.8	68
Fuels and Fat	70.5	783.5	683.3	170.7	25
47 other items	4,410.9	5,753.3	5,673.4	4,490.8	79
Total	9,648.8	15,412.8	14,554.6	10,507.0	72
– Transfer	–	535.9	535.9	–	
Total	9,648.8	14,876.9	14,018.7	10,507.0	75

Inventories at the warehouse in the past five years follow:

Table 5—16 Inventories in Value at Materials Warehouse in 1976 – 1980

(Unit: $1,000)

	Inventories at Beginning	Fresh Supply	Shipment	Inventories at End	Stock-Output Ratio at End
1976	8,251.8	10,375.9	9,606.1	9,021.6	94%
1977	9,021.6	9,831.5	10,107.1	8,746.0	87
1978	8,746.0	11,108.5	11,391.2	8,463.3	74
1979	8,463.3	12,362.8	11,177.3	9,648.8	86
1980	9,648.8	14,876.9	14,018.7	10,507.0	75

Catavi mine has a printing office with two printers for the official paper size (21.5 x 32.5 cm) equipped to print slips and binding books. The office consumes about 15,000 pieces of paper (nine times of an official-size piece) every month. Printing centers on warehouse output slips which average 1,000 blocks (100 sets of slips per block) per month. The printing office's personnel consist of five monthly wage earners and four daily wage earners.

Management costs for the printing office are as follows:

Table 5—18 Management Costs of Printing Office

(Unit: $1,000)

	Monthly Average		
(Management Expenses)	1979	1980	1981
Personnel	2.1	2.4	2.7
Supply	−0.8	−1.4	2.1
Others	0.0	0.1	−3.3
Distribution	0.4	0.1	0.0
Total	1.7	1.2	1.5

Direct management costs, though small, should be absorbed by the products value. The costs should also be compared with expenses for ordering printing from outside to clarify the merit of in-house printing.

5—2—2 Account

Under control of an accounting chief, 18 employees undertake cost accounting and other accounting business. A computer room deals with accounting of factory-by-factor and order-by-order costs, while a cost accounting section prepares ore-wise income statements, a general cost statement and other accounting statements.

The accounting department's monthly average costs totaled 13,300 dollars (including 9,600 dollars in personnel expenses and 1,900 dollars in distribution a/c) in 1979, 17,500 dollars (11,100 dollars and 2,700 dollars) in 1980, and 18,900 dollars (13,300 dollars and 2,500 dollars).

5—2—3 Computer

Catavi mine's computer introduction goes way back to the age of Simon Patiño, when the mine had primitive computers. But it began to actually utilize computers only several years ago. Full-scale utilization started in 1980.

Catavi is now operating the IBM System 3–M15 with 26 employees (including three programmers) under control of a Peruvian supervisor. But the computer now processes only a limited range of data from wages and costs to materials receipts and payments, medicine receipts and payments, goods receipts and payments at the distribution center, block caving evaluation, and contracts for casting plants. Catavi intends to replace the computer with the higher-performance IBM System 34 in 1982 to deal with ore purchase liquidation, overall accounting business, management of fixed assets, management of maintenance work for cars and other machines, and calculation of ore production as well. It also plans the computer room to cover Huanumi mine as well as Catavi itself. But it is acknowledged that even the full-scale computer utilization planned by Catavi may be only a trial as COMIBOL has yet to establish a firm policy of utilizing computers, although computer operators have a positive attitude, the whole of the mine is not ready to accept computerization.

The costs of the computer section follow:

Table 5–19 Computer Room Costs (Unit: $1,000)

	1979	1980	1981
Personnel Expenses	12.9	20.4	19.9
Supply Expenses	5.2	4.5	3.0
Other Expenses	19.0	16.9	12.4
Distribution	0.2	0.5	1.4
Total	37.3	42.3	36.7

The other expenses include 12,200 dollars in rent payment to IBM. Introduction of the new computer would reduce the rent to 7,000 to 8,300 dollars and save paper consumption while increasing computing efficiency. But no decision has been made on the introduction. The number of employees for the computer room can be said to be excessive, if the current amount of work is taken into account.

5–2–4 Ore Purchase Accounting

As explained in the preceding paragraph, Catavi mine has no independent section to undertake indirect production, or purchase of ore from independent miners, which accounts for about 40 percent of the mine's overall output. Various business department sections concerned are dealing with the ore purchases.

Independent miners subjected to the ore purchase are Locatarios, Veneros, Lamas, and miners selling ore output at Uncia Branch.

As illustrated below, annual indirect production, or ore purchases, increased when direct output declined due to political unrest and other factors. Since 1963, however, Catavi has promoted a policy of increasing ore purchase. At present, the policy has taken root.

Table 5–20 Annual Direct Production and Purchase (indirect production)

	Direct Output (A)	Ore Purchase (B)	A/B x 100	Note
1948–52	867 tons	6.3 tons	1%	Before nationalization.
1953–57	683	4.3	1	After nationalization in the 1952 national revolution.
1958–62	403	17.6	4	
1963–67	290	103.0	36	In 1964, the first military regime was established.
1968–72	447	68.3	15	Tin production quotas were set through the International Tin Conference.
1973–77	345	136.3	40	
1978–80	216	125.0	58	In 1978, elections were held for a shift to a civilian government.

Note: Purchase of feed to mill plant and computation differentials for output and purchase are incorporated into direct production.

Before 1974, production remained somewhat flexible. Since that year, however, output has continued to change clearly.

The mining management department's office for management of ore sellers deals mainly with Locatarios, Veneros and Lamas. Priority is given to Locatarios and Veneros, each of which has more miners and produces more than Lamas. The number of groups for Locatarios is limited to 31. A group consists of 18 to 154 miners. Locatarios miners now total 1,436 persons, declining from 1,560 in early 1974, 1,484 in April 1974 and 1,486 in December 1980. They have been suffering from a decrease in working faces for mining which has coincided with a decline in the grade of ore. Veneros miners also decreased from 639 persons in December 1980 to 623 at present. Lamas miners are given as 386 persons.

The three mining organizations' annual production follow in terms of block tin:

Table 5–21 Annual Tin Production

	Locatarios	Veneros	Lamas
1977	1,049 tons	319 tons	(not available)
1978	882	281	(not available)
1979	816	580	(not available)
1980	1,052	449	8.4

Note: The above production amounts include feed for mill plant.

The concentrate shipment office of the superintendencia accepts products delivered in packages (about 40 kilograms per package) by ore sellers. It deals with Veneros Sunday and Monday, Locatarios and the cooperative Tuesday and Wednesday and Lamas Thursday. On Friday and Saturday, it dresses each organization's products in preparation for shipment.

With registration cards presented by sellers, three acceptance officials weigh products delivered to confirm the number of packages, weight and the water content, which are written on acceptance slips. Then, registration cards are returned together with acceptance slips to sellers. Sellers can ask for acceptance of products in terms of packages on their discretion. In this case, an acceptance slip is issued for each package. In the next step, two men losen packages from each organization and stir ore with scoops. Then, ore is poured into four vessels. Ore in each vessel is halved. Three samples are extracted for ordinary analysis, electronic analysis and custody. Upon completion of the analysis, preparations begin for shipment.

After the above procedures, acceptance slips and analysis slips are separately transferred to the ore purchase account section for preparation of an account register and a liquidation statement for each selling organization.

As to products from Locatarios, Veneros and cooperativas Catavi purchases ore with a 13-percent-and-more tin content for a full price. A 10–12.9 percent ore is purchased at half the full price or returned to the sellers, and a 9.9-percent-and-less ore is accepted for nothing. Of Lamas products, Catavi purchases a 10-percent-and-more ore for a full price and accepts a 6-percent-and-less ore for nothing. Lamas ore with a 6.1-9.9-percent tin content is purchased at half the full price or returned. If the ore purity remains to be specified for 10 days after delivery, all products are accepted for nothing. Catavi's accounting section announces purchase prices based on quotations for Veneros and Lamas Thursday before liquidation and payment Saturday. As to Locatarios, a purchase price for a month based on an average quotation is specified early in the following month.

According to Catavi's data, the price of Locatarios ore with a 40 percent tin content is 40% x 76.2% of a quotation. Regalia stands at 26.24 pesos per pound.

A 50 percent tax reduction was given to Locatarios and the other organizations under an April 24, 1980 agreement with the government, based on the March 5, 1980 D.S. 17248 amendment to the Regalia taxation system. As a result, deduction of management costs from their income was revised downward to their advantage, as shown below:

Table 5–22 New and Old Management Cost Deduction Rates

	for Locatarios, Veneros and Lamas			
	Locatarios		Veneros and Lamas	
	new rate	old rate	new rate	old rate
Regalia*	(old tax) x 1/2	8%	(old tax) x 1/2	8%
Mining Lease	4%	6%	4%	8%
Technical Service	3%	3%	3%	3%
Medical Service	–	–	3.5%	3.5%
Education Service	–	3%	–	3%
Management Service	–	3%	–	3%
Transport Expenses	–	–	3.5%	3.5%
Total	7%	23%	14%	30%

*Note: The 1980 agreement was cancelled due to another amendment to Regalia in January 1981, but is still retained between COMIBOL and the three organizations.

The Locatarios miners pay health insurance premium with medical allowance ceilings selected by themselves, based on the No. 188598 Social Insurance Ordinance (October 6, 1978) registered at the social insurance agency (CNSS). They receive medical service at a social insurance hospital in Uncia.

The ore sellers' net income is determined by deducting management costs (7 percent for Locatrios and 14 percent for Veneros and Lamas of total purchase value and Regalia (100% – 50%) from total purchase value. The net income is specified together with income tax and other deduction in registers for each ore delivery and each miner. (Note: Income is distributed to individual miners according to quotas based on their job orders within a group.

Account statements prepared through the above acceptance and liquidation procedures reach a maximum monthly rate of 2,000 pieces (about 60 miners per piece). Usually, 65 to 90 pieces are prepared every week.

At present, seven employees, including an accounting chief, are dealing with the ore

purchase accounting business. But they cannot afford to prepare individual statements of payment details. Employees of other sections undertake such preparation as subcontractors. Statements prepared by the subcontractors are checked by the accounting personnel before delivery to employees in charge of accounting and payment.

The ore purchase procedures are thus outlined comprehensively. Following is a tabulation of part of Table 5–10 attached to the preceding paragraph and other data:

Table 5–23 Ore Purchases from Locatarios, Veneros and Lamas

(Unit: tons/month)

Locatarios	1980		1981	
	(A)	(B)	(A)	(B)
TMS	214,097	178,061	178,354	128,845
LEY (%)	37.85	44.81	35.58	48.27
TMF	81,041	79,783	63,450	62,191
Veneros				
TMS	107,525	107,636	104,657	104,657
LEY (%)	34.90	36.27	35.34	37.17
TMF	37,524	39,035	36,983	38,902
Lamas				
TMS	40,190	18,937	35,888	17,498
LEY (%)	18.90	37.11	18.99	35.92
TMF	7,594	7,027	6,815	6,258

Note; (A): figures in ore purchase account statements.

