Report No. 602a-CH

Appraisal of Copper Sector Project Chile

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Industrial Projects Department

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CURRENCY EQUIVALENTS

Except where otherwise indicated, all figures are quoted in U.S. Dollars (US$) and in Chilean Escudo (E^o)

US$ 1	=	E^o 1,050
E^o 1	=	US$ 0.00095
E^o 1,000	=	US$ 0.9524
E^o 1,000,000	=	US$ 952.38

In October 1975, the Escudo was replaced by the Peso (Ch$) as Chile's monetary unit. Each Ch$ was initially designated as Ch$1 = E^o1000. The exchange rate and currency equivalent in effect on December 31, 1975 were as follows:

US$ 1	=	Ch$ 8.50
Ch$ 1	=	US$ 0.1176
Ch$ 1,000	=	US$ 117.64
Ch$ 1,000,000	=	US$ 117,647.06

WEIGHTS AND MEASURES

All units are metric

1 metric ton	=	1,000 Kilograms
1 metric ton	=	2,205 Pounds
1 kilometer	=	0.62 Miles
1 meter	=	39.3 Inches

ABBREVIATIONS AND ACRONYMS

CAP- Cia de Acero de Pacifico (The State iron ore mining and steel making enterprise)

CIMM- Centro de Investigacion Minera y Metalurgica. (Mining and Metallurgical Research Center)

CODELCO- Corporacion del Cobre (State enterprise established to operate the major copper mines and related facilities)

CORFO- Corporacion de Formento de la Produccion (State industrial development corporation)

ENAMI- Empresa Nacional de Mineria (State agency responsible for small and medium mining sector)

IIG- Instituto de Investigaciones Geologicas (Geological Survey)

SOMEX- Sociedad Minera Explorador y Explotador de Minas (Exploration drilling subsidiary of CODELCO)

Fiscal Year: January 1 to December 31

CHILE

COPPER SECTOR PROJECT

APPRAISAL REPORT

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This report was prepared by Messrs. Bosson and Lorenz, Industrial Projects Department and Messrs McCarthy and Aguirre-Sacasa, Latin America and the Caribbean Regional Programs Department.

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SUMMARY AND CONCLUSIONS

i. This report appraises a Copper Sector Project in Chile for a proposed Bank loan of US$33 million equivalent, consisting of several sub-projects which are directed primarily toward maintaining the country's copper output, and copper generated foreign exchange earnings, reducing operating costs and--as a by-product of these objectives--marginally increasing Chile's proportion of processed copper. In addition to the specific sub-projects, the loan would include some important technical assistance aimed at strengthening the managements of the two enterprises which are to carry out the sub-projects.

ii. The loan would be made to the Republic of Chile and the proceeds on-lend to Corporacion de del Cobre (CODELCO) and Empresa Nacional de Mineria (ENAMI), the two state-owned entities, which account for more than 95% of the country's production of copper. The loan would be for over 15 years, including 3.5 years of grace and bear an interest of 8.5%. The subloans to CODELCO and ENAMI (US$29.54 million to the former and US$3.46 to the latter) would have the same maturities and grace periods as the Bank loan to Chile but would bear a 10% interest rate.

iii. Chile's copper mining industry accounts for approximately 75% of the country's foreign exchange earnings. Copper production continues to provide the best opportunities for increasing Chile's foreign exchange earnings with relatively modest investment. The balance of payments situation in the short and medium term is likely to be decisively influenced by the fluctuations of world copper prices. Lowering costs by improving production efficiency is of considerable significance since earnings from copper are expected to provide a substantial component of government revenues in the future.

iv. The Chilean copper sector comprises three groups of mining operations: Gran Mineria (large-scale); Mediana Mineria (medium-scale) and Pequena Mineria (small-scale). The Gran Mineria is made up of five large mining operations, two of which, Exotica and Andina, started production only recently (1970-71); each of them was originally owned by US companies. After nationalization in 1971 these operations came under the direction of CODELCO acting as a holding company, thus becoming the largest copper producing company outside of the USSR. The Gran Mineria currently accounts for about 85% of Chile's copper output with two mines--Chuquicamata and El Teniente, respectively the largest nonferrous open-pit and underground mines in the world--contributing about 75% of Gran Mineria output.

v. The Mediana and Pequena Mineria account for the remainder of Chile's copper production. The largest entity in these sub-sectors is ENAMI whose

primary function is to purchase and to process in its own smelting and refining facilities partially treated copper minerals from the small- and medium sized mining producers.

vi. Chile is a member of the Conseil Intergouvernemental des Pays Exportateurs de Cuivre (CIPEC) and accounts for 20-25% of the world's published reserves, 12-13% of its mine production and 20% of global net exports. Chile's sales are widely dispersed, placing it in a strong market position. However, the copper market is characterized by considerable price instability which has been having serious repercussions on Chile's foreign exchange earnings and tax revenues. After a period of very high prices, reaching US$1.52 per lb. in April 1974, the copper price fell during 1975 to below US$0.60 per lb., as the result of a temporary over-supply situation created by a drop in demand due to the slowdown in the economic growth of the major copper-consuming countries. The CIPEC countries in November 1974 called for action to halt the decline in prices and agreed to temporarily reduce their copper exports by 10%. A further cutback of 5% was agreed upon in April 1975, this time applying the reduction to production as well. Some of the major US and Canadian copper companies have similarly cut back production. Copper prices are expected, however, to improve during the remainder of the decade. In carrying out a cutback in copper production, Chile has shut down the Exotica Mine-- which was incurring substantial losses at the current low copper price--until some technological problems which have come up in processing Exotica ore can be solved.

vii. CODELCO and ENAMI have put together an investment program of high priority amounting to about US$890 million. This program is intented to maintain production and modernize existing facilities thereby as a result also increasing Chile's copper producing capacities from present levels of about 900,000 MT to 1,100,000 MT per year by 1980 at the earliest. Four independent and self contained sub-projects were selected from this investment program for Bank assistance based primarily on the need to maintain existing capacity, improve production efficiency and reduce operating costs. These, together with technical assistance expenditures represent a total project cost of US$76.8 million of which US$33 million would be the foreign exchange component, equivalent to 43% of net project cost. The proposed loan of US$33 mil- mil-lion will finance the following project components:

(a) Introduction of an underground crushing system at CODELCO's El Teniente mine to handle the different and bulkier type of ore that soon will have to be mined. Without this sub-project the mine would face an increasingly severe production loss which by 1980 would amount to about 30% of present production;

(b) Rehabilitation of CODELCO's Barquito power plant which supplies the El Salvador mining, smelting and refining facilities. This sub-project will eliminate the danger of plant shutdown due to power failure--and the consequent loss of production--as well as result in considerable fuel and maintenance cost savings:

(c) Construction of a selenium recovery plant at CODELCO's Chiquicamata mining complex aimed at the recovery of this metal from the tailings of the Chiquicamata and El Salvador copper refineries;

(d) Replacement of obsolete equipment at ENAMI's Ventanas and Paipote smelters and the modifications of both smelters to burn Chilean coal. Replacement of the equipment is needed to avert breakdowns and production losses and to lower maintenance costs; and

(e) Provision of technical assistance to CODELCO and ENAMI to aid in (i) preparing a comprehensive smelting and refining development strategy for the sector; (ii) preparing long-term mining plans for the El Teniente and Chuquicamata mines; (iii) strengthening project preparation and evaluation capabilities within CODELCO and ENAMI; (iv) improving CODELCO's internal cost accounting, inventory and budgetary control; (v) defining ENAMI's role in further expansion of the small and medium scale mining sector, and (vi) assisting the Government in formulating an overall development strategy for the sector while strengthening the coordination of sector planning.

viii. The above sub-projects represent a small but urgent and important prerequisite to any longer term investment plan which contemplates the further expansion of existing copper mines as well as the development of new deposits. The major constraints to increasing output are market considerations, the availability of financing and the absorptive capacity of the sector's institutions.

ix. The financial rates of return of the individual sub-projects are expected to range from 35 to over 50% even using conservative price and cost assumptions. The economic rates of return will be marginally higher since transfer payments to the Government, apart from taxes, are not significant and more than 95% of the copper will be exported at world market prices. These are unusually high returns and demonstrate the particular benefits that the sub-projects are expected to create. The foreign exchange benefits from the project are also significant, reaching more than US$100 million per year by 1980.

x. Apart from covering the foreign exchange component of the technical assistance, the loan would be used to procure equipment and materials by international competitive bidding except for some 10%, which would be procured through limited international bidding on account of technical considerations and timeliness. It is expected that virtually all of the loan would be applied to foreign exchange expenditures and that it would be disbursed within a period of about three years.

xi. With the assurances contained at the end of the report, the project forms a suitable basis for a US$33 million Bank loan for 15 years, including 3-1/2 years of grace and at an interest of 8.5%.

I. INTRODUCTION

1.01 A Bank mission visited Chile in July 1973 to prepare a technical assistance project designed to help Chile build up a pipeline of future development projects. This mission gave high priority to the development needs of the copper mining sector and its findings were summarized in the President's Report (No.P-1316-CH) which was circulated to the Executive Directors in September 1973. Subsequently, a Bank-financed group of consultants from the Canadian Noranda Mining Company visited Chile during January 1974 to evaluate the impediments to increasing copper production in view of the impact of this commodity on the country's balance of payments. Their findings indicated that Chile's copper production could increase substantially provided an adequate supply of spare parts could be maintained but that even continued production on such a higher level or any additional increases in output would require substantial further investment. Also, although management appeared capable of attending to the immediate operational needs of the industry, there was doubt as to whether it had sufficient experience to adequately determine investment priorities, undertake the preparation of large investment projects and devise policies required to bring about an optimum development of the sector.

1.02 The proposed project, which was worked out in the course of 1974 and 1975, has two prime objectives: first to help solve the urgent production bottlenecks confronting the sector, leading to lower operating costs as well as to increased output and foreign exchange earnings; and, second, to help redress the institutional deficiencies within the sector. These deficiencies are largely attributable to the sudden change of management of CODELCO, now the largest copper producing company outside the U.S.S.R., after nationalization in July 1971, as well as to the large exodus of professional staff that has taken place since 1970. If Chile's copper industry is to develop efficiently over the longer run these difficulties need to be overcome. The report discusses in detail the copper sector in Chile, focussing particularly on its present structure, the adequacy of its institutions and its contribution to the country's economic development. It is hoped that this first Bank operation will lay the foundation for future Bank involvement in the sector, aimed primarily at further improving production efficiency and consolidating the planning and policy-making objectives of the present loan. The project was appraised in stages from September 1974 through October 1975 by Messrs. Bosson and Lorenz of the Industrial Projects Department, and Messrs. McCarthy and Aguirre-Sacasa of the Latin America and the Caribbean Regional Programs Department. A summary of technical terms used in the report is given in Annex 1.

II. THE COPPER SECTOR IN CHILE

A. History and Development of the Sector

1. Early Development

2.01 Copper production in Chile began on a significant scale in the early part of the nineteenth century when it rose from a modest 9% of world production, to 40% in the 1860's and to a high of 62% in 1876. After 1880, when very high grade ore deposits had been depleted, Chile's production decreased substantially, both in absolute and relative terms, and by 1900 represented only 5% of world output. The sector's history is described in more detail in Annex 2-1.

2.02 The invention of the flotation process, the development of an economic process to recover copper from Chilean oxide ores and the arrival of large amounts of capital from abroad--primarily through US enterprises--were the principal factors which influenced the development of large-scale mining operations at the beginning of the twentieth century. Production from these large-scale operations increased Chilean copper output from 42,700 metric tons (MT) in 1909 (5% of world production) to 130,000 MT in 1922 (14.3%) and to 413,000 MT (18.2%) by 1937.

2. Recent Development and Production Trends

2.03 Since the Second World War Chile's expansion has not been as dynamic as that of the rest of the world. From 1951 to 1955 world production of copper expanded at a rate of 3.3% per year, while Chilean production increased at only 2.6%. Output kept pace with world production from 1956-60 but has been trailing since. Between 1960 and 1973 world production has increased by 50% from 4 million tons to approximately 6 million tons but Chilean production expanded only from 550,000 to 750,000 MT, i.e. by 36%. During the earlier part of the decade new investment was minimal as general uncertainty about the investment climate prevailed; as a consequence output from the large copper producers, the Gran Mineria, remained constant between 1960 and 1965.

2.04 Dissatisfaction with low levels of investment and Chile's declining role in the world copper market came to a head during the early 1960's and was instrumental in giving impetus to the political demand for increased government control in determining future output and development of the sector. The so-called Chileanization program of the Frei Administration (1964-1970) represented the culmination of negotiations between the Chilean Government and the foreign-owned companies and provided for (a) a doubling of copper output to 1 million MT per year and a tripling of refining capacity, both by 1970; (b) substantial participation by the Government in copper production and exploration; and (c) state-control of sales of Chilean copper.

2.05 The program, described in detail in Annex 2-7, envisaged bringing into production two new mines--Exotica and Andina-- as well as substantial expansion of existing operations. The total cost of this expansion is estimated to have been US$760 million, of which US$650 million went to the Gran Mineria. However, the full benefits of this program have yet to be realized. Several unforeseen technical problems were encountered which resulted in shortfalls from targeted production. Continuous labor unrest, as well as damaging transport strikes in 1972 and 1973 were primarily responsible for severely aggravating this situation. Production in 1973 from the Gran Mineria reached 616,000 MT, barely 15% above the 1966 level and a major shortfall from the targeted level of 880,000 MT. Production from the small and medium sectors was the same in 1973 as in 1966. After the change in Government in September 1973 production increased substantially, due primarily to improved management, the availability of spare parts and improved productivity. Output for 1974 from the Gran Mineria was 763,000 MT and an estimated 902,000 MT from the sector as a whole.

B. Structure of the Sector

2.06 As described in Annex 2-2, Chile's copper mining industry comprises three groups of operations: (i) large-scale mining (Gran Mineria); (ii) medium-scale mining (Mediana Mineria); and (iii) small-scale mining (Pequena Mineria).

2.07 Large-scale copper mining according to Chilean law refers to those companies in Chile that produce blister, fire-refined or electrolytic copper, in quantities not less than 75,000 MT a year. Five mining companies currently comprise the Gran Mineria del Cobre: Chuquicamata Mining Company, Exotica Mining Company, Salvador Copper Company, El Teniente Mining Company, and Andina Mining Company. These were owned by US companies until Chile acquired minority or controlling interests under the Chileanization agreements negotiated under the Frei Government. Subsequently, on July 11, 1971, the Chilean Congress unanimously approved an amendment to the Constitution authorizing the nationalization of mineral resources and related facilities, including the foreign-owned companies of the Gran Mineria. The Corporacion del Cobre (CODELCO), the State Copper Corporation, assumed ownership and management of the companies, thus becoming the single largest producer of copper outside of the USSR. The constitutional amendment also provided for the deduction of "excess profits" on the basis of an assumed normal profit rate of 12%. As a result, the government decided not to provide compensation to the foreign-owned companies, a decision that was strongly but unsuccessfully appealed. The new Government which came into power in September 1973 declared its intention to compensate the foreign-owned companies and negotiations were successfully concluded with these firms in October 1974 as described in Annex 2-1.

2.08 The Gran Mineria contributes approximately 80 to 85% of Chile's total copper production. Two of these operations, Chuquicamata and El Teniente, respectively the largest open-pit and underground copper mines in the world,

presently account for over 75% of Gran Mineria production. Two new mines, Exotica and Andina, started operation in 1970/71; the former has yet to reach full production capacity. The mining operations of the Gran Mineria are highly mechanized and automated, and all except Andina are integrated from mining through concentrating, smelting and refining.

2.09 The medium-scale and small-scale mining sector 1/ together account for the remaining 15 to 20% of Chile's copper output. As described in Annex 2-2, there are presently five important producers of copper in the medium-scale sector with one other operation yet to reach full production. These mining operations, principally in the hands of private foreign-owned companies with relatively minor state participation, have been generally profitable. In the early 1960's a large amount of the sector's output was in the form of copper concentrate or cement, but an increasing proportion is now produced either as blister, or as refined copper.

2.10 The small-scale mining industry consists of small groups of individuals mining copper deposits located primarily in the northern regions of Chile. Approximately 10,000 miners are working in the sector employing highly labor-intensive methods. These producers are very dependent on the Empresa Nacional Mineria (ENAMI), which has been playing a dominant role in the development of the sector by virtue of being the primary purchaser of the small mines' output, processing their copper in its smelting and refining operations at Ventanas and Paipote, and extending credit and technical assistance. The State Development Corporation (CORFO) is also active in the mining sector but has been primarily involved in fields other than copper.

2.11 The Ministry of Mines has official jurisdiction over the development of the copper industry. It has had a traditionally weak role in the sector, however, is extremely ill-equipped in terms of staff, and has not exerted much influence over planning and policy-making decisions affecting the sector. The Minister of Mines is Chairman of the Board of both CODELCO and ENAMI but most decisions are taken by the executive management of these enterprises.

C. The State-Owned Enterprises

1. CODELCO

i. Formation and Functions

2.12 The State Copper Corporation (CODELCO) grew out of the Departmento del Cobre, which was established in 1955 as an autonomous institution within the Central Bank and given broad powers to monitor sales of all Chilean copper in foreign markets and supervise the regulations governing the use of domestic inputs by the copper companies. In 1967 a new law converted this institution into the State Copper Corporation, having much broader powers and participating in joint ventures with the foreign mining companies in the exploitation of the copper mining operations of the Gran Mineria. The Corporation's

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1/ For legal definitions of these mining activities see Annex 2-2.

formation and present legal statutes, organization, staffing, operations, and financial position are described in Annex 2-3.

2.13 The capital of the five large nationalized companies is owned by CODELCO and ENAMI in the proportion of 95% and 5% respectively, with CODELCO playing the role of head office of an integrated company incorporating the five properties. There is, however, substantial legal ambiguity over the respective roles and authorities held by CODELCO on the one hand and the operating companies on the other which has led to problems of coordination and control. The Government has agreed to take, within a period of one year after the date of signing of the loan, the necessary legislative steps to transform CODELCO and the five large companies into a single fully-integrated company, in which the functions of planning, administration, purchases and sales shall be centralized but in which the management of each mine shall be provided with sufficient autonomy to operate it as a separate profit center.

ii. Organization and Management

2.14 CODELCO is governed by a Board, an Executive Committee and an Executive Vice-President. The Chairman of the Board is the Minister of Mines. The Executive Vice-President is appointed by the President of the Republic and is the legal representative and administrative head of CODELCO. In the past there was little uniformity in the organizational structure of the producing companies, each having inherited a different organization from its former owners. This aggravated the problems of coordination between CODELCO and the companies. CODELCO is aware of the shortcoming and has made some headway in establishing standard procedures for investment planning, personnel administration, production planning, inventory control, budgetary control and cost accounting procedures.

2.15 CODELCO's senior management is competent with extensive technical and executive experience in the mining industry in Chile. However, CODELCO and its operations suffered severely following the nationalization of the Gran Mineria as a result of the exodus of large numbers of foreign and national engineers. This weakened the middle and lower management positions which are now occupied by younger engineers. Nevertheless, operations have been maintained satisfactorily with significant production increases. This is a reflection of the high quality of the engineers emerging from the Chilean university system. The average practical experience of the engineering staff at the Chuquicamata, Exotica and Salvador operations is less than six years and there is still a shortage of qualified mining engineers. The El Teniente and Andina mines suffered relatively less on account of the greater experience of the El Teniente staff, on the one hand, and the continued support of engineering staff of the Cerro Corporation of New York for the Andina operation, on the other.

2.16 The shortage of professional experience is most acutely felt in production planning and control, investment planning, project preparation and evaluation, and research and development. Deficiencies also exist in financial planning, cost accounting and internal controls. There is a notable lack of

cost consciousness in all the Corporation's operations. The inadequacies of the present planning department are, in part, inherited from the practices of the former owners of the mining operations. Investment planning and project preparation were generally carried out by the parent companies at the head office with little participation of the operating engineers and managers in the field. The operating engineers have had virtually no training in planning and show a disinclination to become more involved in it. The management is now preparing a medium to long-term development plan, but has limited personnel with sufficient experience to prepare an investment plan.

2.17 CODELCO is conscious of these deficiencies, and has taken steps to rectify them. A study of CODELCO's organization and operating procedures has been started. The technical assistance component of the loan (paragraph 4.06) aims, inter alia at: (i) strengthening CODELCO's financial and investment planning and control; (ii) improving its cost accounting, budgetary and inventory control and (iii) training staff. CODELCO has agreed to assign priority and adequate counterpart staff to reorganize its present structure and administrative procedures.

iii. Financial Position

2.18 A detailed analysis of the financial performance of CODELCO is difficult because of the incomplete financial records, the unreliability of what information is available and certain policy measures - in particular, the artificial rates of exchange imposed upon the exports of copper - which had a major impact on the companies' financial position. The financial performance of the companies began to deteriorate in 1971 and continued to do so until 1973. This was attributable to large increases in wages and salaries, serious transport strikes and work stoppages, and, most importantly to the imposition of an artificial exchange rate. The upswing in copper prices experienced in 1973, as well as the substantial increase in output in the latter part of the year, improved appreciably the overall financial position of the companies', resulting in a US$65 million cash surplus after replenishing stocks. With the significantly higher copper prices and increased output in 1974, CODELCO's position improved substantially, with operating cash surpluses reaching US$500 million. However, under the terms of the settlement of the expropriation issues, CODELCO was obligated to make US$29 million in debt services payments, which together with income taxes of US$193 million, other taxes totalling US$90 million and urgent investments of US$130 million, left the company at the end of 1974 in a cash short situation, accentuated by the exceedingly low copper prices prevailing at that time. A major factor contributing to this position was the Government practice, until August 13, 1974, of applying an artificially low exchange rate to revenues of CODELCO, inflating the local currency costs to CODELCO by US$384 million. This was in effect an implicit tax on CODELCO for the same amount.

Consolidated Balance Sheets for the Five Large Copper Companies /1

	1971	1972	1973	1974
	US$ Million /2			
Current Assets	387	546	897	812
Fixed and Term Assets	965	992	1,029	1,154
Total Assets	1,352	1,538	1,926	1,966
Current Liabilities	242	471	513	356
Long-Term Debt	467	421	388	192
Equity and Reserves	643	646	1,025	1,418
Total	1,352	1,538	1,926	1,966
Current Ratio	1.6:1	1.2:1	1.7:1	2.3:1
Debt Equity Ratio	42:58	39:61	28:72	12:88

/1 Does not include debt obligation to Cerro, Anaconda and Kennecott Corporations.

/2 Exchange rate used for 1971 US$1 = E°14.4; 1972 US$1 = E°20.0; 1973 US$1 = E°340.0 and 1974 US$1 = E°1870.0.

With the recent settlement for compensation for nationalized properties, the debt obligations of the companies rose by more than US$350 million.

2. ENAMI

i. Organization, Management and Staffing

2.19 The National Mining Company, ENAMI, was established in 1960 with responsibility to administer activities relating to the development of Chile's small-and medium-scale mining industries, as discussed in paragraph 2.10. It is an autonomous state-owned enterprise whose legal representative is the Executive Vice-President, the managerial head of the company. Its legal statutes, organization staffing and financial position are described in Annex 2-4.

2.20 The senior management of the company is in the hands of a seven-member Board, with the Minister of Mines as Chairman. The company's Executive Vice-President has had limited technical and financial experience in the mining industry and is depending heavily on ENAMI's senior management, itself competent and experienced but with little support staff. The technical staff is both competent and experienced, however, particularly at the Ventanas plant. Like the Gran Mineria, ENAMI suffered a loss of qualified engineering staff in the wake of the nationalization of the large copper companies and the political turmoil that followed. A further loss of staff was experienced after September 1973, some of it to CODELCO, as a consequence of wage disparities between the two state-owned enterprises.

ii. Operations

2.21 ENAMI has approximately twenty mineral purchasing agencies, eight treatment plants, two smelting operations (one at Paipote and a modern conventional smelter at Ventanas) and one refinery (also at Ventanas). It also holds equity in several medium-sized operations, e.g., Disputada which came under increasing state control after 1971.

iii. Financial Position

2.22 ENAMI's financial position has been weak since it was first established in 1960. Although the company was expected to cover its operating expenditures from the outset, it has continuously depended on fiscal contributions to cover these costs. This has resulted in part from ENAMI's broader functions of providing technical assistance and subsidized credit (recently discontinued) to small mining producers but also because the major component of the company's expenditures has been for the purchase of ore and concentrates from the small mining producers. Although the price paid to the small producers is related to the London Metal Exchange (LME) copper price, the treatment charge for processing that is deducted from this price has not in the past been sufficient to cover ENAMI's processing costs. This has translated into excessive profits for the more efficient producers and subsidies to inefficient small mine operators.

2.23 ENAMI's earning capacity deteriorated appreciably after 1971 for essentially the same reason as previously (paragraph 2.18) described for CODELCO. The large operating deficits were covered both by fiscal transfers and a line of credit with the Central Bank, the former enabling the company to maintain a sound capital structure as indicated below, but the latter, being short-term debt, has placed the company in an unfavorable liquidity position.

ENAMI - Balance Sheets

	1971	1972	1973	1974 2/
		(US$ million) 1/		
Current Assets	82	76	12	135
Fixed and Term Assets	110	135	41	137
Sub-Total	192	211	53	272
Current Liabilities	74	99	25	64
Long-Term Debt	34	36	16	30
Capital Reserves	84	76	12	178
Sub-Total	192	211	53	272
Current Ratio	1.1:1	0.8:1	0.5:1	2.1:1
Debt/Equity Ratio	29:71	32:68	56:44	14:86

1/ Exchange Rate used for 1971 US$1 = E°14.4; 1972 US$1 = E°20.0; 1973 US$1 = E°340.0 and 1974 US$1 = E°1870.0.

2/ In view of Chile's hyper inflation, ENAMI undertook a major revaluation of its assets and liabilities in 1974 to more accurately reflect the actual financial position of the enterprise.

2.24 On December 31, 1974, a new tariff policy was established aimed at reducing markedly ENAMI's dependence on fiscal transfers. The main features of the new policy are:

(a) the price paid to the small and medium miners for their ores and concentrates is based on the average price of copper (in cents per pound) for the previous month instead of the previous year, provided this price fluctuates between 71 and 90 cents per pound;

(b) when the average monthly price falls below 71¢ a subsidy up to a maximum of 6¢ would be paid;

(c) if the average price rises over 90¢, payments to the producers would be limited to the 90¢ figure with the "excess" being used to form a stabilization fund designed to permit paying subsidies in cases of the price again falling below 71¢; and

(d) in determining the purchase price of mineral ores and concentrates, processing charges are to be subtracted which will reflect the real costs of smelting and refining in ENAMI's plants.

Considerable progress has thus been made to improve ENAMI's financial position. Both the Government and ENAMI agreed to prior consultation between the Borrower and the Bank in the event that the present tariff policy were to be modified.

D. The Contribution of the Sector to the Chilean Economy

1. Foreign Exchange

2.25 Copper is the dominant element in the growth of Chile's mining sector and in her balance of payments situation, and the various contributions that it makes to Chile economy are described in more detail in Annex 2-5. It is the single most important contributor to exports, accounting for approximately 75% of total merchandise exports. Copper exports averaged about 10% of GNP in the last two decades. This average has fluctuated appreciably between 7 and 12%, primarily as a function of world copper prices.

2.26 Copper prices continue to be the major determinant of Chile's export earnings and balance of payments. A difference of one cent per pound in the copper price at current output would be reflected in a difference of foreign exchange earnings of about US$20 million per year. As copper output increases, this effect will become more marked, affecting Chile's national income, its import capacity and its ability to service its external debt.

2. Tax Revenue

2.27 The copper sector has made an important contribution to government revenue. Historically, it has been of two kinds: an explicit component consisting of taxes, such as income taxes and surtaxes, paid directly to the Government; and an implicit component consisting of revenue derived from an overvalued exchange rate for copper transactions, a policy in practice equivalent to an export tax. Fiscal revenues from the Gran Mineria amounted to US$596 million in 1974 and provided about a fifth of government revenues (estimated to be between 4 and 5% of GDP). The dramatic fall in copper prices in late 1974 led to an aggravation of the fiscal situation leading the Government to adopt a policy whereby all revenues of the Gran Mineria operations in excess of the operating costs (estimated at the equivalent of 45¢/lb.), including depreciation and financial charges, are retained by the Government. This is essentially an interim measure until a more suitable system of taxation and dividend payout by the publicly owned mines can be formulated.

3. Employment

2.28 In the early phases of copper mining development, direct labor employment was relatively high in the industry. The total work force built up from 25,000 during the early 1940's to a total of 46,000 by mid-1974; 32,000 in the large-scale mines; 4,000 in the medium-scale mines; and 10,000 in the small-scale sector. The medium-scale sector is becoming increasingly capital intensive, whereas the small-scale sector is likely to remain labor intensive and an important employer. Furthermore, Chile's copper sector, through the major impact it has on the country's foreign exchange earnings and tax revenues, has a very important indirect effect on total employment, in other sectors throughout the country.

E. Sector Performance

2.29 Performance of the Chilean copper sector has been characterized by periods of sporadic bursts and falls far below what the resource base would indicate as potential. In the past, no consistent copper policy has ever been formulated, and historically the Government has been preoccupied with maximizing the short-term foreign exchange and government revenue contributions ignoring the adverse effects of such actions on capital inflows. Income tax levels reached 80% of net income by 1954. As a consequence of the high taxation and the differential exchange policy, local expenditures were kept to a minimum since imports were substantially cheaper than the same products acquired locally. These policies, which are discussed in detail in Annex 2-6, tended to retard foreign investment in the mining sector in Chile, with the foreign companies deciding to expand mines of lower grade ores in the United States rather than increase output and investment in Chile. Fluctuations in the world price of copper, general political uncertainty in the country and high levels of inflation further impeded the Chilean Government in its efforts to provide the climate for further substantial investments during the 1950's and 1960's. Therefore, measured by almost any standard,

investment in the Gran Mineria has been far below what could have been reasonably expected. It was not until the Chileanization program of the Frei administration that the Government eventually provided the framework for a more continuous investment flow by the foreign companies. A discussion of past investment in the sector is given in Annex 2-7.

2.30 Investment policy and the planning of future investment in the nationalized copper industry is of great importance because of its impact on Chile's overall economic development. Policy-making decisions affecting the development of the copper sector need to be centralized in a coordinating unit with an overall view not only of the sector but of Chile's development needs. In view of the continued weak role of the Ministry of Mines, the Government has agreed to create, within a year of this loan's signing a newly structured copper agency responsible for coordination of planning and policy-making in this sector.

F. Investment Plans and Financing Needs of the Sector

2.31 Expansion of Chile's production in the longer term is both technically and financially feasible, as well as economically desirable. Chile copper deposits are relatively high grade, extensive in terms of reserves, and in a location to make them competitive. The major inhibiting factors appear to be the present inadequacies in project preparation and the sector's substantial demand for investment capital. Although the precise pattern of future copper expansion as it relates to the balance between public and private participation is not yet clear, it does appear that foreign private capital will play an important role in future sector expansion.

2.32 Both CODELCO and ENAMI lack a clearly defined medium-term investment plan. This makes it difficult to establish precise investment goals with much certainty. Nevertheless, it is possible to outline priority investment needs to 1980 and make some estimates of the capital requirements in the entire copper sector as described in Annex 2-8, and summarized below:

(a) Rehabilitation, rationalization and modernization of existing mining, concentrating, smelting, refining and service facilities. For instance, Chuquicamata, El Teniente, and Andina contain more than 70% of Chile's copper reserves and will continue to play a major role in the future expansion of Chile's copper sector;

(b) Rehabilitation and expansion of smelting and refining capacity, which at present forms a critical bottleneck in the sector;

(c) Development of new deposits, for which exploration and evaluation programs are now being conducted with more or less intensity. These include primarily the El Abra, Andacollo and Los Pelambres deposits, but also the Mocha, Cerro Colorado, Quebrada Blanca and Pampa Norte deposits.

2.33 The tentative investment program of US$890 million, of which about 90% will be needed to maintain existing production and to modernize facilities, would as a result increase production to about 1,100,000 MT by 1980 at the earliest. This would require an annual investment of US$125 million in 1976 increasing to approximately US$190 million in each of the remaining years through 1980. Approximately 35% of the capital costs would be in foreign exchange and 65% in local costs. While it can be expected that once copper prices have again become firmer CODELCO will generate significant cash surpluses, a large part of these earnings will be transferred to the Government as taxes and dividends (as indicated in paragraph 2.27) to finance investment needs in sectors other than in copper. Hence, the availability of domestic savings to finance the local currency cost of the copper sector investment program will depend to a large extent on the inter-sector priorities yet to be established by the Government.

2.34 Almost certainly, foreign capital will be required to cover the foreign component of any future expansion of this sector. The extent to which foreign private capital will be made available to finance the development of the new deposits is not yet known. Indications to date are that, at least in the short-term, not much foreign private equity will be invested in the sector despite a liberal investment code. It appears that heavy reliance will have to be placed on private and public debt financing. Apart from the financing constraint, much improvement in project preparation and planning will be required in order to implement such an investment program.

III. THE COPPER MARKET

3.01 The world market supply and demand for copper, its price structure and the specific markets for Chile's mineral products are discussed in Annexes 3-1 and 3-2. The following gives a brief description and the major conclusions.

A. International Supply and Demand

3.02 Proven published copper reserves in countries other than centrally planned economies are conservatively estimated at 272 million tons of copper content -- more than 40 years supply at the present rate of mining. Some 60% of these are located in the Western Hemisphere while the African Copper Belt accounts for 25%. Six countries, USA, Canada, Chile, Zambia, Zaire and Peru account for about 75% of the 1974 world mine production of 6 million tons, while Chile alone accounted for 12% or 902,000 tons.