(B): figures in Catavi's ore-wise income statements.

The table indicates ore purchases from Lacatarios and Lamas include a considerable amount of very-low-quality ore with an average 3 percent tin content, subjected to Catavi's purchase for nothing, contributing slightly to beneficiation.

Table 5–24 Average Ore Purchase Prices

(Unit: $/pound)

	Locatarios	Veneros	Lamas	Average	Ore Sale Quotation for Catavi's Output
1980 average	6.11	6.00	4.64	5.99	6.90
1981 average	4.55	4.56	3.37	4.47	5.45

Table 5–25 Purchase Prices' Ratios to Catavi's Ore Sale Quotation

	Lacatarios	Veneros	Lamas	Average	Ore Sale Quotation
1980 average	88.55%	96.96%	67.25%	86.81%	100%
1981 average	83.49	83.67	61.83	82.02	100

Ore corresponding to the above purchase price ratios could have very high quality in 1980. Even in 1981, Catavi purchased ore at relatively higher prices compared with the price list. Only the Lamas price is almost reasonable.

In this respect, doubts are left over the mine's profitability as explained in the preceding paragraph. Therefore, it is advisable to make full-scale use of computers for accurate accounting.

The ore purchase costs are incorporated into a special cost group under the overall cost control system as explained above. A certain proportion of management and personnel expenses in each department concerned has long been distributed to the special group. But such distribution should go to a separate distribution item. The current distribution practice could distort the ore purchase costs and complicate the cost control. Examples of such distribution to the special cost group include one third of income of the manager, the submanager and others, and one fourth of the complement at the analysis office.

Meanwhile, 4.5 percent of ore purchase value specified in the cost statement is distributed to the item of financial expenses. This practice should also be reconsidered because ore purchases' proportion in Catavi's overall production has been changing.

5–2–5 Original Book of Salaried Employee

The salaried employee office has eight employees, including one daily wage earner, to deal with wage accounting business for the 1,800 Catavi employees, ranging from management of employees' attendance and nonattendance, reason for nonattendance, extra attendance, leaving office earlier than usual, and other matters, to deduction from wages. Although there are many wage deduction items in general, Catavi's items total as many as 25. As a result, wage accounting business is extremely complicated. In case all wage accounting business is done manually, one person can deal with wage accounting for 100 employees generally. As a Table 5–26 indicates, however, each employee at the ledger office undertakes two times as much as that standard with an average daily overtime reaching four hours. Virtually, the office has 10.5 employees. If computers' use for wage accounting is taken into consideration, the number of deduction items is deemed excessive. Another problem may involve productivity of the office's personnel.

Table 5–26 Accountinf Work Time

	Personnel	Total Work Units	Basic Wage	Overtime	Others	Total	Overtime's Ratio to Total
Average for July – December '80	7	457	$bl0,676	$bl0,446	$bl8,599	$b39,721	99%
Average for January – June '81	7	425	10,382	10.896	18,464	39,742	105

5–2–6 Administration of Day Laborers

Two offices are set up at Catavi and Siglo XX to manage attendance of 2,800 daily wage earners.

Each employee for daily wage, upon his arrival at a work site, submits a registration medal with his identification number on to the fixed counter and receive the day's card. There are two kinds of cards for odd and even days. He then submits the card to his supervisor so that the supervisor specifies the type of work, a work amount and other factors for determining a daily wage during the office hours. When leaving office, the employee receives the card from the supervisor and present it to the counter in exchange for his registration medal. While registration medals are left at the counter, the daily wage employee management section tabulates such employees' attendance and their distribution to each business section for presentation to a chief officer. At the same time, wage matters are recorded on each employee's ledger on the basis of his daily attendance card. Ledgers are compiled at the end of every month for processing at the computer room.

The daily wage employee management section has six officials at Catavi and 26 at Siglo XX. Catavi deals with 900 daily wage employees (150 persons per management official) and Siglo XX 1,950 persons (75 persons per official). At Siglo XX, where working places are dispersed, several counters are set up to deal with daily wage employees' attendance. Management officials go to the counters when such employees attend and leave office. The management section adopts a flexible working hours system to meet daily wage employees' working hours.

5–2–7 Employment

The employment section manages files of all individual data of employees, dealing with employment agreements, annexed health and birth certificates, alteration of jobs, management of paid holidays, issue of certificates for current and former employees, and other

management matters involving employees. The number of individual files, accumulated since the Patino age, amounts to about 74,000 files, classified by name. Retired employees' files are also managed. The employment section consists of 12 officials, including one daily wage earner.

5–2–8 Company General Store

The section has a central office, a central ration warehouse and company general store (pulperia) at Catavi, Siglo XX, Cancaniri, Miraflores and El Tranque under a supervisor to supply miners with foods and other necessaries.

Bolivia's mines were legally obligated to put company general store for miners under direct control in 1927 when Catavi was expanding production under the leadership of Patino.

Items handled by company general store center on daily necessaries fixed by law. The number of ration items changes within a range of about 35 to about 60 items. The stations occasionally handle consignment sales of certain goods, including shoes, for suppliers. Rations in value, handled by the store, are as follows:

Table 5–27 Monthly Average Handling Amount by Company Store

(Unit: Pesos)

	Purchases	Sales	Inventories at Year-end	Months to sell Inventories	Sales in Dollars
1976	12,164	11,910	27,570	2.3 months	596,000 dollars
1977	9,705	10,239	21,177	2.1	512,000
1978	11,645	11,125	27,415	2.4	556,000
1979	12,464	12,469	27,363	2.2	(the Peso value was changed)
1980	19,980	18,756	37,245	2.0	765,000

Item purchases per employee are tabulated below on a monthly average basis:

Table 5–28 Monthly Average Purchases per Employee

	Monthly Wage		Daily Wage		Other	
	Employees (persons)	Purchases (pesos)	Employees (persons)	Purchases (pesos)	Employees (persons)	Purchase (pesos)
1976	1,796	1,175	2,992	1,090	221	5,130
1977	1,762	932	2,888	874	172	6,874
1978	1,765	1,010	2,830	919	161	8,761
1979	1,999	1,129	3,217	1,004	161	16,454
1980	1,908	1,313	3,145	1,209	181	26,467

Note: the monthly purchase figures have no relations with the a/c number of monthly and daily wage employees. If based on figures for purchases per employee, the number of employees in 1980 total 4,939 persons – 1,840 for monthly wages and 3,099 for daily wages.

Purchases per employee are comparatively small because prices of sugar, rice, beef and bread are frozen. If the number of employees is put at 4,939 persons, one employee would have been given 2,114 pesos in subsidy. Virtually, ration purchases per employee would have been 3,300 to 3,450 pesos.

The company store section have 154 employees, including 68 day workers, at the five distribution stations. Monthly sales for distribution section employee, based on Table 5–27, come to 4,970 dollars, which are deemed not so high. Each store has branches adjacent to company houses for sales of fresh foods, including meat and vegetables. Actual classification of store is rather complicated, compared with the number of items. The complicated classification and the credit sale practice should be reconsidered. It would be possible to boost sales value for each company store section employee.

Company store report that the ratio of losses stood at 54.2 percent in 1976, 46.7 percent in 1977, 42.6 percent in 1978, 47.7 percent in 1979 and 53.5 percent in 1980. The losses included the above-mentioned subsidies. The ratio for 1981 is estimated to have risen due to a hike of wholesale prices for the four ration items subjected to a freeze on retail prices.

(Note: The denominator for calculating the loss ratio is not specified, though it may be the warehouse wholesale value or the value of purchases from the warehouse).

Annual losses were given as 56,843,000 pesos (2,842,000 dollars) in 1976, 55,869,000 pesos (2,793,000 dollars) in 1977, 57,724,000 pesos (2,886,000 dollars) in 1978, 79,349,000 pesos (3,876,000 dollars) in 1979, and 132,634,000 pesos (5,471 dollars) in 1980. Losses in the first half of 1981 were 3,556 dollars, according to the cost statement and detail of losses is shown in Table 5–29 in which 65 percent of the losses is of meat.

Table 5–29 Breakdown of Losses at Company Store

(Unit: 1,000 pesos)

	1978	1979	1980
Losses Attributed to the Freeze on Ration Prices			
Sugar and Rice	9,296 (100)	12,198 (131)	22,182 (239)
Bread	17,704 (100)	18,996 (107)	27,928 (158)
Beef	31,379 (100)	38,840 (124)	64,431 (205)
Losses Attributed to Supply as Replacement for Ration Shortfall			
Bread	68 (100)	199 (293)	84 (124)
Beef	1,283 (100)	2,973 (232)	8,637 (673)
Losses Attributed to Sales of Goods to Cover Surplus Bread and Beef Ration Tickets	–	–	6,390 (1,403)
Losses Attributed to Purchase of Surplus Ration Tickets	1,148 (100)	9,772 (851)	9,714
Losses Attributed to the Freeze on Ratio Prices at COMIBOL and Other Mines than Catavi	294 (100)	384 (131)	601 (204)
Income from Rise in Management Costs, etc. (1, 2 or 5%rise)	−3,429 (100)	−4,013 (117)	−7,333 (214)
Total	57,743 (100)	79,349 (137)	132,634 (230)
($1,000)	2,887 (100)	3,876 (134)	5,471 (190)
(Conversion Rate)	($b20 = $1)	($b20,472 = $1)	($b24.51 = $1)

The freeze on ration prices of key food items was established at Catavi in the age of Patino. In 1956 after nationalization, the freeze system was absorbed into wages and legally abolished. But the first military regime, inaugurated from 1964 to 1965, revised the system while carrying out COMIBOL's personnel cutback. Since then, the price freeze system has been maintained and the item prices themselves have remained unchanged for all mines under COMIBOL. The frozen prices are as low as one-tenth of 1980 ordinary prices. Thus massive losses result from the difference.

Table 5–30 Prices of Key Food Items and 1981 Ordinary Average Prices

Item	Price	Ordinary Price	
		1980	August 1981
Sugar	1.17 pesos/kg	10.51 pesos/kg	29.10 pesos/kg
Rice	1.30 pesos/kg	13.00 pesos/kg	18.24 pesos/kg
Meat	2.82 pesos/kg	41.16 pesos/kg	51.20 pesos/kg
Bread	0.11 peso/piece (40NZ)	0.95 peso/piece	1.60 pesos/piece

Although the wide price gap may be inevitable, purchase of surplus ration tickets indicates problems with inspection of the ration amounts.

The current monthly rations are 33 kilograms of meat for a five-and-less-man family and 37 kilograms for a six-and-more-man family, 550 pieces of bread, 24 kilograms of sugar and 16 kilograms of rice. Each ration food is supplied to employees in equal weekly installments.

Total rations and per capita rations in the past several years are tabulated below:

Table 5–31 Items for 1976 – 1980

	Beef		Sugar		Bread		Rice	
	Total (t.)	Monthly per Capita Rations (kg)	Total (t.)	Monthly per Capita Rations (kg)	Total (1,000 pieces)	Monthly per Capita Rations (pieces)	Total (t.)	Monthly per Capita Rations (kg)
1976	1,897	31.3	1,229	20.2	29,470	492	472	7.8
1977	1,864	31.5	1,219	20.6	29,528	500	467	8.0
1978	1,729	32.1	1,196	20.6	29,596	511	468	8.1
1979	2,062	33.8	1,347	21.9	32,916	535	647	10.7
1980	1,983	32.6	1,381	22.7	34,276	564	806	13.2

Note: The number of employees for calculating per capita rations was 4,788 persons in 1976, 4,650 persons in 1977, 4,595 persons in 1978, 4,863 persons in 1979 and 4,940 persons in 1980. The per capita rations' relations with surplus rations are not clear because the total includes even rations for dormitories. The total may include a surplus which was not rationed to employees. A 15 percent beef surplus is estimated for 1980 when 1,676 tons was rationed to employees.

In January – July 1981, a surplus ration accounted for 178 tons or 15 percent of 998 tons of beef rations and 691 loafs or 3 percent of 19,766 loafs of bread rations. (Note: company store attribute this phenomenon to employees' food expense saving amid inflation. Catavi welcomes a decline in ration purchases as contribution to reduction of transport costs.)

The long-retained price freeze system is one of employees' vested interests serving as a basis for determining retirement allowances. Virtually, it is absorbed into the wage system. Revision or abolition of the freeze system, therefore, may cause a big labor problem. Even if this system is abolished, inflation allowances could be introduced instead. Such change would also affect the income tax and social insurance premiums indirectly. The price freeze system is a problem not only for Catavi alone but also for the whole COMIBOL. But we must not that the system's weight in overall personnel expenses has been increasing to boost overall costs.

The company store section's costs are tabulated below. A deficit resulting from management expenses stood at 312,000 dollars in 1979 and 328,000 dollars in 1980. So far, sales costs for some ration items have been raised by 1, 2 or 5 percent every year to absorb part of depreciation and management expenses. But they must be more then doubled in order to offset the current management expenses.

Table 5–32 Company Store Monthly Average Costs

(Unit: $1,000)

	1979	1980	1981
Personnel Expenses	36.2	46.1	44.8
Supply Expenses	1.2	1.6	2.2
Other Expenses	−1.1	−1.7	−3.3
Distribution	6.0	6.3	9.1
Total	42.3	52.3	52.8
(annual Total)	507.6	627.6	633.6 (estimate)

5–2–9 School Education

Catavi has 17 elementary, junior high and high schools as tabulated below, under the August 15, 1936 supreme order obligating an enterprise with 30 or more school-age children to set up and manage local schools. The schools are managed in accordance with the guidance of the Education Ministry and COMIBOL's educational affairs section. In addition to the 17 schools, Catavi has three night supplementary education centers, and a night general education center for adults.

Management of these schools is undertaken by a total of 484 persons – school directors, about 416 teachers, 65 persons for feeding and miscellaneous services, and three guidance office officials – under control of the educational affairs chief. Students total 14,071 persons – 13,335 for day schools and 736 for night schools. (Note: For night schools, Catavi has 135 students and seven teachers, Siglo XX 429 students and 18 teachers, and Miraflores 172 students and five teachers. All of these teachers are from day schools. There are no exclusive teachers for night schools.)

The expenses for elementary and junior high schools is covered by cost of administration while the government raises expenses for high schools. Costs for each student are computed as follows:

(Direct Expenses) + (Management Expenses) + (Cost Distribution) + (a/c Transfer) = (All-School Average Costs)

$15.82 + $2.38 + (–$6.91) + $7.13 = $18.42

(an average for January – June 1981)

Note: The number of students is put at 11,245 persons.

All school buildings and equipment are owned by COMIBOL and belong to Catavi. The number of students as of September 1981 is tabulated below. Costs for children other than those of Catavi employees are transferred to the head office and offset by Regalia payments as government contribution.

Table 5–34 Education Costs and Contribution

	Number of Students (persons)	Education Costs (dollars)	Contributor
Employees' Children	6,675	129,628.50	Catavi Management Costs
Veneros and Coop-Children	975	18,934.50	Government (transferred to the Catavi head office for offsetting by Regalia)
Locatarios Children	1,957	38,004.94	
Social Insurance Money and Pension Receivers' Children	1,207	23,439.94	
Subcontractors' Children	157	3,048.94	
Orphanages' Children	166	3,223.72	
Children of COMIBOL Employees other than Catavi Employees	107	2,077.94	Other Mines' Costs
Total	11,244	218,358.48	

Catavi employees' children account for 59 percent of the total students.

Although education costs for other children than those of Catavi employees are not raised by Catavi, the mine must bear management and equipment costs for all students, including children other than those of Catavi employees. (Note: Investments in school equipment totaled 56,600 dollars in 1980.)

Table 5–33 Detail of Education Expenses

Class			1981 (October 1981)				1980 (monthly average) ($1,000)					1981 (monthly average)			
	School Name	Location	Number of Students	Number of Teachers	Number of Student per Teacher	Other Personnel	Personnel Expenses	Supply Expenses	Other Expenses	Distribution	Total	Personnel Expenses	Supply Expenses	Other Expenses	Distribution
School	Escuela 1° "G. Busch"	Catavi	859	24	36	(Catavi Tranque	11.7	0.5	0.1	Δ 42.3	Δ 30.0	12.0	0.4	Δ 0.1	Δ 39
	" 2° "M. Sucre"	"	886	24	37		11.8	0.7	0.2	0.4	13.1	11.4	0.4	0.3	0.1
	" 3° "Potosi"	Siglo XX	1,161	30	39	17	17.6	0.7	0.1	Δ 42.3	Δ 23.9	17.0	0.4	0.2	Δ 39
	" 4° "F. Tamayo"	"	1,190	30	40		14.8	0.6	0.0	0.1	15.5	14.3	0.4	0.3	0.1
	" 5° "6 de Junio"	"	1,032	29	36		14.0	0.5	0.0	0.1	14.6	13.9	0.3	0.1	0.2
	" 6° "Libertad"	"	1,081	29	37	Mina	13.4	0.5	0.1	0.1	14.1	14.3	0.4	0.2	0.1
	" 7° "T. Frias"	Cancañiri	338	15	23	48	7.7	0.3	0.1	0.2	8.3	7.0	0.2	0.2	0.2
	" 8° "E. Avaroa"	Miraflores	962	29	33		13.4	1.2	0.1	0.0	14.7	14.1	0.4	0.3	0.1
	" 10° "L. Cabrera"	Tranque	91	7	13		3.2	0.2	0.1	0.1	3.6	3.2	0.1	0.1	0.1
	" 11° "Bolivia"	Siglo XX	1,090	32	34		16.5	0.8	0.1	0.0	17.4	17.0	0.8	0.2	0.1
	" 12° "Independencia"	Miraflores	347	14	25		7.1	0.6	0.1	0.0	7.8	7.6	0.3	0.3	0.0
	" 13° "Ayacucho"	Catavi	719	23	31		11.8	0.9	0.2	0.2	13.1	12.7	0.7	0.2	0.1
	" 14° "M. Cardenas"	Siglo XX	751	25	30		12.1	0.7	0.1	0.1	13.0	12.6	0.5	0.2	0.1
	" 17° "Nueva"	"	738	26	28		12.0	1.1	0.0	0.1	13.2	12.3	0.5	0.2	0.2
	Colegio Nal "Junin"	Catavi	705	33	21		Government Contribution					Government Contribution			
	" " "Siglo XX"	Siglo XX	755	23	33										
	" " "America"	"	630	23	27										
	Total		13,335	416	32	65	167.1	9.3	1.3	Δ 83.2	94.5	169.4	5.8	2.7	Δ 77
Management	School Management Office					4	4.5	0.7	0.2	0.0	5.4	3.3	0.4	0.2	0.0
	Overseas' Study Expenses						–	–	3.5	–	3.5	–	–	3.2	–
	Outdoor School Expenses							–	2.6	–	2.6	–	–	3.6	–
	Breakfast and Lunch Feeding Expenses (all schools)						3.3	–	6.9	0.1	10.3	4.1	0.0	11.4	0.0
	Maintenance Expenses						0.3	–	–	–	0.3	0.4	–	–	–
	Religion and Circle Expenses						0.3	0.2	–	–	0.5	0.2	0.0	0.0	
	Total						8.4	0.9	13.2	0.1	22.6	8.0	0.4	18.4	0.0
Grand Total				416	–	69	175.5	10.2	14.5	Δ 83.1	117.1	117.4	6.2	21.1	Δ 77

Table 5–35 Outline of Medical Care

	Personnel (persons)				1980 Medical Services				Monthly Average Costs for 1980				Monthly Average Costs for 1981			
	Doctors	Monthly Wage Employees	Daily Wage Employees	Total	Examinations	Treatments	Prescription Cases	Integrated Hospital	Personnel Expenses	Other Expenses	Distribution	Total	Personnel Expenses	Other Expenses	Distribution	Total
Integrated Hospital	11	102	101		189.5	12.2	439.7	⊙ 854 delivery cases (838 buths)	116.3	19.2	7.3	142 8	116.1	20.2	7.3	143.6
Nurses' Training School		4	5		–				–	–	–	–	–	–	–	–
Catavi Children's Hospital		14			(18.2)			⊙ Deaths: 91 males, 81 females	18 9	2.3	0.5	21.7	20.8	3.3	0.4	24.5
Siglo XX Clinic	3	19	14		96.4	42.9	184.4	⊙ Analysis: 46,096 cases	15.9	1.5	2.3	19.7	16.1	1.7	2 4	20.2
Cancañiri Clinic		3			7.4	3.2	18.3		2.6	0.0	0.2	2.8	3 0	0.0	0.2	3.2
Miraflores Clinic		4			9.8	4.0	36.9	⊙ Surgical operations: 1,178 cases	3.9	0 1	2.7	6.7	3 5	0 4	2.9	6 8
El Tranque Clinic		1			(0.4)				0.2	–	–	0.2	0.4	0 0	–	0.4
Mining Rescue Station		16			–	4.6		⊙ Inpatients (the number of beds total 65,551 with the filling ratio standing at 53.5%)	5.9	0.1	0 0	6 0	6.0	–	–	6 0
Catavi Dental Clinic	4	2			1.0	(*1) 3.2	7.6		1.3	0.1	0.1	1.5	1.3	0 1	0.1	1.5
Siglo XX Dental Clinics (No 1 and 2)		4			0.8	4.7			2.9	0.1	0.1	3.1	2.8	0.1	0.1	3.0
Cancañiri Dental Clinic		1			0.1	1.2			1.0	0 0	0.1	1.1	1.1	–	0.1	1.2
Miraflores Dental Clinic		1			0 1	1.4		⊙ Examinations include 4,780 admissions (total admissions number 7,499 cases) ⊙ X raying 10,392 cases ⊙ Rehabilitation 19,017 cases	1 0	0.0	0.1	1.1	1.2	0.1	0 0	1.3
(Total)	18	171	120	309	305.1	77.4	686.9		169.9	23.4	13 4	206.7	172.3	25.9	13 5	211.7
Maintenance Costs										0.1		0.1				
Management Expenses and Legal Family Allowances					(Unit. 1,000 cases)				18 2	26.1	Δ16.2	28.1	19 8	29.7	Δ16.2	33.3
Medicine and Medical Equipment Expenses										77 6						
Total	18	171	120	309	305.1	77.4	686 9		188.1	127.2	Δ2.8	312.5	192 1	55 6	Δ2 7	245 0

Note:

(1) Personnel data is based on Annexed Material II.
(*1) Total of treatment and tooth extraction cases

(2) Costs are based on the cost statement and IBM's calculation.
Costs for 1981 do not include medicine and medical equipment expenses

(3) 1980 medical services are based on "1980/Informe Annual."