3.03 The world 1/ copper supply comes from two main sources, (a) from mine production, and (b) from secondary or scrap recovery and is consumed in two different forms, i.e., either as refined copper produced from mined ore or scrap, or as scrap for direct use. Scrap plays an important role in the

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1/ Excluding centrally planned economies.

world's copper supply. It averages about 40% of total copper production. Scrap recovery has proven very price elastic and thus acts as supply-demand balancing factor. World production of refined copper increased by an average of 4.1% per annum over the 1960-73 period and reached 7.7 million tons in 1974. Refining facilities, historically located in industrial countries, were recently expanded primarily in Japan, Zambia, Zaire, Chile, Peru and Australia.

3.04 Copper has important technical qualities such as corrosion resistance and electric and thermal conductivity and is widely used for electrical equipment and supplies, construction and housing, transportation, appliances, etc. Consumption of copper is concentrated in the developed, industrialized countries, with the USA, Canada, Western Europe and Japan accounting for nearly 92% of the Western world consumption. During the 1960-73 period refined copper consumption increased steadily by 4.5% per annum. In general, growth of copper consumption and industrial production are closely correlated; however, during the sixties fast growing economies, such as Japan and Brazil experienced over-proportionally high increase in copper consumption, averaging 10%-20% per annum.

3.05 Net exports of copper as concentrate, blister and refined metal have increased by 7% per annum since 1969, reaching 3.58 million tons in 1972. During that year, the major importing countries were the Federal Republic of Germany (16%), the U.K. (14%), Belgium (12%), the USA (10%), Japan (9%), while Zambia (20.5%), Chile (18.3%), Zaire (12.5%), and Canada (9.2%), lead the copper exporting countries. In 1967 Zambia, Chile, Zaire and Peru formed CIPEC 1/ an organization which coordinates the actions and protects the interests of these copper exporting developing countries in an oligopolistic market. The then four CIPEC countries accounted in 1972 for 37.5% of the world's copper mine production, 20.5% of refined copper production and 57% of new copper exports. During the recent (November 1975) CIPEC conference in Lima, Indonesia was accepted as a full member and Australia and Papua/New Guinea as associates. As a consequence all CIPEC countries together could account for about 70% of copper exports.

3.06 During the past decade, production and sales of copper were generally in line with one another; however, hedging against political events, strikes, inflation, as well as speculation and build-up or drawdown of stocks, have led periodically to supply/demand imbalances. There exists a high degree of uncertainty about the future copper market. In the recent past, most major copper producing countries have continued expanding their capacity even while the economic situation in developed countries has been slowing down copper consumption. The projected demand/supply for refined copper is summarized in the following table:

1/ CIPEC - Conseil Intergouvernemental des Pays Exportateurs de Cuivre.

World /1 Refined Copper Supply/Demand Projections
(million tons of copper content)

	1973	1974	1975	1976	1977	1978	1979	1980
	-(actual)-							
Supply								
--Mine Production	6.0	6.2	5.4	5.2	5.8	6.7	7.0	7.3
--Refined Production	6.6	6.8	6.4	6.1	6.8	7.9	8.2	8.6
Demand								
--Refined Consumption	6.8	6.2	5.9	6.4	7.0	7.9	8.2	8.5
Surplus (Deficit)	(0.2)	0.6	0.5	(0.3)	(0.2)	0.0	0.0	0.1

/1 Excluding centrally planned economies.

3.07 Based on the above table and discounting variations in scrap supply and metal stocks copper will again be in a statistical oversupply position by the early eighties. On the other hand, were copper consumption to recover more rapidly and grow at the historical 4.2%, no oversupply would result.

B. Copper Price Structure and Projections

3.08 Copper is traded at producer prices, the London Metal Exchange (LME), and the Commodity Exchange (COMEX) in New York. The bulk of copper's international trade, including Chile's exports, are sold at LME prices, although less than 10% of copper sales are actually delivered from LME stocks.

3.09 Copper is characterized by its low short-term elasticities of demand and supply which create huge and volatile changes in price. Since 1965, copper prices have not fallen below the US$0.45/lb level, but reached a peak of US$1.52/lb (in current terms) in April 1974, caused by non-industry speculations following the oil crises and hedging against the US miners' strike, only to drop to less than US$0.55/lb in early 1975 as stocks were released and industrial production growth slowed down.

3.10 With the dramatic drop in copper prices, the CIPEC countries in November 1974 called for action to halt the decline in prices, and for the first time since the establishment of CIPEC, agreed to temporarily reduce their copper exports by 10%. It was hoped that this would halt the price drop at about 60¢/lb. A decrease in price below this level would not only seriously affect the trade balance of these countries, but also the viability of some of the producers. The action has not, however, had any significant impact on the market and a further cut-back of 5% was instituted in April 1975, this time calling for a 15% production cut-back as well. A major factor

affecting this cyclical decline in price was the Japanese copper stocks (200,000 tons) overhanging the market, which are large in comparison to the about 340,000 tons which are estimated as being withheld from the market by the CIPEC action up to March 1976. The action may, however, advance somewhat the cyclical upswing, as prices will eventually move again to more normal levels dictated by production costs and draw down of inventories. However, substantive price improvement is not likely to develop before the second half of 1976. For that year (1976) the average copper price is estimated at 67¢/lb in current terms as compared to about 56¢/lb in 1975. Each of the CIPEC countries can, over the short-term, effectively use the export cut-backs to their advantage, as is being done by Chile, by moving operations to lower grade areas of the mines, increasing mine development activity and waste removal, shutting down processing lines to carry out modifications leading to cost reductions, and catching up on the backlog of maintenance work.

3.11 From 1929 through early 1974, copper prices followed a long-term upward trend. Expressed in 1975 dollars, they rose from an average level of US$0.54/lb. during the 1929-38 decade to US$0.69/lb. during the 1949-58 decade and to US$0.82/lb. between 1959 and 1968. The 1969-73 average was US$0.97/lb. Prices increased to US$1.05/lb. in 1974 then fell sharply to below US$0.60/lb in 1975. Price projections for copper, taking into account the prevailing uncertainties, cannot be more than an intelligent guess. In the short-term, i.e., for 1976, it is expected that copper prices will stabilize between US$0.60/lb and US$0.70/lb (current prices) as releases of consumer stockpiles continue and the depressed economic growth in developed countries cannot be counterbalanced by accelerated industrialization of less developed nations. In the medium run, as mentioned in paragraph 3.07, there is the possiblity of a slight oversupply of refined copper by 1980. Nevertheless, prices are expected to increase to between 70-80¢/lb in 1977-80 (in real 1975 terms).

C. Marketing Chilean Copper

1. Sales Organization

3.12 CODELCO is responsible for the sale of all copper produced by the Gran Mineria and ENAMI for the copper produced by the medium and small mines. Some of the larger private mines may make direct sales, but each contract requires the prior approval of CODELCO.

2. Sales Procedures

3.13 Approximately 80-85% of the refined and blister copper is sold through annual contracts. These contracts cover: the type of copper the client will buy, the quantities to be delivered monthly and for the year, the procedure for determining prices, the place of delivery, the form and currency of payment, as well as other details of lesser importance. The remainder (15-20%) of the copper is traded during the year as spot sales. Copper concentrates are sold on annual contracts. The minor minerals such as silver, molybdenite and selenium are sold as spot sales.

3. Price Policy

3.14 Chile, like the majority of world copper producers except the USA, uses the daily quotations on the LME in determining the price of copper sold to its clients. The quotations is the official seller's cash price for bars of electrolytic copper.

4. Destination of Sales

3.15 Chile sells its copper on a wide geographic basis, the distribution varying each year. In 1974 the most important markets were: Japan (16%); Federal Republic of Germany (15%); UK (12%); USA (10%); Italy (9%); and People's Republic of China (6%).

IV. THE PROJECT

A. Background

4.01 Following several years of inadequate reinvestment the copper sector in 1973 reached a position where urgent capital expenditures were required to secure existing capacity, replace obsolete equipment and plants to reduce production costs, increase the efficiency of operations to maintain the sector's competitive position in the world market and diversify production. CODELCO put together a program of urgent and high priority investments, with a total estimated cost of about US$890 million. ENAMI also prepared a priority investment program with a total estimated cost of about US$100 million. From discussions with the managements of CODELCO and ENAMI, and a review of the respective programs, five sub-projects, with a total cost of about US$77 million, were selected for Bank financing, including a significant technical assistance component. At the request of the Government, it was agreed that the subprojects would reflect the priority needs of the sector as a whole and not solely those of the sector's major entity, CODELCO. Selection of these sub-projects was made on the basis of: the need to maintain existing capacity; their cost saving potential; diversification and improvement of operations; high return on investment; the status of project preparation; speed of execution; suitability for the Bank's procurement requirements; and impact on foreign exchange earnings.

B. Description

4.02 The project includes four distinctly separate sub-projects with four principal objectives: rehabilitation, elimination of production bottlenecks, recovery of useful by-product material and technical assistance. These sub-projects, which are self contained and independent of the rest of the investment programs, are described in Annex 4 and briefly summarized below:

	Bank Contribution
CODELCO Projects	Million US$
(a) Underground crushing station at El Teniente (Mina Futura) to preserve output;	5.66
(b) Rehabilitation of Barquito Power Plant for supplying El Salvador Mine and Smelter Facilities;	12.50
(c) Construction of Selenium Recovery Plant to process Chuquimata and El Salvador Anode Slimes; and	0.49
(d) Technical Assistance	3.97
Contingencies	6.92
Sub-total CODELCO	29.54
ENAMI Projects	
(e) Replacement of equipment components for smelting and refining operations at Ventanas and Paipote; and	2.42
(f) Technical Assistance	0.33
Contingencies	0.71
Sub-total ENAMI	3.46
Grand Total	33.00

1. CODELCO Projects

4.03 The introduction of a primary underground crusher and related infrastructure system has become an absolute necessity at the El Teniente mine if the mine is to maintain its present level of refined copper production of 250,000 tons per year, which is otherwise projected to decrease by at least 30% by 1980. Over a period of more than 70 years, the El Teniente mine had produced from the secondary enriched zone using highly efficient block caving techniques. Although it had been evident for some time that the mine would have to produce eventually from the underlaying primary ore zone, a point which now is about to be reached, no comprehensive testing of caving and/or breakage pattern of the primary rock had been conducted to adequately determine ore handling characteristics. Primary rock turned out to be considerably more compact than expected, leading on average to three times larger blocks which cannot be accommodated by the existing transportation infrastructure without costly secondary blasting. This is expressed in a drop of productivity from 250 tons per man shift to 25 tons in the

primary zone, and would, in the absence of action to introduce the underground crushing system, increasingly translate into both costlier mining and loss of production as the proportion of output from the primary zone goes up. Besides the crusher station itself the sub-project consists of a chute system before and after crushing.

4.04 The rehabilitation of CODELCO's Barquito power plant, which supplies the El Salvador mining, smelting and refining facilities, involves completing the replacement of the plant's old, dilapidated, high cost and unreliable steam and diesel generating units by installing new steam generating units of a capacity of 15-20 MW. A waste heat recovery boiler for the plant's existing new gas turbine and a fuel preparation plant to permit the gas turbine to burn heavy fuel oil will be added. The installation of this equipment would eliminate the danger of a plant shutdown due to power failure, and the consequent loss of production, as well as result in considerable fuel and maintenance cost savings. At the same time the sub-project allows (through the added power availability) a moderate expansion of the El Salvador mine's production of fine copper to 100,000 tons per year that forms part of CODELCO's 1967 investment program. The El Salvador mine, as is the case with the two other major mines in the north (Chuquimata and Exotica) has to be self-sufficient in power since the system of the public power companies does not service the region.

4.05 Construction of a selenium recovery plant at Chuquimata aims at the recovery of this metal from the anode slimes in the Chuquimata copper refineries. The ore of both of these mines contains small quantities of selenium (approximately 1 part in 15,000 parts of copper), which during treatment ends up in the anode slimes of the copper refineries. These slimes are now treated in the Noble Metals Plant at Chuquicamata to recover gold and silver. The sub-project will treat the tailings of the Noble Plant and recover the selenium by leaching and precipitation, resulting in a powdered product of commercial quality (99.5% selenium). While substantial testing with the assistance of two outside experts has been completed, the plant will be conservatively constructed in two stages. First a 9-ton/year pilot plant will be installed subsequently to be upgraded to a 35-ton/year commercial plant. The plant will have a capacity to treat 700 tons/year of anode slimes.

4.06 As discussed earlier, CODELCO requires considerable strengthening in order to: (i) make up for the loss of large numbers of engineers following nationalization; (ii) replace the services originally provided by the ing nationalization; (ii) replace the services originally provided by the former owners; and, importantly, (iii) consolidate the CODELCO Group into a fully integrated company. To meet these objectives a substantial technical assistance program is proposed with the following components:

(i) Planning systems, Project Preparation and Evaluation:

- Assistance in project identification, preparation and evaluation. Formulation of a definitive 5-year investment program.

(ii) Specific Studies to assist with Planning and consisting of the preparation of:

- A comprehensive smelting and refining development strategy and investment program for CODELCO and Chile's copper sector as a whole.

- A long-term mining plan for the Teniente mine, taking into account the difficult mining conditions being encountered with the present methods as production moves into harder rock.

- A long-term mining plan for the Chuquicamata mine, to improve pit efficiency, and make provision for future expansions.

(iii) Specific Experts:

- Employment on a retainer basis of foreign experts, most notably metallurgists, for trouble shooting.

(iv) Organization and Structuring the CODELCO Group:

- Employment of foreign experts to supplement a study for revamping, and streamlining the organization structure of CODELCO and its subsidiaries with a view to consolidating CODELCO into a fully integrated company.

(v) Internal Procedures:

- Coupled with the reorganization is the need to revise the internal corporate procedures, including cost accounting, inventory control, data collection, data processing, information systems and production and budgetary control.

4.07 Staffing requirements for both Chilean staff and foreign experts are estimated as follows:

Staff Requirements for Technical Assistance to CODELCO
(in man years)

		Chilean Staff	Foreign Experts
(i)	Planning Systems	30	20
(ii)	Specific Studies:		
	- Smelter Strategy	2	2
	- El Teniente Mine Plan	20	5
	- Chuquicamata Mine Plan	5	3
(iii)	Specific Experts	-	4
(iv)	Organization	5	5
(v)	Internal Procedures	40	18
	Total	102	57

2. ENAMI Projects

4.08 This sub-project consists of the replacement of antiquated or obsolete equipment components at ENAMI's Ventanas and Paipote smelters - including a cathode copper starter sheet machine for Ventanas and a blister copper caster for Paipote - and the modification of both smelters' burners to enable them to operate on Chilean coal as well as petroleum products. Replacement of the equipment is needed to avert breakdowns and production losses and to lower maintenance costs; moreover, it is urgent since spare parts for the more than 25-year-old equipment are now hard to find. Modifications of the burners will give the smelters flexibility and permit them to use the cheapest available fuel at any one time. As a consequence operating costs will be reduced and increase operating reliability.

4.09 To assist ENAMI with strengthening its management and operations, a technical assistance component has been included as well. The objectives of this assistance will be to (i) improve present planning and project preparation procedures; (ii) conduct specific technical and economic feasibility studies; and (iii) assist ENAMI diversify its mineral production. ENAMI has agreed to provide the necessary counterpart funds and staff to successfully carry out this technical assistance.

C. Ecology

4.10 Throughout the copper sector the work conditions and level of safety consciousness are generally good; however, some of the existing plants do require improvement and the companies are cognizant of this. The four sub-projects, however, all have adequate provisions for environmental protection. Furthermore, the El Teniente underground crushing plant and the Ventanas and Paipote smelting and refining equipment process existing materials streams without producing additional effluents. The same is true for the Barquito power plant improvement project and the Chuquicamata Selenium recovery plant which in effect recovers part of the selenium metal from dust and wash solutions.

D. Organization and Management

4.11 Each of the projects will come under the direction of the engineering and operating staff of the individual operating companies. In all the projects, foreign experts or consultants will assist in project implementation. For the Barquito power plant, McLellan and Partners, a UK firm, are primarily responsible for engineering design, procurement and construction supervision. Local contractors will undertake the civil works of the power plant. The design for the underground crushing station at El Teniente will be done by the company's engineering staff who will supervise the construction phase. Two foreign experts have been retained to assist company engineering staff for the selenium plant. In view of the available expertise in CODELCO and ENAMI, the arrangements for implementing the sub-projects are satisfactory.

4.12 The technical assistance programs will be administered through detailed terms of reference and reporting requirements agreeable to the Bank. The concept of assigning teams made up of foreign and counterpart staff under the direction of a project manager will be used. The teams will report to senior management. These arrangements are considered satisfactory.

E. Implementation Schedule

4.13 The sub-projects financed by the Bank will be executed within about three years from early 1976 through early 1979. Project implementation schedules are as follows:

		Project Status October 1975	Completion Date
(a)	El Teniente underground crushing plant	Design engineering underway	July 1978
(b)	Barquito power plant	Preliminary consultants study completed	Early 1979
(c)	Chuquicamata selenium plant	Preliminary design completed	July 1978
(d)	CODELCO - Technical Assistance	Program to be initiated	September 1978
(e)	Ventanas/Paipote modernization	Design engineering underway	June 1978
(f)	ENAMI - Technical Assistance	Program to be initiated	November 1978

4.14 These timetables are considered reasonable, particularly because of the urgency attached to the projects, and the steps already taken to get them underway. Except for the Barquito power plant and the technical assistance component, all projects have advanced to the stage of detailed design engineering.

F. Project Costs

4.15 The project's costs, net of taxes and duties, is estimated at US$76.8 million. Its foreign exchange component is about US$33 million or 43% of net project costs. Over and above these amounts, an estimated US$2 million in interest during construction will be incurred by CODELCO and ENAMI in connection with their respective sub-projects.

4.16 Estimated costs of the projects are detailed in Annex 4 and summarized below:

Summary Capital Costs
(in US$1,000)

	Local	Foreign	Total	% of Base Cost
CODELCO Projects				
(a) El Teniente Crusher System	25,570	5,660	31,230	58.0
(b) Barquito Power Plant	2,400	12,500	14,900	27.7
(c) Chuquicamata Selenium Plant	979	486	1,465	2.7
(d) Technical Assistance	2,290	3,970	6,260	11.6
Total Bases Costs	31,239	22,616	53,855	100.0
Physical Contingencies	3,497	2,916	6,413	11.9
Price Escalation	5,930	4,007	9,937	18.5
Working Capital	2,200	-	2,200	4.1
Sub-Project Cost	42,866	29,539	72,405	134.5
Interest during Construction	-	2,010	2,010	
Financing Required - CODELCO	42,866	31,549	74,415	
ENAMI Projects				
(e) Ventanas/Paipote Modernization				
- Ventanas/Paipote Burners	270	1,143	1,413	41.1
- Paipote Blister Caster	325	597	922	26.8
- Ventanas Starter Sheet	40	677	717	20.8
Sub-Total	635	2,417	3,052	88.7
(f) Technical Assistance	60	330	390	11.3
Total Base Cost	695	2,747	3,442	100.0
Physical Contingencies	70	277	347	10.1
Price Escalation	136	433	569	16.5
Sub-Project Cost	901	3,457	4,358	127.0
Interest during Construction	-	20	20	
Financing Required - ENAMI	901	3,477	4,378	
TOTAL PROJECT COSTS	43,767	32,996	76,763	
Total Finance Requirements	43,767	35,026	78,793	

4.17 These costs are based on late 1975 estimates. They include an overall physical contingency of 11.8% of base costs and vary somewhat from sub-project to sub-project depending on the firmness of the estimate on hand and the stage design engineering has reached. Furthermore, a provision for price escalation 1/ of 16.4% of base cost plus physical contingencies has been made, reflecting a rather short project implementation time and the fact that orders for equipment are about to be placed. All cost estimates have been made in US$ equivalent on the assumption that the rapid internal inflation rate will be matched by frequent adjustments to the exchange rate. The technical assistance costs are estimated by the Bank using known consultant charges prevailing in late 1975, plus 10% contingency and 10% per year price escalation allowances. As such the cost estimates are considered reasonable.

G. Financing Plan

4.18 The sub-projects will be financed as follows:

	Financing Plan		
	Local Currency	Foreign Currency	Total
	US$ Million		
CODELCO Cash Generation	42.87	2.01	44.88
ENAMI Funds or Government Contributions	0.90	0.02	0.92
IBRD Loan for:			
CODELCO Sub-projects	-	24.55	24.55
CODELCO Technical Assistance	-	4.99	4.99
ENAMI Sub-projects	-	3.06	3.06
ENAMI Technical Assistance	-	0.40	0.40
Sub-Total IBRD Loan	-	33.00	33.00
Total	43.77	35.03	78.80

4.19 The Bank funds will cover 42% of total estimated financing requirements and 92% of the foreign exchange components. The remaining costs of the sub-projects will be financed by CODELCO and ENAMI, which are expected to have sufficient earnings to do so from their cash flows. Nevertheless, agreement was obtained from CODELCO and ENAMI and backed up by the Government that

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1/ Assuming Price escalation as follows:

	1976	1977	1978
Equipment	12%	10%	8%
Civil Works	16%	14%	12%

all the necessary local and foreign currency finance, other than the Bank loan, will be made available. The Government has also agreed to provide any additional funds that might be required for the timely completion of the project.

4.20 The Bank loan will be made to the Government of Chile, for a period of 15 years including 3-1/2 years of grace at an interest rate of 8.5%. The proceeds of the loan will be on-lent separately to CODELCO and ENAMI on identical terms except at an interest of 10%. The foreign exchange risk will be borne by the two companies.

H. Procurement, Allocation of Bank Loan and Disbursement

4.21 Items to be financed by the Bank loan will be procured by international competitive bidding procedures following Bank Guidelines. For some of the smaller "standardized" items, representing about 10% of the loan, bids will be sought from suppliers in at least three Bank member countries, including Switzerland. Apart from the technical assistance, of which the Bank loan would cover the foreign exchange component only, all other Bank funds will be used for financing of equipment and materials, most of them imported. For purposes of bid comparison the Bank's preferential rules will be applicable to local and regional suppliers. The consultants and experts for the technical assistance component will be recruited internationally. Evaluation will be made on the basis of technical and professional competence with prices to be negotiated subsequently.

4.22 Disbursement of the Bank loan is expected to be as follows:

	Disbursement of Bank Loan			
	1976	1977	1978	1979
	(in US$ million)			
Incremental Disbursement	2.0	15.0	13.0	3.0
Cumulative Disbursement	2.0	17.0	30.0	33.0

Disbursements will be made against 100% of the cif value of imported equipment or the ex-factory cost of locally manufactured equipment following international competitive bidding, and the foreign exchange component of the technical assistance. Any unused funds will be cancelled.

I. Financial Analysis of the Project

4.23 The financial rates of return of individual sub-projects are expected to range from 35 to over 50%; those for three of them are calculated in Annex 4 together with the assumptions made and are summarized below:

	Discounted Cash Flow (DCF) Rate of Return (Real Terms)
El Teniente Crusher System	greater than 50%
Barquito Power Plant	
- Fuel price levels of 1975	35%
- Half of expected fuel savings	20%
Chuquicamata Selenium Plant	
- Existing selenium price levels	35%
- Reduction of selenium price by 50%	8%

These returns are based upon conservative operating cost and pricing assumptions and the sensitivity analyses show that even with drastic reductions in benefits or sales prices returns would still be satisfactory.

4.24 The expected benefits from the replacement of equipment components for the Ventanas and Paipote smelter are difficult to quantify in terms of DCF rate of return. The equipment to be replaced is clearly old and increasingly obsolete leading to frequent plant break downs. Since there is a smelter capacity shortage in Chile, frequent unavailability of the equipment items translates into a cost to the economy. The conversion of the diesel fuel burners into coal burning units, using local coal, will generate annual foreign currency savings in the neighborhood of US$1.3 million which compares to the conversion cost of a total of about US$1.8 million.

4.25 The financial benefits to be derived from the technical assistance program are expected to be very significant. Improved planning and project evaluation will result in a better selection of projects, earlier project implementation and improved financial planning, and hence, more efficient expenditures of capital costs and cost savings. The smelter and refinery study could result in very large savings in terms of future investment and operating costs. The El Teniente mining plan has to be undertaken if the mine is to continue to operate at its present level. The Chuquicamata mining plan is similarly a prerequisite to future expansion. The specific experts, by assisting in eliminating processing bottlenecks and operating problems, are expected to bring about substantial cost savings as should CODELCO's reorganization and improvement of its internal procedures.

V. FINANCIAL ANALYSIS OF THE COMPANIES

A. CODELCO

1. Financial Position

5.01 As shown in Annex 2-3 and summarized below the operating cash surplus in 1974 was a vast improvement over the previous years.

Consolidated Cash Flow Statements for the Five Large Companies (Constant 1976 Prices)

(in US$ million)

	-(Actual)-		(Forecast)				
	1974	1975	1976	1977	1978	1979	1980
Revenue	1,762	1,309	1,162	1,272	1,182	1,182	1,137
Operating Costs	1,261	875	875	953	885	881	876
Income Taxes	193	103	67	79	73	73	72
Operating Surplus	308	433	220	240	224	228	189
Debt Servicing	199	312	110	110	110	100	100
Available for Investments or Government Dividends	109	121	110	130	114	128	89
Debt Service Coverage (times)	1.5	1.4	2.0	2.2	2.0	2.3	1.9

Despite the large drop in prices in the latter part of 1974, a severe cash stringency experienced in early 1975 and the expected continuation of relatively low prices during the remainder of the 1970's, the cash surplus generated by CODELCO is expected to remain substantial. The drop in 1975 costs over those of 1974 is primarily the result of the abolition of the artificial exchange rate which significantly increased local costs in US dollar terms. Implementation of the proposed rehabilitation program, including the Bank financed sub-projects, is expected to help maintain operating costs at the present low level.

5.02 In 1974 and 1975 the debt service requirements were high in part due to expropriation payments. Thereafter, debt service coverage of about two times and the low existing debt/equity ratio place CODELCO in a favorable position for raising additional debt. The total investment program through 1980 as presently envisaged could be financed by debt without increasing the debt/equity ratio above 50:50, even assuming all cash surpluses were paid out as dividends to the Government. In any case CODELCO's debt service arising from the proceeds of the Bank loan is small and expected to be less than 3% of its total debt service. Furthermore, the Bank loan portion to CODELCO is equivalent to the change in the Corporation's revenue caused by a change in the copper price of 1-1/2 ¢/lb.

2. Auditing

5.03 By law CODELCO is subject to audit by the Superintendency of Banks, but otherwise has no formal auditing requirements. However, CODELCO has appointed Price Waterhouse to conduct the audit of its 1974 accounts. CODELCO agreed to either continue this contract or engage other auditors acceptable to the Bank to carry out annual audits of CODELCO's accounts.

B. ENAMI

1. Financial Position

5.04 As mentioned in paragraph 2.22, ENAMI has in the past operated with significant losses. However, since deficits have been covered by Government transfers a favorable financial position has been maintained as indicated by the debt/equity ratio of 18:82 for the end of 1974. On the other hand, the company had a negative working capital position, due primarily to the large line of credit extended by the Central Bank in the period 1971-73. Since much of this amount was the result of the artificial exchange rates imposed upon copper exports, the Government agreed to cancel this debt thus placing ENAMI again in a satisfactory liquidity position.

5.05 Even more importantly, the Government has decided to operate ENAMI as an autonomous and financially viable entity and has already taken steps to increase operational efficiency, reduce costs, and establish a more realistic level for the price of the ores and concentrates ENAMI purchases from the small mines for further processing. The Government has agreed to maintain ENAMI as a financially viable entity and to continue making available to ENAMI such funds as needed to meet all its obligations, including debt service. The part of the Bank loan to be on-lent to ENAMI is US$3.46 million or 10% of the total Bank loan.

2. Auditing

5.06 By law ENAMI is subject to audit by the Government auditor (Controloria de la Republica), which conducts only superficial audits of ENAMI. Recently, ENAMI contracted Price Waterhouse to review their accounting procedures and conduct an audit. ENAMI agreed to either continue this contract or engage other auditors acceptable to the Bank to annually audit ENAMI's accounts.

VI. ECONOMIC JUSTIFICATION FOR THE PROJECT

A. Benefits to the Economy

6.01 The copper sector plays a major role in the Chilean economy and accounted in 1974 for approximately 10% of GDP, 80% of foreign exchange earnings and 20% of tax revenues. Its continued competitiveness on the world market is, therefore, of paramount importance to the country. The sector has suffered a prolonged period of inadequate reinvestment, a deterioration of operations and a radical change in ownership and management and therefore urgently needs rationalization and some technical inputs. The project is directed, as discussed in Chapter IV, to rationalizing the sector, improving operational efficiency, reducing costs and improving the absorptive capacity for future investment and expansion. The copper sector will continue to play a dominant role in Chile's development and act as catalyst for the country's

economic growth. Chile has good deposits in favorable locations, giving it some comparative advantages over other suppliers. The project is directed at helping to maintain this advantage.

B. Foreign Exchange Effect

6.02 The foreign exchange benefits from the project have to be measured in terms of maintenance of productive capacity as compared with foreseeable losses in the absence of the project. Whilst the amount of loss of foreign exchange benefits is difficult to quantify for the Ventanas/Paipote smelting equipment items, the proposed investment in El Teniente will help prevent a possible US$26 million reduction in foreign exchange earnings in 1978. Net savings in 1979 will amount to US$77 million and are expected to be in excess of US$100 million by 1980 and thereafter. In addition, the necessary investments in the Barquito power plant will not only prevent unscheduled stoppages, which could result in substantial production losses at the El Salvador mining and smelting complex, but will lead to foreign exchange savings in fuel consumption of US$2.8 million in 1978 and US$5.6 million per year by 1980.

C. Employment Effect

6.03 The project will provide very little additional direct employment. However, since at present, the companies' labor force is larger than needed due primarily to a significant build-up during 1971 and 1973, the project will allow better deployment of the labor force. One very important benefit of the project will be the upgrading through the technical assistance component of the skill levels of the professional staff as well as that of lower and middle management. By increasing foreign exchange earnings and tax revenues, the project is expected to have an important bearing on employment in Chile's other economic sectors.

D. Economic Rate of Return

6.04 The economic rates of return of the sub-projects will be only marginally above the high financial returns since transfer payments to the Government, apart from income taxes, are not significant and more than 95% of the copper will be exported at world market prices. As mentioned previously, these are unusually high returns and demonstrate the particular benefits that the sub-projects are expected to create.

VII. AGREEMENTS REACHED

7.01 The Loan Agreement and Project Agreements will record the following major agreements and assurances.

1. CODELCO will:

   a. Review its organization structure, administrative procedures, planning and project evaluation functions, with a view toward

strengthening management and improving coordination, as well as its cost accounting systems and inventory and budgeting control systems (para 2.17).

b. Provide sufficient funds to complete each of its sub-projects (para 4.19).

c. Have its accounts audited by an independent auditor acceptable to the Bank (para 5.03).

2. ENAMI will:

a. Consult the Bank in the event that the present tariff policy, relating to the purchases of ores and concentrates from the small and medium miners, were to be modified (para 2.24).

b. Make available sufficient funds to complete each of its sub-projects (para 4.19).

c. Have their accounts audited by an independent auditor acceptable to the Bank (para 5.06).

3. The Government will:

a. Within a period of one year after signing the loan, take the necessary legislative steps to transform CODELCO and its five large companies into a single integrated corporation, with centralization of the functions of planning, sales, procurement and administration, but will at the same time provide the management of each mine with sufficient autonomy to operate it as a separate project center (para 2.13).

b. Establish within one year, a suitable mechanism to coordinate and control sector planning and policy-making (para 2.30).

c. Insure that CODELCO and ENAMI have sufficient funds available to them to complete each sub-project and technical assistance program to be financed by the Bank loan (para 4.19).

d. Provide such financial assistance as necessary to maintain ENAMI as a financially viable entity (para 5.04 and 5.05).

7.02 With these assurances, the project forms a suitable basis for a Bank loan of US$33 million of which US$29.54 million would be made available to CODELCO and US$3.46 million to ENAMI.

Industrial Projects Department
December 1975

CHILE: COPPER SECTOR PROJECT

GLOSSARY OF TECHNICAL TERMS

CONCENTRATOR: A plant which separates ore into economically valuable products (concentrates) and rejects (tailings). Usually refers to a plant which utilizes the physical properties of the ore magnetism, specific gravity.

ELECTROSTATIC PRECIPITATION: Air or gases are drawn through a high potential direct current field causing the dust particles to acquire an electrical charge, and deposit themselves on the collecting surface (the anode). One of the more efficient dust collection methods.

ELECTRO-WINNING: Recovery of a metal by means of electrochemical processes. The copper in an acidified copper sulphate solution is deposited on the cathode of an electrolytic bath. The product, CATHODE COPPER, requires melting in a furnace to be marketable as electrolytic copper.

FLOTATION: A method of separation in which a froth created in water is used, with a variety of reagents, to float finely ground minerals whereas other minerals sink.

HYDRO-METALLURGY: The treatment of ores or concentrates by dissolution of some component and its subsequent recovery from the solution.

LEACHING: The extraction of a soluble metallic compound from an ore or concentrate by selectively dissolving in a suitable solvent, such as water or sulphuric acid. The solvent is usually recovered by precipitation of the metal or metals.

MOLYBDENITE: A black, platy disulfide of Molybdenum, MoS_2, the most common ore of Molybdenum. Molybdenum is a silvery-white, very hard metallic element in the chromium group. Its physical properties are similar to those of iron and its chemical properties are similar to those of a non-metal. Used for electrodes of mercury-vapor lamps, as wire for winding electrical resistance furnaces and in steel alloys. As an alloying agent it increases hardness and toughness and raises strength.