Table 5–36 Statement of Medical Service Income and Expenses (monthly average)

(Unit : $b 1,000)

Class			1978 Value	1978 Proportion %	1979 Value	1979 Proportion %	1980 Value	1980 Proportion %	Note
Income	Employer's Contributions	(Basic Amount) x 8%	923.5	68	1,098.8	65	1,252.4	62	In July 1980: Veneros and Lamas 386.8 Non-Employees Patients 12.3 Total 399.1 (Veneros and Lamas account for 97 percent)
	Employees' Contribution	x 2%	230.2	17	274.6	16	312.7	15	
	Others		198.2	15	317.0	19	475.0	23	
	Total		1,351.9	100	1,690.4	100	2,040 1	100	
Expenses	Personnel Expenses	Direct Expenses	916 0	68	1,264.1	75	1,868.1	91	Compensation for the first three days is covered by sections to which patients belong. Compensation for fourth and subsequent days is covered by the head office's a/c.
		Ration Losses	366.8	27	562 2	33	893 6	44	
		Indirect Expenses	718.2	53	998.1	59	1,359.5	67	
		(sub total)	(1,996.0)	(198)	(2,824 4)	(167)	(4,121.2)	(202)	
	Medical Service Expenses		71.9		323.1	19	381.8	19	
		Medical Equipment	40.5	3	44.0	3	38.4	2	
		Payments for Medicine	105.5	82	1,491.4	88	735.3	85	
		Medicine Purchases	4.6		4 6		19.3		
		Analysis, Blood Bank	30.2		38.2		59.7		
		Meals	195.5	14	240.3	14	366 5	18	
		Transfer from Other Groups	7.0		70.6	4	93.4	5	
		Transfer to Other Groups	Δ229.1	Δ17	Δ232 8	Δ14	Δ290.3	Δ14	
		(sub total)	(1,229.1)	(91)	(1,979.4)	(117)	(2,404.1)	(118)	
	Compensation	Disease and Delivery Holidays Holidays for Injures Resulting from Official Duties Travelling Expenses	355.8	26	491.8	29	744.1	36	
		(sub total)	(355.8)	(26)					
	Other Expenses	Transport	114.5	8	147.2	9	225.3	11	
		Repair and Maintenance	65.4	5	67.8	4	117.2	6	
		Electric Power	43.8	3	58 6	3	82.1	4	
		Car Repair	33.3	–	33.7		66.4	3	
		Others	48.4		27.3		49 8		
		(sub total)	(305.4)	(23)	(334.6)	(20)	(540.8)	(27)	
	Depreciation		72.0	5	98.1	6	92.4	4	
	Total		3,958.3	29.3	5,728.3	339	7,902.6	387	
Losses			Δ2,606.4 $1,000 (130.3)	Δ193	Δ4,037.9	Δ239	Δ5,862.5 $1,000 (239.2)	Δ287	

5–2–10 Medical Service

Article 75 of the current labor law provides that a company which is located more than 10 kilometers away from a town or a city and has more than 500 employees must have more than one hospital with all necessary medical equipment. Abiding by this article, Catavi has 14 medical facilities – an integrated hospital, a children's hospital, clinics at Siglo XX, Cancañiri, Miraflores and El Tranque, dental clinics at Catavi, Siglo XX, Cancañiri and Miraflores, a mining rescue station and a nurses' training school.

These facilities are managed by the medical affairs director and 309 employees – 18 doctors, 171 monthly wage employees (inclusive of nurses) and 120 daily wage employees. Their medical services cover 23,000 Catavi employees and family members, 1,000 Veneros and Lamas workers (a total including family members is estimated at 4,000 persons), and several other subcontracting workers.

As shown in Table 5–35 on the outline of medical services, these facilities deal with 1,000 medical examination cases, 2,300 medicine prescription cases and 180 impatients per day. A doctor deals with 56 medical examination cases, 10 impatients and 128 medicine prescription cases every day. Thus doctors shoulder terrible burdens.

Under the social security law, the employee and the employer contribute 3.5 and 24.5 percent each of management costs of the hospitals and clinics. Of the total 28 percent, the hospitals and clinics take 10 percent, under a contract with the social security corporation, to provide employees, who are absent from office for less than one year due to diseases, delivery or injury resulting from official duties, with medical services. The social security corporation raises costs for compensation for workers' accidents and deaths, and treatment of disabled, aged and long-ill employees. The 10 percent contribution from the employees and employer and a 3.5 percent contribution from Veneros and Lamas miners are treated as the fundamental part of financial resources for the medical facilities.

Other patients than Catavi employees are asked to pay 120 percent of treatment fees and 130 percent of medicine prices, which also form part of the financial resources.

The monthly statement of income and costs for the medical facilities, reported to COMIBOL's head office and the social security corporation, indicates a large deficit. The deficit is transferred to the head office and offset by Regalia as government contribution.

The deficit, amounting to 2.8 million dollars a year, is three times as large as income. But it is processed separately from the mine's income statement and has no effect on the mine's income or expenditure.

Some quarters recommend that the mine transfer management of the medical facilities and the schools to the government. Some doctors think they could take advantage of such transfer. To Catavi employees, however, the current system is more favorable. Such transfer would not be easy. Furthermore, the transfer could cause another problem with the social security corporation. If the corporation, which is already financially plagued, is obliged to absorb medical service deficits of private companies as well as public corporations, social insurance premiums of both employees and employers would have to be raised. The corporation remains reluctant to undertake the management of private medical facilities. (Note: As to ordinary private companies, their medical service deficits, and costs for school children of others than their employees are not authorized to be offset by Regalia as government contribution, although some teachers are occasionally dispatched by the government to their schools. In this respect, COMIBOL and other public corporations are privilaged.)

5–2–11 Theater, Cinema House

Catavi mine runs six cinema houses at Catavi, Siglo XX, Cancañiri, Miraflores and El Tranque for employees' entertainment. Income from the cinema houses is incorporated into a special separate account at the head office as is the case with income from casting

Security expenses account for a conspicuous 63 percent of the personnel expenses. The share of distribution in construction, company house maintenance and other costs from the construction cost group stands at 42 percent.

plants. Four employees undertake their management. Temporary workers for the management are also employed if necessary. Income and expenditure for the cinema houses follow:

Table 5–37 Cinema Houses' Income and Expenditure (monthly average)

(Unit: 1,000 pesos)

	1978	1979	1980	
Income				
Admission	40.2	42.5	43.9	(100)
Expenses				
Film Rent	137.9	146.0	144.9	(330)
Personnel	40.9	52.2	69.2	
Supply	0.7	18.4	1.9	
Other Expenses	15.4	29.3	26.9	
Total	194.9	245.9	242.9	(553)
Losses	154.7	203.4	199.0	(453)
	($7,700)	($10,000)	($8,100)	

Note: "Other expenses" include electric power, transport, construction and distribution of depreciation.

The admission at the cinema house is set at one peso for a Catavi employee and five pesos for a non-employee, far less than 10 to 20 pesos at general movie theaters.

Catavi may have to reconsider management of the cinema houses at a time when color television sets are diffusing in Bolivia.

5–2–12 Welfare

The welfare section undertakes maintenance and management of 4,100 company houses, their allocation to employees, management of company house residents, maintenance of infrastructure, cleaning of residential areas, maintenance and management of seven visitors' lodging houses and club facilities, control of 47 sports grounds, stands and snack bars, and security of the whole mine. Its personnel consisted of 30 monthly wage employees and 283 daily wage employees as of August 1981.

This section's relations with merchants should be taken into account, because it deals with welfare for 26,000 Catavi employees, of which company house residents account for 19,500.

Of the welfare costs, personnel expenses capture the largest share of 52 percent.

Table 5–38 *Welfare Facilities (1980)*

Class			Class of Company House					
			Catavi	DigloXX	Cancañiri	Miraflores	El Tranque	Total
Management Employees and Expenses		Number of Employees (daily workers)	100 (88)	121 (111)	57 (54)	51 (47)	-	330 (300)
			$1,000	$1,000				
		Monthly Expenses (guard expenses)	78.5 (16.5)	101 6 (30 6)	22.5 (16 0)	22.4 (12.4)	-	225 (75 5)
Housing	Users	Employees for Monthly Wages	337	448	28	44	3	860
		Mining Workers for Daily Wages	1,100	1,460	284	334	59	3,237
		(Total)	(1,437)	(1,908)	(312)	(378)	(62)	(4,097)
	Type of Houses	3LDK and larger	48	43	-	-	-	91
		2DK	381	659	7	59	3	1,109
		1DK	1,008	1,206	305	319	59	2,897
	Conditions	Better	645	381	22	37	2	1,087
		Ordinary	608	1,233	112	175	30	2,158
		Worse	184	294	178	166	30	852
	Infrastructure	Water Conduits	2	1	-	1	1	5
		Public Water Cocks	55	60	22	19	5	161
		Company Houses Receiving Water Service	283	166	22	32	2	505
		Public Washing Lots	3	-	2	2	1	8
		Public Lavatories	24	16	7	4	4	55
	Residents	Employees	1,489	1,713	112	209	22	3,545
		Family Members	6,118	8,164	408	1,076	185	15,941
		(Total)	7,607	9,877	520	1,285	207	19,496
		Males	3,709	4,863	272	656	106	9,606
		Females	3,898	5,014	248	629	101	9,890
Environments	Sports	Foot Ball Grounds	1	2	2	1	1	7
		Basket Ball Courts	9	7	2	4	2	24
		Tennis Courts	4	2		1	-	7
		Vasca Grounds	2	1	1	1	-	5
		Swimming Pools	1	-	-	-	-	1
		Recreation Grounds	2	-	-	-	-	2
		Cockfight Pits	1	-	-	-	-	1
	Clubs	Employees' Social Clubs	2					
		Sports Clubs	(6)	(8)	(1)	(3)	(1)	(19)
	Others	Churches and Chapels	4	2	1	-	1	8
		Libraries	1	1	-	-	-	2
		Markets	1	1	-	-	-	2
		Shop Stands	4	4	1	2	-	11
		Snack Bars	4	1	-		-	5
		Mining Workers' Lodging Houses	3	1	2	1	-	7
		Dressmaking and Knitting Shops	1	2	-	-	-	3
		Barber Shops	2	1	1	-	-	4
	Cinema House		1	2	1	1	1	6
	Distribution Stations, Bread Bakeries, Meat Processing Works		1	1	1	1	1	5
Dormitories for Visitors, Employees and Hospital Attendants			3 (2 for visitors, 1 for hospital attendants)	2 (1 for visitors, 1 for employees)	-	-		5 (3 for visitors, 1 for hospital attendants, 1 for employees)
	All Lodging Facilities' Accommodation Capacity (Number of Beds)		788 (71)	232 (21)				1,020 (92)

5–2–13 Social Services

The social services section under direct control of the general manager undertakes spiritual aspects of welfare for employee while the above-mentioned welfare section deals with material aspects. For example, the social services section, consisting of six employees (including one daily wage earner), promotes group activities to improve social morals, sends officials to employees' home to solve family disputes or cooperate in solution, and holds lecture meetings. It also deals with control of miners' dining rooms and school breakfast feeding, Examinations of applicants for scholarship, underground dining room and examination of applicants for admission to the nurses' training school.
school.

5–2–14 Communication

The communications section under the president's control handles radio and mail contacts between the head office, branches and mining offices. Telegraph is adopted for radio communications to save time. In August 1981, the telegraph and telephone corporation set up an automatic communications system linking the neighboring to La Paz, Oruro and other major cities. This would enable Catavi to use the automatic communications system, reducing radio contacts between the head office and branches.

Mine telephone systems, which are controlled by other sections, have exchanges at Catavi, Siglo XX and Miraflores. The number of telephone circuits is 160 for Catavi, 150 for Siglo XX, and 35 for Miraflores. Such telephone systems are used for contacts between offices, company houses and other facilities at each mine.

The communications section consists of five employees for radio contacts, one for mail contacts, and 12 (including four daily wage earners) for telephone exchanges.

5–2–15 Statistics

The statistics section keeps, classifies and make copies of reports and statistics presented to the general manager. Thus it is virtually a secretariat rather than a statistics section. The above mentioned business is handled by two officials, who depend on their memories for main- tenance of documents without making any index of documents. Thus documents' maintenance is deemed unsatisfactory.

The section also has the manager's secretariat (two employees), a legal adviser's office (a legal adviser and two employees) to prepare contracts with mining subcontractors and

take procedures for collection of accounts receivable, a clearance office (22 employees, including one daily wage earner) to handle clearance of materials, rations and fixed assets, an inner control office (four employees) to manage and support the Board of Audit standards, and Uncia Branch (one employee) to deal only with ore purchase procedures.

The above-outlined management subgroup of Catavi's support service group is mostly put under direct control of the superintendent of business. Doubts are cast over such management system. As explained at the preceding paragraph, some accounting figures calculated at a section are occasionally different from relevant figures calculated by other sections, indicating that accounting procedures have yet to be unified comprehensively.

5–3. Terms of Payment for Metales

Most tin concentrates produced at Catavi mine are sold to the Public Smelting Corporation (ENAF, Empresa Nacional de Fundaciones) at present, and only two to five percent of low grade ores from Kenko mill plant is exported to Capper Pass & Son Ltd., United Kingdom.

Since an upgrading facility of low grade concentrate (up to 15 to 20%) has been completed and put in operation in 1980 at Vinto smelting plant (Oruro) of the Public Smelting Corporation, it is expected the whole production from Catavi will be sold to the ENAF before long.

All the final products from Catavi including the purchased ores, are brought together at two shipping warehouses (Bodega Barrilla) of the Metallurgy Division, packed in bags (PP bags), sampled for inspection, grouped into a standard lot of 720 bags/30t, and loaded onto boxcars of 25t or 30t capacity which are owned by COMIBOL or the National Railways Corporation. These boxcars are brought to Oruro or Vint smelting plant through the line joining National Railways line at Machacamarca via Uncia, or to Matarani Port of Peru via Guaqui.

COMIBOL and ENAF have signed an annual blanket sales contract, under which the concentrates of Catavi are dealt with. COMIBOL has continued asserting a trading system with consignment smelting from the beginning which does not come into acceptance yet, so that the ownership right of ore transfers to the Public Smelting Corporation at the time of each interium liquidation or full payment.

The sales contract is divided into three sections high grade tin ores, low grade tin ores, and volatilization tin powder ores under the terms of delivery at Vint smelting plant on each of them. An inspector from COMIBOL is permanently stationed at Vint smelting plant

to attend and confirm weighing and sampling of the product delivery. When a grade difference of 15% or more is found between the delivery note and the acceptance test, the treatment is negotiated by consultation between the two parties after a re-analysis. When the difference is less than 15%, the price difference is divided into two. The details of terms are as follows.

1) High grade ore : terms on ore containing tin 40% or more.

(1) 31;688 DMT, Sn 42.71%

(2) Unit reduction – 1.5% reduction for 50% quality :

(a) 0.02% reduction per 1% over 50%

(b) 0.02% rise per 1% under 50%

(3) Penalties :

(a) For ore containing antimany and/or arsenic 0.15% or more, the price is reduced at a rate of US$ 25/DMT per 1% increment.

(b) For bismuth content of 0.40% or more, the price reduction is US$ 28 per 1% increment.

(c) For sulfur content of 2% or more, the price reduction is US$ 4 per 1% increment.

(d) For iron content of 9% or more, the price reduction is US$ 4 per 1% increment, provided that a premium of the same rate is added when the content is less than 5%.

The total penalty amount is limited at US$ 50/DMT.

(4) Treatment charge (T/C)

US$ 805.58 per ton of dry concentrate (DMT).

(5) Sales cost

(a)	Marine freight	US$ 135.42 / NMT x NMT
(b)	Railroad freight (from Vint to Matarani)	US$ 54.00 / NMT x NMT
(c)	Shipping expenses	US$ 6.00 / NMT x NMT
(d)	Forwarding expenses	US$ 13.00 / NMT x NMT
(e)	Consul visa charge	US$ 0.05 / NMT x NMT
(f)	Harbor expenses	US$ 6.00 / NMT x NMT
Total		US$ 214.47 / NMT

In addition :

(g) Marine insurance premium

(Contained metal value-unit-penalty T/C) x 110% x 0.121%

(6) Regalia

Regalia is computed according to the calculation method specified by law.

(7) The metal price is based on the lowest of the four quotations of the first and the second sessions of LME, and is settled on the average metal price of such lowest values for 30 days after the day of delivery.

(8) The payment is carried out in such a way that 100% of the interium debit notes is paid within 25 days and the final liquidation is realized around 120 days after the delivery.

(9) Special bonus

Because of a special agreement between the two parties, COMIBOL receives a bonus of US$ 8 /DMT from ENAF at present.

2) Low grade ore : Terms on one containing tin less than 40%.

(1) 5,940 DMT, Sn 28.22%

(2) Unit reduction : 1% evenly

(3) Penalty

For arsenic content of 0.2% or more, the price is reduced at a rate of US$ 35 /DMT for every 1% increment, provided that the total amount is limited to US$ 50 /DMT.

The other conditions are the same as those for high quality ore with the exception of US$ 183.40/NMT for the marine freight.

3) Volatilization tin fine ore

(1) 5.104 DMT, Sn 50%

(2) Unit reduction: 1% evenly

(3) Penalties:

(a) For arsenic content of 0.2% or more, the price reduction is US$ 35/DMT for every 1% increment.

(b) For sulfur content of 0.22% or more, the price reduction is US$ 4/DMT for every 1% increment.

However, the total penalty amount is limited to US$ 80/DMT.

The other conditions are the same as those for high grade ore.

The above descriptions explain the trading conditions for ore sales of COMIBOL to ENAF. However, the former corporation is selling a small portion of the concentrates from Kenko mill plant to Capper Pass & Son Ltd., and therefore the trading terms are shown as follows.

4) Trading terms for Capper Pass & Son Ltd.

(1) Unit reduction, 1% evenly

(2) Penalties:

(a) Arsenic – £23.81/DMT for every 1% increment.

(b) Sulfur – £0.35/DMT for every 1% increment, provided that the upper limit is £ 7.32 in total.

(3) T/C : £ 167.52/DMT, with a bonus of £ 3.17/DMT for concentrates containing tin 40% or more.

(4) Costs for pollution protection and energy :

£ 23.81/DMT for pollution protection, and £ 54.58/DMT for energy consumption.

(5) The metal price is the average value of the lowest settlement prices of LME for 40 days after the day of visa for customs clearance.

(6) The delivery is at the port of destination, and the payment is carried out in such a way that 100% of the interium debit notes is settled from L/C and the final liquidation is realized within 90 days after the day of customs clearance.

5–4 Regalia

Regalia is an account statement on the revenue due to the ore sales and the statement brings about a great influence on the profit and loss of Catavi mine, that is to say a with-holding tax is put under obligation to be deducted and paid so much as 20% or higher of the net income depending on the metal price. The explanations of Regalia,which corresponds to the corporate income tax and the export tax, are as follows.

In Bolivia, a financial inflation started with the Chaco War which was brought on with Paraguay in 1932. This inflation was more greatly fed by the invalued effect of the international inflation due to the World War II and also by the Nationalism Revolution which occurred in 1952. Such a history naturally affected the foreign-exchange rate with the following results:

1940	40 Bolivianos / US$ 1
1952	600 "
1954	1,800 "
1956	13,000 "
	(Ceiling quotations = 190)

The new revolutionary administration had to provide various policies to stabilize the currency and economy in Bolivia, thus enacted, with the aid from the United States and

International Monetary Fund, the Currency Stabilization Law and a series of economy-related laws on the base of free economy rules in December, 1956. In Bolivia where the industrial structure can be said to consist of only the mining, the mining-related taxation systems have resulted in Regalia which was named by the revolutionary administration to indicate a metaphorical and ironical feeling but is now exposed to critical opinions through various historical changes with the background of previously mentioned and other social conditions.

The previous mining-related taxation systems covered a so wide range that including, the royalty and mining property trading tax, mining profit tax, mining profit dividend tax. ore export tax, ore export additional tax, ore export additional customs, various local taxes, foreign currency transfer tax, foreign currency transfer additional taxes and so on. Moreover, they frequently changed according to the times and circumstances. Therefore, gathering these taxes into one system "Regalia" was significant in its own way.

The relationship between the changes in the taxation systems accompanying the progress and changes of social circumstances and in the mining productions is shown in Table 5–39.