ORE: A naturally occurring mineral, or minerals, which can be mined at a time, at a place, and at a benefit.

REFINING: The purification of crude metallic products. In copper, represents the final stage in the processing to relatively pure metal. Usually accomplished by electro or fire methods. Product is usually called ELECTROLYTIC OR FIRE REFINED COPPER, respectively.

REVERBERATORY FURNACE: A furnace, with a shallow hearth, having a roof that deflects the flame and radiates heat on the surface of the charge.

ROASTING: Heating an ore or concentrate to effect some chemical change that will facilitate smelting. For sulphide ores, the roasting converts the sulphides to oxides.

SELENIUM: A non-metallic element, widely distributed in small quantities in base metal deposits. Obtained from sulfide ores and copper refining. Used as a decolorizer for glass, in red glasses and enamels, and in photoelectric cells and rectifers. Symbol Se.

SOLVENT EXTRACTION: A method of separating one or more substances from a mixture, by treating a solution of the mixture with a solvent that will dissolve the required substances, leaving the others.

SMELTING: A metallurgical operation in which metal is separated by fusion from those impurities with which it may be chemically combined or physically mixed. In copper, the metal is usually obtained as a molten matte. The product is usually 70% copper.

TAILINGS: The part of any ore separated by processing and treated as inferior in quality or value; the gangue, sand, gravel slimes and other refuse material resulting from the washing, benefaction or treatment of ground ore. Those portions of treated ore regarded too poor to be treated further.

November, 1975
Industrial Projects Department

CHILE: COPPER SECTOR PROJECT

THE DEVELOPMENT OF COPPER IN CHILE

A. Early Development

Production Trends

1. While it is known that the Incas and later the Spanish mined and processed copper in Chile in the 16th Century, it was not until 1820 that copper mining began in Chile on a stable basis, with Chilean and British interests playing the major roles. As shown in Table 1, see following page, Chile has played an outstanding role in world copper production.

2. In the decade 1841-1850 Chile produced 100,000 tons of copper, or 22 percent of world output and in the following decade (1851-1860) produced on average 22,000 tons per year, more than 30 percent of world output, making it the number one producer. Production expanded further in the 1860's and 1870's to more than 40 percent of world output; mostly by domestic and some British interests. However, Chile's production declined from 1880, and by the early 1900's Chile accounted for only 5 percent of world output. This relative decline in Chile was due to:

(a) World demand and production, particularly in the U.S.A., increased extremely rapidly; and

(b) the high grade copper mines upon which the Chilean production had been based were depleted and Chile had, therefore, to switch to employing the low grade porphyry deposits, which required large investments and considerable time for implementation.

The Introduction of Large Scale Mining

3. The first two decades of the 20th century marked the entry of U.S. enterprise and the introduction of large-scale mining in Chile. Chile's position began to improve again when in 1906 the El Teniente porphyry deposit was brought into operation, followed during World War I with production from the large Chuquicamata deposit and, shortly thereafter, from the Potrerillos porphyry deposit, reaching 15 percent of world output by 1922, a level maintained through the late 1950's.

4. After a century of working of high grade stringers, the porphyric potential of El Teniente became known and the Braden Copper Company was formed, completing the first concentrating plant in 1906 with a capacity to treat 250 tons of ore per day. By 1912 a larger plant with a capacity of 3,000 tons per day (ore) was in operation. In 1916 the Braden Copper Company was acquired by Kennecott Copper Corporation, then the world's largest copper producer accounting for 40 percent of the total production. The success of this operation attracted other interests to Chile.

Table 1. The Relative Importance of Chilean Copper in World Production

Period	Production for period		Chile Production as percentage of World Production	Major Producers
	World	Chile		
	(metric tons of fine copper)		(%)	
1801-1810	163,000	15,000	9.2	England/Japan
1811-1820	168,000	15,000	8.9	England/Japan
1821-1830	244.000	65,000	8.5	England/Japan
1831-1840	325,000			
1841-1850	441,000	100,000	22.7	England/Chile
1851-1860	578,000	220,000	32.4	Chile/England
1861-1870	1,000,000	401,000	40.1	Chile/England
1871-1880	1,250,000	457,000	36.6	Chile/Spain
1881-1890	2,254,000	367,000	16.3	U.S.A/Spain
1891-1900	3,750,000	236,000	6.3	U.S.A/Spain
1801-1900	10,[illegible]3,000	1,875,000	18.[illegible]	U.S.A/Chile
1901-1910	6,940,000	352,000	5.1	U.S.A/Mexico
1911-1920	10,928,000	676,000	6.2	U.S.A/Japan
1921-1930	13,407,000	2,027,000	15.1	U.S.A/Chile
1931-1940	16.276,000	2,702,000	16.6	U.S.A/Chile
1941-1950	23,387,000	4,347,000	18.6	U.S.A/Chile
1951-1960	33,671,000	4,451,000	13.2	U.S.A/Chile
1961-1970	51,[illegible]65,000	6,391,000	12.4	U.S.A/U.S.S.R.
1971-1974	28,[illegible]14,000	3,070,000	10.6	U.S.A/U.S.S.R.
1901-1974	185,[illegible]06,000	24,016,000	13.0	U.S.A/Chile
1801-1974	195,479,000	25,892,000	13.2	U.S.A/Chile

Source: CODELCO

5. Mining of high grade veins contained in the Chuquicamata deposits dates back to the 16th century. After two years of testing for a method to process the oxide ores, the Chile Exploration Company was organized in 1912 with U.S.A. capital, and production began in 1915. Anaconda Copper Mining Company acquired the property from the original owners in 1923, and expanded its capacity to 170,000 tons of fine copper per year by 1927 and 222,000 tons by 1941, the largest copper mine in the world.

6. Sparked by the success of other parties in Chile, the Andes Copper Mining Company was set up in 1913 as a wholly owned subsidiary of the Anaconda Company to explore the Potrerillos deposits. By 1927 the mine, concentrator and smelter went into operation, producing 50,000 tons of fine copper per year, until the deposit was exhausted in 1960, at which time a new deposit, El Salvador, 32 km from Potrerillos, replaced the latter.

B. Recent Development and Production

Post War Production

7. Since the war, Chile's expansion in copper production has not been as dynamic as world expansion. Table 2, page 4, shows that since 1950 world copper production has almost tripled with an average annual growth rate of 4.3 percent while Chile's production has doubled with an average growth rate of 3.1 percent. Substantial new investments during President Frei's administration have not yet reached full capacity which should have raised production over the one million ton mark and hence maintained Chile's share of production at 14 percent of world total.

8. Most of Chile's production has come from the three large mining complexes: Potrerillos-Salvador, Chuquicamata, and El Teniente. See Table 3, page 6. Two new mines which started in 1971, Exotica and Andina, will play an important role in the future. Several medium size mines also play a significant role.

Chileanization and Nationalization

9. The three older mines -- El Teniente, Chuquicamata and El Salvador -- were operated as wholly owned subsidiaries of Anaconda and Kennecott until 1967, when as a first step towards nationalization Chile acquired 51 percent ownership of El Teniente from Kennecott and participated as a minority shareholder in the new Andina and Exotica operations with Cerro Corporation and Anaconda respectively.

In 1969 the Government negotiated an arrangement with the copper companies whereby a progressive Chilean participation in profits accruing from copper prices in excess of US$0.40/lb. was levied in the form of an overprice tax. Also, an agreement was reached with Anaconda on the purchase by Chile of a 51 percent share in the Chuquicamata and El Salvador mines which Anaconda continued to run under a management contract.

Table 2. Copper Production in Chile and the World

Years	World Production			Chilean production			Chilean production as a percentage of world production
	Total	Annual average	Increase annual average	Total	Annual average	Increase annual average	
	(000 tons fine copper)		%	(000 tons fine copper)		%	%
1951-1955	14,123	2,839	3.3	1,949	390	2.6	13.7
1956-1960	18,324	3,665	5.2	2,509	502	5.2	13.7
1961-1965	23,488	4,698	5.1	2,941	588	3.2	12.5
1966-1970	28,161	5,632	3.7	3,328	666	2.4	11.8
1971-1973	20,813	6,956	7.3	2,185	728	3.0	10.5
Average 1951-1973		4,567	4.3		561	3.1	12.3

Source: CODELCO

10. "Chileanization" agreements included detailed and complex provisions regarding Chile's payments for the newly acquired partnership. Agreements with Anaconda also established Chile's obligation to purchase the remaining 49 percent shares of Chuquicamata and El Salvador between 1971 and 1981 under an agreed pricing formula. Agreements were put in force between 1966 and 1970 establishing the following joint companies:

Start-up	Mine	Operating Company	Ownership		
			Chile		Foreign
1904	El Teniente	Sociedad Minera El Teniente S.A.	51%	49%	Kennecott through Braden Copper Co. which owned 100% before April 14, 1967
1959	El Salvador (predecessor was Potrerillos)	Cia. de Cobre Salvador	51%	49%	Anaconda through Andes Copper Mining Co., which owned 100% before December 31, 1969
1915	Chuquicamata	Compania de Cobre Chuquicamata S.A.	51%	49%	Anaconda through Chile Exploration Company which owned 100% before December 31, 1969
1971	Exotica	Compania Minera Exotica S.A.	25%	75%	Anaconda
1971	Rio Blanco	Compania Minera Andina S.A.	30%	70%	Cerro Corporation

11. On July 11, 1971, under the Allende Government, the Chilean Congress unanimously approved an amendment to the Constitution authorizing the nationalization of mineral reserves and related facilities, particularly of the five large properties listed above. The nationalization became effective July 16, 1971, and Corporacion del Cobre (CODELCO), the national copper company assumed ownership, thus becoming the single biggest producer outside the U.S.S.R.

Table 3

CHILE: COPPER SECTOR PROJECT

COPPER PRODUCTION (1940-74)
(in 000 metric tons)

Year	Gran Mineria						Medium and Small Mines	All Mines	Contribution by	
	El Salvador	Chuquicamata	El Teniente	Exotica	Rio Blanco	Total			Gran Mineria	Medium and Small Mines
1940-49 av.	72	213	133	-	-	418	n/a	n/a	n/a	n/a
1950-59 av.	42	201	149	-	-	392	n/a	n/a	n/a	n/a
1960-69 av.	80	272	163	-	-	515	101	616	84%	16%
1960	79	232	169	-	-	480	53	533	90%	10%
1961	73	250	159	-	-	482	67	549	88%	12%
1962	82	276	152	-	-	510	76	586	87%	13%
1963	88	275	145	-	-	508	94	602	84%	16%
1964	77	288	163	-	-	528	94	622	85%	15%
1965	74	253	153	-	-	480	106	586	82%	18%
1966	78	304	155	-	-	537	100	637	84%	16%
1967	78	277	182	-	-	537	124	661	81%	19%
1968	86	275	161	-	-	522	139	661	79%	21%
1969	77	283	180	-	-	540	148	688	78%	22%
1970	93	263	177	2	6	540	151	691	78%	22%
1971	85	250	147	35	54	571	127	698	82%	18%
1972	83	235	191	31	54	594	124	718	83%	17%
1973	84	263	178	32	56	616	100	716	83%	17%
1974	80	357	226	32	68	763	127 /1	890 /1	86%	14%

/1 Preliminary.
Source: Banco Central de Chile, CODELCO, ENAMI.

12. Compensation was to be paid on the book value of the companies' assets excluding any mineral rights. The amount of compensation was to be determined by the Controller General. However, the constitutional amendment also provided for the deduction of "excess profits" obtained by the companies between 1955 and 1970. The amount of "excess profits" deductions was to be determined by the President of Chile. In addition, amounts which in the view of the Chilean State had not been usefully invested and amounts payable by CODELCO for shares in the joint mining companies under agreements which the nationalization legislation declared null and void could also be deducted. The amount of compensation after deduction and adjustments was to be paid on a deferred basis over an extended period at interest rates not less than three per cent.

13. Under the legislation, President Allende instructed the Controller General to deduct the following amounts of excess profits:

Chuquicamata (Anaconda)	US$ 300 million
El Salvador (Anaconda)	US$ 64 million
El Teniente (Kennecott)	US$ 410 million

These amounts were calculated on the basis of an assumed normal profit rate of 12 percent for the period between May 5, 1955, and December 31, 1970. The Chilean authorities also claimed that comparisons of the return on investment in Chile with investments elsewhere by the companies, showed much higher returns in Chile. On these bases the Controller General announced the compensations in October 1971 as follows:

Table 4: COMPENSATION FOR NATIONALIZATION OF 5 LARGE MINES

	Chuquicamata	El Salvador	El Teniente	Exotica	Andina
			(U.S.$ millions)		
Book value on December 31, 1970	242.0	68.4	318.8	14.8	20.2
Less Deductions					
Mineral rights	5.4	0.4	0.2	0.2	1.5
Faulty installations	13.1	5.6	20.5	4.6	0.3
Excess profits	300.0	64.0	410.0	-	-
Revaluations	-	-	198.5	-	-
Total deductions	318.5	70.0	629.2	4.8	1.9
Total compensation	- 76.5	- 1.6	- 310.4	10.0	18.3

14. The principle of retroactive excess profits deductions as well as many details of the calculations were disputed by the foreign companies which appealed to a special tribunal set up to administer the nationalization. However, the tribunal ruled that it had no powers to review the President's decision on excess profits deductions, and the companies withdrew from public legal proceedings within Chile and sought court decisions in other countries.

15. The present Chilean Government has declared its intention to pay compensation for the nationalized assets and has recently completed negotiations with the foreign companies. An agreement was reached with Cerro Corporation on the payment of US$41 million in cash and notes for the Andina mine. Cerro will continue to provide technical assistance and engineering services and help expand the operation. An amount of US$260 million was agreed on with Anaconda for compensation for Chuquicamata and El Salvador. Settlement has also been reached with Kennecott for settlement of El Teniente; total compensation of US$68 million was agreed upon, of which US$6.5 million was paid as a deposit, the remainder payable over 9-1/2 years. Negotiations have now been completed with Anaconda for the settlement of the Exotica Mine.

C. The Structure of Chilean Copper Production

16. Chile produces copper in various forms, i.e., concentrates, blister copper, fire refined and electrolytic copper. Less than five percent of total production is used by domestic fabricators and manufacturers, and part of their production is exported, as shown in Tables 5 and 6 below.

Table 5: COMPOSITION OF CHILEAN COPPER PRODUCTION, 1960 - 1973
(in %)

	1960	1964	1972	1973
Ore and slag	0.3	0.1	1.1	2.9
Concentrates	3.6	3.6	9.8	11.9
Cement	1.9	1.9	1.2	2.2
Blister	49.7	49.7	23.6	23.0
Fire refined /1	16.1	16.1	13.6	10.9
Electrolytic	28.6	28.6	50.7	49.1
TOTAL	100.0	100.0	100.0	100.0
(in '000 t)	(532)	(622)	(717)	(746)

/1 Including production of Mantos Blancos.

Source: CODELCO

17. The major conclusions are:

(a) Except for the last few years, all mine production from the Gran Mineria was smelted, but the proportion refined increased from 45-50 percent in the early 1960's to 55-60 percent in the late 1960's to 65 percent in the early 1970's. Smelter capacity did not keep pace with increases in mining and concentrating capacity.

(b) Refinery capacity in the Mediana and Pequena Mineria increased from zero in 1960 to the equivalent of 40-45 percent by 1969 and smelting capacity from 50 percent in 1960 to 70-75 percent in 1969.

(c) For the sector as a whole refined metal increased from 40-45 percent of total production in 1960 to 55-60 percent in the early 1960's. Throughout the period about 95 percent of total production has been smelted.

November, 1975
Industrial Projects Department

CHILE: COPPER SECTOR PROJECT

STRUCTURE OF THE COPPER SECTOR

1. The copper sector in Chile is divided into three major groups: Gran Mineria (large-scale mining); Mediana Mineria (medium-scale mining); and the Pequena Mineria (small-scale mining). These three groups come under the jurisdiction of the Ministry of Mines.

A. Gran Mineria: Large-Scale Mining

2. Five mining companies make up the Gran Mineria: 1/ (Sociedad Minera El Teniente S.A.; Compania Minera El Salvador S.A.; Compania Minera Chuquicamata S.A.; Compania Minera Exotica S.A.; Compania Minera Andina S.A.). All of these were owned by U.S. companies until Chile acquired part or majority ownership under Chileanization agreements negotiated under the Frei Government between 1966 and 1970. These agreements established several joint companies with government ownership held through the Corporacion del Cobre (CODELCO), the State copper corporation. Under the Allende Government, a bill proposing an amendment to the Constitution, authorizing the nationalization of mineral resources and related facilities of the copper mines, was approved on July 11, 1971 and became effective on July 16, 1971; on this date Chile took possession and assumed charge of the plants of the five large nationalized copper deposits.

3. The sector accounts for about 80 percent of Chile's total copper production and is characterized by very large-scale operations: Chuquicamata and El Teniente are respectively the largest open-pit and underground copper mines in the world. The operations are highly mechanized and automated, and are generally integrated from mining through concentrating, smelting and refining. A detailed description of the operations is given in Annex 2-3, Section D.

B. Small- and Medium-Scale Mining Sector

Introduction

4. The importance of the small- and medium-scale mining (SMM) sector in Chile has been little emphasized in studies made on the subject and its needs received insufficient attention from the Government to develop adequate

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1/ All mines with an annual output of at least 75,000 MT. Although strictly speaking Andina and Exotica mines have an annual production inferior to this figure, they are considered part of the Gran Mineria.

policies for the sector. By 1970 the SMM sector was responsible for a sixth of total exports and 22 percent of total copper output. Almost half of the sector's mining production was in the hands of a few, highly profitable foreign-owned companies with Chilean companies having a relatively minor role.

5. The legal definition of the small-scale mining industry is "a mining or mineral-treating activity, owned by individuals or companies whose total capital, as stipulated in its statutes, is not in excess of 70 'annual basic salaries.'" 1/ The medium-scale mining industry, on the otherhand, is that mining activity, whose total capital exceeds the above amount but whose total annual output is inferior to 75,000 MT fine copper. In addition to these legal differenciations, the other principal distinction between the small- and medium-scale and large-scale, (LM) mining industries include the different commercialization of the copper produced, the tax laws affecting the industry and the state agencies involved in the operation of these industries.

Structure of the SMM Sector

6. The small-scale mining industry consists of groups of individuals (generally between 1-50 persons) mining copper deposits located primarily in the northern regions of Chile. The miners organize themselves in one of several different ways: (a) groups of miners, often with their families, work the mine providing all necessary inputs, (b) individual miners ("pirquineros") exploit a particular mine, paying the owner of the mine a certain percentage of total mineral output; (c) small entrepreneurs employing miners, paying a fixed salary to them, and providing the capital and operational needs; (d) on the basis of mining cooperatives, though these have yet to be of significance. The system of "pirquineros" (b, above) is the most widespread of these organizations involving between 6-8,000 miners of the 10,000 miners employed in the sector. The working equipment and machinery used in the sector is extremely rudimentary. The small-scale mining sector is far more labor-intensive than either the medium- or large-scale mining sector.

7. As mentioned later, the sector is very dependent on ENAMI, which is the primary purchaser of minerals from the small- and medium-sized producers, and whose structure, management and operations are described in Annex 2-4.

8. There are presently five important producers of copper in the medium-scale mining industry. One other producing company, Sagasca Copper Company, started production in 1972 but has not yet reached full capacity.

1/ "Annual Basic salary" = sueldo vital annual (in early 1974 equivalent to about $400).

The financial structure, reserves, production capacity and plant descriptions of these major operations are briefly summarized below:

(a) Compania Minera Disputada de las Condes S.A.

Up to 1971, 80 percent of capital had been owned by the French company, Penarroya, and the residual capital by individual Chileans. ENAMI is now owner of 70 percent of the company's stock. The company was first formed in 1916 and its major operations include the Disputada mine and a flotation plant (7,200 tons of ore/day) in the Valparaiso province, and the Chagres smelter in the Aconcagua province. The total output of the Chagres smelter is presently 36,000 TM/year which is mainly produced as blister copper. Proven reserves are estimated to be equal to 40 million tons (1.25 percent copper) at the Disputada mine, and 20 million tons (1.6 percent copper) at the El Soldado mine (approximately 15-20 years of proven reserves at the existing rate of production). Recent exploration has provided convincing evidence that both the Disputada and Andina mines are part of the same deposits; hence potential reserves may be very large (a multiple of 40 million tons).

(b) Empresa Minera Mantos Blancos, S.A. (45 kms from Antofagasta)

A fully integrated mining operation which started production in 1961 and which is controlled by foreign capital (50 percent Marvis Corporation; 21 percent Empresa Sudamericanas Consolidadas, both of the Hochschild group; 7.5. percent IFC; 10 percent CORFO; small amounts of U.S., Canadian capital). This company developed a new processing operation to exploit the copper deposit. Total production of fine copper--mainly as refined and electrolytically pure copper--is approximately 32,000 tons per year. Reserves have been declining and are currently estimated to be five years of open-pit reserves, with additional recoverable reserves from underground mining.

(c) Compania Minera y Comercial Sali Hochschild S.A.

This company was formed in 1937 and is completely Chilean-owned. The company has three treatment plants: Ojancos (600 tons/of ore/day) and Chanaral (500 tons of ore/day) in the Atacama province; La Patagua (240 tons of ore/day) in the Aconcagua province. The bulk of the mineral treated in these plants comes from the company's mines and the rest from small producers in the nearby area. In addition there is a small amount of sulphuric acid production (300 tons/day).

(d) Sociedad Minera Pudahuel Ltda. (formerly, Santiago Mining Company)

The company was formed in 1969 as a result of the purchase of the Santiago Mining Company, a subsidiary of Anaconda. The company has two major deposits--"La Africana" and "Lo Aguirre" 1/ at Pudahuel, although only the former has been exploited--and a treatment plant with a capacity of 7,200 tons of ore/day. Annual production of fine copper is approximately 4,000 TM. The assets were in the hands of a Chilean investment group from 1969-72 but was confiscated and put under the ownership of ENAMI in the middle of 1972. The present ownership of the company is under review by the Chilean authorities.

(e) Compania Minera Tocopilla S.A.

First founded in 1919, financial structure comprises both foreign and Chilean capital. The company has two treatment plants in the province of Antofagasta whose capacity is 545 tons of ore/day. Annual production is about 3,500 TM of fine copper.

The annual production of these companies in the period 1965-73 as well as that of ENAMI is summarized in the following table:

1/ A $40 million investment involving the Sociedad Minera Pudahuel LTDA and the US company, Holmes and Narver, for the exploitation of Lo Aguirre (planned annual production of 22,000 MT fine copper) has recently been agreed upon.

CHILE: COPPER SECTOR PROJECT

PRODUCTION OF ENAMI AND THE PRINCIPAL PRIVATE COMPANIES OF THE MEDIUM-SCALE MINING INDUSTRY (1965-73)
(thousands of metric tons)

Years	Principal Private Companies						ENAMI [2]	Total SMM Sector [3]
	Disputada	Mantos Blancos	Sali [1] Hochschild	Pudahuel (Ex-Stgo. Mining)	Tocopilla	Subtotal		
1965	27.6	23.7	2.7	7.2	3.3	64.5	38.7	106
1966	26.6	27.4	3.5	3.8	3.6	64.9	20.0	100
1967	29.7	25.0	5.2	4.6	3.5	68.0	46.0	124
1968	33.2	30.3	5.6	4.3	3.0	76.4	50.6	139
1969	33.6	31.3	6.6	3.5	3.5	78.5	53.6	148
1970	38.4	34.1	6.1	4.4	3.8	86.8	53.4	151
1971	34.3	32.5	6.2	3.0	3.5	79.1	54.6	137
1972	28.8	29.8	n.a.	n.a.	n.a.	n.a.	58.2	124
1973	11.7 [5]	26.7	n.a.	n.a.	n.a.	n.a.	73.3	127
The average share of each companies' output as a percentage of total output from the small- and medium-scale mining sector [4]	24.7	22.6	4.0	3.4	2.7	57.4	34.8	100

1/ Excludes output from subsidiary companies.
2/ Calculated on the basis of annual exports; it should be remembered that what appears here as production corresponds to ENAMI's purchases from the small mining producers.
3/ Excludes Andina production in 1970 and 1971.
4/ For period 1965-71.
5/ Fall in output during 1972 and, particularly, 1973, reflects, in part, increasing ENAMI control of Disputada mining operations; the sum of Disputada and ENAMI production for 1972 and 1973 approximates to that of previous years.

Source: CODELCO, ENAMI, and Boletin Mensual of the Banco Central.

Importance of SMM Sector to the Chilean Economy

9. Copper exports from the SMM sector increased from 7 percent of total merchandise exports in 1960, to 16 percent in 1970, and approximately maintained this proportion between 1971-73. Its contribution to total copper production has also increased correspondingly in the same period as can be seen from the following table:

RELATIVE PRODUCTION BY THE LARGE, MEDIUM AND SMALL PRODUCING SECTORS

Sector	1960	1965	1968	1970	1971	1972	1973
	(percentage)						
Large	90.0	82.0	79.0	77.3	80.6	82.7	82.4
Medium	6.0	14.1	15.3	16.7)	19.4	17.3	17.6
Small	4.0	3.9	5.7	6.0)			
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

10. An important difference exists between the SMM sector and the LM sector in that the annual outputs of the former have been far more sensitive to the fluctuations in the world price of copper. The sharp increase in output evident since 1960 is due to various new mines and smelting operations which started up during this period. These include the Chagres smelter, the Mantos Blancos mining operation, and ENAMI's new smelter and refinery. Whereas at the beginning of the decade a large proportion of the "fine copper" produced was in the form of copper concentrate or cement, by the end of the decade an increasing proportion of copper output in the sector was processed either to blister or electrolytically refined copper.

Commercialization

11. All sales of copper in the sector can be made directly to foreign buyers. However, CODELCO has been delegated the responsibility of controlling these operations and must authorize each one of them. These can be of two kinds: the sale of electrolytically refined copper and the sale of copper concentrates or cements to foreign clients for further processing. CODELCO must approve each detail of the final contract including the prospective buyer, the volume sold and the price at which the copper is sold, the sales commission, insurance and transport costs and other details. Since 1965 the average annual sales price of copper from the SMM sector compared with copper from the LM sector has not differed markedly. Prior to 1966, however, appreciable price differences were often recorded when the small- and medium-sized copper producers were governed by copper prices

quoted on the London Metal Exchange, whereas the large copper producers were still controlled by U.S. companies and sold the vast proportion of their copper at a fixed price. Towards the end of the last decade ENAMI started to play an increasingly important role in the sale of copper from SMM sector, with the start up of the Ventanas smelter and its consequent greater participation in the processing of ore from the SMM Sector. An additional change which was proposed, but never in fact materialized, was that CODELCO should be completely responsible for all sales in the SMM sector --including ENAMI's. At the end of 1973 the traditional system was again operative whereby production from the SMM sector was commercialized independently, partly by ENAMI and partly by the private companies themselves, subject always to CODELCO approval, however.

Tax Regulations Affecting the Sector

12. Historically, the small-scale mining industry was virtually exempt from the normal tax regulations, including income tax, governing industrial enterprises; it was also exempt from having to pay import duties on inputs required for its operations. The only tax to which the industry was subjected was a 2 percent tax on the volume of its mineral sales which was retained by the domestic buyer, generally ENAMI. The medium-scale mining industry also benefited from import duty exemptions but the tax regulations were more complex with no uniform pattern existing. Several industrial tax laws were applicable but in practice the Government negotiated directly with the company concerned and the outcome was invariably an agreement in which tax payments were minimal. More recently, tax benefits, particularly import duty exemptions, have been discontinued and the SMM sector is now subject to standard tax regulations affecting industrial enterprises.

Sectoral Needs

13. Important measures are either under consideration or have already been taken to improve inadequacies in the SMM sector and to coordinate its long-term development. One measure is a reform of the regulations governing the sector with the objective of increasing revenues derived from the operations of the medium-sized companies and preventing situations in which such enterprises pay less taxes than the smaller enterprises. Another measure is that the Government should play a more cohesive role in formulating a development strategy for the sector. Several problems are being given consideration here which include: (i) defining the guidelines for additional foreign investment (the new foreign investment law has clearly helped but the fiscal regime needs clearer definition); (ii) improving the current, inefficient organizational structures of the small-scale mining industry--a complex problem in view of the significant employment generating effect of the sector; (iii) reviewing the adequacy of the system for establishing ENAMI's mineral purchasing prices; (iv) establishing sector priorities for the development of important new copper deposits such as Andacollo, Lo Aguirre and others, which could have a significant

impact on total output at the end of the present decade; and finally, (v) carrying out detailed feasibility studies to evaluate the likely benefits derived at a national level from the exploitation of a given deposit. Such decisions will require some measure of centralized government planning, that ENAMI exercise a much more dynamic and decisive role than at present, and that government policies have sufficient flexibility to allow scope for private initiative.

14. In order to ensure the efficient exploitation of current mining operations and at the same time achieve this without detrimental effects on Chile's overall development, two conditions are essential:

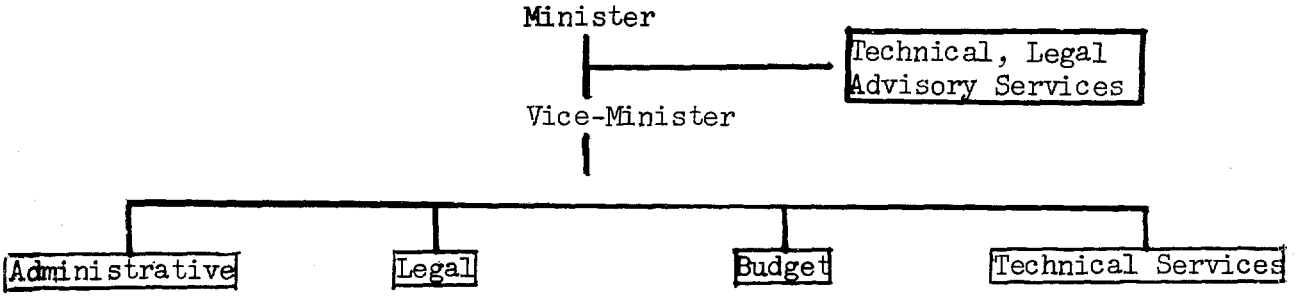
(i) A high degree of decentralization with regard to the operational and productive aspects of each copper company's mining operations; and

(ii) Centralization of sector planning and policy-making decisions affecting the sector's development.

Centralized and effective coordination of the copper sector's development does not yet exist. Although consideration is being given to establishing a planning unit within a new CODELCO-like Agency no definitive decision has been taken. Investment decisions relating to the development of new copper mines or to the expansion of existing capacity should be centralized within such a planning unit.

C. Ministry of Mines

15. The Ministry of Mines has official jurisdiction over all mining development in Chile with the exception of the nitrate industry. It is responsible not only for the copper sector but includes also iron-ore mining and other metals such as lead, gold and silver which are produced in small amounts. The Ministry has been traditionally weak and has exerted little influence in coordinating overall planning of the sector. Its policy-making role has also been minimal. The foreign-owned companies, and, before and after nationalization, the State Copper Company (CODELCO), have enjoyed a high degree of autonomy in not only the operational and administrative aspects of copper mining development but also in investment planning. When the Government has intervened on policy decisions affecting the development of the sector it has in most cases not been through the Ministry of Mines. The Ministry's functions in practice have tended to be legal in kind (responsible for the Mining Code) and in providing limited technical services to the mines. The organization of the Ministry is shown below:



The Ministry has an extremely small technical and professional staff. Although the Minister is chairman of the Board of both CODELCO and ENAMI, decision-making has been mainly exerted through the Executive Vice President and senior management of these companies.

16. A major revamping of the Ministry is currently being considered aimed at strengthening the role of the Ministry in the sector and bringing possibly the energy-related fields of petroleum, coal and natural gas under the same ministerial jurisdiction. The agencies responsible for the development of these mining activities are currently under the Corporacion de Fomento.

D. Corporacion de Fomento (CORFO)

17. The Government's development agency, CORFO, within its many developmental responsibilities covering the agricultural and industrial sectors, has a mining division which comes under the Industrial Department for Non-renewable Natural Resources. CORFO has also three important autonomous subsidiaries in the mining sector, the Petroleum Company (ENAP), the Coal Company (ENACAR) and the Nitrate Industry (SOQUIMICH). CORFO's own activities in the mining sector extend to the initial development phase--prospection, evaluation of geological resources, delineation of ore bodies, metallurgical studies--which would allow the subsequent exploitation of geological deposits. Its activities have been generally in those sectors where other state entities were not involved, i.e., outside of the copper sector and iron-ore mining, although CORFO has collaborated with CODELCO in geological studies related to delineation of the El Abra copper deposit and is represented on the Board of both CODELCO and ENAMI. CORFO's mining division has four units: mining economics, mining prospection (including drilling), chemical and extractive metallurgy, development and production. CORFO's principal mining activities currently include:

(a) Atacama Salt Deposits - preliminary studies leading to exploitation of the salt deposits;

(b) Limestone Deposits - preliminary studies aimed at increasing Chile's production;

(c) Phosphorus Mineral Development - evaluation of Chile's apatite reserves; and

(d) Magallanes Coal Deposits - geological studies in cooperation with ENAP aimed at exploitation of low-grade coal reserves.

Industrial Projects Department
April 1975

CHILE: COPPER SECTOR PROJECT

CODELCO (CORPORACION DEL COBRE)

A. Formation and Present Legal Statutes

1. In 1955 Law No. 11,828 "Ley del Cobre", created the "Departamento del Cobre" as a technical department of the Central Bank to act as a control agency for the copper industry and supervise observance of the legal provisions governing the industry. In 1967 a new Law No. 16,624 converted the Departamento del Cobre into the Corporacion del Cobre (CODELCO, located in Santiago as a wholly Government owned corporate entity, as a vehicle for government participation with the foreign mining companies in the exploitation of the five large mines.