Table 5–39 Paid Tax Amounts before Enforcement of Regalia

Year	Mining Production	Royalty	Mining Property Trading Tax	Mining Profit Tax	Mining Profit Dividend Tax	Foreign Currency Transfer, and its Additional Taxes	Export and its Additional Taxes	Others	Total	Percentage for Production
1922	1,083	0.4	0.3	0.5			3.5	0.3	5.0	0.5%
1924	1,443	0.6	4.4	4.7			6.9	0.4	17.0	1.2
1926	11,526	0.5	0.1	3.1			8.9	0.3	12.9	0.9
1928	1,501	0.5	0.1	2.2			7.4	0.4	10.6	0.7
1930	1,202	0.2	0.5	0.0			3.1	0.3	4.1	0.3
1932	516	0.3	0.0	0.0			2.9	0.4	3.6	0.7
1934	1,138	0.5	0.1	1.0			11.2	10.6	13.4	1.2
1936	1,258	1.0	0.1	2.2			10.3	1.0	14.6	1.2
1938	1,212	1.7	0.4	3.3	1.1		26.5	1.7	34.7	2.9
1940	2,339	1.1	1.3	4.9	2.6	219.3	242.7	2.2	474.1	20.3
1942	2,662	2.1	0.8	67.9	0.9	435.1	286.8	5.1	798.7	30.0
1944	3,057	1.8	0.5	122.0	20.5	421.6	252.7	4.7	823.8	26.9

(Unit: Million Bolivianos)

(Source: Tasa e Impuestos Sobre LA Industria Minera en Bolivia – 1946 – Rene Ballivian

Table 5–40 Paid Tax Amounts after Enforcement of Regalia

(Unit: MLN US$)

Year	Export from Mining	National Revenues								Estimated Regalia from Mining	Total Tax Amount of Mining	Percentage to Mining Export
		Domestic Taxes	Customs	Others	Regalia		Export Tax	Total	Percentage of Mining			
					Petroleum and Others	Mining						
1966	131.5	26.2	28.9	1.8	0.1	4.0	–	61.0	6.5	5.6	5.6	4.2
1968	139.0	31.5	29.3	2.3	4.5	2.8	–	70.4	4.0	3.9	3.9	2.8
1970	209.9	36.9	35.2	3.3	0.1	14.7	–	90.2	16.3	20.7	20.7	9.9
1972	174.2	43.2	30.0	5.0	4.2	3.1	10.0	95.5	13.7	4.4	14.4	8.3
1974	387.3	64.8	47.2	11.8	44.0	45.1	40.0	252.9	33.6	63.5	103.5	26.7
1976	366.9	116.3	72.6	16.9	63.0	42.7	29.4	340.9	21.1	60.1	89.5	24.4
1978	515.0	157.9	97.8	48.9	45.9	77.1	23.4	451.0	22.3	108.5	131.9	25.6
1980	641.1	176.6	102.0	46.4	66.4	72.2	5.2	468.8	16.5	101.2	106.4	16.6

- The table shows the details of the national revenues and the statistics of the Central Bank are converted into US$.
- The total Regalia amount paid by mining industry includes a portion which is paid directly to the Local Development Public Corporation, universities and others without passing through the National Treasury, and the data for such a portion is not clear. Thus the estimated Regalia is shown in the third column from the right end by multiplying with a coefficient of 1/0.7105 which is assumed to correspond to the unknown portion.

As being clearly understood from the table, the production and tax revenues fell down sharply at the time of Chaco War, but they recovered along with the raise of nationalism, especially after the establishment of a nationalistic administration led by President Bush in 1939.

In the "Regalia" taxation system, the tax rates for industries having facilities like mining were relatively higher, because the system included a progressive taxation on the forecasted balance profit coming from the standard production cost which was set against the metal price based on the international current price, and a tax which depended on the product quality. If the real circumstances were reflected into the system, there might be no problems, but because the standard production had to depend on the base of results in the past, the tax rates were forced to be high, which impeded the promotion of industries.

After the enforcement of Regalia, some promotion measures have been adopted : setting the upper limit on the progressive taxation rate, reviewing the standard production cost, reducing the tax rate for production increments, deducting a portion of the mining cost from taxation and so on, but there is no basic alteration.

The current taxation systems for the mining industry have been simplified into Regalia, the mining and metallurgy research tax which is applied when a private enterprise exports ore independently, and the royalty. They have been enforced by the highest government ordinance, No. 10550, along with the ordinance for devaluation in October, 1972, and the export tax which was revised several times thereafter has been repeated.

The current "Regalia" has been revised by the highest government ordinance, No. 17248, issued on March 5th, in 1980, when it changed from the progressive taxation system into the fixed rate taxation system, and the presumed standard cost has been reviewed and altered by the highest government ordinance, No. 17934, announced on January 9th, in 1981. Only the sections of these revisions related to tin are as follows.

(1) A tax rate of 53% is applied to the constructive profit which is the difference between the metal price published by the Ministry of Finance and the presumed standard cost. The allocation of the tax rate is 38% for the National Treasury, 13% for the Local Development Public Corporation, and 2% for the Exploration Fund (exempted for Cooperativos).

(2) The presumed standard costs are as follows.

Public Mining Corporation : US$ 4.48 / pound of metal

Private company (A) : US$ 3.93 / pound of metal

Private company (B) : US$ 4.20 / pound of metal

Cooperativos : US$ 4.37 / pound of metal

The presumed standard costs for private companies (A) and (B) are determined on the base of production of 4.5 MT/month of the metal.

(3) For so-called "fine crystal" or "colloidal" tin ore which contains tin 20% or less, and complex ore containing tungsten and tin, 50% of the taxation is reduced according to the decision of the Ministry of Finance based on the assessment of the Ministry of Mining. For complex ore containing tungsten and tin 20% or more respectively, 12% of the metal price is deducted for taxation.

(4) Tax reductions for ore containing tin 20% or less have been decided by the highest government ordinance, No. 17551, issued on August 12th. in 1980, and they depend on tin content as follows:

10 to 10.99%	50 %	tax reduction
11 to 11.99%	45%	"
12 to 12.99%	40%	"
and so forth to		"
18 to 18.99%	10%	"
19 to 20.00%	5%	"

(5) The Ministry of Finance decides and announces the legal metal price based on the average of the lowest LME metal prices for the previous 15 days. The exchange rate between UK£ and US$ is decided on the base of the quotations corresponding to the 15 days published by London Metal Bulletin.

(6) The ore weight is indicated in Dry Metric Ton, and calculated in such a way that the gross weight is subtracted by 1% for the bag, 5% for pellets and container, 1% for transportation loss, 2% for moisture content in general ore and 5% for moisture content in flotation concentrates.

(7) The weight unit conversion is 2,204.62 lbs/MT/1,000 kg.

(8) The mine producer bears the tax payments, and users such as smelters are obliged handle the withholding taxation business.

(9) When the International Tin Council changes the lower limit of the metal price zone, the constructive cost is altered by the same rate within 15 days.

The above description is the outline of the current Regalia, in which clarifications and improvements such as the establishment of legal metal price, the revision prospect on the constructive cost, and the standard rules for calculation are put in practice. On the other hand there are some disadvantages like the conversion of the progressive taxation into the

fixed rate which resulted in a real tax increase. In recent years, the mining industry along with the Ministry of Mines, saying that Regalia is a reckless taxation system, has actively promoted basic improvements in the industry, including requests to foreign consultants about improvements of the mining-related taxation system. The present military junta has decided that, because of lowering of tin production due to various conditions, the establishment of improved mining policies is the most urgent business. As a result of several discussions with all members of the mining industry, a general investigation conference was held with attendance of representatives from the related agencies, the mining industry and others in July, 1981, at Tarija City. The conference has adopted the mining policy for midterm (1981 to 1985), which is confirmed being different from the conventional one and has gained the consensus. The policy also was previously approved by the government.

The matter worthy for a special mention is that the application of a tax rate on the actual profit has been approved. It may be nothing to say that the application of this tax rate must be based on the mining accounts standard, which is now under preparation with the aid of the government of Canada.

It is reported that the Public Mining Corporation is now making itself ready for application of the actual profit taxation system in the coming year or the year after next at least, by enforcement of an accounts handling system based on the new mining accounts standard. Some private companies are switching their conventional accounting systems into new ones based on the standard, thus considering to put them into practice in this fiscal year.

The Tarija conference has also decided that the current Regalia system may continue to be applicable to smaller mining companies. At present, the adjustment of the constructive cost is under consideration, and so 10% raise of the constructive cost may be realized in near future, according to the Ministry of Mining and Metallurgy.

5–5. Considerations and Proposals

The investigation on this division has resulted in a general report, because the division is only a subordinate subject from the viewpoint of the whole investigation, and because the main efforts have been concentrated on the investigation of the real state of affairs. The following controversial points are not only peculiar to Catavi mine, but also related to the whole COMIBOL and the administrative policies of Bolivia on the management of mines. These controversial points may also be discussed in the investigation being carried out by the World Bank in parallel with our investigation, but being indispensable to the rational

operation of Catavi mine they are referred to in this section.

5–5–1 Organization

As mentioned in 5–1–3, "Mine Cost", it can be understood that the present organization has been established before the nationalization of the mine with few alterations even after being put under the management of COMIBOL; some small alterations, similar to the case of operation facilities, have been practiced on the fundamental organization established in the era of Patio. Especially in Bolivia, alterations of an organization in vain may cause confusion. On the other hand, persisting in an organization which does not suit the real state of things brings about various negative aspects. For instance, contradictions between the management section and the prime cost control section will result in (1) unclear responsibility for the prime cost control, (2) decline in morale of the person in charge of each job, (3) impossibility of the comparative analysis on the differences between the expected production and operating budget and their achievements, which in turn fails in taking appropriate countermeasures and end up only as a list of figures to be compared, and (4) difficulties in an all-over judgement and in taking systematic correspondence between sections. The contradictions can be understood due to (1) the frequent personnel reshuffling of the managing staff at each mining site of COMIBOL; they are forced to change their posts in usually less than two years, thus their recognition on irrationalities of the organization cannot be boosted up to the stage of actual revision, and (2) the organization of the headquarters of COMIBOL is not constituted to clearly correspond to the management section of each mining site. At least, the person in-charge of the management should be responsible to the prime cost control section with a well-established job relationship between the management section and the prime cost control section.

Some typical proposals for an integrated organization at Catavi mine are: (1) considerations may be necessary to simplify the organization in such a way that the organization should be roughly divided by regions as Siglo XX and Catavi with a submanager for each to do the management, or sections under direct control of the manager and the submanager should be rearranged and unified into the lower hierarchical sections, (2) it should be considered, for business supervision, to provide two divisions for management and public welfare to integrate smaller sections.

Note: The present business superintendent manages 19 large and small sections without any staff, being able to spare only 20 minutes on a daily average to look after each section except

treatments of external subjects. There is probably just enough time for him to only sign his name on the remitted papers without paying any attention to the details mentioned.

5–5–2 Responsibility and Authority

Naturally responsibility and authority must be clear and simple for functional activity of organization, however, in Catavi mine, the organization is clear, but the positions where responsibility and authority lie has resulted in complexity. This is not only problem of mine itself but also a result of making loose activity as private enterprise by the policy that the government deal COMIBOL as governmental organization.

To make an organization exhibit its full function as an organization, the specified jobs and authorities to implement them must be allocated to each section, and above all the allocation of authority on personnel is important, which has not been necessarily realized in the organization of COMIBOL. Thus the preservation of authority has been practiced by the centralization of the job authorities. The employment system of COMIBOL is basically not equal but similar to the life-long employment system except some special occupations.

With considerations on these points, job authority should be delegated to the lower hierarchies as much as possible so that the senior staff of the mine can devote themselves to the intrinsic management of the mine.

5–5–3 Office Work

All office work is by nature only a procedure to deal with business, and therefore it is the principle to put it into practice simply and clearly. The office work at Catavi mine contains too many procedures only aiming at perfunctory procedures, and there a trend can be found that the essential purposes have been neglected. To put it in concrete terms, many detailed data have been continuously prepared for a long term at each division, which may be said to be admirable. There are many problems, however, in arrangement of such data, and practical applications of the data are also insufficient. The senior staff of the mine are so busy that not only they cannot check effectively such detailed data but also they may be kept from understanding correctly the general situation of the mine. The simplification and rationalization, being deeply correlated with the previously mentioned delegation of authority, remain to be investigated in future.

5–5–4 Application of Computer

Catavi mine has already introduced a computer and is now promoting its application, which must be advanced greatly. The present application has, however, some aspects where the contentment has not been obtained yet at each field section, thus the improvement of the computer application system should be positively investigated. Education on the computer may be necessary to modify the reaction of rejection against a new system and to get the understanding of related persons in each section. At the present state, there are some areas in which confidence on the computer-processed results is lacking, and some duplication in job procedures is occurring, which must be improved.

5–5–5 Talent and Education

Many persons competent in special fields are assigned to the production engineering department, while there is only one competent person who is the manager of business audit other than a full-time service legal adviser in the business control department, other management staff of which consists of experienced persons. Therefore, consideration may be necessary to widen the business view through job education, and to provide chances for mutual development by assigning competent persons.

At any rate, it may be a possible to practice in-company education and training in order to get a new understanding of the importance of the business control department, from which integrated judgements on business can be obtained.

5–5–6 Conclusion

The major problems have been picked up as they are in the above description. It is clear that the previously mentioned actions will never be solution measures even practiced in parallel with technical improvements for such an enterprise which has resulted in an after-tax loss of ten million dollars or more for every year and has a great possibility of a continuous 25% loss on sales.

However, it is also certain that Catavi mine cannot be easily disposed at simply because of its receipts and disbursements; the reason for this is that, from the national point of view, Catavi mine accounts for 9% of the mining industry and 0.5% of the whole industry employee populations, 16% or more of the mining related treasury receipt, around 5% of the total acquisition of foreign currencies wellhead, and some 15% of the total tin production in Bolivia.

In taking the contribution of Catavi mine to the community into consideration, it is also required to promote the rearrangement of the organization by practicing some urgent improvements even if they are only a few. At present, Catavi mine is embracing some public utility like businesses such as hospitals, schools and railways, and a casting plant, which has made the organization of Catavi mine more complicated. An example of countermeasures for improvement is that (1) the public utility like hospitals be put under control of the government or the autonomy to change them into the governmental urban hospitals for public residents, and the industrial injuries and diseases due to the mining work be treated under the contract between the hospitals and the mine, (2) the casting plant be separated from Catavi mine making itself as an independent enterprise with measures for its improvement and development. The casting plant has been in operation of its full capacity with receiving all orders from COMIBOL, and a plan to double the production capacity is now under investigation; the balance of the plant is profitable for the time being for COMIBOL. Thus the casting plant can probably develop independently in Bolivia, and also can be a substitute site for another industry. It Catavi mine, with making its auxiliary department be independent, can be put under a consistent organization devoting simply to the mining business including exploration, exploitation, concentration and ore-selling, then the proper personnel disposition and simplification of each organization will be easily carried out.

CHAPTER 6 RELATIONSHIP OF CATAVI MINE WITH THE STATE AND THE COMMUNITY

In the vicinity of Catavi mine, as seen in Fig. 6–1, there are Uncia and Llallagua where the seats of the first and the third county offices of Provincia Bustillo Deparamento Potosi are respectively situated; and villages of Andavilque, Sauta, Viluyo and Tojota. Furthermore, there are fourty-odd hamlets in the area of some 10 Km radius around Catavi.

The seat of the second county office of Provincia Bustillo, Chayanta, is also located about 15 Km away from Catavi on the route via Uncia to Sucre which was the political capital of Bolivia up to 1889.

6–1 Area and Population

According to the data from the national census conducted in 1976, the area and population of Provincia Bustillo Departamento Potosi where Catavi is located, and their proportion compared to the whole of Boliva are as follows.

Table 6–1 Areas, Population and Population Density

	Area		Population		Population Density
	Km^2	%	x 1,000	%	per Km^2
Whole Bolivia	1,098,581	100.0	4,613.5	100.0	4.2
Departamento Potosi	118,218	10.8	657.7	14.3	5.6
(Ciudad Potosi)			(77.4)	(1.7)	
Pref. Bustillo	2,335	0.2	91.4	(2.0)	39.1

The population density of Provincia Bustillo exceeds 35.9 per Km^2 of the Provincia Frias in which Potosi city, the seat of the State Government, is situated, and is extremely high when compared with other prefectures in Potosi State. The total population of Catavi, Llallagua, Siglo XX and Uncia reaches 54% of the total population of Provincia Bustillo.

Note. "Bolivia en Cifas" published by the Statistic Agency (March, 1981) indicates the population estimates as 5,600,000 for the whole Bolivia, 798,300 for Departamento Potosi, and 84,200 for Potosi City. "Estadistica Regionales – Potosi" published by the some agency (September, 1980) has estimated the populations as 5,570,100 for the whole country, 794,100 for Departamento Potosi in 1980; and 5,719,900 and 815,500 respectively in 1981.

The above figures suggest an estimate of the present populations as 120,000 or more for Provincia Bustillo, and about 70,000 as the total of Catavi, Llallagua, Siglo XX and Uncia.

The present populations can be estimated as follows for the first and third counties of Provincia Bustillo where Uncia, Llallagua and Andavilque, deeply related hamlets to Catavi mine, are located.

Table 6–2 Number of Households and Population by Region

Region	Households (x 1,000)	Population (x 1,000)
Catavi mine	3.6 *	20 *
Uncia	1.6	8
Llallagua	7.7	34
Andavilque	0.4	2
Others	1.6	23
Total	14.9	87

Note* : For only those living in the compary's houses

: 1. Population in Catavi mine is based on the data from "The Public Welfate Department" (Dec. 1980).

2. The figure in Uncia was obtained from the deputy mayor (Sep. 1981)

3. The figure for Llallague is based on the data offered by the treasurer of the city office.

4. The data on Andavilque and others are estimated from the note of Table 6–1.

At present, the number of the direct employees of Catavi mine is 4,600, which includes 2,400 of the ore-purchasers (Locatarios, Venelos and Lamas). When the number of households of such employees of the ore-purchasers are included, about 50% of the total households directly devote their lifes to Catavi, while those households indirectly related to Catavi are transporters using buses and trucks, stores, restaurants and the like; and also farmers (especially suppliers of potatoes, maize, barley and others) and stock farmers who are supporting the diets of the residents, and the ore-sellers by secret digging and steading may be also counted up.

The statistics on commerce of Llallague indicates that the number of persons engaging in various commercial occupations are: 460 groceries, 84 general stores, 229 stall-keepers, 45 restaurants, 12 shophouses, 222 handicraftsmen, 7 timber and woodworkers, 5 bars and night-clubs, and 15 lawyers, dentists and other specialists, totaling into 1,283. On Sunday, a market is opened, gathering people from the neighboring districts one after another in trucks etc., and showing a great brickness; the existence of Catavi mine is a major factor

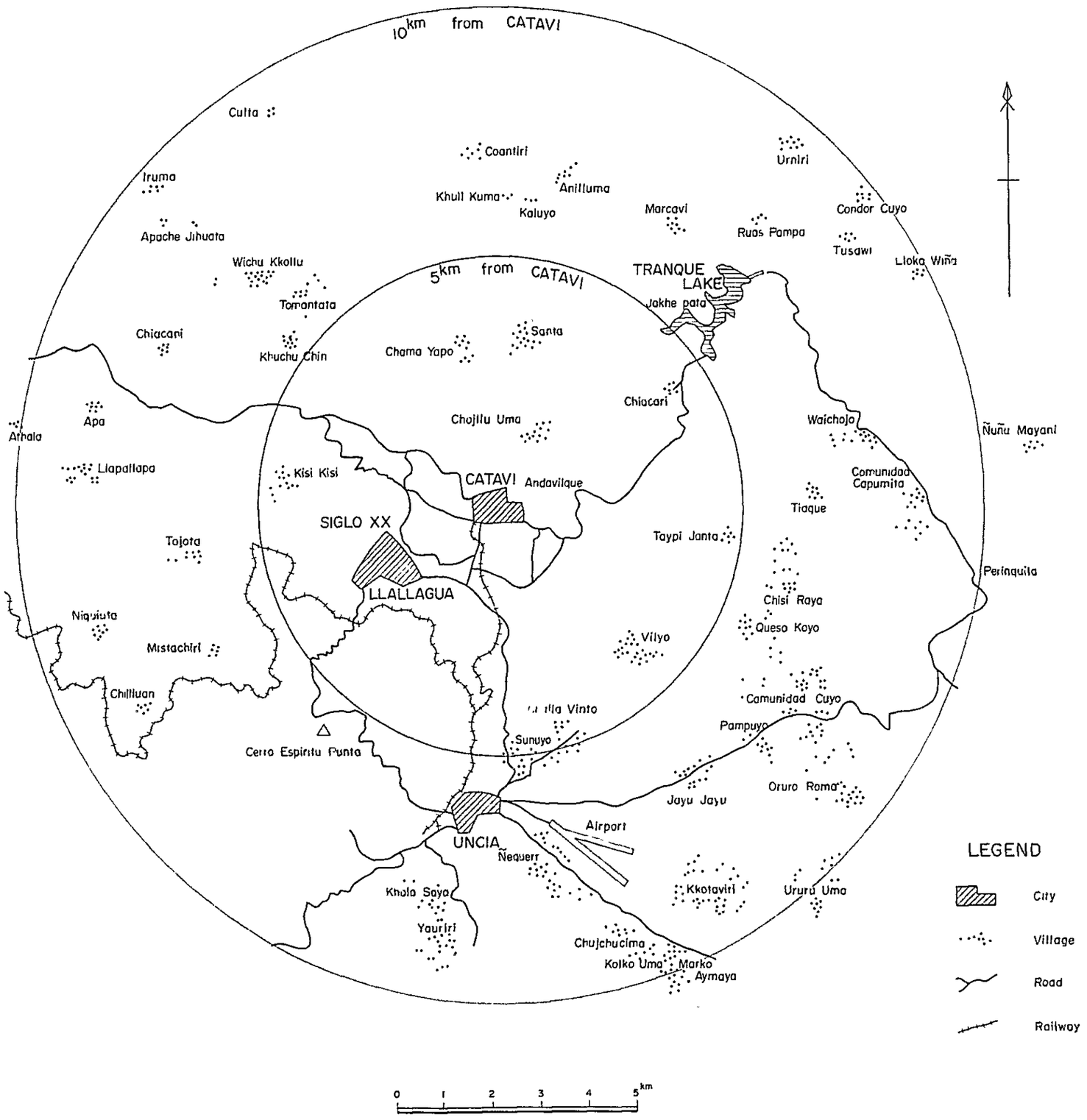


Fig. 6-1 Distribution of villages around of the Catavi Mine

contributing to these activities.