2. Liaison with the Government is provided through the Ministry of Mining. CODELCO is administered by a Board, an Executive Committee and an Executive Vice-President.

3. The Board is composed of:

1. Minister of Mining (Chairman)
2. Executive Vice-President of CODELCO (Vice-Chairman)
3. Undersecretary of Mining
4,5. Two representatives of the President of the Republic
6,7. Two representatives of the Central Bank
8. Director of Taxation
9. Executive Vice-President of CORFO
10. Manager of Enami
11,12. Two representatives of Gran Mineria
13-16. Four representatives of the Institute of Mining, Engineers of Chile, Asimet, the employees covered by the Copper Workers Statute.
17. One representative of Sociedad Nacional de Mineria.

A quorum for meetings is absolute majority of its members (i.e. nine) and resolutions are adopted by absolute majority of the directors present, except in cases where special majorities would be required. Board members serve two years and can be reelected.

4. The Executive Committee is composed of:

1. Minister of Mining or in his absence the Undersecretary of Mining.
2. Executive Vice-President of CODELCO
3,4. Two directors representing the President of the Republic
5. One director representing the Central Bank.

A quorum for meetings is at least three members, one of whom must be the Minister, Undersecretary or Executive Vice-President. Resolutions are adopted by the majority of those present.

5. The executive Vice-President is appointed by the President of the Republic and is the legal representative and administrative chief of CODELCO responsible for implementing the decisions and resolutions adopted. The Auditor appointed by the President of the Republic also attends meetings of the Board and Executive Committee with the right to speak. He may substitute for the Executive Vice-President.

6. With the nationalization of the Gran Mineria, new rules were issued on July 7, 1972, in DFL No. 1 1/ which conferred additional powers on CODELCO. The decree provided that the capital of the nationalized enterprises was to be owned by CODELCO and ENAMI in the proportion of 95 percent and 5 percent respectively. DFL No. 1 is at present, together with a few decrees issued since September 1973, the principal legal instrument establishing regulations for the administration and operation of the nationalized copper companies. It lays down a statute for the nationalized enterprises, determines their capital structure, organization and administration, gives general guidelines on accounting, balance sheets, profits and auditing. Under the existing legislation each of the companies is supposed to be governed by an Administrative Council of 11 members: four representatives from CODELCO designated by the President of the Republic, one representative from ENAMI designated by the President of the Republic, five representatives from the employees of the company elected by vote, and one representative to act simultaneously as President of the Council and General Manager of the company who can be designated and removed by the President of the Republic. However, since the change of government in September 1973, the administrative councils have been abolished and administration of each company is effected solely through the General Manager. CODELCO has the power to request from the companies all data and audit it deems fit, and to establish regulations on economic, financial and labor policy and other activities of the companies. CODELCO is responsible for marketing the copper and its by-products produced by the companies, and also for procurement of equipment, spare parts, materials and the supplies required.

7. The legislation now governing CODELCO is the product of an evolution of the Chilean copper sector development and political events rather than a conscious plan; hence, it leaves to interpretation the actual role CODELCO should play. Clearly, it is an entity that directs and supervises the production activities of the copper-producing enterprises and at the same time provides service in marketing, purchasing and finance. However, there is considerable disagreement over whether CODELCO should behave more as a service institution providing services to producing companies or as a fully integrated company directly participating in the management of the producing entities. This dichotomy also exists in the present legislation and setup of CODELCO:

1/ Decree with force of law.

on the one hand policies of production, personnel, marketing, and purchasing are directed by Codelco staff; production and investment planning are centralized and coordinated in Codelco, suggesting a leaning to the "integrated company" approach; and on the other, the accounts for the companies are consolidated under the Gran Mineria (i.e. the five mines) and not under CODELCO, with deductions (commissions) for budgetary support of CODELCO, suggesting a thinking of the latter as more a service organization. This dichotomy pervades the thinking of the various executives within CODELCO and the producing companies.

8. A clear policy is definitely needed. 1/ The concept of CODELCO as a fully integrated company, directing the activities of the producing entities within the framework of relative management autonomy, is strongly recommended and should help ensure that each producing entity at all times strives for maximum efficiency in their operations and investment decisions. An early step should be to adjust the accounting system to allow for consolidated CODELCO accounts versus consolidated Gran Mineria accounts. CODELCO should be thought of as a single company with the producing entities considered as individual profit centers. A thorough review of all legislation governing CODELCO and the Gran Mineria is needed with a view to revising it to remove ambiguity and provide clear guidelines for operation and development of the Gran Mineria del Cobre. This should of course be tied to a complete review of the operating and development policy for the overall Chilean copper sector, to ensure that the coordinating and control functions now performed by CODELCO are transferred to an appropriate monitoring body which would coordinate not only the operations of CODELCO, ENAMI, the small and medium companies but also of the foreign companies which may participate in the development of many of the presently unexploited deposits.

B. Organization

9. Organization charts are attached as follows in pages 6 to 13 this Annex:

Chart I	CODELCO
Chart II	Compania de Cobre Chuquicamata
Chart III	Compania Minera Exotica
Chart IV	Compania de Cobre Salvador
Chart V	Sociedad Minera El Teniente
Chart VI	Compania Minera Andina
Chart VII	Centro de Investigacion Minera y Metalurgica (Mining and Metallurgy Research Center)
Chart VIII	Instituto de Investigaciones Geologicas (Geological Research Institute)

CODELCO

10. As discussed above CODELCO is governed first through a Board of Directors (seventeen members), second through an Executive Committee, and thirdly through the Executive Vice-President (Mr. Andres Zauschquevich). The organization then divides into two areas: a) general management, which includes

1/ By August 1975 a clear policy had emerged and considerable progress made to implement many of the recommendations contained in paragraph 8.

departments in Sales, Purchasing and Warehousing, Finance, Administration and Industrial Relations, and b) Enterprises Management, which directly controls and also provides staff services to the operating companies.

11. Sales: By decree CODELCO is responsible for the sale of the copper and by-products not only from the Gran Mineria but also is responsible for monitoring all sales of copper (and by-products) produced in the sector, a function it has performed well to date. Centralizing the sales is very important to ensure efficient utilization of Chile's mining and processing facilities, efficient investment and development planning.

12. Purchasing: Purchasing of all imported goods has been centralized for all the companies within the CODELCO head office, but local materials are purchased separately by each company with the minimum of guidance from the central office. This department still requires considerable strengthening; warehousing procedures, inventory control, reordering practices all need to be reviewed. Standardizing of procedures and coordination between the central office and the responsible departments in the operating companies must be improved. Steps are being taken in this direction.

13. Financing: Accounting for each of the enterprises is done by their own staffs at present following the procedures used by the companies before nationalization. These accounts are submitted to the Finance Department in CODELCO where they are consolidated into the Gran Mineria for the five companies, but not for CODELCO. The latter is needed. The accounting practices used are adequate but should be standardized between the companies. The central office is currently setting up a coded accounting system that will be adopted by all the companies and CODELCO. Budgetary control and cost accounting varies considerably between the companies, being superior for El Teniente and Andina, than for the Northern group, but requires considerable improvement. At present there is very little interplay between the financial and production departments and there exists a definite lack of cost consciousness in all operations at all levels of management. Also, financial planning by department, by company and by CODELCO is virtually absent. Hence, a major effort is needed to strengthen the financial functions in both the CODELCO central office and in the companies, and also to improve cost consciousness of the operators. The concept of profit centers could usefully be introduced. Revamping the accounting and financial systems would be an integral part of the corporate reorganization referred to in paragraph 8.

14. Administration and Industrial Relations have functional links between CODELCO and the operating companies which otherwise act significantly autonomous.

15. Enterprises Management: The General Managers of the producing companies report to the Enterprises Manager, who also has reporting to him departmental managers for Investment Planning, Production Planning, Engineering, Research and Development, and Geological Services. While the former group appears to have a direct line relationship with the Enterprises Manager, there exists some ambiguity in view of DFL No. 1, which establishes, as described in paragraph 6 above, an Administrative Council responsible for governing the operations of the

operating companies. However, as also mentioned in paragraph 6, the administrative councils are not operative. Nevertheless, this ambiguity raises the potential for conflict, particularly since much of the legislation (even recent legislation) governing the Gran Mineria refers directly to the operating Companies, at times excluding reference to CODELCO. The relationship between the departments listed above, that fall under the Enterprises Manager, and the operational companies is functional only. No line relationship exists; hence, coordination and cooperation is of utmost importance if these departments are to usefully fill their role. Some resistance to this functional link is being encountered on part of the companies which points up the importance of modifying the legislation to converting CODELCO to a fully integrated company.

16. Planning: Several problems are very apparent for the Investment Planning Planning department for the following reasons:

a) In the past each mine operated as a separate entity, with investment and production decisions being directed from the private owners. Little or no coordination between mines was practiced.

b) Except for El Teniente, and possibly Andina, most investment planning and project design and evaluation was done by the parent companies abroad with little participation of the engineers and managers of the producing companies.

c) This has led to a position where the engineers and administrators in the producing companies, not having been exposed to the planning function, are reluctant to divert their attention from production and day to day operations to assist in the planning effort. This situation is aggravated by the large exodus of senior engineers that took place after nationalization.

d) Not only is there a shortage of engineers within CODELCO and the producing companies as a whole, but particularly there are almost no engineers with experience in project evaluation and planning per se. A "planning philosophy" is absent and many of the personnel look to projects solely from the point of view of the budgeted allocation. Engineers often proceed with engineering design without consideration of capital costs, the operating cost and most importantly the financial viability of the project. Despite the fact that guidelines for project preparation have been prepared, few projects are presented in an integrated form that allow for a judgement on project viability let alone project priorities.

e) Very importantly, the dichotomy of views as discussed above on the role of CODELCO, as an integrated company or a service organization.

Now more than ever before it is extremely important that a coordinated development plan (and strategy for development) be prepared for the Gran Mineria. This requires two major steps:

a) establishing of a policy at senior management and possibly at Ministerial levels, and

b) development of a long-term Investment Plan.

17. CODELCO management is very conscious of those needs and are taking steps now to prepare a five-year investment program. A first draft is expected by late 1975. A short-term investment program has been prepared for 1974/5, mainly on the basis of urgent needs and completion of continuing programs. However, the problem of inadequate project preparation must be solved before it will be possible to prepare optimal strategy for development of the Gran Mineria.

CHART I: CODELCO (CORPORACION DEL COBRE)
ORGANIZATION CHART

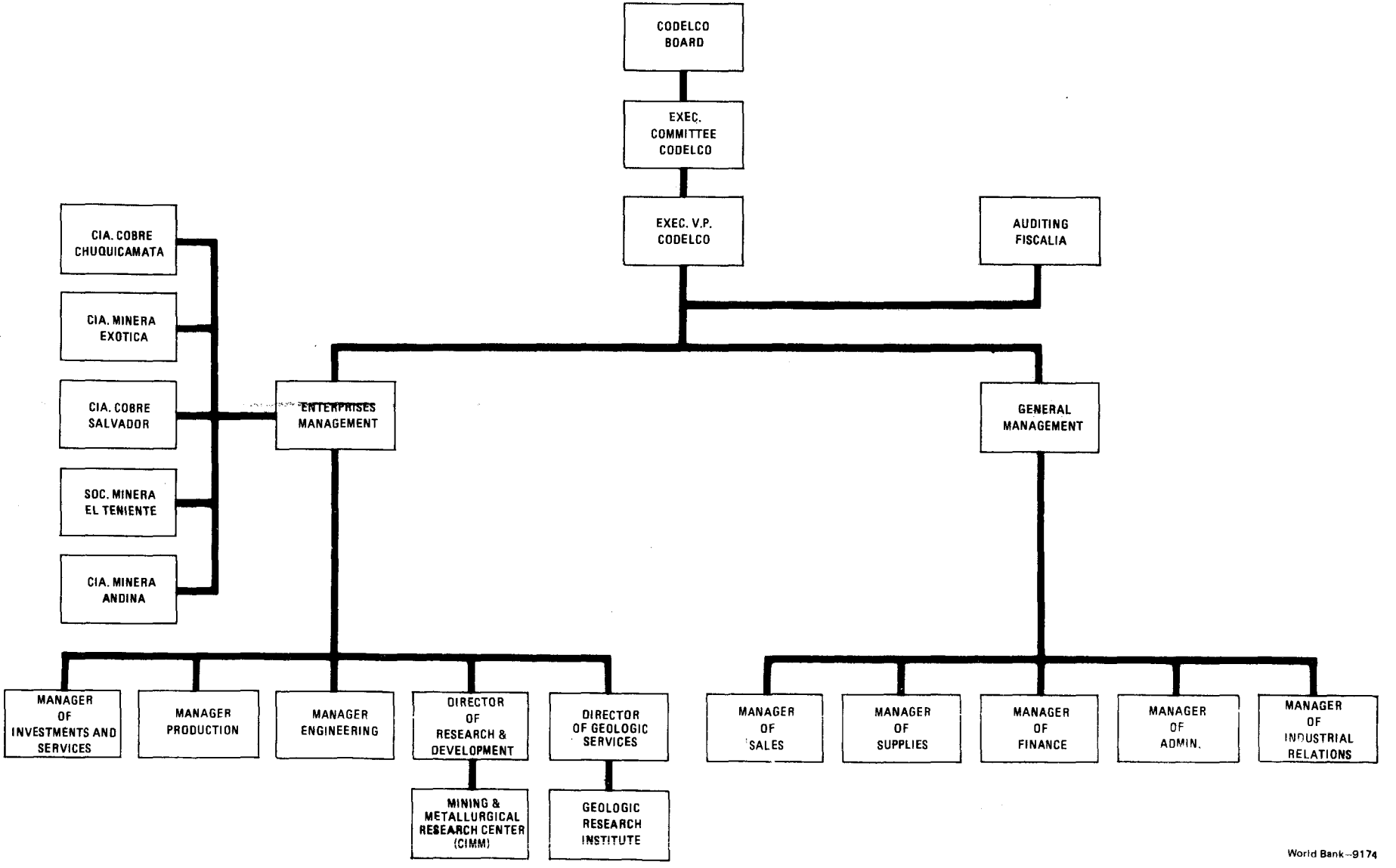


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CHART II: COMPANIA DE COBRE CHUQUICAMATA
ORGANIZATION CHART

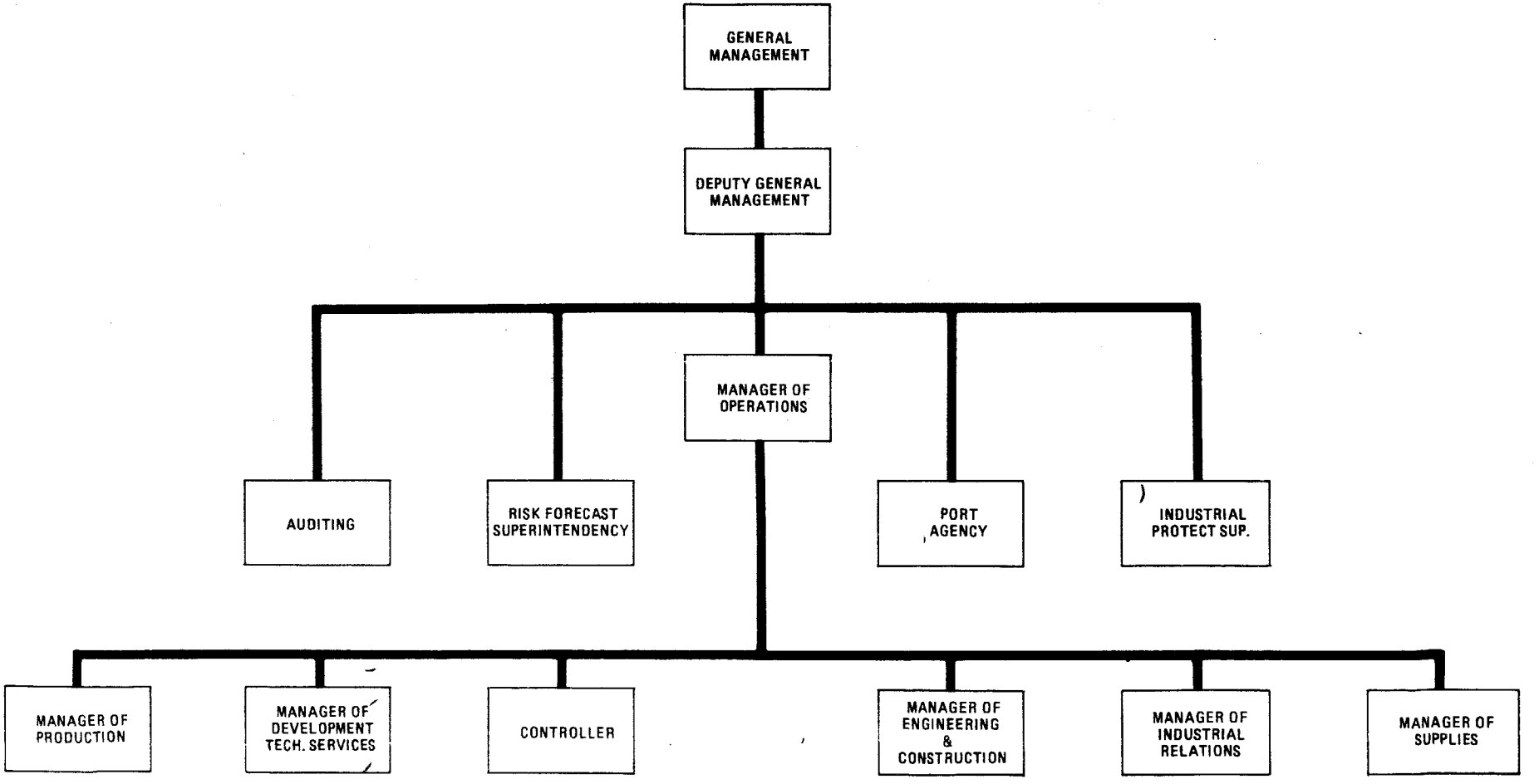

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CHART III: COMPANIA MINERA EXOTICA
ORGANIZATION CHART

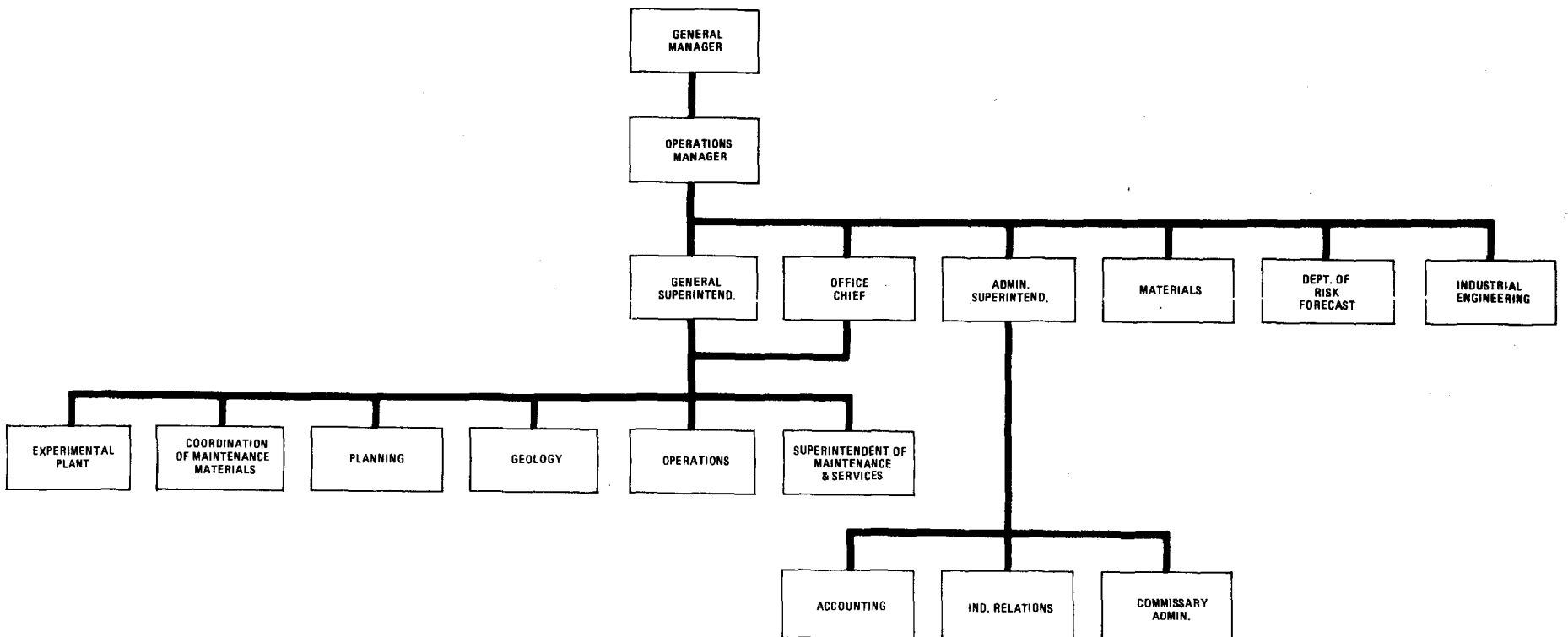

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CHART IV: *COMPANIA DE COBRE SALVADOR*
ORGANIZATION CHART

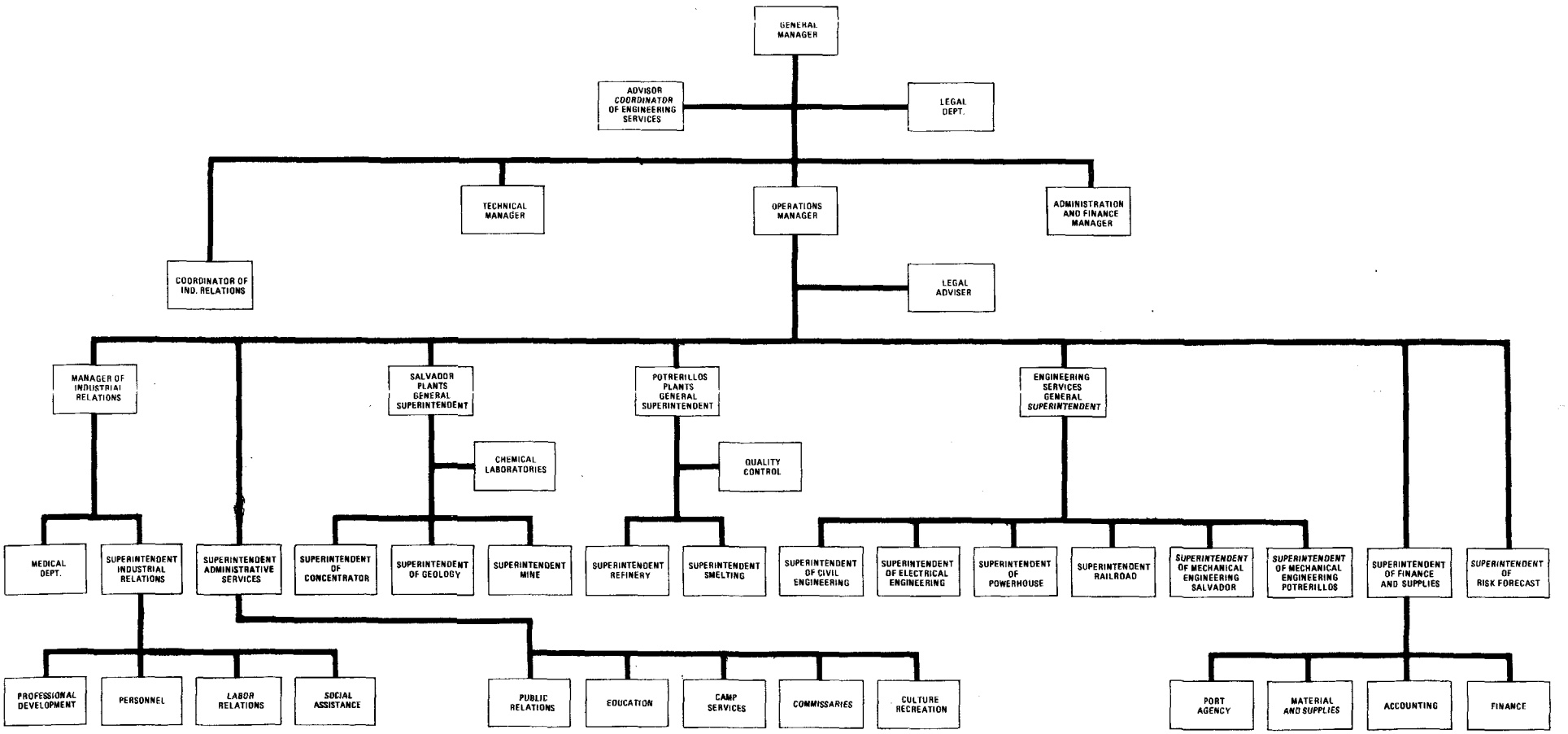

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CHART V: SOCIEDAD MINERA EL TENIENTE
ORGANIZATION CHART

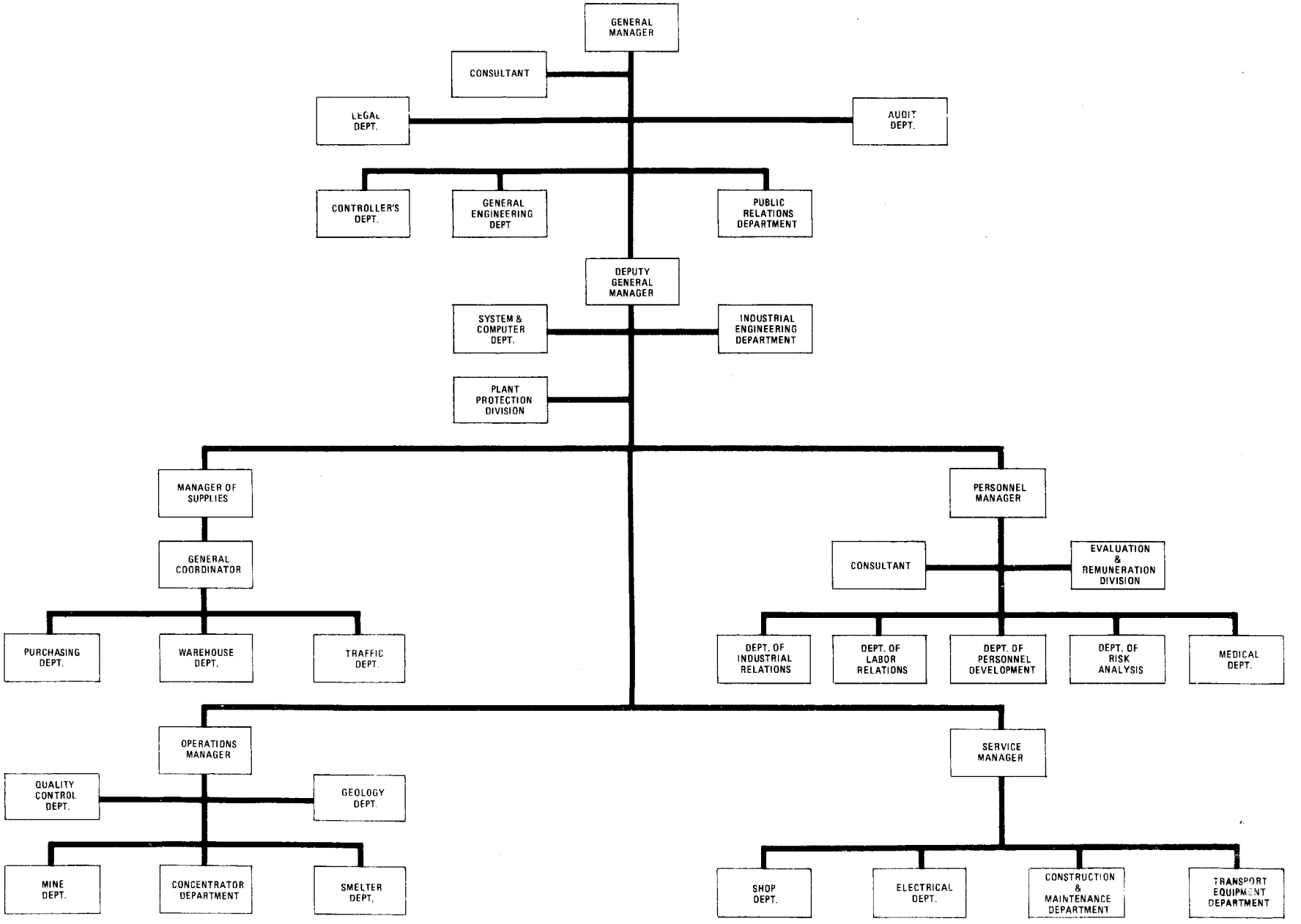

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CHART VI: COMPANIA MINERA ANDINA
ORGANIZATION CHART

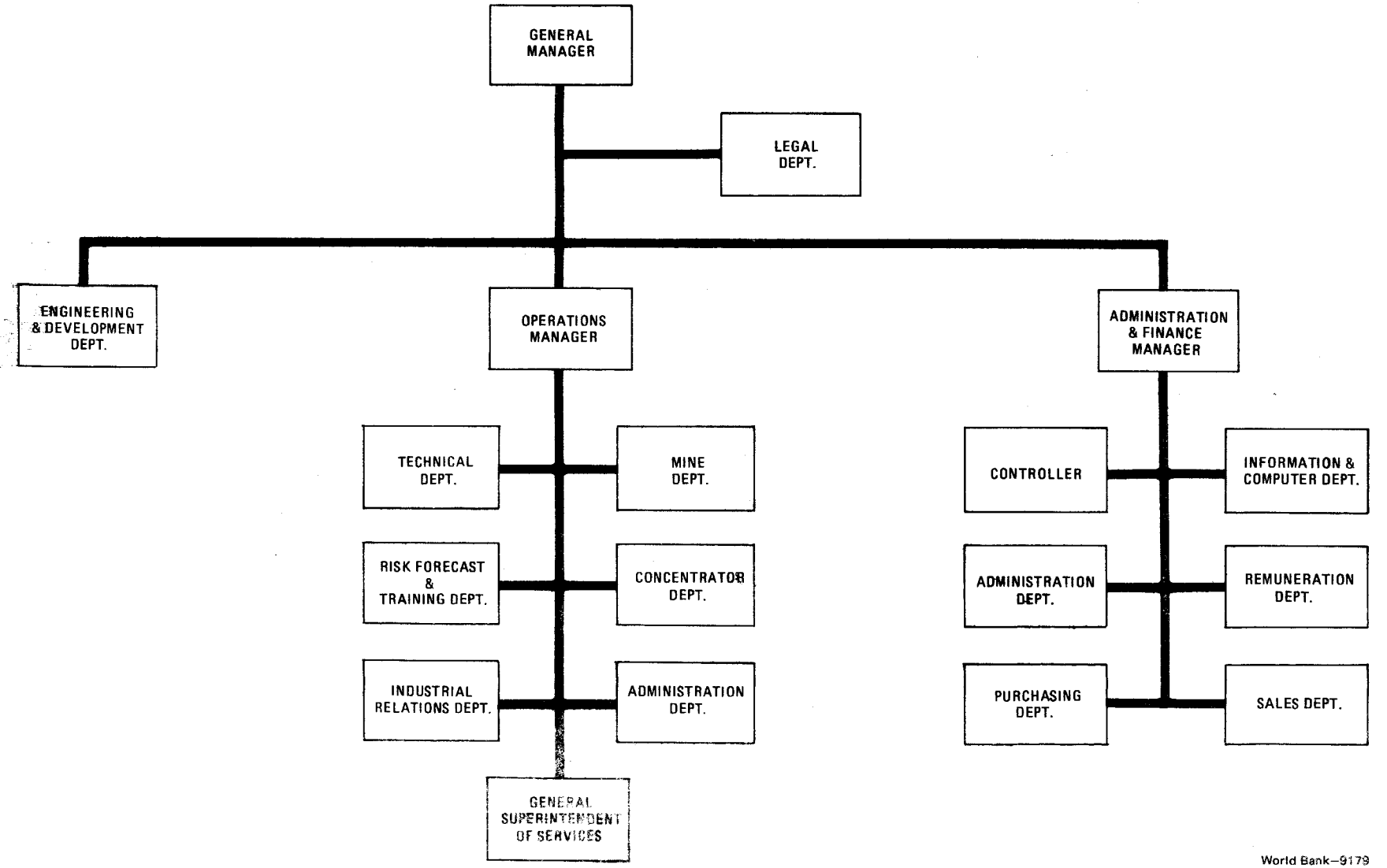

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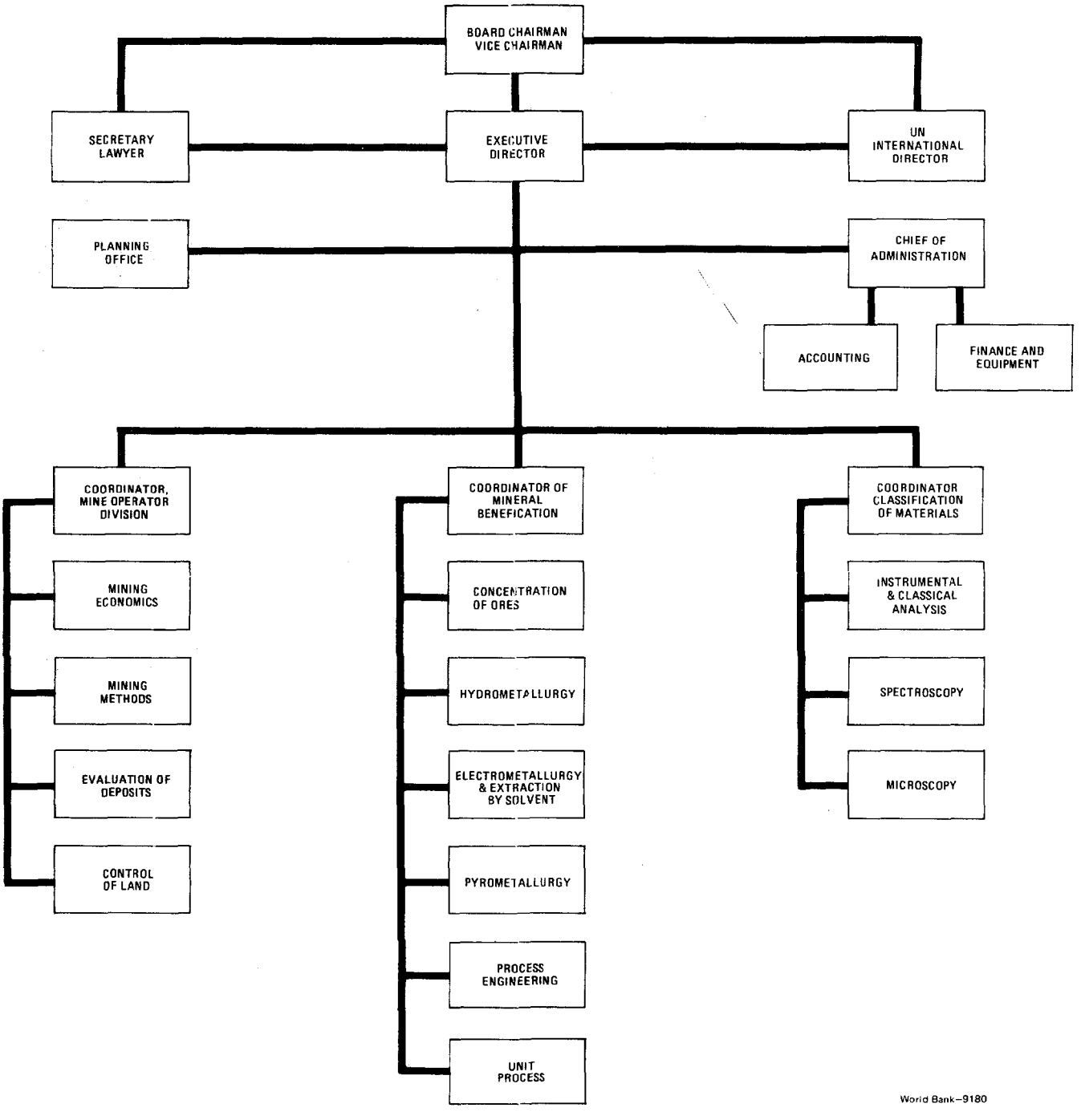
CHART VII: CENTRO DE INVESTIGACION MINERA Y METALURGICA ORGANIZATION CHART



World Bank–9180

18. Research and Development: With the nationalization of the Gran Mineria use of the large sophisticated research organizations of Anaconda and Kennecott was lost to the Chilean industry. It has therefore been necessary to replace them with a national research center, and there is no doubt the Chilean copper sector is definitely large enough to support a significant research and development effort. To provide for a fully coordinated research effort, CODELCO took two major steps:

a) They established a Research and Development Division to identify the needs and problems faced by the Gran Mineria, to prepare research projects and conduct these programs, and

b) Took over control of the Centro de Investigacion Minera y Metalurgica (CIMM), which was set up in 1970 with assistance from the UN, Belgium, Canada and Great Britain (see description paragraphs 52-56 this annex).