The situation of the population involved in the Catavi mine related work exceeds 9% of that of the whole mining industry and reaches 0.5% of that of the whole industry in Bolivia as shown in Table 6–3.

Table 6–3 Mining-Related Population

Year	Whole Industry (x1,000)	(A) Whole Mining (x1,000)	(B) COMIBOL (x1,000)	(C) Catavi Mine (x1,000)	(D) Ore-sellers (x1,000)	(C)+(D) (A) (%)	(C) (B) (%)
1977	1,476.3	74.2	24.6	4.7	2.5	9.7	19
1978	1,520.6	78.3	25.1	4.6	2.5	9.1	18
1979	1,580.5	79.9	26.4	5.0	2.5	9.4	19

6–2 Education

At Catavi, based on the highest government ordinance dated on August 15th, 1930, 14 grade and junior high schools have been managed perfectly by Catavi mine. For three high schools, officers from the Ministry of Education manage the facilities offered by Catavi. The data for 1980 show the numbers of students; 1,179 in kindergartens, 6,961 in grade schools, 2,982 in junior high schools, and 2,181 in high schools, totaling into 13,305, and this figure was 13,335 in 1981. These schools have been established originally for the children of the employees of COMIBOL but now children of ex-employees (recipients of the social compensation pension), ore-sellers, bakeries and others also attend. The ratio of children of COMIBOL to others is 60 : 40, with exception of high school students.

Because the primary school education (five-year system) is compulsory according to the educational laws in Boliva, the expenses of the grade schools should be borne by the government. On the other hand, the law enacted in 1930 requires enterprises to manage primary schools, and there have been some contradictions caused by the alterations in educational systems.

Note: The former system of six-year for primary, and six-year for junior-high and high schools was changed into the current system of five-year for primary, three-year for junior high, and four-year for high schools in 1970s.

As a result, the expenses on children of those other than the employees of the COMIBOL are imposed on the national treasury, thus virtually a half of the expenses are

borne by the national treasury. However, from the viewpoint of essential philosophy on education, it is desirable that the national treasury should bear the full expenses: the present burden on the COMIBOL should be assumed as a contribution to the nation and society, which mounts up to 1.5 million dollars annually.

The public schools in this vicinity are two kindergartens (two-year system), five grade schools, three junior high and high schools, and one special school located in Uncia, with 590, 2,294, 1,075 and 1,660 students respectively, totaling in 5,685 with 267 teachers. These figures show that Catavi mine takes charge of 70% of the total students of 19,000 in the vicinity, among which some 26% includes the children of those other than the COMIBOL's employees.

6–3 Medical Care

According to the current labor standards law, Catavi mine keeps a polyclinic, a children's hospital, and clinics and dental offices at various locations in the mining residential area.

The polyclinic has a group of 11 specialized physicians, and is equipped with the second greatest faculty as a general hospital of COMIBOL following to the first one at La Paz, thus it is one of the few well-equipped polyclinics in other states with nothing to say on neighboring prefectures. Consequently, the polyclinic has been engaged in the therapy of urgent and incurable general patients in the neighboring districts because of the public and social character of the medical care, in spite of that their patients are limited to the employees, their families and relatives in principle. The existence of the polyclinic gives the community residents a great feeling of reassurance despite few opportunities to utilize it.

The only medical facilities in this district are a hospital which the Social Compensation Corporation has recently constructed for the employees of Locatario, ore-sellers, at Uncia, and a hospital and several dental clinics under management by a cooperative of the residents. There is no national health insurance system, but there is the Social Compensation Corporation which is like an industrial injury and health insurance operated with the premiums paid by the employers and employees. Accordingly, it is the reality that such medical care is a far and inaccessible for the general populace, especially for peasants.

As mentioned in another item on the administration division medical care, the revenue and expenditure of the medical care of Catavi mine reaches an annual deficit of 3 million dollars, and the data on medical care in the 1980 fiscal year has shown that both the numbers of external patients and prescriptions accounted for about 12% of the whole, and 12% of the

whole expenditure was equal to 464.3 thousand dollars annually, while the revenue was 232.6 thousand dollars annually, thus the balance deficit was 231.7 thousand dollars which corresponded to only 8% of the total deficit. The medical payments essentially charged to the Social Compensation Corporation should consist of the burdens of the employers and employees, but the Locatarios Venelos and Lamas for this instance, are not charged as the employer, it will be required to bear 500 thousand dollars at least in the 1980 fiscal year (*1), and the burden for the external patients will be benefit and that for the employees will be deficit. Moreover this deficit is the burden to the national treasury without affecting the revenue and expenditure of the mine, and other expenses from the national treasury are forced to bear that amount of deficit.

(*1). If 3.5% charges of Venelos and Lamas are estimated as 90% of other incomes (the result in July of 1980 was 97%), then the charge will be : 475 thousand pesos x 90% x 8%/ 3.5% x 12 months x 1/24.51 (peso/dollar) = 478 thousand dollars.

The contribution of Catavi's medical care to the community is a very little. At any rate, because the deficit is passed on to the national treasury, the mine should investigate a system with which the medical care will serve not only the employees but also the community by taking the social and public character of medical care into consideration.

6–4 Tax

Catavi mine has been paying Regalias, an integrated tax on production and sales of ore, and resultant income every year : 14.6 million dollars for fiscal 1980 and 20.1 million dollars (including the export tax) for fiscal 1979. Among the tax, 24.5% greatly contributes the community development as a source of revenue of the Comporación Desarrollo de Potosi. As other local taxes, the mine has been paying 100 thousand pesos to Uncia and Llallague every year respectively. The national treasury receives the afore-said Regalias, the withholding taxes from employees, the customs due to import of various materials and so on from the mine. On the other hand, because the treasury must bear the expenditure for schools and medical facilities, the actual revenue retained, the balance after the subtraction of above expenses (the source of revenue of the Corporacion Pesarrollo is perfunctionarily paid into the national treasury once, and then is allocated), is 11 million dollars [14.6 M$ (for school) – 2.9 M$ (For medical care)] from Catavi mine, with additional estimations of 0.3 million dollars for the withholding taxes (*1) and of 0.5 million dollars for the customs on imports of materials (*2) in fiscal 1980, despite of a deficit of 1.0 million dollars, thus Catavi mine

has served the national treasury about 12 million dollars in total annually.

Note. *1 If the average income per head is 5,000 pesos per month and the average dependents are 4.5, then the annual income tax will be about 1,400 pesos, which equals to 0.3 million dollars for the Mine = 1,400 pesos x 4,862 persons x 24.51 peso/dollars.

*2 The customs on imported materials is estimated on the base of actual results in 1980 with assumptions that the tariffed materials correspond to 62% of the whole purchased materials; and the average customs surtax is 3%, the warehouse tax is 2%, and the charge for consul's visa is 1%, totaling to 6%. Thus the result is (11.5 M$ + 2.0 M$) x 62% x 6% = 0.5 M$.

There is also the income tax from the ore-sellers in addition, the sum of these three can be estimated to be 1 (one) million dollars.

The progress in contribution of the mining industry to the national treasury's revenue based on the data from the Ministry of Mining (for 1977 and 1978) and the statistics from the Central Bank is shown in Table 6–4 with additional details on Catavi mine.

Table 6–4 Contribution of Mining Industry and Catavi Mine to Treasury Revenue

Year	Treasury Revenue	In which, Mining	whole Industry	In which, Catavi Mine		
					% of Mining Industry	% of Treasury Revenue
1977	382 M$	103 M$	33%			
1978	427	119	28	19 M$	16%	4%
1979	411	* 90	21	16	18	4
1980	481	* 84	17	21	25	5
1981 (1/2)	254	* 19	9	* 3	16	1

Note: Figures marked with * are estimations from the statistics of the Central Bank. Figures for Catavi mine come from the profit and loss for 1981, and the results of (the statement of profit and loss of the COMIBOL) + (the income tax and estimated customs) for 1978 to 1980.

The table shows that Catavi mine bears 4 to 5% of the treasury's taxation revenue, which corresponds to some 16 to 20% of that from the whole mining industry.

6–5 Income of Foreign Currency

The income of foreign currency is largely dependent on the mining industry. The progress in purchase amounts of foreign currency by the Central Bank from the mining

industry based on the usual transaction is indicated in Table 6–5 with the results of Catavi mine, which corresponds to about 5% of the whole purchase amount by the Central Bank.

Table 6–5 Purchase of Foreign Currency*

Year	Purchase by Central Bank	In which, whole Mining Industry		In which, Catavi Mine		
					% of Mining Industry	% of Pruchase of Control Bank
1977	680M$	335M$	49%			
1978	884	426	48	48M$	11%	5%
1979	891	473	53	52	11	6
1980	1,001	440	44	47	11	5
1981 (1/2)	490	204	42	14	7	3

* : Foreign currency purchase by Catavi mine is calculated as net sales amount in sales profit and loss (gross sales – T/C) – (selling cost), but (production amount in production profit and loss) – (selling cost) for 1981.

The percentages as compared to the whole tin export are shown in Table 6–6, where it can be seen that Catavi account for some* 15%.

Table 6–6 Export of Tin

Year	Whole Export (x1,000t)	Corporation (x1,000t)	(%)	Catavi (x1,000t)	(%)
1978	29.7	20.1	68	4.4	15
1979	26.6	17.7	66	3.9	15
1980	22.5	15.2	68	3.4	15

* : Because the smelting yield must be taken into consideration for the sale amounts to the Empresa National de Fundición, the data are of rough figures.

6–6 Others

The social revolution in 1942 which has largely changed the history of Bolivia was realized by the combination of the National Revolution Movement Party and its friendly party. Especially the alliance relation between the National Revolution Movement (MNR) Party and the United Labor Unions of Mining (FN STMB) with a care of the laborers of Catavi mine played a greatly meaningful role to promote the revolution. Consequently there is an excessive consciousness among the laborers of Catavi mine thereafter saying that

they are the people who have driven the revolution forward, and the successive administrations have dealt with the mine with the perception on this fact; thus Catavi mine is one of politically important districts. It may also be understood as a probable result of awareness on Catavi mine and its laborers that an automatic switching trunk network system has been established at Llallagua in August of 1981 following the one at the seat of State Government.

As mentioned above, it cannot be ignored that the communities centering at Uncia and Llallagua have been constituted potentially depending on Catavi mine.