As with the planning department, coordination of research is very important but has met with some resistance, for many of the same reasons listed under planning in paragraph 16 above. The director of research is making a major effort to establish a working relationship with all the producing companies. Correctly utilized, major benefits can be realized from the research center.

19. The Departments of Production, Engineering and Geology appear to have established satisfactory functional links and working relationships with the operating companies.

The Companies

20. While each of the companies is administered by a general manager, the organizations from there on differ considerably between companies, depending upon that inherited from the private companies. This contributes to some of the coordination problems discussed above, making it difficult to:

a) establish functional links between the companies and the central departments of CODELCO;

b) establish standard procedures for investment planning, personnel administration, production planning and control, purchasing and inventory control, and research and development, and

c) very importantly, standardize budgetary control, implement rigorous cost accounting procedures, establish accounting codes, and introduce financial management.

Any major reorganization would in itself be a major task which the shortages of staff would make difficult to implement at this stage. Nevertheless, it would be very useful to review the total organization structure of CODELCO and the companies, with a view to improving coordination, standardizing, eliminating redundancies and duplications, and establishing clearly defined lines of responsibilities and authorities. Internal reporting procedures could be improved to facilitate coordination and assist decision making. There exists a very obvious lack of communication and a reluctance to communicate not only between the companies and CODELCO but also between the departments within CODELCO. Steps must be taken to rectify the situation. In full realization of the problem the management have engaged a consultant team (Consultores en Ingeneria y Administracion de Empresas) to: a) study the reorganization of CODELCO and the companies, including an analysis of the information system; b) Review the system of costing and establish a cost accounting system; and c) Review the existing and prepare a new system for production control. The study has been underway for about six months and it is expected that preliminary results will be available by mid 1975. It is very important that management make an early decision to implement recommendations of the study. One question that readily comes to mind is, is it necessary for each producing company to have a head office located in Santiago independent of CODELCO? Would it not be more effective to combine the functions of the separate Company head offices under the CODELCO staff? This should improve efficiency, elminate duplication, and lower the staff requirements (an important factor considering the shortage of qualified staff) and consequent costs.

C. Staffing

21. Largely as a result of the mass exodus of engineers (foreign and national) in 1971/72 after the nationalization of the Gran Mineria by the Allende Government, CODELCO and the Gran Mineria have a problem of serious staffing deficiencies. Nevertheless, the senior management in CODELCO has been filled with experienced and qualified personnel, with few important gaps. Support staff is thin and overall the CODELCO group has a very young staff with limited experience. For example, the average experience of the engineering staff at Chuquicamata is four or five years, and at Potrerillos, which was left with only two mining engineers at one point after nationalization, the average length of experience is close to two or three years. The average length of experience at Andina is somewhat longer, and the staff at El Teniente tends to be the most experienced of all operations, primarily as a result of the "Chileanization" agreement reached in 1967 with Kennecott. Andina has the benefit of support from Cerro engineering staff as agreed under the nationalization contract.

22. Despite the relative inexperience of the staff and promotion of young staff members to senior posts, the production operations of the mines have been carried out reasonably effectively, and production since September 1973 has increased substantially. This is a creditable performance given the poor state of operations inherited by the administration in September 1973 and the lack of spare parts. Nevertheless the operations still operate

considerably below the potential and suffer from the lack of mining engineers but particularly from a lack of metallurgical engineers (hydro and pyrometallurgical) and process control engineers. It has been estimated that more than 150 additional metallurgial engineers (versus 100 now engaged) are needed to efficiently operate the concentrating plants, smelters and refineries. Process control is one area which needs substantial improvement for all the operations and which will have substantial financial benefits. Possibly more than 50 additional mining engineers are required for operations, but also importantly needed are experienced operational supervisors. Also the Gran Mineria faces the Chile-wide problem of shortages of skilled tradesmen: welders, mechanics and electricians.

23. Perhaps even more crucial is the lack of qualified people to fill some of the staffing functions of CODELCO and the five companies. Areas affected are:

a) production planning and control,
b) investment planning,
c) project preparation and evaluation,
d) research and development,
e) warehousing, purchasing, inventory control, and
f) administrators.

These gaps not only place a heavy burden on the staff now responsible for the above functions, but will place a definite limit on the Gran Mineria's ability to expand its operations. These staffing needs will be more difficult to fill than those for the production activities since more experienced people are sought.

24. Cognizant of the staffing problem the management have established a division of "Human Resources" under the Director of Research and Development. This unit is at present making an inventory of the total professional resources of the companies, with a view to identifying specific staffing gaps and training needs. An active recruiting program is under way, but given the worldwide shortage of mining and metallurigcal engineers and administrators, and relatively low salaries of CODELCO this can only be a partial solution. A major emphasis will have to be placed upon training of existing staff through special university courses, through scholarships for travel to other operations, through exchange programs, and special on the job training, etc. The use of consultants and other technical assistance will also be needed. A very important factor to be taken into account is the underutilization of engineers by CODELCO and the companies. Engineers are often assigned tasks that could more fittingly be done by technicians without university level training. It is very possible that if all jobs now performed by engineers or vacant were closely scrutinized, it would be found that many of them could be adequately performed by technicians or experienced workmen with a little training. Hence the shortage of engineers may not be as serious as thought. This aspect should be given more consideration. Training of technicians may be the real problem.

25. The labor force is well trained, and except for some of the skills listed above, in adequate supply. At present as a result of the Allende policies, the operations are over-staffed, despite the large layoffs. Normal attrition is expected to reduce the labor force to normal levels within one or two years. The following table lists the employment in the Gran Mineria in June 1974.

Persons Employed in the Gran Mineria (June 1974)

Entity	Number of persons
CODELCO	717
Compania de Cobre Chuquicamata	10,421
Compania Minera Exotica	418
Compania de Cobre Salvador	5,929
Sociedad Minera El Teniente	12,695
Compania Minera Andina	2,021
Centro de Investigacion Minera y Metallurgica	117
Instituto de Investigaciones Geologicas	243
Total	32,561

D. Description of Operations

26. **Following are brief descriptions of the operations administered by CODELCO.**

Chuquicamata

27. The Chuquicamata complex consists of a large-scale open-pit mine, a concentrator, a smelter and a refinery, located 240 km NE of Antofagasta, 2,870 m above sea level. It has an extremely dry continental climate with moderate temperatures.

28. The Mine is based upon a huge porphyry copper deposit. Proven reserves are 1,500 million tons at 1.21 percent copper and about 0.04 percent molybdenum to a depth of 400 meters. Yet one drill hole to 600 meters below the pit bottom showed continued mineralization of more than 1.2 percent copper. Hence, the potential reserves are really a multiple of the 1,500 million tons of proven reserves. **The** ore in the upper part of the deposit (i.e. that part accounting for the main production to date) consists chiefly of copper oxide minerals (antlerite, brochantite and atacamite). However, the primary ore making up most of the deposit and which will account for most of future production consists chiefly of copper sulphide minerals (chalcocite, covelite, chalcopyrite). The Chuquicamata pit is the largest non-ferrous open-pit mine in the world, 3,400 m long, 1,400 m wide, 400 m deep, with a production capacity of 180,000 tons of ore and waste/day. With the existing stripping ratio of 1.5:1, 100-120,000 tons of waste is removed per day and 55-65,000 tons of ore. Average grade in 1974 was 1.80 percent copper, and should average 1.6 percent or more over the next four-five years. Equipment on order will increase this by 45-50,000

tpd to 230,000 tpd. These capacity figures, however, assume an equipment availability factor of 40 percent which is extremely low and a more normal availability of 65-70 percent would increase these figures significantly. Recent production of more than 350,000 tons of ore and waste for one day give creditability to this conclusion. In the 36-year production plan, the strip ratio will increase but it will never be greater than 3:1. Conventional drilling and blasting is used. The waste on the upper benches is mainly loaded out by the train system, the remainder of the waste and all ore is hauled by truck. As part of the expansion expansion program a 54" gyratory primary crusher was installed in the pit, connected by conveyor belt through an incline tunnel to the concentrator. This, however, forms a bottleneck and needs modification. The planned capacity of 5,000 tons/hour has never been attained. Mining during the next five years will be in the southwest and northwest part of the open pit and then later in the eastern part of the pit. Considerable stripping is required to ready the east side for production. With additional equipment now on order, production equipment will total twenty-two electric shovels (up to 16 yard capacity), nine rotary drills (12-15" diameter), eighty trucks with capacity of 100 and 120 tons, plus railroad equipment. During the period 1968-73 operations in the open pit deteriorated significantly, due to improper production sequence and lack of spare parts. This resulted in the doubling and even tripling of bench heights from the standard 13 meter height resulting in hazardous, unsafe conditions and pit slope instability. Some progress has been made in stepping out the stripping requirements and getting the bench heights to 13 meters for better production control and safety, but normal conditions will not be restored before late 1975. Better equipment utilization and scheduling could provide significant increases in production with little or no investment, and reduce operating costs. Achieving further significant increases in production should be afforded high priority.

29. The Concentrator. Primary crushing is conducted by (a) a gyratory crusher (60") located at the concentrator which is fed directly by truck, and (b) by a 54" crusher located in the pit, connected to the concentrator by conveyor. These are followed by five lines of secondary and tertiary crushing facilities, 12 lines of grinding facilities (rod and ball mills) grinding to 50 percent - 200 mesh, flotation, regrind, thickening, filtering, molybdenum separation and copper drying facilities. The concentrator has the capacity to treat 65,000 tons of ore at 1.65 percent copper per day, but with debottlenecking (a small investment of US$500,000), could be increased to 75-80,000 tons per day (at 1.65 percent copper this equals 1,100 tpd of fine copper, the present target). With a small investment in the order of US$5-6 million in additional grinding facilities flotation cells, and tailings thickeners, it has been estimated that capacity could be increased to 90,000 tpd at 1.65 percent copper; this equals 1,400 tpd. of fine copper, or more with the existing grade of 1.80 percent copper). As the mine grade drops mill capacity will have to be increased further. The concentrator produces (a) approximately 2,000-2,500 tpd of copper concentrate grading 35-45 percent copper with a recovery rate of 90-91 percent (the grade will drop with the deeper ore owing to a higher chalcopyrite/chalcocite ratio); and (b) 18-22 tons per day of molybdenum concentrate grading 54 percent Mo., with a recovery ratio of 50 percent. The copper content of the tailings is 0.21 percent. In the period 1972-74 the

flotation cells were replaced by larger units providing a better recovery (1-1/2 percent) for a total cost of US$17 million.

30. The Molybdenum Plant has a capacity of 18 tpd but a new plant is now under construction which will go into production in 1976 with an estimated output of 45 tpd of 54 percent molybdenum. Note: Chuquicamata is a large molybdenum mine, and the grade increases to 0.09 percent MoS_2 to the west.

31. The Smelter built in 1948-52 has a present capacity of 680 tpd of blister copper (i.e. 2,000 tpd of 38 percent copper concentrate) with a 50 percent matte, which is sufficient to treat only 60-65 percent of the mine and concentrator output. Plans have been made to expand this capacity to 800-850 tpd of blister by eliminating bottlenecks, which will still be short of the 1,100 tons required (i.e. 3,200 tpd of 38 percent copper concentrate) to treat the total Chuquicamata output. Since the Chuquicamata ore has a high arsenic content (1-1.5 percent), most smelters outside Chile hesitate to accept it, or impose heavy penalties. The smelter has four reverbatory furnaces (one as spare) and five converters (one spare). The converters form the main bottleneck to smelter production and this has been accentuated over the past several years by the use of low quality Chilean bricks. Imported brick will result in some improvement. Hence, it is proposed to install an additional (the sixth) converter. Also it is necessary to install one anode casting wheel, two anode furnaces, one hot metal overhead crane, two new concentrate dryers and a reclaimer for bedded material, and to extend the building by 50 meters. Total cost is estimated at US$15 million. Coupled with a 200 tpd oxygen plant to supply the converters with oxygen (at an estimated cost of US$6 million), these investments should increase smelter capacity to the 800-850 tpd figure quoted above. Rebuilding of one of the reverbatory furnaces just completed and rebuilding of a second one plus the introduction of oxygen into the reverberatories should help obtain better recoveries by reducing delays in charging the converters and providing for a better mixing of the converter slag in the reverberatories. Smelter recovery is expected to improve from 95 percent to 98 percent, with the copper content of the slag decreasing from the high 1.9 percent to 1.0 percent.

32. The Electrolytic Refinery has a capacity of 900 tpd of cathodes, but requires additional cathode melting facilities.

33. Electrowinning Plant for recovering copper from the leach solutions of the oxide leaching plant treating the Exotica ore. Daily production capacity is 181 tons, equivalent to 60-65,000 tpy.

34. Noble Metals Plant: Here gold and silver are recovered at the rate of 2,300 kgs per week by treatment of the anode sludge from the electrorefinery. Increased recoveries should be possible with better control. A new Selenium plant will recover approximately 13,000 kg of Selenium per year.

Exotica

35. The Exotica ore body located 1 - 1-1/2 km from Chuquicamata was developed as part of the 1965-70 expansion program. The deposit which extends 1,400 m N-S and 1,200 m E-W, has proven reserves of about 185 million tons of 1.7 percent copper. The copper is contained in copper oxides in which copper silicates predominate, with smaller proportions of malachite, atacamite, and wad (an amorphous oxide with some manganese content). To date more than 150 million tons of gravel overburden have been removed and 14 million tons of ore mined. The deposit is mined by open-pit methods, and was designed for a capacity of 36,000 tpd. At present some 78,000 tons of gangue and 26,000 tons of ore are extracted each day. Mine equipment totals two rotary drills, 34 100-ton trucks, and four 13-cubic yard shovels. The ore is crushed in a 54" gyratory primary crusher to -7 inches and then transported by conveyor (2,600 meters) to a leach electrowinning plant where it is first ground in cone crushers to -3/8 inch, and then leached with 93 percent sulphuric acid for 82 hours. The leaching is by percolation. The oxide minerals dissolve in the acid and form a liquor or pulp rich in copper sulphate. The ore is then washed in water for 40 hours. The complex nature of the Exotica ore, however, makes it necessary to cleanse or purify the pulp; one quarter therefore is purified by adding lime, and three quarters by passing it through a chloride plant which yields cupruous chloride. The cleaned pulp then passes to the electrowinning cells (at Chuquicamata) where the copper is recovered as cathodes, melted and cast as wirebars, in the Chuquicamata smelter.

36. To date Exotica has only been able to reach 35 percent of its design capacity. The major problems are inadequate design of the leaching electrowinning plant. The Exotica ore consists of several geological types which are mineralogically very complex. While the leaching plant has a capacity for 350 tons of copper per day (with good leaching ore from Chuquicamata), it can only leach 150 tons of copper per day from the treatment of 20,000 tpd of 1.2 percent Exotica copper ore, achieving a 57 percent recovery. The tailings contain between 0.5 and 0.8 percent copper. The leaching vats become blocked with colloidal silica, impurities of alumina, manganese, iron, magnesium and zinc. Acid consumption is excessive. Some improvement is expected by expanding the crushing plant (installation of two Symons shorthead and one Symons standard crushers, plus loading the unloading bridges, replacing the clamshell with a bucketwheel excavator for cleaning the vats, redesign of conveyors to reduce spill, and installation of dust control equipment. Recovery should increase by 70 percent and copper production to 180-200 tpd. The electrowinning section has a very low current efficiency (50 percent), ferric iron in the electrolyte attacks the copper starting sheet and there is a heavy slime build-up. The situation is being studied. A small one gallon/minute solvent extraction pilot plant has been operating for several months, and a larger 50 gallon/minute pilot plant is under construction. A small agitation leaching pilot plant has been built in Exotica. Preliminary tests indicate that a plant to be built in three stages, the last to be completed in 1978, can produce 350 tpd of copper from 36,000 tpd of Exotica ore. Total new investment is expected to be US$113 million.

El Salvador

37. The El Salvador mine is located in the Atacama province, 1,050 km north of Santiago, 2,600 m above sea level. The climate is dry. The mine is located 150 km from the port of Chanaral.

38. The Mine uses block-caving and sub-level caving methods to extract ore from several porphyry ore bodies 40 to 200 meters below the surface. Proven ore reserves are 260 million tons averaging 1.3 percent copper and 0.012 percent molybdenum. The mining methods are reasonably modern, using scooptrams and drill-jumbos. Haulage is by trolley locomotive pulling 47-ton cars to the crushing plant. The deposit outcrops with low grade copper of 0.3-0.4 percent copper and has the potential for a small open pit mine with ore reserves of 15-16 million tons of mixed sulphides and oxides. Mine capacity is about 25,000 tons of ore per day, yielding approximately 85,000 tons of fine copper per year. The mine suffers from bad scheduling of block caving sequences in earlier years (highgrading), which has led to high rock pressure requiring heavy expenditures for support in the sub-levels and haulage drifts. The LHD machines in the sub-levels are old and need replacement. Two new LHD machines are on order. An investment of US$2.5 million is needed to improve the ventilation system.

39. The Concentrator located near the mine is modern consisting of four grinding sections (each with one rod mill and two ball mills) followed by cyclones and flotation. The concentrator produces two concentrates: (a) a 46-47 percent copper concentrate (high due to chalcocite in ore) with an 82-85 percent recovery ratio (low due to presence of copper oxides in the ore); and (b) a 57 percent molybdenum concentrate with a recovery ratio of 86 percent. Concentrator design capacity is about 220,000 tons of concentrate per year. The tailings containing 0.3 percent copper are thickened and treated in a treatment plant at Llanta, producing a 4 percent copper concentrate which is recycled. The concentrate is transported via a 4-inch pipeline to Llanta and from there by train to the smelter at Potrerillos. It has been proposed that a sand/slime separation and sulphidization of the oxide minerals could increase the copper recovery.

40. The Smelter located at Potrerillos 32 km from the mine is very old and obsolete. It has the capacity to smelt 240,000 tons of concentrates and is presently processing all El Salvador's output (190,000 tons) plus about 20,000 tons from Chuquicamata. The smelter has five roasters used for drying concentrates, one operational reverbatory furnace (two others have been dismantled), three operating converters (one spare), two anode furnaces and an anode casting wheel. Concentrates are received as a slurry in railroad cars from the concentrators. The smelter recovery is only 93 percent versus 98 percent for other smelters. Energy and fuel consumption is high, maintenance costs are high and the working environment is very poor with high gaseous discharges. The anodes produced are of very poor quality leading to a large amount of anode scrap. The poor design and age of the smelter raise doubts as to the viability of attempting to modernize and improve the efficiency of the smelter, although this is well worth considering. Modernization of the

smelter would entail a new reverberatory furnace, two waste heat boilers, a new converter blower, three new converters with air supply lines and hoods, a precipitator for converter gases, and restoration of walls and roof to improve ventilation and work environment. Cost would be US$15-20 million, which compares favorably with US$90-100 million for constructing a new smelter and refinery.

41. The Electrolytic Refinery also located at Potrerillos has nominal capacity of about 76,000 tpy (65,000 is a more obtainable figure). This is only about 75 percent the capacity of the smelter. The cathodes are cast into wire bars. The refinery is old and inefficient. Quality control is not good and the shipped product is often inferior. The electrical generating facilities in the Barquito plant located on the coast 110 km from the refinery are in poor condition and require investment to keep not only the smelter and refinery operating but also the concentrator, mine, workshops and townsite.

El Teniente

42. The El Teniente complex consists of a large underground mine, concentrators, a smelter and refinery, and workshop facilities, located 132 km SE of Santiago, on the Cordillera 2,500 m above sea level.

43. The Mine: The El Teniente Mine is based upon a deposit with more than 3 billion tons, averaging 1 percent copper. The main copper minerals are chalcopyrite, bornite, chalcocite and coveline. More than 450 million tons have been mined to date. Average run of mine grade is now 1.5 percent copper and 0.02-0.04 percent molybdenum, and is expected to remain similar for the next ten years. The underground mining method used is block caving (blocks of 60 x 60 x 100 m), with ore being extracted from two separate areas: North Mine (16 blocks) and South Mine (8 blocks). Present mining capacity is about 55,000 tpd: 37,000 tons at North Mine, 18,000 at South Mine. To date this method has worked well, the ore is highly fractured and caves readily into smaller fragments. The mine does not have a primary crusher and ore is fed directly to secondary cone crushers, which makes El Teniente (the largest underground metal mine in the world) the only major mine without a primary crusher. The ore grade will drop with the move to the primary ore and by 1980 the output will have to increase to 62,000 tpd compared to 55,000 tpd to maintain the same copper output.

44. The Concentrators: El Teniente has two concentrators: the Colon concentrator completed in 1971 and the Sewell concentrator built in 1906. The combined capacity of the concentrators is 55,000 tpd run of mine, producing 1,500-1,600 tpd of copper concentrates, with 44 percent copper content and 12 tpd of molybdenum concentrates with 56 percent molybdenum content. Recoveries are 81 percent and 50 percent for the concentrates respectively, and considerable improvement should be possible. With the change to primary ore (predominantly chalcopyrite) from the secondary ore (predominantly chalcocite) the concentrate grade will drop to 30 percent (versus 44 percent).

The run of mine ore (31,000 tpd in Sewell and 25,000 tpd in Colon) is crushed directly by Symons cone crushers followed by grinding in ball mills and cycloning and flotation. The absence of a primary crusher causes large fragments to be delivered from the mine, causing interruption of feed through the wobbler and cone crushers with subsequent high maintenance--a serious bottleneck.

45. The copper-molybdenum concentrate from the Sewell concentrator is transported by pipeline 9-1/2 km to the Colon concentrator where the molybdenum is separated, and the final copper concentrate produced. The copper concentrates are then piped in slurry form 2-1/2 km to the smelter at Caletones.

46. The Smelter built in the 1920's and subsequently expanded, contains three rotary driers, nine roasters, two reverberatory smelting furnaces, eight converters, three holding furnaces, two reverberatory refining furnaces and a 400 tpd oxygen plant. An imbalance between the two reverbs and eight converters was corrected by construction of a new reverberatory furnace. Present smelter capacity is about 520,000 tons of concentrate (220,000 tons of fine copper) with a recovery ratio of 94 percent (which is low in comparison to other smelters). Slag analyses run at 0.8 to 1.29 copper. In 1975, therefore, there will be some excess tonnage of concentrate of what the smelter can handle. This shortfall is caused by a failure of the expansion program to meet its obligations and a failure of the concept of smelting concentrates in converters with oxygen enriched air. The reverberatory furnaces form a major bottleneck; hence, a new reverberatory has recently been commissioned, and with the rebuilding of another reverberatory furnace in late 1974, smelter capacity is expected to increase sufficiently to handle all concentrate produced (i.e., to 650,000 tons). Eventually (after five-seven years) the mine will be extracting ore which will produce 30 percent copper concentrates and if copper production is to be maintained, the tonnage of concentrates to be smelted will increase by 50 percent. Hence, some major modifications are required. The staff at El Teniente are currently looking at the alternatives of a) rebuilding one of the older reverbs, b) installing the Noranda Continuous Process Smelter, or c) installing a flash furnace.

47. El Teniente produces fire refined copper in the two reverberatory refining furnaces. In 1974, the product mix has been about 71,000 tons of fire refined, 108,000 tons of blister, and 41,000 tons of electro-refined. The latter is produced at Enami's Ventanas Refinery.

48. Infrastructure. El Teniente has large foundries and machine shops and the engineering division is fully staffed with engineers of all disciplines Recently water and power have been in short supply. Thirty towers on the main transmission line were damaged by storm, but have almost been repaired again. A subnormal snowfall in 1973 created a water problem requiring pumping from the Coya river. A new tailings disposal system is required urgently

to replace the one presently used. A new tailings dam is under construction and finance is being sought for a 40 km tailing conduit between the concentrator and the dam.

Andina

49. Located 50 km NE of Santiago in the Andes at an altitude of 3,900 m above sea level, Andina consists of a mining and concentrator complex but not a smelter. The finished product is 39 percent copper concentrate, shipped to Japan for smelting. The climate is harsh and access difficult.

50. The Mine put into production in 1970 is based upon an underground porphyry deposit in andesite intruded by granodiorite with measured reserves of 115 million tons of 1.6 percent copper and approximately 0.03 percent molybdenum. Main sulphide minerals are chalcopyrite and bornite with some chalcocite. Further exploration is being conducted to extend the reserves. Mine production recently reached 13,000 tpd of 2.2 percent copper and 0.03 percent molybdenum ore. Production is expected to reach 3-1/2 million in 1974 and may be expanded to 6-1/2 million tons by 1978 with a credit from Sumitomo of Japan. Mine grade will drop to 1.8 percent by 1978. Block caving methods are used, with ore passes feeding through chutes onto a conveyor system. Initial difficulty in inducing caving has been solved and the ore is now flowing smoothly. Primary and secondary crushing is done in the mine with two jaw crushers (42-inch and 48-inch) and a Symons cone crusher.

51. Concentrator. Because of the heavy snow falls and avalanches that occur during the winter, the concentrator is located underground, connected directly with the mine through a six-kilometer tunnel. Tertiary crushing with a cone crusher is followed by grinding in two rod mills and four ball mills. The concentrator is of conventional sulphide flotation circuit, with a design capacity of 10,000 tpd of ore. It produces a 30 percent copper concentrate with 88 percent recovery. The concentrate is transported as a slurry to Saladillo, 1,700 m above sea level, through a 26 km pipe 4" in diameter, where it is filtered and dried before being shipped by truck or train to the Ventanas Smelter owned by Enami 150 km distant. Part of the concentrate is smelted and refined by Enami and part is exported. The tails contain 0.26 percent copper.

Mining and Metallurgical Research Center (CIMM)

52. CIMM was set up in late 1970 as an applied research center under the Ministry of Mines to serve the needs of the production sector, particularly but not exclusively copper. The center received technical and financial assistance from the United Nations, Belgium, Canada and Great Britain. The objectives of CIMM were specified as:

(a) to build up a high-level research staff;

(b) to create the physical infrastructure needed for research; and

(c) to carry out applied research in accordance with the most imperative needs of the national mining industry.

53. Over the past three years the center built its staff up to a level of 117, including 76 professionals (of which 12 are foreign experts) and 41 administrative and service staff. Work has been carried out in the following fields:

(a) Mining - Mining methods, orebody evaluation, mining economics;

(b) Mineral Beneficiation - ore dressing, pyrometallurgy, hydrometallurgy, solvent extraction, process engineering; and

(c) Mineral Characterization - assay procedures, chemical, mineralogy and spectroscopy.

54. Studies. To date the center has conducted studies as follows:

(a) Mining Section: (i) statistical techniques for analyzing orebody reserves, grades, and impurities; (ii) slope stability at Chuquicamata and Exotica mines; (iii) rock mechanics and ventilation problems at El Salvador; (iv) open-pit equipment availability and utilization studies at Chuquicamata--truck versus rail; (v) economic studies of the effects from moving to the harder ores in both El Teniente and Chuquicamata;

(b) Mineral Beneficiation - (i) various flotation reagents to lower the pyrite content of the Chuquicamata concentrate; (ii) new processes of sulphidization of oxide minerals in the El Salvador ore to allow their recovery; (iii) crushing and screening at El Salvador; (iv) hydro-metallurgical problems at Exotica, agitated leaching, solvent extraction, classification of Exotica ore for suitability for leaching; (v) leaching and solvent extraction for recovery of copper from Chuquicamata waste dumps; (vi) recovery of selenium from the anode slimes from Chuquicamata and El Salvador; (vii) reagents to expedite settling of tailings; (viii) improvement of electrowinning and electrorefining techniques - periodic reverse currents; (ix) use of oxygen in converters; and

(c) Mineral Characterization: (i) chemical and mineralogical analyses; (ii) review of sampling and assaying methods used in mines; (iii) establishing standards.

55. Results: The value and quality of these studies or areas of research varies considerably. Some have been completed, but for many a start was merely made and a continuing program is under way. While the quality of some of the studies has been excellent and some have made use of well-known experts, others have been of superficial nature. The staff is relatively young and inexperienced in operational practice which has created some disadvantages and made cooperation from the production personnel more difficult to obtain. As discussed earlier, staffing of the Center with the quality of people needed to make it a major factor in the copper sector will be very difficult and in the short and medium term it will be necessary to place heavy reliance on foreign expertise under some aid program. Administration of the center should be improved, and greater effort placed upon personnel policies. At present there is much dissension among the staff and many have recently left leaving vacancies which are difficult to fill. Salaries are just one problem requiring urgent attention. It must be recognized that the major asset of any research organization is the people it possesses, without which all the equipment in the world is of no value. To date the work has provided some very useful results. A project for the recovery of selenium will soon be financed and repay the research costs in multiple each year. Good progress in research on solvent extraction will lead to a project to improve Exotica's problems.

56. One of the problems faced by the Center has been inadequate budgets and lack of research equipment and facilities. To date the Center has been working in temporary buildings and making use of the university laboratory facilities. Budgetary support has come mainly from CODELCO, and after September 1973 the new CODELCO administration took over the Center placing it directly under its charge. CODELCO has provided the center with a capital budget of US$5 million to allow it to complete permanent facilities consisting of office buildings, laboratories and pilot plant and semi-industrial testing installations. When completed the Center will have adequate facilities to become a major research center. All that remains will be the efficient utilization of this center. However, while the mineral beneficiation testing is ideally located in the Center, the mining studies may be better located with CODELCO itself with better access to the engineering and operatting staff. Any improvement in process control in the concentrators and smelters which leads to improved recovery should pay handsome dividends. Recoveries are now low and even an improvement in recovery of the Gran Mineria by 1/2 percent would more than cover the annual budget of the Center five or more times.

Geological Research Institute (IIG)

57. IIG was established in 1967 as a state institution intended to conduct basic geological research in Chile. In 1970 many people left the institute and it required rebuilding into an effective organization. In 1972 the institute became more closely connected with CODELCO.

58. The Institute does work in three fields:

(a) Regional Geology, or basic infrastructure geology with mapping orientated to Chile's immediate needs;

(b) Economic Geology, by far its largest effort in both metallics and non-metallics.

(c) Applied Geology, exploration using geophysical, geochemical methods plus related field work and laboratory analyses.

The work of each section is coordinated with that of the geological staffs of the Gran Mineria, and correlated to evaluate possible prospects.

59. IIG has a central office in Santiago and regional offices in Arica, Iquique, Antofagasta, Copiapo, La Serena, Concepcion and Aysen. It is staffed by 243 persons including 160 professionals (geologists, engineers, chemists, etc.).

60. With the large number of known copper deposits in Chile and the subsequent very large inventory of copper reserves, it does not appear that the best use is being obtained from the Institute by exerting a major effort in the search for copper. CODELCO should be able to adequately handle this. IIG could usefully help to locate geological favorable areas for minerals other than for copper, and help Chile diversify its resource base. Increased emphasis on preparation of metallogenic maps, regional geological maps and assistance in the prospecting for and exploration of other basic metals (possibly lead, zinc, iron ore, etc.) coal, nitrates, potash and salt deposits, etc., would seem to be optimum strategy.

E. Financial Position

Recent Past (1970-1974)

61. Because of the rapidly advancing exchange rate, the artificial rates imposed upon the exports of copper, and some past inappropriate procedures, the financial statements for CODELCO and the Gran Mineria are not fully meaningful. Regrettably during the Allende regime many of the accounts and records were destroyed, and partial information only is available on the financial position of the companies in 1971, 1972, and 1973. However, audited financial statements are available for 1974 operations.

62. Nevertheless the information available indicates that the financial performance of the companies began to deteriorate in 1971. The primary causes were: the large increase in wages and salaries implemented by the new regime; the sharp drop in world copper prices from an average of 62¢/lb (LME) in 1970 to 48¢/lb (LME in 1972; and the imposition of an artificial exchange rate which adversely affected the copper revenues. As indicated in Table 1, unit production

costs (after taxes) increased from 27-29¢/lb in 1969, 1970 to 45-50¢/lb for the 1971-1973 period. If the effect of the artificial exchange rate is removed, the production costs for 1971-1973 still remain high at 36-45¢/lb. In 1971 and 1972 the five companies together barely showed a consolidated profit. However, with the sharp increases in prices in the 1973 and the almost doubling of the rate of production in the fourth quarter; the companies showed a significant profit in 1973 and 1974. As indicated in Table 2, net cash generation for the five companies in 1972 barely reached break-even, but in 1973 and 1974 cash surpluses were realized even after replenishing stock levels.

63. Despite the poor performance of the five mines during the 1971-73 period, a sound financial position was maintained as indicated by the consolidated balance sheet, Table 3. Consolidated balance sheets treating CODELCO as a "holding company" parent of the five mines are now being prepared. The current ratio dropped to 1.2:1 in 1972 but recovered to 1.7:1 in 1973. With the rescheduling of debt negotiated in early 1974, the consolidated accounts for the five mines indicated a current ratio of 2.3:1 and a debt/equity ratio of 12:88. Following the settlement of the expropiation issues, CODELCO however, will be saddled with a much greater debt burden. From the settlements with Cerro Corporation, Kennecott and Anaconda, Chile has agreed to the following:

a) For the Rio Blanco Mine, the Government has agreed to pay a total $40 million to be paid back over 15 years; $15 million to be by the Government and $25 million to be assumed by CODELCO with a 14-1/2 percent interest charge; and

b) For the three Anaconda properties a total of $250 million will be paid over ten years with a 4-1/2 percent interest charge; $194 million will be assumed by CODELCO, ($6 million paid in 1974), $59 million will be assumed by the Government.

(c) For the Teniente Mine, the Government agreed to pay $63 million compensation to be paid in cash and notes over a period of 10 years at 10% interest.

64. Because of the very favorable financial performance of the companies during 1974 and the considerable investment with cash generation, the debt/equity ratio did not increase by the end of 1974. Hence, the company is expected to remain in a stable financial position and readily service its debt obligations.

The Immediate Past (1974-75)

65. Tables 4 and 5 present the actual and projected cash flows for the Gran Mineria for 1974 and 1975 respectively. The operating cash surplus for 1974 improved vastly over that of the three previous years, despite a significant jump in production costs. For 1974, this was the result of a significant increase in prices (averaging 93¢/lb of fine copper) coupled with a large production increase. However, the prices dropped to less than US$55¢/lb in early

1975; prices in 1975 are expected to average around 56¢/lb (much lower than the average for 1974). Revenues from sales fell considerably due principally to the sharp fall in world copper prices but also to the agreement between the CIPEC countries to cut back production and exports by 15%. Despite a reduction in unit operating costs resulting from a stabilization of production conditions and the severe budget cutbacks (15% in local currency) ordered by the Minister of Finance, only a small operating cash surplus will be realized.

66. In 1974 the heavy debt servicing requirements (US$54 million to foreign lenders, and US$146 million to the Central Bank) plus the considerable equipment replacement, debottlenecking and rehabilitation investment requirements placed CODELCO in a significant cash deficit position, requiring a severe curtailment of the capital expenditures in the final quarter. Much of the investment program had to be postponed. The debt servicing requirements for 1975 are lower than for 1974 but capital expenditures have had to be curtailed to a total of just over $100 million to maintain a net cash surplus. Clearly CODELCO needs to obtain additional funds to: a) rationalize existing operations; b) make up for lack of investment over the past four years; c) complete the investment program begun in 1967; and d) continue with their expansion program.

Medium-Term Future (1976-1980)

67. Based on projected production and copper prices (Table 6) CODELCO is expected to maintain a sound financial position with operating cash surpluses averaging about US$200 million during the period 1976-1980. Profits are expected to continue to be about US$300 million per year during the projected period. Approximate estimates would indicate total debt servicing requirements (repayment and interest) at about $100-110 million per year in the early years. This leaves the CODELCO group with cash surplus of about US$200 million per year for capital investment. The profitability of the operations will ensure that a sound financial position and capital structure is maintained. However, the taxation regime will most probably be altered to significantly increase Government revenues from this source.

F. Recent Production Performance (1974 and 1975)

68. Production from the Gran Mineria reached 763,000 tons in 1974, 24% higher than the 1973 production (the previous high) and 18,000 tons more than the budgeted production figure for the year. As indicated in Table 7:

a) The production for Exotica was below the programmed figure (77%), but equal to the 1973 production level--as the mine continued to experience severe processing problems; the mining operation came to a standstill on December 1, 1974, for a period of at least 6 months as part of a concentrated effort by the CIPEC countries to stabilize falling copper prices.

b) The El Salvador and El Teniente Mines achieved targeted production. El Salvador, however, dropped 2-3% below the 1973 production level which was a direct result of the more difficult mining conditions experienced with the move of production areas from the softer to the blockier ore. El Teniente, on the other hand, exceeded the 1973 production level by 24% or the previous high by 15%, despite the gradual move into the blockier ore. As more and more of the production areas move into the blockier ore, maintaining this performance will become increasingly difficult.

c) The Chuquicamata mine exceeded targeted production by 7%, or the 1973 level by 36%, or the previous high by 17%.

69. Table 8 shows the production of Molybdenite from the three operations, Chuquicamata, Salvador and Teniente. At 9,000 tons of fine Molybdenum, this represents a 90% increase over the 1973 production; a direct result of greater mine production and improved by product process control.

70. Overall operating performance of the CODELCO Group in 1974 was much improved over the previous three years, a result of better management, increased availability of spare parts and supplies, and vastly improved labor relations. The increase in production reflected, in part, a realization of the large investments undertaken by the five companies between 1966 and 1972, but still falls short by 14% of the 880,000 tons capacity expected from these investments. This shortfall is made up as follows:

Mine	Capacity Expected From Investment Program (1968-71)	Actual Production in 1974	% Variance
El Salvador	90	80	-11
Chuquicamata	354	357	+1
El Teniente	274	225	-18
Exotica	102	32	-69
Andina	63	68	+8
TOTAL	883	762	-14

71. Both Chuquicamata and Andina have reached targeted capacity, with El Salvador and El Teniente desplaying small shortfalls due, in both cases, to the problems experienced with block-caving mining methods in the primary ore. Exotica has experienced major processing problems for which test work has found a solution but which requires substantial additional investment to rectify.

Table 1

CHILE: COPPER SECTOR PROJECT

CONSOLIDATED ACCOUNTS FOR THE FIVE LARGE COPPER COMPANIES

INCOME STATEMENT

	1969		1970		1971		1972		1973		1974	
Sales Volume (000 tons)	544		540		571		593		616		763	
	($ Million)	($/lb)	($ Million)	($/lb)	($ Million)	($/lb)	($ Million)	($/lb)	($ Million)	($/lb)	($ Million)	($/lb)
Sales Revenue	792.4	0.66	840.0	0.70	665.5	0.53	602.8	0.46	1,012.5	0.75	1,612.0	0.96
Cost of Products Sold					381.7	0.30	406.8	0.31	655.4	0.48	979.0	0.58
Sub-total					283.8	0.23	196.0	0.15	357.2	0.26	633.0	0.38
Administration Costs					86.8	0.07	67.5	0.05	113.0	0.08	180.8	0.11
Financing Costs					50.1	0.04	44.1	0.03	47.6	0.04	36.4	0.02
Depreciation					69.0	0.05	69.7	0.05	55.0	0.04	71.5	0.04
Operating Profit					77.8	0.06	14.8	0.01	141.5	0.10	344.3	0.21
Other Income[2/]					1.0		6.7		357.6	0.26	6.0 (51.7)[3/]	- (0.03)
Taxes					36.5	0.03	10.9	0.01	119.4	0.09	88.7	0.05
Net Income	468.0	0.39	491.1	0.41	42.3	0.03	10.6	0.01	379.7	0.28	209.9	0.13

Source: CODELCO

Footnotes:

1/ From August 1970 the exchange rate allowed the Gran Mineria for converting Sales Revenues into Escudos was maintained fixed at 15.8 through to August 19 then increased to 20.0 to April 1973, increasing to 22.4 for May, 45.0 for June-August, 46.0 for September, 110.0 October, 111.3 November and 130.0 December. At the same time local costs inflated 22.1 in 1971, 163.4% in 1972 and 508.1% in 1973. This artificial exchange rate inflated the local costs expressed in US dollars beyond actual costs. To determine the impact of this artificial exchange rate, the "Operating Profit" has been recalculated using an exchange rate adjusted to reflect devaluation of the Escudo, as follows:

	1971		1972		1973	
	(US $million)	($/lb)	(US $million)	($/lb)	(US $million)	($/lb)
Operating Profit before tax	144.7	0.11	132.1	0.10	502.6	0.37
Operating Profit after tax	104.0	0.08	96.0	0.07	374.4	0.28

2/ Includes the profit from the reduction of the dollar value of the Escudo debt with the central bank, due to the devaluation.

3/ Other costs.

October 14, 1975

Table 2

CHILE: COPPER SECTOR PROJECT

CONSOLIDATED ACCOUNTS FOR THE FIVE LARGE COPPER COMPANIES
CASH FLOW STATEMENTS (1972-1973)

	1972					1973				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
	(US$ million equivalent)									
A. FOREIGN CURRENCY: Offshore										
1. Sources of Funds										
Revenues from Sales - foreign	149.8	143.8	127.9	129.3	550.8	149.7	193.7	180.1	310.5	834.0
Other	1.4	25.6	0.9	1.1	29.0	-	-	-	5.6	5.6
Sub-total	151.2	169.5	128.8	131.4	579.8	149.7	193.7	180.1	316.1	839.6
2. Application of Funds										
Materials and Supplies	13.1	16.8	6.7	9.7	46.3	13.3	16.3	13.4	20.6	63.6
Freight and Insurance	3.1	3.6	3.1	4.5	14.4	5.0	4.9	3.4	5.5	18.8
Refinery Charges	0.8	1.1	0.8	0.8	3.4	0.4	0.7	0.7	0.4	2.2
Debt Servicing	9.3	14.6	1.1	6.9	32.0	7.2	13.8	3.9	9.6	34.6
Miscellaneous	17.3	11.0	1.9	4.2	33.8	1.4	3.0	11.5	23.1	38.9
Sub-total	43.6	47.1	13.6	6.1	129.9	27.3	38.7	32.9	59.2	158.1
3. Net Cash Generation Offshore	107.6	122.4	115.2	104.8	449.9	122.4	155.0	147.2	256.9	681.5
B. FOREIGN CURRENCY: Onshore										
1. Sources of Funds	17.5	8.1	5.6	4.8	36.0	-	-	-	54.0	54.0
2. Application of Funds										
Selling Expenses	)1.6	2.3	1.3	2.2	7.1	1.8	1.2	0.7	1.0	4.8
Freight and Insurance	)					-	-	-	0.9	0.9
Refining Charges	12.3	5.0	4.0	3.5	24.8	-	-	-	18.0	18.0
Debt Servicing	-	-	6.4	-	6.4	3.1	3.0	-	120.5	126.5
CODELCO Charges	-	-	-	-	-	1.0	6.8	6.0	0.8	14.6
Miscellaneous	8.5	2.0	3.8	8.4	22.7	0.9	0.8	1.4	0.3	2.9
Income Tax	5.0	16.5	5.2	0.2	26.9	-	-	1.1	20.1	21.2
Sub -total	27.4	25.8	20.5	14.2	87.9	6.8	11.8	9.2	161.6	189.4
3. Net Cash (Deficit):Onshore	(9.9)	(17.7)	(14.9)	(9.4)	(51.9)	(6.8)	(11.8)	(9.2)	(107.6)	(135.4)
C. NET FOREIGN EXCHANGE GENERATION	97.7	104.7	100.3	95.4	398.1	115.7	143.2	138.0	149.2	546.1
	(US$ Million)					(Escudos - Billion)				
D. LOCAL CURRENCY										
1. Source of Funds										
Sales	5.02	14.2	13.6	9.2	42.0	0.2	0.2	0.5	2.6	3.5
Company Store	)					0.2	0.2	0.5	0.9	1.8
Other	)23.2	9.2	5.9	114.7	152.9	0.1	0.1	0.1	0.3	0.6
Line of Credit	)					3.0	1.2	6.4	0.7	11.4
Sub-total	28.2	23.4	19.5	123.9	194.9	3.4	1.8	7.5	4.5	17.3
2. Application of Funds										
Salaries	63.6	63.1	57.6	116.4	300.7	2.9	2.5	4.9	8.4	18.7
Salary Tax	-	-	-	-	-	0.2	0.2	0.2	0.6	1.2
Materials	28.9	38.2	28.1	45.6	140.8	1.2	1.3	2.3	8.8	13.6
Services	12.6	29.7	28.0	38.2	108.4	1.1	1.6	2.8	5.8	11.3
Debt Servicing	0.9	0.1	0.8	-	1.8	-	-	-	0.3	0.4
Investment	7.7	5.2	7.1	9.2	29.3	0.2	0.3	0.5	1.0	2.1
Costs of Refining	0.1	1.0	2.1	2.0	5.3	-	-	-	-	-
Sub-total	113.8	137.3	123.7	211.4	586.3	5.6	5.9	10.8	24.9	47.3
3A. Net Local Currency (Deficit)	(85.6)	(113.9)	(104.2)	(87.5)	(391.4)	(2.1)	(4.1)	(3.4)	(20.4)	(30.0)
3.. Weighted Exchange Ratio						20.1	28.5	57.2	119.7	62.5
3B. Net Local Currency (Deficit) (in US$ Million)						(105.8)	(143.8)	(59.4)	(170.4)	(479.4)
E. NET CASH FLOW OF GRAN MINERIA	12.1	(9.2)	(3.9)	7.9	6.7	9.9	(0.6)	78.6	(21.2)	66.7

Table 3

CHILE: COPPER SECTOR PROJECT

CONSOLIDATED ACCOUNTS FOR THE FIVE LARGE COPPER COMPANIES

BALANCE SHEET [1]

	1971	1972	1973	1974
	(US $ Million equivalent)			
ASSETS				
Current Assets				
Cash	34.0	22.6	16.7	7.2
Inventories [2]	200.6	323.2	528.1	555.7
Receivables-short term	102.2	125.9	260.5	183.7
Prepaid Expenses	50.4	73.9	59.3	65.1
Sub-total	387.2	545.6	864.6	811.7
Other Assets				
Mine Development [3]	19.6	24.8	61.9	17.6
Receivables-long term	17.5	17.2	17.0	13.2
Sub-total	37.1	42.0	78.9	30.8
Fixed Assets				
Gross Fixed Assets, Installations and Equipment	1,347.0	1,438.8	1,514.4	1,735.8
Less: Cumulative Depreciation	419.4	480.9	531.6	612.0
Net Fixed Assets	927.7	949.9	982.8	1,123.8
TOTAL ASSETS	1,352.0	1,537.6	1,926.3	1,966.3
LIABILITIES AND CAPITAL				
Current Liabilities				
Accounts Payable	187.1	290.9	376.7	356.1
Debts with Central Bank [4]	54.6	180.2	136.6	--
Sub-total	241.7	471.2	513.3	356.1
Long-term Debt	466.6	420.7	387.6	192.2
Other Obligations	0.2	0.2	0.4	0.2
Capital and Reserves	601.3	634.9	645.3	1,207.9
Profit for the Year	42.3	10.6	379.7	209.9
Sub-total	643.6	645.5	1,025.0	1,417.8
TOTAL LIABILITIES AND CAPITAL	1,352.0	1,537.6	1,926.3	1,966.3
Current Ratio	1.6:1	1.2:1	1.7:1	2.3:1
Debt/Equity Ratio	42:58	39:61	27:73	14:86

Source: CODELCO

Footnotes:

1/ Balance Sheet for December 31, for each year.

2/ Inventories valued at the cost of production, and materials valued at average purchase cost (except 1971 which used LIFO). The Inventories include:

	1971	1972	1973	1974
Finished Products	32.4	84.0	131.7	186.0
Products in Process	34.2	71.4	120.5	
Materials & Supplies	129.1	148.8	238.4	366.9
Others	4.9	19.0	37.4	2.6
TOTAL	200.6	323.2	528.1	555.5

3/ Mine Development costs are amortized as a charge to production of the ore made available by the development.

4/ These made up from the purchase of dollars and loans to service lines of credit. The need to do so was a result of the artificially low rate given to the companies for the sale of their sales revenue. In June 1974 the Ministry of Finance, passed a resolution to convert the debt existing on December 31, 1973 into equity.

Industrial Projects Department
September 1975

Table 4

CHILE: COPPER SECTOR PROJECT

CONSOLIDATED ACCOUNTS FOR THE FIVE LARGE COPPER COMPANIES

CASH FLOW STATEMENTS (1974)

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
			(US$ Million)		
A. Foreign Currency Off-Shore					
1. Source of Funds	417.2	529.6	466.3	339.3	1,752.4
1.1 Direct Sales	350.1	516.0	396.1	293.7	1,556.0
1.2 Exchange of Goods	41.1	12.6	17.4	-	71.1
1.3 Others	26.0	0.9	52.8	45.5	125.3
2. Use of Funds	100.9	75.2	116.6	113.4	406.2
2.1 Materials and Supplies	25.7	30.1	37.0	36.7	129.4
2.2 Freight and Insurance	6.8	6.5	7.5	7.5	28.4
2.3 Refining Charges	0.8	0.9	0.3	0.7	2.7
2.4 Debt to Central Bank	8.9	12.9	37.7	34.0	93.6
2.5 Debt Service	16.7	10.9	8.0	17.9	53.5
2.6 Miscellaneous	0.8	1.3	0.5	1.0	3.7
2.7 Exchange of Goods	41.1	12.6	25.5	15.6	95.0
Net Cash Generation Off-Shore	316.3	454.3	349.6	225.9	1,346.2
B. Foreign Currency On-Shore					
1. Source of Funds	11.0	3.8	-	3.6	18.4
2. Use of Funds	51.7	145.6	136.9	64.9	399.1
2.1 Income Tax	27.4	67.6	78.4	20.0	193.4
2.2 Housing Tax	-	-	-	6.4	6.4
2.3 Selling Expenses	1.6	1.5	1.0	0.4	4.6
2.4 Freignt and Insurance	2.9	3.7	3.8	3.2	13.5
2.5 Refining Charges	10.0	-	-	-	10.0
2.6 Debt Service	6.6	67.0	52.0	20.2	145.9
2.7 Codelco Charges	2.8	3.9	1.4	9.5	17.5
2.8 Miscellaneous	0.4	1.9	0.4	5.2	7.8
Net Cash (Deficit) On-Shore	(40.7)	(141.8)	(136.9)	(61.3)	(380.7)
C. Net Foreign Exchange Generation	275.6	312.6	212.7	164.6	965.5
D. Local Currency			(Escudoes Millions)		
1. Source of Funds	3,259	3,916	12,580	21,359	41,114
Sale of Copper and Sub-products	1,647	448	8,215	14,296	24,606
Company Stores	654	1,054	1,451	2,945	6,105
Other	958	2,413	2,914	4,117	10,403
2. Use of Funds	51,853	104,666	168,913	263,020	588,452
Salaries	18,918	32,216	42,610	61,036	154,779
Materials	20,288	39,295	67,776	111,761	239,121
General Costs	3,213	8,203	12,193	17,050	40,659
Selling Expenses	124	1,221	2,275	3,015	6,635
Refining Charges	889	2,525	5,603	7,128	16,145
Cost of Company Stores	3,128	5,818	7,467	11,982	28,396
Taxes	1,634	6,047	15,395	23,300	46,376
Investment	3,331	9,340	15,594	27,748	56,013
Amortization and Interest	328	-	-	-	327
3.A Net Local Currency (Deficit)	(48,594)	(100,750)	(156,333)	(241,661)	(547,338)
3. Weighted Exchange Rate (Es/US$)1/	183:1	295:1	785:1	1453:1	
3.B Net Local Currency (Deficit) (in US$'000)	(265.5)	(341.4)	(199.1)	(166.2)	(972.2)
E. Net Cash Flow (US$ Million)	10.1	(28.8)	13.6	(1.6)	(6.7)

1/ This is at best an estimate, subject to a large margin of error due to the very rapid inflation rate, and difficulty in determining the exact dates of expenditures. The exchange rates applied to CODELCO were as follows: Jan. 1-Feb. 5 130; Feb. 5-Mar. 10: 200; Mar. 11-20: 235; Mar. 21-May 12: 263; May 13-26: 300; May 27-July 7: 330; July 8-Aug. 5: 550; Aug. 6-12: 860; Aug. 13-26: 900; Aug. 27-Sept. 2: 930; Sept. 3 - 16: 990; Sept. 17 - 26: 1050; Sept. 27 - Oct. 16: 1100; Oct. 17 - Nov. 6: 1250; Nov. 7 - Nov. 25: 1340; Nov. 26 - Dec. 9: 1680; Dec. 10 - 31: 1870.

Source: CODELCO
September 1975

Table 5

CHILE: COPPER SECTOR PROJECT

CONSOLIDATED ACCOUNTS FOR THE FIVE LARGE COPPER COMPANIES

CASH FLOW STATEMENTS (1975)

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
	(US$ Million)				
A. FOREIGN CURRENCY					
1. Source of Funds	318.3	238.3	355.3	294.7	1,203.8
a. Sales Revenue	233.6	238.2	221.8	203.8	897.4
b. Loans Revenue	84.7	0.1	133.5	90.9	306.4
2. Application of Funds					
a. Operations					
Materials and Supplies	35.7	29.5	27.9	28.0	121.1
Freight and Insurance	8.8	9.8	10.2	8.7	37.6
Refining Costs	1.8	1.5	2.3	1.9	7.4
DFL No. 1	4.7	3.8	4.8	3.4	16.8
Income Tax (Min. of Fin.)	42.7	1.5	31.0	28.1	103.4
Tax (Ministry of Defense)	23.2	20.3	21.6	20.3	85.4
Market Switching	3.8	1.8	1.0	0.9	7.5
Interest and Principal	-	18.1	75.9	58.4	152.4
Miscellaneous	1.6	4.1	3.4	1.4	7.7
Sub-Total	122.3	90.5	178.1	151.1	539.3
b. Investment	7.6	8.4	4.0	2.9	22.8
c. Debt Servicing	67.9	33.8	36.7	21.6	160.0
Total Applications	197.8	132.7	218.8	175.6	722.1
3. Net Foreign Exchange Surplus	120.5	105.5	136.5	119.1	481.6
B. LOCAL CURRENCY					
1. Source of Funds	16.5	15.2	15.9	15.7	63.2
2. Application of Funds					
a. Operations					
Salaries	43.2	29.9	31.0	39.5	143.6
Materials	39.5	44.8	66.0	57.2	207.5
Services	15.8	19.9	21.3	20.4	77.4
Tax	10.1	11.2	15.8	14.6	51.7
Other	0.4	0.5	0.3	-	1.3
Sub-Total	109.0	106.3	134.4	131.6	481.4
b. Investment					
Projects	16.9	14.0	11.4	11.0	53.3
Customs Taxes	-	-	-	-	-
Sub-Total	16.9	14.0	11.4	11.0	53.3
c. Company Stores	4.0	3.9	4.0	3.8	15.6
Total Applications	129.9	124.2	149.8	146.4	550.3
3. Net Local Currency Deficit	(113.4)	(109.1)	(133.9)	(130.7)	(487.0)
C. NET CASH SURPLUS (Deficit)	7.2	(3.6)	2.6	(11.6)	(5.4)
Operating Cash Surplus	18.9	22.7	(75.8)	(67.3)	(101.5)

Source: CODELCO

October 14, 1975

Table 6
CHILE: COPPER SECTOR PROJECT

CONSOLIDATED ACCOUNTS FOR THE FIVE LARGE COPPER COMPANIES
CASH FLOW STATEMENTS (1976-1980)

		(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)		(9)	(10)	
Year	Company	Production and Sales (000 tons)	Sales Price US$.67/lb	Sales Revenue (US$ million)	Cash Costs ($/lb)	Cash Costs Total ($ million)	Depreciation ($ million)	Total Production Cost ($ million)	Profit (Loss) ($ million)	Income Taxation Rate (%)	Income Taxation Rate (US$ million)	Total Cash Surplus After Taxes Available for Debt Repayment & Investment (US$ million)	Debt Servicing Repayment Interest (US$ million)	Cash Surplus for Investment Dividends (US$ million) (Rounded)
1976	Chuquicamata	400		591	45	397	31	428	163	30	49	145		
	Teniente	247		365	46	251	34	285	80	20	16	98		
	Andina	60		89	35	43	11	54	35	15	5	41		
	Salvador	79		117	60	105	4	109	8	29	2	10		
	Exotica	0		0	0	0	0	0	0	15	0	0	—	—
	Total	786		1,162	46	796	80	875	322		67	294	110	184
1977	Chuquicamata	424		626	45	421	32	453	173	30	52	153		
	Teniente	249		368	45	247	39	286	82	20	16	105		
	Andina	68		101	35	53	9	62	39	15	6	42		
	Salvador	80		118	60	106	3	109	9	29	3	9		
	Exotica	40		59	47	42	1	43	16	15	2	15	—	—
	Total	861		1,272		855	84	953	319		79	324	110	214
1978	Chuquicamata	364		538	45	361	28	389	149	30	45	132		
	Teniente	250		369	45	248	37	285	84	20	17	104		
	Andina	66		98	34	50	10	60	38	15	6	42		
	Salvador	80		118	60	106	3	109	9	29	3	9		
	Exotica	40		59	46	41	1	42	17	15	2	16	—	—
	Total	800		1,182		806	79	885	299		73	303	110	193
1979	Chuquicamata	364		538	45	361	28	389	149	30	45	132		
	Teniente	250		369	45	248	36	284	84	20	17	103		
	Andina	64		96	34	48	9	57	39	15	6	42		
	Salvador	80		118	60	106	3	109	9	29	3	9		
	Exotica	40		59	45	40	2	42	17	15	2	17	—	—
	Total	778		1,180	45	803	78	881	288		73	303	100	203
1980	Chuquicamata	364		538	45	361	28	389	149	30	45	132		
	Teniente	250		369	45	248	35	283	85	20	17	104		
	Andina	60		89	34	45	8	53	36	15	5	39		
	Salvador	80		118	60	106	3	109	9	29	3	9		
	Exotica	40		59	45	40	1	41	18	15	2	17	—	—
	Total	794		1,173		800	75	876	286		72	301	100	201

Footnotes by column:
(1) Production estimates as now foreseen with existing investment plans.
(2) Valued at estimated 1976 prices.
(3) (1) x (2).
(4) Cash Costs: Based upon the 1975 operations, adjusted for increased capacity, and improved operational control.

(5) Estimated for 1975 on basis of fixed assets, adjusted annually for equipment replacement and new investment, allowing 15% annual inflation rate.
(6) (4) + (5).
(7) (3) - (6).
(8) Tax rates as negotiated with the private companies before nationalization and maintained after nationalization.
(9) (7) + (5) - (8).
(10) Very preliminary estimates based upon debt schedules, results of negotiation with Cerro Corporation, Anaconda, and Kennecott.

Source: CODELCO and mission estimates.

Table 7

CHILE: COPPER SECTOR PROJECT

COPPER PRODUCTION OF THE GRAN MINERIA (1974)
(Actual versus Programmed)
(tons of fine copper)

MONTH	CHUQUICAMATA		EXOTICA		SALVADOR		ANDINA		TENIENTE		TOTAL		VARIATION
	Actual	Progr.	Actual	Progr.	Actual	Progr.	Actual	Progr.	Actual	Progr.	Actual	Progr.	Actual/Progr.
January	26,273	24,465	3,616	4,280	7,011	6,796	6,373	5,224	16,787	15,065	60,060	55,830	107.6
February	24,156	23,621	2,989	3,951	6,764	6,140	5,881	4,876	15,058	12,736	54,848	51,324	106.9
March	26,867	25,930	3,134	4,280	7,451	6,796	5,959	5,400	18,530	17,012	61,941	59,418	104.2
April	26,871	25,093	3,416	3,797	7,370	6,596	5,449	5,224	20,860	20,425	63,966	61,135	104.6
May	31,607	27,430	2,292	3,413	7,089	6,796	5,989	5,400	18,046	16,792	65,023	59,831	108.7
June	28,005	27,672	3,164	3,073	5,939	6,596	5,545	5,803	19,667	19,154	62,320	62,298	100.0
July	33,567	29,882	2,786	3,280	6,200	6,796	4,105	6,025	22,157	22,619	68,815	68,602	100.3
August	34,502	30,231	1,789	3,240	6,206	6,796	5,818	5,803	23,132	23,196	71,447	69,266	103.1
September	31,111	26,884	2,595	2,430	6,444	6,597	5,253	5,358	15,091	17,332	60,494	53,601	103.2
October	33,114	31,905	2,330	3,647	6,257	6,690	6,347	6,025	16,862	20,398	64,910	68,665	94.5
November	30,575	29,534	2,432	3,073	6,359	7,047	5,872	5,803	19,601	19,774	64,839	65,231	99.3
December	30,142	29,988	1,644	3,182	7,257	6,693	5,789	5,803	19,801	19,200	64,633	64,866	99.6
TOTAL	356,790	332,635	32,187	41,646	80,347	80,339	68,380	66,744	225,592	223,703	763,296	745,067	102.4
Variation Actual/Programmed	107.3		77.3		100.0		102.5		100.8		102.4		

SOURCE: CODELCO

September 1975

Table 8

CHILE: COPPER SECTOR PROJECT

MOLYBDENUM PRODUCTION FOR THE GRAN MINERIA (1974)
(Metric Tons)

MONTH	CHUQUICAMATA			SALVADOR			TENIENTE			TOTAL	
	Concentrate	Grade	Fine Mo	Concentrate	Grade	Fine Mo	Concentrate	Grade	Fine Mo	Concentrate	Fine Mo
January	460	54.93	253	186	57.49	107	274	57.71	158	920	518
February	973	54.23	528	207	57.26	119	387	57.54	223	1,567	870
March	918	55.06	505	218	57.16	125	404	56.54	228	1,540	858
April	760	53.84	409	189	57.01	108	311	59.25	184	1,260	701
May	723	54.45	394	217	57.39	125	266	56.87	151	1,206	670
June	694	54.06	375	218	56.94	124	273	56.49	154	1,185	653
July	1,054	54.74	577	209	56.98	119	271	56.88	154	1,534	850
August	1,064	54.50	580	271	56.88	154	331	56.05	186	1,666	920
September	975	55.22	539	170	56.90	97	311	56.14	175	1,456	811
October	1,164	54.06	629	163	56.91	93	363	56.72	206	1,690	928
November	1,164	55.06	641	185	56.87	105	368	56.63	208	1,717	954
December (*)	697	55.19	385	201	56.87	114	324	55.00	178	1,222	677
TOTAL (*)	10,646	54.62	5,815	2,434	57.11	1,390	3,883	56.78	2,205	16,963	9,410

SOURCE: CODELCO

Industrial Projects Department
September 1975

CHILE: COPPER SECTOR PROJECT

EMPRESA NACIONAL DE MINERIA (ENAMI)

A. Formation and Present Legal Statutes

1. The National Mining Company (ENAMI) was established on February 29, 1960, under Decree 153 by a merger of two government entities, the Mining Development and Credit Fund (CCFM) and the National Smelting Company (ENF). The CCFM had been functioning as a state-owned technical agency since 1927, when it was set up, and its primary role had been to organize and coordinate various activities related to the development of Chile's mineral activities, including the sale of such minerals. The ENF, established in 1955, was formed from the Paipote Smelting Company, with responsibility for not only administering and expanding the Paipote smelting operation but also for the development of new smelting and refining operations, including treatment plants.

2. Decree 153 established ENAMI as an autonomous state-owned enterprise which is governed by the articles of the above decree and by the resolutions of its Board of Directors. These legal articles define the functions, social objectives, and guidelines for the financial and administrative operating procedures. The legal representative of ENAMI is its Executive Vice President who is also the managerial head of the Company.

B. Organization

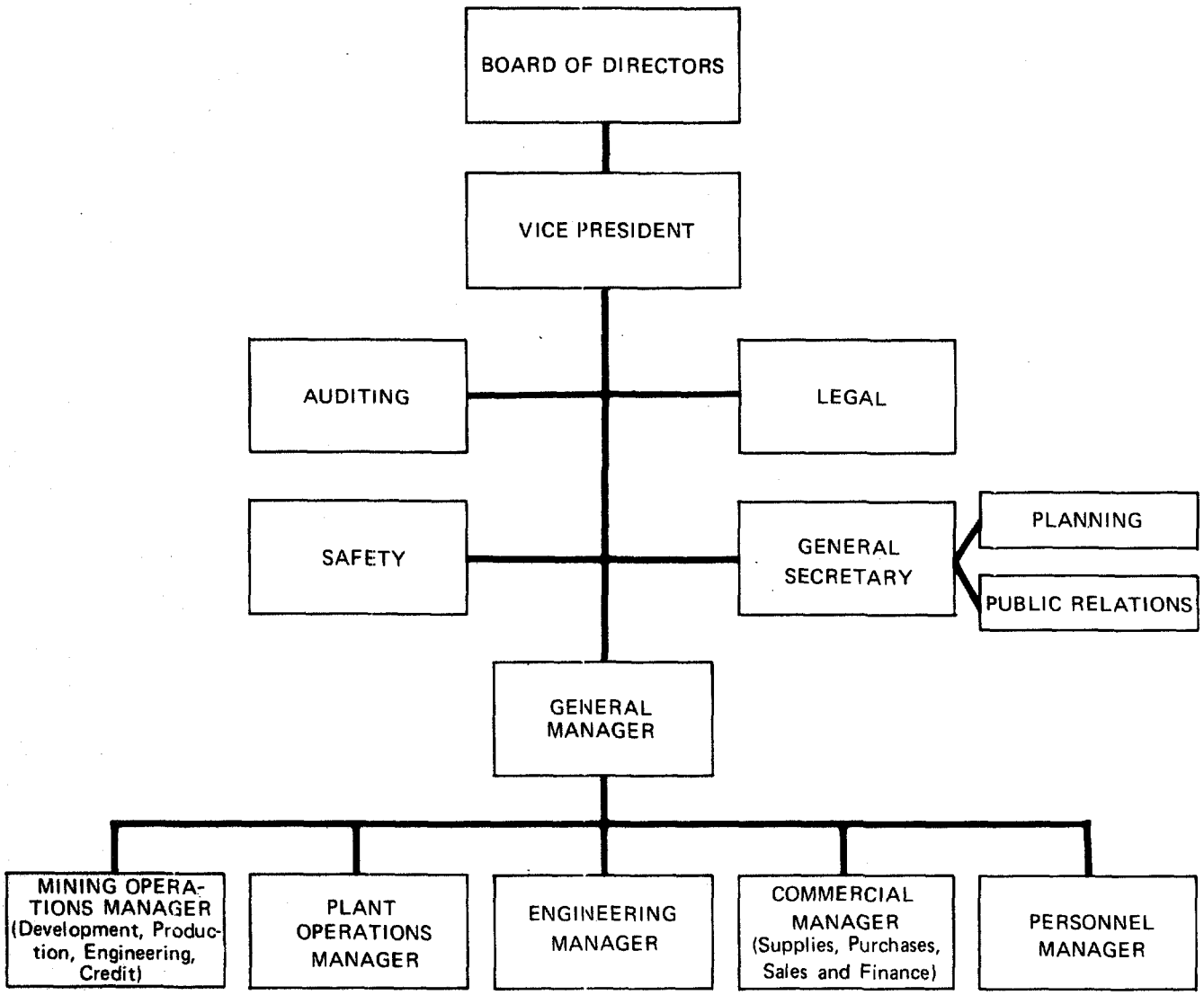
3. ENAMI's structural organization, as established in 1960, has been subject to several modifications since that date. The senior management of the Company was in the hands of its Board which consisted of seven members, the majority of them either high-level executives of Chile's public sector agencies or direct appointees of Chile's President. The Minister of Mines was the Chairman of the Board. For a brief period after the change in government on September 11, 1973, the primary responsibilities of the Board were carried out by the Executive Vice-President and an advisory council consisting of ENAMI's senior management. The Board has now been reactivated. Directly under the Executive Vice-President is ENAMI's General Manager who is entrusted with the administrative responsibility for ENAMI's principal departments: Mining, Operations, Purchases and Sales, Finance and Personnel. The organizational structure is summarized in Chart I.

C. Staffing

4. Like the Gran Mineria, ENAMI suffered a significant loss of qualified engineering staff in the period 1971-73 both from its central Santiago office and from its principal operational plants. This situation has served only to aggravate the severe staffing problems that ENAMI has continually had.

CHILE: COPPER SECTOR PROJECT

EMPRESA NACIONAL DE MINERIA
ORGANIZATIONAL CHART



World Bank—9739

CODELCO's larger mining operations have been able to attract preferentially the better qualified engineers from Chilean universities by offering higher salaries, superior living conditions and a more challenging professional career. There has also been an alarming exodus of experienced engineers from ENAMI to the large copper mines since January 1974 due primarily to large salary differentials between ENAMI and these companies; with the guidelines for future salary increases having been clarified, this trend has been checked. The most important of ENAMI's operational plants, however, the smelter and refinery at Ventanas--has been able to maintain both experienced management and high-quality engineers for the plant. This had been primarily a result of its choice location and because the smelting and refining operation is the most modern and best run in Chile. Many of the young operational engineers who subsequently worked at the Chuquicamata, Salvador and El Teniente smelter operations have done a period of "apprenticeship" at the Ventanas smelter.

5. ENAMI's senior management is experienced and competent but its support staff is thin. A new Executive Vice-President was appointed in September 1974 to replace the former one who was appointed after the change in government. These appointees have neither technical nor financial experience in the mining industry. They have depended for their advice on the senior managers of ENAMI's major departments, individuals of long-standing experience in the company. At lower levels there is a lack of qualified people to assist in production planning and control, investment planning, and project preparation and evaluation. ENAMI's total staff for all its operations is 4,600 of which approximately 3,000 are nonprofessional workers in ENAMI's operations. The Ventanas operation employs 1,500.

D. Description of Operations

6. The major functions of ENAMI in the copper sector are:

(i) the development of the small and medium mining sector in Chile by providing credit to mining operations, the rental or sale of mining equipment and machinery and extending technical assistance and training to mining cooperatives and small and medium size producers (the credit operations have been recently suspended);

(ii) the purchase of mineral ore or partially-treated ore from small and medium-sized producers for further treatment, and

(iii) the operation and administration of its own treatment plants, smelting operations and refineries to further process mineral purchased from the small and medium mining sector as well as semi-processed copper--usually concentrates, precipitates or blister--received from the large mining operations.

Although ENAMI has jurisdiction over all minerals, in practice its activities are confined to the copper sector; a small volume of by-products (gold, silver, selenium, tellurium and others) are recovered from the anodic slimes of the Ventanas refining operation. At the end of 1971, ENAMI had twenty-one mineral purchasing agencies, eight treatment plants, two smelters (at Paipote and Ventanas) and one refinery (at Ventanas). Between 1971 and 1973 ENAMI became increasingly involved in the operation of small and medium sized mining companies that came under state control but this will eventually be transferred to the private sector. A more detailed description of ENAMI's current operations now follows:

1. Ventanas Smelter and Refinery

The smelter and refinery are located approximately 50 kms to the north of Valparaiso on the Chilean coast. The total smelting capacity of the plant is 234,000 MT of charge per year as concentrates, precipitates or ores which can be fused directly (60,000 MT/year of fine copper), and 100,000 MT of electrolytically refined copper per year. Present expansion plans contemplate increasing these capacities to 720,000 MT and 140,000 MT, the latter increasing to 200,000 MT in a subsequent stage.

Ventanas is a modern conventional smelter which was originally designed to produce 3,000 tons/month of copper. To increase the capacity at the reverbatory furnace a third waste heat boiler is being added. Ventanas is planning to add a flash furnace and two 13' x 13' converters. The smelter is well located close to a port with adequate dock facilities.

2. Paipote Smelter

This is a custom smelter for the small mines in this region of Chile. It is located close to Copiapo, the provin cial capital of the Atacama region. The actual capacity of the plant is approximately 200,000 MT per year of charge and 4,000 MT a month of blister plus 3,500 MT a month of sulphuric acid.

3. Mineral Treatment Plants

ENAMI has various mineral treatment plants located close to the mineral purchasing agencies in the northern mining areas of the country. The ore for these plants is purchased from the small mining producers in the region. The principal ones are:

a) Cabildo Plant (in Cabildo)

A flotation plant which started up in 1965 and which has a capacity to treat 30,000 MT per month of ore. The concentrates are sent to the Ventanas smelter.

b) Illapel Plant (in Illapel)

A flotation plant which started operations in 1956 and with a capacity to treat 12,000 MT per month of ore. The concentrates are sent to the Ventanas smelter.

c) Jose A. Moreno Plant (near Taltal)

This plant started operations in 1966 and has a capacity to leach 9,000 MT per month of copper oxide ore. A small proportion of the ore (consisting of a mixture of oxide and sulphide) is subjected first to concentration by flotation. The leached copper precipitates and the sulphide concentrates are sent to the Paipote smelter.

d) Rio Salado Plant

Located next to the Osvaldo Martinez plant (see f) on the edge of the Rio Salado which carries away the tailings from the concentrating plants at El Salvador mine. This plant's only function is to recycle these tailings, producing 400 TM of concentrate a month (110 TM of fine copper) which is subsequently sent to the Paipote smelter.

e) Manuel A. Matta Plant

Located close to the Paipote smelter, this flotation plant started up in 1968 and has a capacity to treat 32,000 TM per month of ore.

f) Osvaldo Martinez Plant

Located 36 kms from the port of Chanaral on the railroad between Pueblo Hundido and Chanaral. The major components of the plant are:

(i) a flotation plant to treat 8,000 TM per month of mineral ore;

(ii) a leaching plant to treat 3,000 TM per month of mineral ore; and

(iii) a sulphuric acid plant which produces 600 tons of acid per month. Both the concentrates and precipitates are sent to the Paipote smelter.

g) Domeyko Plant (52 kms to south of Vallenar)

First installed in 1931 to treat gold containing mineral ore. It has subsequently been modified and now treats 3,000 TM of ore per month by flotation. Concentrates are sent to Paipote.

h) President Pedro Aguirre Cerda Plant (s.e. of Copiapo)

Built in 1929, currently treats 8,500 TM per month of ore by flotation, with concentrates being sent to Paipote.

i) Vallenar Plant (SOCIEDAD VALLENAR)

Has a flotation plant, with a capacity to treat 7,500 MT of ore a month, and a leaching plant, with the same capacity, which is currently being completed.

E. Financial Position

7. ENAMI's financial position in the period 1960-70 has been conditioned by the responsibilities it has had in the development of the small and medium-scale mining sector. In the past ENAMI's role had been different from that of an autonomous State enterprise like the National Electricity Company (ENDESA) or Petroleum Company (ENAP) which finance not only operating expenditures but also part of their investment needs. However, ENAMI will now cover its own operating expenditures and investment requirements. Its broader functions of providing subsidized credit and technical assistance to the smaller mining producers have shaped ENAMI in the role of a government mining agency as well as that of government mining company. This duality of role has severely affected ENAMI's past financial performance. As an important purchaser of partially treated copper mineral produced by the small-scale mining industry, it has had to provide sufficient incentives in terms of a guaranteed mineral purchase price to sustain the sector, a policy in practice that has been tantamount to a government subsidy. This large component of ENAMI's local currency operating expenditures--the purchase of raw materials--has been the primary reason for ENAMI incurring operating cost deficits and for its increasing dependence on central government transfers to meet these deficits.

8. ENAMI's financial position has been weak throughout the last decade and fiscal contributions have formed a significant part of ENAMI's current income. Instead of providing the incentives which would lead to increased development of the sector, the methods for establishing the purchase price

of ores and concentrates from the small miners have translated into excessive profits for the more efficient producers and unwarranted subsidies for the inefficient mining operations. Neither outcome had a beneficial effect on ENAMI's financial position, much less on the development of the sector as a whole. While it is true that government policy was concerned with sustaining mining activities which provided a livelihood for a significant proportion of Chile's labor force, it presented the government with an easy solution to a delicate socio-economic problem and distracted it from examining viable alternatives.

9. Approximate estimates of ENAMI's smelting and refining unit production costs for the Ventanas plant are summarized in Table 2. A comparison of unit production costs from year to year should take into account several factors. Conversion of these costs from nominal escudo terms to dollar terms in 1971 and 1972 is misleading because of the overvalued exchange rate. Thus, unit costs in cents per pound are somewhat higher for these years than for subsequent years. At the same time, the pricing of key inputs--particularly fuel--did not reflect their real cost in 1971 and 1972. By October 1973 the exchange rate began to reflect more accurately the real value of the escudo. With the recent increase in prices, fuel has been increasingly an important component of Ventana's unit production costs as reflected in the 1974 figures. Wages and salaries, which were a major component of unit costs in 1971 and 1972, became relatively less important factors in the cost structure after 1973. Unit production costs for both the smelting and refining operations in 1974 have averaged between 12-14¢/lb., which is competitive with production costs elsewhere.

10. The primary factor in ENAMI's overall production costs has been the purchase price paid for raw materials. For the reasons given above, a translation of these expenditures into dollar terms is difficult. In 1973, however, assuming the average annual exchange rate to be E°90=US$1.00, these expenditures corresponded to about 90¢ per pound. Even allowing for probable underestimation of the real exchange rate, these prices are extremely high, considering the average price received by Chile in 1973 was only 75¢/lb., for the sale of refined copper offhore.

11. In 1971, as in the Gran Mineria, ENAMI's financial position deteriorated appreciably. Government policy established a differential exchange rate for copper transactions--which bore no relation to the real cost of production. Levels of inflation began to increase appreciably, leading to increased wages and production costs. The Government's solution to ever-widening operating deficits was both simple and deliberate. While making only marginal adjustments to an artificially low exchange rate for copper, a line of credit was opened with the Central Bank that in 1972 and 1973 (Table 1) covered 50 percent of ENAMI's operating costs. Operating deficits reached astronomical proportions by 1973 in an environment in which financial performance ceased to have any meaning.

12. On December 31, 1974, the Minister of Finance established a new tariff policy designed to reduce marketly ENAMI's dependence on fiscal transfers. The main features of the new policy are:

(a) the price paid to the small and medium miners for their ores and concentrates is based on the average price of copper (in cents per pound) for the previous month instead of the previous year, provided this price fluctuates between 71 and 90 cents per pound;

(b) when the average monthly price falls below 71¢ a subsidy up to a maximum of 6¢ would be paid;

(c) if the average price rises over 90¢, payments to the producers would be limited to the 90¢ figure with the "excess" being used to form a stabilization fund designed to permit paying subsidies in cases of the price again falling below 71¢; and

(d) in determining the purchase price of mineral ores and concentrates, processing charges are to be subtracted which will reflect the real costs of smelting and refining in ENAMI's plants.

13. This tariff policy has been in effect since January 1975; the price range is to be modified correspondingly in the light of future variations in production costs. Considerable progress has thus already been made to improve ENAMI's financial position.

Table 1

CHILE: COPPER SECTOR PROJECT

CONSOLIDATED ACCOUNTS FOR EMPRESA NACIONAL DE MINERIA
INCOME STATEMENTS (1968-1973)

	1968		1969		1970		1971		1972		1973		1974	
	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital
A. Foreign Currency (US$ million)														
1. Source of Funds	52.7	6.9	87.3	9.6	95.9	13.7	65.2	10.9	63.8	3.0	95.8	2.95	163.3	4.74
Sales Revenue	(45.4)	-	((78.4)		(82.8)		((60.3)		(61.7)		(95.5)		(142.0)	
Other Revenue (primary fiscal contribution)	(7.3)	(6.9)	(8.9)		(13.1)		(4.9)		(2.1)		(0.3)		(21.3)	
2. Application of Funds														
a) Operations	52.7		87.3		95.9		65.2		63.8		95.8		163.3	
Materials and supply, services	(3.4)		(4.1)		(1.9)		(2.0)		(2.4)		(1.0)		(2.1)	
Local currency current budget transfer	(41.9)		(74.6)		(83.1)		(63.1)		(61.2)		(94.7)		(161.2)	
Other	(7.2)		(8.6)		(10.9)		(0.1)		(0.2)		(0.1)			
b) Investment		1.9		4.8		1.2		2.6		1.8		1.46		1.76
c) Amortization		5.0		4.8		6.6		6.8						
d) Other						5.9		1.5		1.2		1.49		2.98
Total Applications	52.7	6.9		9.6		13.7		10.9		3.0	92.2	2.95		4.74
B. Local Currency (in million Escudos) 1/														
1. Source of Funds	518.7	46.5	823.4	115.1	1,249.5	162.6	1,953.0	207.0	3,697	435.2	19,961	3,424	149,524	14,175
Fiscal Contribution	25.8	(29.6)	(18.8)	(51.3)	(23.1)	(69.0)	(152.9)	(108.5)	(195)	(138.5)	(800)	(809)	(-)	(-)
Sales	(20.3)	-	(54.5)	-	(67.3)	-	(94.5)	-	(486)		(3,337)		(21,652)	
Foreign currency current budget transfer	(419.5)	(6.3)	(672.7)		(1,141.1)		(840.0)		(1,083)		(11,278)	(239) b/	(125,147)	(9,688)
Other (Loan repayments, interest, dividends, depreciation) 2/	(53.1)	(10.6)	(77.4)	(63.8)	(18.0)	(93.6)	(44.0) a/	(98.5)	(55) a/	23.6	(143	(1,148)	(2,725)	(4,487)
							(821.6) a/		(1,878) a/	273.1	(4,403)	(1,228)		
2. Application of Funds														
a) Operations	518.7		823.4		1,249.5		1,953.0		3,697		19,961		149,524	
Salaries	(64.4)		(105.0)		(171.2)		(243.0)		(658)		(2,706)		(23,347)	
Raw Materials 3/, services, etc.	(376.5)		(579.6)		(865.9)		(924.0)		(2,017)		(14,511)		(112,024)	
Current transfers (Social security, depreciation, etc.)	(31.5)		(55.8)		(119.7)		(230.4) c/		(200.4) d/		(560)		(120)	
Others	(46.3)		(83.0)		(92.7)		(555.6) c/		(821.6) d/		(2,684)		(14,023	
b) Investment		19.4		55.8		92.5		84.8		170.4		1,439		8,303
c) Loans		19.9		41.4		54.6		97.4		245.5		1,930		3,871
d) Amortization		7.2		17.9		15.5		18.7		18.7		36		289
e) Other								6.1		0.6		19		1,712
Total Applications	518.7	46.5	823.4	115.1	1,249.5	162.6	1,953.0	207.0	3,697	435.2	19,961	3,424		14,175

1/ Exchange Rates: 1968/69: US$=E°9.88; 1969/70/71: US$=E°12.21; 1971/72: US$=E°25.0; 1972/73: US$=E°88.8; 1974: US$=E°831.
2/ In the ENAMI income statement, depreciation appears as current expenditure in local currency, and as source of funds under capital.
3/ Corresponds to copper mineral purchasing price from small- and medium-sized mines.

a/ Central Bank Credit.
b/ Excedente de Presupuesto Corriente.
c/ Servicio Venta Anticidada Banco Central.
d/ Banco Central Amortizacion Linea.

September 1975

Table 2

CHILE: COPPER SECTOR PROJECT

ENAMI - PRODUCTION COSTS - VENTANAS

	1971 Average	1972 Average	1973 Average	1974 Average
SMELTER				
Total charge smelted (metric tons/month)	16,320	17,854	16,517	17,602
Recovery (%)	94.77	96.5	95.3	95.6
Total blister production (MT/month)	3,464	4,824	4,649	4,958
Total cost per ton blister				
E°/ton	1,392	2,431	11,211	125,681
US$/ton	112.2	135.6	205	154.6
US¢/pound	5	6.1	9.3	7
Major cost components (as % of total)				
Fuel	10.2	9.2	6.8	37.3
Wages and salaries	43.0	53.5	47.8	26.6
Depreciation	14.6	10.8	9.0	10.0
Electrical energy	5.5	4.6	3.5	3.7
REFINERY				
Anode production (MT/month)	9,875	11,079	11,302	11,842
Cathode production (MT/month)	7,572	8,808	8,379	8,628
Wirebar production (MT/month)	6,606	8,203	7,999	8,570
Total cost per ton wirebar				
E°/ton	1,436	2,028	8,897	91,793
US$/ton	115.9	127.4	177.8	115.3
US¢/pound	5.3	5.8	8.1	5.2
Major cost components (as % of total)				
Fuel	7.4	4.3	4.4	26.4
Wages and salaries	48.4	58.4	51.8	34.0
Depreciation	12.1	8.9	7.8	10.0
Electrical energy	9.5	7.5	6.0	8.6

E°1 . = US$1.0 1971
E°20 = US$1.0 1972
E°340 = US$1.0 1973
E° = US$1.0 1974

Industrial Projects Department
September 1975

Table 3

CHILE: COPPER SECTOR PROJECT

ENAMI - BALANCE SHEETS
(million current Escudos, E°)

Fiscal Year (July-June)	1968	1969	1970	1971	1972	1973	1974 /7
ASSETS							
Current Assets							
Cash 1/	4.1	13.7	198.6	59.3	59.9	495.1	11,368
Receivables 2/	79.4	117.2	192.0	323.0	566.1	1,141.7	86,618
Inventories	377.7	321.2	654.4	800.4	889.1	1,561.9	154,985
Subtotal	461.2	452.1	1,045.0	1,182.7	1,515.1	4,198.7	252,971
Other Assets							
Fiscal Contribution 3/	17.4	44.1	41.8	107.5	445.6	2,478.0	-
Investments (Shares, bonds, etc.)	5.1	9.1	23.9	38.0	78.9	927.2	33,876
Other 4/	153.5	224.6	344.8	606.8	911.6	5,655.0	72,178
Subtotal	176.0	277.8	410.5	752.3	1,426.1	9,060.2	106,055
Fixed Assets							
Gross Fixed Assets	539.2	763.5	1,038.8	1,111.0	1,613.6	6,906.1	219,369
Less Depreciation	76.0	142.2	216.3	285.3	333.8	2,126.6	68,525
Net Fixed Assets	463.2	621.3	822.5	825.7	1,279.8	4,779.5	150,844
TOTAL ASSETS	1,100.4	1,351.2	2,278.0	2,760.7	4,221.0	18,038.4	509,870
LIABILITIES AND CAPITAL							
Current Liabilities							
Accounts Payable	117.7	172.8	306.4	394.8	399.8	3,389.4	98,289
Debts with Central Bank	140.5	153.4	358.3	616.0	1,313.1	5,217.0	21,338
Debts with Other Banks	2.4	2.6	62.1	58.7	59.8	14.4	-
Subtotal	260.6	328.8	726.8	1,069.5	1,972.7	8,620.8	119,627
Long Term Debt	236.1	257.3	285.7	252.9	379.6	2,496.5	57,425
Other Obligations 5/	155.4	77.0	277.1	234.7	341.8	2,807.9	37
Capital and Reserves 6/	448.3	686.1	988.4	1,203.6	1,526.9	4,113.2	332,781
TOTAL LIABILITIES AND CAPITAL	1,100.4	1,351.2	2,278.0	2,760.7	4,221.0	18,038.4	509,870
Debt/Equity Ratio	47:53	33:67	36:64	29:71	32:68	56:44	15:85

1/ In both domestic and foreign currency.
2/ Primarily credit to small mining producers; includes delinquencies (5-7%)
3/ For capital budget, housing; in 1972 includes fiscal transfer to current budget.
4/ Includes construction works in progress, deferred costs.
5/ Includes workers' benefits, social security and various other provisions.
6/ Includes fiscal contributions (1968-72).
7/ For 1974 period covered is July 1, 1973-December 31, 1974; subsequent fiscal years will cover period January-December.

Industrial Projects Department
September 1975

CHILE: COPPER SECTOR PROJECT

CONTRIBUTION OF THE COPPER SECTOR TO THE CHILEAN ECONOMY

A. Value of Production

1. The copper mining industry makes available to the Chilean economy a certain volume of resources which are potentially convertible into both consumer and capital goods. The total amount of resources generated directly by the sector -- the so-called gross availability effect--is measured by the total value of copper production. This in turn depends on three key elements: the sales price of copper, total physical output, and the product mix of copper output.

2. At the beginning of the 1955-64 period the value of production started to increase compared with the period 1940-54 and a yearly average in constant 1961 prices of $310 million was maintained. Nevertheless, in terms of output, 1960 production was only slightly higher than 1944 and even in 1964 only 15 percent higher. Gran Mineria production stagnated from 1960-64 and provided added impetus for the Government to reach an agreement with the foreign-owned companies to formulate a long-term development strategy for the sector.

3. After 1965, an expansion program for the Gran Mineria was agreed upon which was to increase copper output from 476,000 MT in 1965 to 880,000 MT after 1971. Although the planned for output increase has not been achieved, output did increase to over 600,000 MT by 1973 and 760,000 MT in 1974. The value of export sales (an approximate measure of the value of production since less than 5 percent of copper production represents domestic sales) climbed from US$363 million in 1964 (61 percent of total exports) to $1,088 million (82 percent of total exports) in 1973 and to more than US$1,500 million in 1974. Marked variations occurred in this period reflecting the fluctuations of world copper prices rather than changes in copper output. Export sales in 1972, for instance, amounted to only US$658 million even though output was only 4 percent less than in 1973. The product mix of copper output has also changed considerably since 1960, increasing the value of exported copper. In the early 1960's the proportion of refined copper from the Gran Mineria was 45-50 percent of the total but this percentage had increased to 65 percent in the early 1970's. A similar increase in refining capacity took place in the small- and medium-scale sector.

4. Copper exports from the Gran Mineria averaged about 8 percent of GNP in the period 1952-71. In specific years this average fluctuated appreciably: 5.6 percent in 1953 due to difficulties in selling copper; 6.4 percent and 5.2 percent in 1957 and 1958 due to extremely low copper prices;

over 9.5 percent in 1955, 1956 and 1969 due to high copper prices. These fluctuations were reflected in Chile's total exports since copper production from the Gran Mineria represented the primary export commodity. In summary, the copper sector has a dominant influence within the Chilean economy as the single most important contributor to exports.

B. Resource Availability

5. Up until the Chileanization program, government strategy aimed primarily at maximization of foreign exchange and tax revenues on current production. Its thinking has been short-term in character and has generally disregarded the longer-term impact of increased investment levels on foreign exchange and tax revenues.

(i) Foreign Exchange Contribution

6. Chile's foreign exchange earnings and balance of payments situation continue to be extremely dependent on world copper prices. Although the Government can stimulate production it can only influence the price at which copper is sold to a limited extent. A difference of only one cent in the copper price at current output would be reflected in a difference of foreign-exchange earnings of about $18 million. As copper output increases this effect will become more marked, affecting Chile's national income, its import capacity and its ability to service external debt.

7. Each of the three factors--output, price and product mix--have contributed to increasing the value of copper exports, as indicated in paragraph 3. Prices still continue to be the major determinant of export value, however. Price stability has been a sought after goal of the Government's commercialization policy although one which the Government has had less influence in controlling. While government strategy has been successful in making Chile less dependent on the United States by enlarging the share of copper exports sold on the London Metal Exchange, it has not been successful in stabilizing what continues to be primarily a market-dictated world copper price. In 1965 copper exports amounted to $429 million (output: 479,000 MT)

1/ The foreign exchange contribution can be considered from two viewpoints, the gross contribution as measured by the value of total copper exports and the net contribution which includes, in addition, the foreign and local components of the copper sector's expenditures. The foreign component would include repatriated profits of the foreign-owned companies, interest payments and expenditures outside of Chile whereas the local component includes expenditures made in Chile, wages to Chilean miners and investment expenditures. Although the Government's real concern should be with the net foreign exchange contribution, an analysis of this subject is complex and has had little importance so far in the development of copper sector policies.

and increased to $926 million (output: 540,000 MT) in 1969, during a period of exceptionally high copper prices. After 1969, only in 1973 and 1974-- other years of high copper prices--was the 1969 value of copper exports exceeded. Table 1 summarizes the gross foreign exchange contribution of copper exports 1964-73 as well as indicating its increasing share of total exports during this period. Copper exports are expected to maintain a 75% share of export revenue to 1980.

(ii) Government-Revenue Contribution

8. The Government revenue contribution has consisted of two components, an explicit component involving several taxes paid directly to the Government--primarily income taxes and surtaxes--and an implicit component involving revenue derived from an overvalued exchange-rate for copper transactions. Copper tax revenues have always been an important source of government revenue and have become increasingly important since 1952. At the same time the sharp and unpredictable copper price variations have exerted severe repercussions on the Government's budget and have been an important reason for the state of permanent crisis of Chile's public finances. In 1955, for example, the Central Government received $58 million in revenue from copper surtaxes; in 1958 taxes fell by approximately the same amount. Similar fluctuations were experienced in subsequent years.

9. The different and changing tax regulations which have been levied on the copper industry (see Annex 2-6, for full discussion of Fiscal Policy Development) have had important implications on both the volume and stability of copper revenues. At the same time, as gross revenues increased, their sensitivity to changes in output, but more especially to erratic price fluctuations, also increased. With the nationalization of the industry in 1971 tax revenues became even more dependent on copper price fluctuations. Fiscal revenues from copper currently provide about a third of government revenue (estimated to be over 7 percent of GDP in 1974), more than twice the 1969-70 level. This extreme dependency on the vicissitudes of the world copper market demands a corresponding modification of government fiscal policy. It is essential that policies are adopted which will utilize the windfall revenues generated at times of high prices to cover budget needs when prices fall. It is equally important that the government refrains from its past inclination of financing current expenditures with these windfalls but instead diverts these "excess" revenues for capital investment to diversify Chile's productive capacity outside of the copper sector.

10. Tax payments by the foreign-owned companies during the period 1930-39 were generally low--on the average only 5.8 percent of the value of production, and only about 25 percent of the average annual outflow of repatriated profits. After 1939 taxes paid to Chile as a percentage of the value of production increased from 11.5 percent in 1939 to 14.0 percent in 1940, 22.6 percent in 1948, 49.9 percent in 1952 and had risen to 63.5

percent by 1953. Although in subsequent years annual revenue contribution in nominal terms was well in excess of previous values, it represented only between 25-30 percent of total value output. The contribution of copper revenues to total tax revenues between 1952-70 is shown in the following table:

Year		Tax Revenues of the Gran Mineria as Percentage of total Government Revenues /1
1952		41.4
1953		30.6
1954		30.7
1955		48.2
1956		34.5
1957		17.3
1958		12.8
1959		18.9
1960		16.4
1961		12.5
1962		13.0
1963		14.9
1964		19.3
1965		16.5
1966		21.8
1967	Chile gained 51% ownership in El Teniente	18.7
1968		16.8
1969	Chile gained 51% ownership in El Salvador and Chuquicamata	26.7
1970		18.7
Average		22.6

/1 Direct taxes, does not include implicit taxes from artificial exchange rate.

Source: Importancia del Cobre en la Economia Chilena taken from "El Cobre en el Desarrollo Nacional."

Table 1

CHILE: COPPER SECTOR PROJECT

COPPER EXPORTS AND TOTAL EXPORTS
(in million of US dollars)

Year	Total Exports (fob)	Total Copper Exports	Copper Exports Share in Total Exports (percent)
		ACTUAL	
1964	592	363	61
1965	684	429	63
1966	866	599	69
1967	873	651	75
1968	911	684	75
1969	1,172	926	79
1970	1,112	840	76
1971	985	690	70
1972	858	658	77
1973	1,323	1,088	82
1974	2,043	1,557	76
		PROJECTED 1/	
1975	1,578	970	61
1976	2,162	1,489	69
1977	2,651	1,927	73
1978	3,052	2,215	73
1979	3,428	2,447	72
1980	3,725	2,712	73

1/ Using copper price projections of copper LME price for the years 1975 to 1980 inclusive.

Source: Central Bank of Chile; IBRD Projections.

December 1975

11. The implicit component of the copper sector's tax contribution, i.e., an overvalued foreign exchange rate, was an important factor in determining growth not only of the sector but also of Chile's national income. The differential foreign-exchange rate was used as an effective discriminatory device against the companies to control inflation and obtain a larger resource release for the country. The overall long-term effect was a supression of the mining sector and of economic growth. Chile's copper output during the last two decades grew at an annual rate of 2 percent while world production increased at double this rate. The net effect was a reduction of profits forcing the Government to impose more taxes to maintain the sector's total explicit tax contribution. The implicit taxes were all too often translated into direct subsidies to importers who purchased foreign-exchange at less than real value. Since the Government was unable to efficiently control the allocation of foreign-exchange the new benefactors of the policy were the importers and the overall impact of the policy has proved detrimental to economic growth. This long-term effect of this policy did not lead to an increase in revenue generated by the Gran Mineria and the repercussions of adopting such a policy were not anticipated: a reduction in the use of Chilean inputs, and a disincentive to increasing the labor component of production costs or making further investment.

12. After more than a decade using only a single exchange rate, the use of a differential exchange rate was reintroduced after nationalization of the industry in 1971. Clearly, the objective was no longer one of ensuring a maximum return to Chile of the sector's foreign-exchange earnings. One objective of this policy was to divert a portion of the revenues generated by the copper industry from the Treasury to the Central Bank. However, once again it had the effect of encouraging the use of imported inputs which increased substantially between 1971-73. It also proved to be an inefficient tool in controlling Gran Mineria expenditures in local currency. In August 1974 this exchange rate system, equi-valent to an export tax, was abolished and replaced by a more efficiently-designed tax policy on the Gran Mineria copper operations.

C. Direct Employment Effect

13. After the virtual collapse of the nitrate industry in the early 1930's copper became Chile's major export commodity. Besides providing a major portion of Chile's foreign-exchange requirements, the nitrate industry had employed a significant proportion of Chile's labor force. The nitrate boom had given rise to a labor shortage within Chile as a whole and to labor migration from other sectors. The copper industry only in part, however, replaced the nitrate industry as a major source of employment. In the early phases of copper mining development labor employment was relatively high in the industry. The total work force in the copper industry had reached 20,000 by 1940 and increased to almost 25,000 by 1943. Since then employment declined sharply to less than 15,000 in 1955. This was a period

of low levels of copper investment and high taxes, and a period in which labor was discriminated against in favor of capital as a consequence of rising labor costs. Total employment increased after 1955. The following table summarizes the major employment trends since 1960:

Employment in the Gran Mineria

Years	Employment
1961-63	18,198
1964-66	19,100
1967-69	21,700
1970-71	24,156

Up to 1966, the Government did not have an employment policy for the large-scale mining industry and there is little evidence it appreciated the impact of high copper taxes on employment. Furthermore, a combination of an over-valued exchange rate, salary policies and duty-free import of capital goods, had the overall effect of discouraging an increase in the work-force and, as a consequence, the foreign-exchange contribution to the country. The Chilean large-scale copper mining industry is capital- rather than labor-intensive and has been significantly input-saving over time. This trend is likely to continue. Over the last two decades there has been a modest increase in the work force accompanied by markedly larger increases in wage levels. This has meant an increase in the foreign exchange "returned" to Chile in order to cover wage costs. In 1970 these expenditures corresponded to 40 percent of total production costs, or $150 million in absolute terms.

14. While the medium-scale mining sector has also become increasingly capital-intensive since 1960--by 1971 the five major producers employed slightly over 4,000--the small-scale mining sector continues to play an important role as a source of employment for Chile's labor force. It was estimated that in 1970-71 approximately 10,000 people were employed in these mining operations. Although the Government is aware of the inefficient production methods of these small-scale operations, the problem of absorbing this work-force into more productive economic activities outside of the small-scale mining sector remains.

D. Domestic Demand Contribution

15. The input requirements and overall growth of the copper sector have had a measurable impact on output, investment and productivity of the other sectors of the economy. One major contribution can be recognized, which has had an effect on overall economic growth: the expansion of the market for Chilean goods. Market expansion has been reflected by increased demand for other sector products derived principally from payments to factors

of production as well as the copper sector's demand for intermediate goods. This contribution has been of considerable significance to the economic well-being of the Norte Grande and O'Higgins provinces of Chile, for instance, which have been largely sustained by factor payments and demand for intermediate goods.

Industrial Project Department
April 1975

CHILE: COPPER SECTOR PROJECT

POLICIES OF THE COPPER SECTOR

A. The Development of Fiscal Policy in the Copper Mining Sector

1. Taxation policy has for a long time been a critical element in determining the proportion of foreign-exchange returned to Chilean Government by the copper mining industry. It has been a key factor also in determining investment levels in the sector throughout the period of foreign ownership of the industry, as well as a bargaining point between the Government and the foreign companies in negotiating agreements related to ownership, state involvement in the sector and the provision of adequate investment incentives. Taxation policy has had a decisive role in influencing the volume of external resources available to the country and has had a significant impact on Chile's economic development.

2. In the early part of the century, taxation rates on the copper industry were extremely low and had little impact in providing Chile with foreign exchange. Only in 1925 was a special income tax on copper mining introduced and not before 1930 was the level of taxation at all substantial. In the period 1925-32 the investment climate was characterized by free trade in copper, free conversion of foreign exchange and the same taxation regulations for both foreign and Chilean producers. A profits tax on the Gran Mineria, which had been introduced in 1925, was raised from 12 to 18 percent in 1934 but nothing approaching a national taxation policy emerged until the late 1930's. In 1932 exchange control was introduced which required that a portion of the foreign companies' operating costs be paid in local currency purchased at a differential rate. This measure, tantamount to an effective tax on the Gran Mineria, was staunchly resisted by the foreign companies and was to have severe repercussions on the development of the sector in subsequent decades.

3. The emergence of the first vestiges of a national fiscal policy dates from 1939 when the development activities of the Corporacion de Fomento de la Produccion (CORFO) were financed with an additional 15 percent tax on profits, raising the total tax on profits to 33 percent. In 1942 a new tax regulation was introduced which was to foreshadow the application of an "excess price" tax, or surtax, in subsequent years until 1955. This tax of 50 percent was imposed on profits and was temporarily raised to 60 percent in 1947. By 1954 the effective tax on foreign-owned companies had increased to 80 percent of net profit, one of the highest in the world.

4. The Government's objective in this period was to maximize revenue per pound of copper over the short-term rather than the "aggregate retained value" from copper for the country over the long-term. A consequence of the

high taxation laws and the differential exchange policy was that local expenditures were kept to a regulation minimum since imports were substantially cheaper than the same products acquired locally. The high taxation provided no tangible benefits to Chile but had the overall effect of hurting the country as much as the foreign-owned companies. There is considerable evidence that a combination of these policies retarded foreign investment in the mining sector in Chile, with the foreign companies deciding to expand mines of lower grade ores in the United States rather than increase output and investment in Chile.

5. The New Treatment Law of May 1955 marked the beginning of a period of taxation policy fundamentally different from that which had existed beforehand. The inspiration behind the new law was an awareness that Chilean copper output had been stagnating for a long period and that the development potential of the sector had not been achieved, primarily as a result of inappropriate policies. The new law--which was designed to encourage foreign investment, stabilize tax revenues and stimulate additional copper processing in Chile--established a basic rate of 50 percent on net profits, plus a surtax of 25 percent. The latter declined proportionately as production exceeded a base level, defined as 95 percent of the average output of the company during the period 1949-53. This base level represented a total production of 333,000 TM per year, significantly lower than installed capacity, and was quickly exceeded. The new law also abolished the existing differential exchange rate. Another aspect of the new law was the provision for accelerated depreciation, particularly with regard to new investments. This measure proved to be an attractive incentive for the foreign companies and was especially beneficial to the new El Salvador mine which replaced the depleted Potrerillos mine in 1959.

6. The 1955 law substantially improved the investment climate and was followed by increased new investment, though not as large as had been hoped for by the proponents of the legislation. It was also subjected to considerable political criticism in Chile by those who argued that it had resulted in substantial loss of governmental revenue. Furthermore, at the precise moment when the tax law became effective a sudden rise in the world price of copper took place and the combination of favorable tax legislation and high prices resulted in large profits for the mining companies. This increased ill-feeling within Chile towards the tax legislation. The 1955 legislation was nevertheless preserved until 1959 when two additional measures were introduced increasing effective tax to almost former levels. Once again these measures had a dampening effect on investment. Plans for further investment were shelved and the sector experienced a period of uncertainty from 1960-65.

7. In the early 1960's the Christian Democratic Party under the leadership of Eduardo Frei--who was to become President of Chile in 1964--had proposed a revision of the laws and government policies for the Gran Mineria, the so-called "Chileanization" program. The major objectives of the program included a doubling of copper output by 1970, substantial participation by the Government in copper production and exploration, a tripling

of refining capacity by 1970, state-control of sales and reducing Chile's dependence on U.S. markets. Tax incentives and tax guarantees were provided which would assure the profitability of the new operations. A multiplicity of tax laws were introduced in 1964. A new mineral law No. 16,624 established a basic tax rate of 52.5 percent of net profits, plus a variable surtax of 33 percent for the Chuquicamata mine. The surtax reduced to zero if production reached 100 percent above the "basic output" level, defined as 95 percent of the average 1949-53 output. The El Salvador mine was taxed at 50 percent of net profits, but with a reduction in allowable depreciation from 8¢/lb to 1.8¢/lb. The joint venture mines were afforded special tax treatment. El Teniente (51 percent government) was subject to 20 percent profits tax, plus 30 percent tax on dividends paid to Kennecott. Andina and Exotica (25 percent government owned) were subject to 15 percent profits tax and 30 percent dividend tax. The net effect was to reduce the tax burdens appreciably. As indicated in the table on page 8, taxes as a percentage of gross sales increased from an average of 7 percent between 1930-39, to almost 20 percent between 1940-49 and averaged 27 percent and 32 percent for the periods 1950-59 and 1960-69 respectively. The goal of the Frei program was to negotiate a long-term contract with the foreign-owned copper companies which would assure the creation of productive capacity consistent with the maximization of total net revenues. Fiscal policy was a key ingredient of the Government's incentive package and provided the long-term guarantees that the companies had been seeking for almost two decades. The situation which had prevailed in 1955-1956--however, a combination of favorable tax incentives and high world copper prices--occurred once again ten years later. Profits exceeded all previous levels and provided a bonanza to the foreign companies. Such profits were also primarily responsible for fueling the political pressures for outright nationalization of the Gran Mineria, an event which was subsequently to take place in July 1971.

8. The nationalization of the Gran Mineria has demanded a corresponding change in fiscal policy. Both government fiscal revenues and foreign-exchange earnings have become increasingly sensitive to fluctuations in the world price of copper. The Chilean Government has been striving to formulate a fiscal policy to meet this changing situation, i.e., to control expenditures in accordance with these price variations, and to use the surplus resources generated at times of high copper prices to finance expenditures when prices are depressed. At the same time, these surpluses need to be directed towards the installation of new productive capacity in the country in sectors other than the mining sector. With the dramatic fall in copper prices in late 1974 and early 1975 to below 55¢/lb. from the high of $1.45/lb. in mid-1974, the profitability of the Gran Mineria and hence its tax liabilities declined dramatically, contributing to an aggravation of the fiscal situation. As an interim measure the Government has adopted the following policy; all revenues of the Gran Mineria operations in excess of the operating costs, estimated to be the equivalent of 45¢/lb., are now being retained by the Government. This system of forced revenue transfers is to be used only as an interim measure until a more suitable system of taxation and transfer of a part of the net earnings of the publicly-owned mines to the Government can be formulated.

B. Development of Exchange-Control Policy

9. Exchange rate policy, as applied to the copper mining industry, has been the other major instrument utilized by successive Chilean governments since 1932 to increase government revenue generated from copper production. In the same way as taxation policy, it has been a sensitive point in all relations between the Government and the foreign-owned companies. The idea that a differential exchange rate should apply to Chile's primary export commodity has been deep-rooted in government thinking. Even after the nationalization of the industry in 1971 both the Allende government and the present military government maintained a differential rate as a means for channeling revenue generated by the copper industry to the rest of the public sector. Only recently--since August 6--has this rate been discarded and been replaced by a uniform exchange rate.

10. The first exchange controls on transactions related to the copper mining industry were imposed in 1932. These exchange controls required that a portion of the local operating costs--the so-called "legal costs of production"--had to be paid in Chilean currency acquired at a special and discriminatory rate. This marked the beginning of a differential rate that was to continue in subsequent decades signifying one exchange rate for transactions affecting the Gran Mineria and another for transactions outside of this industrial activity. The net impact was an effective tax on mining operations of the Gran Mineria which was to continue until 1955.

11. Throughout this period the general regulations governing exports specified that all revenues derived from sales outside of Chile had to be returned in their totality to the country. In the case of foreign companies, this revenue was returned to the banking system and any subsequent purchase of foreign-exchange--for the purpose of local expenditures and repatriation of profits--was conducted through the existing channels with Central Bank approval. The Gran Mineria, however, enjoyed a uniquely privileged position in that it was not subject to this regulation, returning foreign-exchange to Chile only to the extent that it found itself required to make payments in local currency.

12. The New Treatment Law of 1955 (see Annex 2-5, paragraph 5) brought to an end the special exchange rate for copper. Starting from 1956 all transactions were carried out at a single exchange rate, a system which survived until 1962 and which had the effect of encouraging the companies to shift their purchases to Chilean suppliers. During 1962 a dual exchange rate was briefly introduced but was eliminated again before the end of that year. The Chileanization program, elaborated by the Christian Democratic Party in the early 1960's but whose basic legislation was not passed until January 1966, explicitly guaranteed there would be no discriminatory exchange agreements similar to those which had existed previously. This endured until the

Allende Government came to power when a system of multiple exchange rates was introduced, affecting not only the copper industry but also a series of other import-export transactions and which survived until almost the end of 1973.

C. Development of Investment Policy - Before and After Nationalization

The Period to Nationalization

13. The low historical investment levels in the period 1930-1945 were primarily affected by the depressed conditions in the world copper market during the 1930's and the shortage of capital goods during the Second World War rather than by the Government's tax policy. Despite the rapid growth of world demand in the aftermath of the war, however, investment in Chile's copper sector by the foreign-owned companies did not increase between 1948 and 1955. It is certain that high levels of taxation and uncertainties regarding government policy played a significant role in keeping investment levels low. The only major investment in this period was in the Chuquicamata mine ($132 million) which reflected more Anaconda's interest in maintaining its share of the world market than the profitability of additional investment.

14. By any standards investment in the Gran Mineria during this period was low. The stagnation of copper output in the Gran Mineria in the face of rising world demand gave rise to the New Treatment Law in 1955, designed primarily to encourage output and investment in new productive capacity. In the aftermath of this law, investment did increase significantly with additions to capacity taking place in the Chuquicamata, El Teniente and, most importantly, the El Salvador mines; over $200 million was invested in total. Nevertheless, investment did not attain the level expected and the increase was short-lived. Fluctuations in the world price of copper, general political uncertainty in the country and high levels of inflation were primarily responsible for this. By 1960, however, the foreign companies were prepared to consider making substantial investments--up to $500 million over a five-year period--in return for tax guarantees and other provisions. An agreement was finally reached in the Frei Chileanization program which became law in early 1966. This program sought primarily a doubling of copper output by 1970 and a substantial participation of the Government in copper production. The investment program contemplated further expansion of the Chuquicamata, El Salvador and El Teniente mining operations, as well as bringing into production two new mines, Andina and Exotica. Total planned investment to 1971 was approximately $470 million.

15. While risk and political uncertainty as well as high taxation policy were undoubtedly the factors which were largely responsible for the lack of a continuous investment flow, the low propensity of the foreign companies to reinvest out of profits is attributable to other factors, outside of the

Government's control and Chile found itself continually subject to these in its attempts to arrest the outflow of foreign-earned income from Chile. The world depression in the 1930's and the copper price fixing policy of the U.S. during periods of war were two examples of this. The Chileanization program provided the framework for a more continuous investment flow by the foreign companies. Nationalization of the industry, however, in 1971--before the program could be fully completed--transformed the ownership of the sector. The Table on page 7 summarizes the returns from the three large mining producers in the period 1930-69.

Industrial Projects Department
April 1975

CHILE: COPPER SECTOR PROJECT

PAST INVESTMENTS IN THE CHILE COPPER SECTOR

A. Gran Mineria: Large-Scale Mining

An Overview

1. Little is on record of the investments made in the early development of the Gran Mineria, except that:

(a) The first mine El Teniente was incorporated in 1904 with a capital of US$2.3 million as Braden Copper Company and sold in 1916 to the Kennecott Copper Corporation for US$57 million (95 percent of stock);

(b) The Chuquicamata mine was incorporated by Guggenheims in 1912 as Chile Exploration Company and 51 percent of the stock was sold to Anaconda Company in 1923 for US$77 million; and

(c) The Potrerillos mine was also bought by Anaconda from the Guggenheims.

2. The records available indicate that investment in large-scale copper mining from 1930 to 1969 was as follows:

Table 1: Total Investment in the Large Copper Mining Sector (1930-69)

Period	Total	Annual Average
	--------US$ million--------	
1930-39	12.1	1.2
1940-54	161.1	10.7
1955-64	251.1	25.1
1965-70	631.3	105.2
1971-73	75.8	25.2

3. By the end of 1973 the accumulated gross investments in the Gran Mineria was indicated on the corporate accounts as almost US$2.5 billion. Accumulated net fixed assets are shown as approximately US$1 billion.

Programs 1955 to 1965

4. In 1955 the Government of General Carlos Ibanez promulgated Law No. 11,828, known as "Ley del Cobre", which fixed a basic tax of 50 percent on profits of the companies plus an additional tax of 25 percent that decreased in direct relation to the increase in production, providing a tax burden much

more severe than previously in effect. While this created some hesitancy, the foreign copper companies were nevertheless prepared to embark on a major investment program. Kennecott announced its intent to increase annual capacity of El Teniente from 165,000 metric tons to 255,000 metric tons with a US$200 million investment; Anaconda planned to build a new refinery at a cost of US$128 million; and Cerro Corporation offered to invest US$75 million to bring Andina into operation with a production of 60,000 tons/year. However, these plans were conditional upon the Government agreeing to a 20-year tax guarantee, and were shelved in 1962 when surtaxes were levied on top of the basic income tax liabilities--contrary to previous legislation. Tax reached 80-90% of taxable income for some operations. The funds were instead applied to projects in the U.S. and production stagnated between 1960 and 1964, although earlier investments realised increases in capacity between 1955 and 1960.

Programs 1965 to 1973

5. In 1964, exploratory talks began between the Christian Democrats and the foreign copper companies regarding nationalization and expansion, even before President Frei was elected in September 1964, and the victory of his Christian Democratic Party in March 1965. A program was agreed upon which called for "Chileanization" of foreign owned copper companies and included the following objectives:

(a) To boost copper production by 1972 to 1.2 million (short) tons, of which almost 1 million (short) tons (880,000 metric tons) would come from the Gran Mineria;

(b) To refine a much higher share of copper production in Chile, in order to increase revenues, create jobs, and to provide raw materials for expansion of a metal fabricating industry;

(c) To provide for Chilean Government participation in the production and marketing of copper as a partner of the producing companies in order to provide more state control over the country's most important export; and

(d) To integrate the copper industry into the national economy.

6. In separate negotiations with each of the companies agreements were reached on tax reform, financing the investments, and Chilean participation in "mixed" companies. The expansion and nationalization programs effectively commenced in 1967.

Expansion Targets

8. An impressive program was formulated, which was the largest undertaken in Chile, and covered the ongoing operations of Chuquicamata, El Teniente and El Salvador, plus two new deposits, Exotica and Andina, as summarized below:

Table 2: Gran Mineria Expansion Program (1967-72)

Mine/Plant	1965 Output	Planned 1972 Output	Increase
	('000 metric tons)		-- % ---
Chuquicamata	253	355	40
El Salvador	74	100	35
El Teniente	152	255	67
Exotica	-	100	-
Andina	-	70	-
Total	480	880	84

Project Descriptions

9. Chuquicamata: Decree No. 1771 of December 23, 1966, authorized Chile Exploration Company to make an investment of US$99 million, later increased to US$159 million to expand the mine, concentrator and refinery. The objective of the investment was to increase the capacity for mining and treating sulphide ores from 170,000 tpy to 355,000 tpy and a total installed refinery capacity from 270,000 tpy to 455,000 tpy, including the treatment of oxide ore from Exotica. The project included: purchase of mining equipment (shovels, trucks, drills), mine development, modernization of the oxide leaching plant, expansion of the sulphide concentrator, expansion of the smelter, and elecro-extraction and refining plants, installation of an additional 55,000 Kw generating capacity in the Tocopilla electric plant, port installations in Antofagasta, welfare works, increased transportation capacity and general services.

10. El Salvador-Potrerillos: Decree No. 1770 of December 23, 1966, authorized the Andes Copper Mining Company to invest US$10 million later increased to US$13 million in the expansion of capacity to 100,000 tpy. The project included: adding a third bay to the electrolytic refinery to expand refinery capacity from 33,000 tpy to 66,000 tpy; expansion of the Barquito diesel electric station, and underground mine development to increase capacity to 25,000 tpd.

11. El Teniente: Decree No. 316, of March 1, 1967, authorized the expenditure of US$230 million by Sociedad Minera El Teniente to increase production capacity from 160,000 tpy to 280,000 tpy. The project included:

increasing electrolytic refining capacity from 50,000 tpy to 120,000 tpy and fire refining capacity from 66,000 tpy to 118,000 tpy; development of new areas of mine; expansion of existing one; construction of the new No. 8 level connecting the mine with the Colon Concentrator, including construction of the railroad and purchase of rolling stock; construction of the new generating capacity and distribution system for electric power, including construction of a 110 Kv high-tension line; construction of high-speed all-weather highway from Rancagua to Colon (40 km), and general services. The project was originally scheduled for completion by June 1970.

12. Exotica: Decree No. 215 of February 13, 1967, authorized an investment by Compania Minera Exotica of US$38 million for development of the Exotica mine. The project included: exploration to delineate the ore body; engineering of pit design; pit development, stripping; purchase of mining equipment; and installation of ancillary facilities required to supply sufficient ore to the Chuquicamata oxide plant for producing 100,000 tpy of fine copper.

13. Andina: Decree No. 1999 of December 9, 1966 authorized an investment of US$89 million later increased to US$157 million for the development of the Rio Blanco mine by the Compania Minera Andina. The project included: engineering, development and start-up of an underground mine using block-caving methods; excavation and installation of an underground sulphide concentrator, installation of power generating capacity and distribution system; provision of water supply; transport facilities; port installations, townsite and services, plus ancillary works.

Financing and Expansion

14. The program originally estimated to cost US$426 million equivalent in 1965/66, quickly escalated to US$590 million by 1970 and by 1973 had reached US$617 million with parts of the program still not satisfactorily completed. Further investments of more than US$150 million are still required before the production target of 880,000 tpy will be realised. Table 3, page 5, summarizes the investments made for each project to the end of 1973. In addition Anaconda embarked on a housing program with estimated costs of about US$70 million.

Table 3

CHILE: COPPER SECTOR PROJECT

INVESTMENTS MADE IN THE EXPANSION PROGRAM
(US$ millions)

Company	1967	1968	1969	1970	1971	1972	1973	Total 1967-73	Authorized Investment Original	Authorized Investment Revised
Compania de Cobre Chuquicamata (Decree No. 1771)	24.3	64.5	19.3	30.9	10.8	2.5	9.4	161.8	99	159
Compania Minera Exotica (Decree No. 215)	11.4	3.9	11.5	19.7	1.2	-	-	47.6	38	38
Compania de Cobre Salvador (Decree No. 1770)	5.4	4.0	2.0	1.2	0.6	0.1	-	13.3	10	13
Sociedad Minera El Teniente (Decree No. 316)	12.2	78.3	91.3	29.8	46.7	-	-	258.3	230	230
Compania Minera Andina (Decree Nos. 1699 and 46)	22.4	27.1	34.7	47.7	3.6	0.7	0.2	136.6	89	157
Total	75.8	177.8	158.9	129.3	62.9	33.4	9.5	617.6	466	597

SOURCES: Chuquicamata: Report on construction costs on December 31 each year.
Exotica: Report of construction costs on December 31 for 1967 and 1968. Financial statements for 1969 and after.
Salvador: Financial statements.
El Teniente: Progress Reports Plan 280 for 1968, 69, 71: Codelco report on Development of Expansion Programs 1967; Report on statements of costs 1970;
Andina: Reports on construction costs (1967/68/69); Annex 7 of Accounting Reports.

15. Foreign sources financed a major part of the program. The U.S. Eximbank (US$196.5 million), private foreign banks (US$80 million), and Japanese copper smelters (US$32 million), together provided about 50 percent of the total financing. Another 20 percent (US$121 million) was financed by loaned from Kennecott and Cerro to their Chilean subsidiaries. Equity investments by Cerro and Anaconda in the two new mines ($26 million) and reinvestment of earnings (US$75 million) by Anaconda accounted for a further 17 percent of the finance. The remaining 10 percent (US$56 million) came primarily from Codelco. Completion of the projects to reach targeted production levels will come primarily from cash generation.

Results of the Expansion Program

16. Several important problems were encountered such as design errors, underestimation of capacity of installations and even serious mistakes in respect to technological concepts. Difficult labor relations in particular as well as transport strikes in 1972-73, resulted in a large shortfall of production below those targeted. The considerable start-up problems and delays in the completion of construction and engineering not only persisted into early 1974, but were aggravated by shortage of capital, spare parts and very importantly the large exodus of some 300 highly qualified technicians at the end of 1970 and early 1971--just at the time the new installations had to be run-in--when the Allende Government de facto reduced the comparatively high salaries of these people and abolished their privilege to receive at least part of their remuneration in U.S. dollars. In addition, when the inevitability of nationalization was realized, the companies employed various short-cut techniques in an endeavour to produce as much as possible in the time remaining.

17. The production shortfalls are summarized in Table 4, page 7.

18. Instead of obtaining an 85 percent increase in capacity between 1965 and 1972 as planned originally, a 28 percent increase had only been realized by 1973. This increased to 59 percent in 1974, which is still significantly short (120,000 tons) of the target. To a large extent this short-fall was a result of poor management and lack of worker discipline of the nationalized properties as evidenced by the fact that after reorganization of Codelco with the change in Government in September 1973, production for the five mines increased to 207,800 for the fourth quarter 1973 (or 831,200 annual equivalent) which is only 6 percent short of the 880,000 ton target or an expansion increase of 75 percent versus the planned 85 percent. The production for the month of December 1973 reached 73,000 tons which annualized becomes 876,000 tons or almost the target figure. The shortfall from target in 1974 is due partly to some technical deficiencies of the program, and very importantly is affected by the lack of capital and spare parts, management deficiencies and operational problems resulting from poor operational control and procedures over the past three years.

Table 4

CHILE: COPPER SECTOR PROJECT

RESULTS OF THE EXPANSION PROGRAM

	Actual Production 1965	Production Targets (1965) 1/ 1972	Targets (1970) 2/ 1971	1973	Actual Production 1971	1973	Shortfall 3/ 1973	% Change (1965-73) 4/ Target	Actual	% Achievement	1974 Actual Production
					(000 metric tons)						
El Salvador	74	100	90	90	85	84	16	35	12	35%	80
Chuquicamata	253	355	300	354	250	263	91	40	5	12%	357
El Teniente	153	253	260	274	147	178	75	80	17	21%	226
Exotica	-	102	77	102	35	32	68	-	-	32%	32
Rio Blanco	-	70	60	63	54	56	14	-	-	80%	68
Total	480	880	787	883	571	616	270	85	28	35%	764

1/ Targets established by the companies.
2/ Revised targets by CODELCO made shortly after nationalization of the companies.
3/ Shortfall over initial target (1965).
4/ Percentage change in production of 1973 over 1965 production.

19. In Chuquicamata, the output in 1973 was only 5 percent higher than that in 1965, but actually lower than the outputs in 1964, 66, 67, 68 and 69, versus an expected production increase of 40 percent with the expansion program. The causes were numerous. First, in the months prior to nationalization, mine development was neglected and all equipment was used to extract as much ore as possible. Second, the lack of foreign exchange, the increasing difficulties of obtaining spare parts, and mining trucks supplied by tradition by U.S. suppliers, and delays in deliveries from new suppliers (Australia), and poor maintenace led to a deterioration of the production equipment and a rapid reduction in the availablity of the equipment. The mine rolling stock at times operated at only 50 percent capacity. Third, design errors and defects in the newly installed primary crusher in the pit and the conveyor belt to the concentrator plus inadequate processing capacity of the smelter provided production bottlenecks. The newly installed smelter had been designed without regard to Chiquicamata's altitude of 2,300 m above sea level, causing the reverbatory to function at only 65 percent of its nominal capacity. Fourth and most important, however, was the steady social unrest and poor management during the start-up of the expanded facilities. The labor force was increased, while output declined, hence, productivity declined substantially. Poor mining practice such as doubling bench heights, led to a significant deterioration of safety conditions, poor blasting efficiency, and lower equipment utilization factors.

20. The production increases after the change of government in September 1973 show the importance of non-technical factors: output for the last three months of 1973 reached 92,200 tons (370,000 tons annual equivalent) which is 107 percent of the targeted output. Production in 1974 reached 357,000 tons or the targeted output (70 percent of the projected expansion). With the improved availability of spare parts, receipt of the new trucks and other equipment recently ordered with suppliers credits, minor improvement in the primary crushing facilities and continued better management, pit design and production planning even further increases are expected in 1975 and 1976, although the working of lower grade ore will provide some bottlenecks.

21. The El Salvador project was small, costing only US$13 million, with a projected production increase of 25,000 tons. Total production reached 93,000 tons in 1970 (75 percent of the planned increase), but dropped again to a level of 83,000 tons for 1971 through 1973 with the mass exodus of engineers with the nationalization. At one point only two engineers were left to operate the El Salvador mine. Depletion of the more friable secondary ore and the movement of the production to the harder primary ore areas is the major cause for the shortfall. In addition, one of the newly installed diesel generators exploded and the others have operated less than satisfactorily, posing a limit on the utilization of the new refining capacity also installed under the project. Production in the immediate future is expected to be limited to the present levels of 85,000 tpy, because of the difficulty being experienced in mining the harder ore, and the electric power bottleneck. Further investment in both these areas is needed to achieve the production target of 100,000 tpy.

22. At El Teniente, the production level of 1972, while exceeding the 1965 level by 40,000 tons, barely exceeded the levels of 1966, 69 and 70, and fell considerably short of the targeted production. El Teniente's poor performance can be mainly attributed to poor management and labor problems during the running in of the new equipment. The loss of large numbers of qualified engineers and supervisors, adverse climatic conditions (reducing the water supply below the normal minimal level), plus some significant design errors in the new smelter, all contributed to the problems. The concept of smelting concentrates in converters with oxygen-enriched air failed, and it was thus necessary to build a new reverbatory furnace (completed in April 1974) to increase smelter capacity to that planned in the program. In addition, a special water supply line is under construction to avoid future difficulties. Production in 1974 reached 225,000 tons (88 percent of target). El Teniente, similarly to El Salvador, is experiencing problems in moving the production areas from the friable secondary ore to the harder primary ore. Achievement of the production target established at the beginning of the expansion program depends upon the success with which this problem can be solved.

23. The development of the Exotica mine ran into severe technical (metallurgial) problems and has been unable to attain more than 30 percent of design capacity. Exotica is located very close to Chuquicamata and was discovered at a time when the oxide ore at Chuquicamata was nearing depletion and the operations turning to sulphide ore. Since the Exotica ore was an oxide, the plan was to treat the Exotica ores in the Chuiquicamata oxide processing facilities (leaching, electrowinning). The proximity of the two deposits and the preliminary results of the test drilling suggested that there were no important differences in the characteristics of the two ores. Hence, insufficient exploration and ore testing was undertaken. As it turned out, the Exotica ore is very different from the Chuqui oxide ore and the process used for the latter was not suited. Subsequent drilling and testing has demonstrated that not only is the Exotica ore much more complex, but the ore body is composed of three different types of ore, all of which need different treatment. Testing has demonstrated that the use of solvent extraction between the leaching and electrowinning stages should solve the major problems of impure leaching solutions now encountered. Alternative leaching methods are also being considered and tested. Steps are being taken to install the new facilities. Major investment of more than US$90 million will be required before Exotica could be operated at its originally targeted figure of 100,000 tons.

24. **Andina**, in spite of early serious technical difficulties related to the block caving, was brought into production in early 1971, reaching almost 80 percent of capacity in that year, a level it maintained through 1973, rising in 1974 to the targeted level. Apart from inducing the initial caving the project experienced only minor technical problems. Delays in completion of the infrastructure and housing facilities for the work force contributed to some loss of production.

B. Mediana y Pequena Mineria (Medium and Small Mines)

The Program 1968-72

25. In addition to expansion of large mines, Chile planned to increase the production of its small and medium copper mines from 100,000 tons in 1965 to 220,000 tons in 1972. Thus, total Chilean copper output was to increase more than 90 percent, from 580,000 tons in 1965 to 1.2 million tons in 1972. ENAMI, the State Mining Company, was to organize and execute a major part of the medium and small mines' expansion.

26. In this context ENAMI undertook in 1968 a three-year program to increase its own mine production from 52,000 tons to 96,000 tons per year and to provide additional smelting and refining capacities for processing part of large and medium mines output under toll agreements. Total refined production by ENAMI facilities was to reach 164,000 tons in 1972 (1968: 108,000). The increased production was to provide 4,700 additional jobs.

Table 5: ENAMI EXPANSION PROGRAM (1968-73)

	Actual 1968	Targeted 1972	Change 1968-72	Change % Increase
	(000 metric tons)			
Own production				
Electrolytic copper	28	46	18	64
Blister	24	35	11	46
Concentrates	-	16	16	-
Sub-total	52	97	45	87
Toll operations				
For Gran Mineria	12	16	4	33
For Mediana Mineria	44	51	7	16
Sub-total	56	67	11	20
Total	108	164	56	52

27. The remaining 56,000 tons (50 percent) of the expansion to 220,000 tons was to be met by the private-medium and small operations.

Investment Costs

28. Investment under the ENAMI program was initially estimated at US$85 million (US$47 million local, US$38 million foreign). The major part was to finance mine and plant as shown below:

ENAMI Expansion Program (US$ million)

Item	Cost
Refining	4.0
Smelting	20.5
Treatment	16.8
Mine development	20.4
Mixed companies	8.6
Other	6.5
Working capital	8.2
Total	85.0

Achievements

29. The performance of this sector was even more dismal than that of the large mines, and in 1973 production was only 100,000 tons, the same as that in 1965, although output had reached 150,000 tons in 1969 and 1970.

30. A major part of the ENAMI program was delayed because of delays in arranging the necessary foreign financing; only 15 percent of total investment was implemented and financing arranged for the remainder by early 1970. With the change in Government in 1970, implementation of the project almost stopped and the increase in capacity shown in the late 1960's by the private sector was reversed with increased labor dissension, and less favorable economic conditions, namely, the imposition of an artificial exchange rate on the receipts from mineral exports, uncertainty of the Government's intentions and actions to form mixed companies, and transport strikes. Many of the smallest operations were temporarily closed down.

Industrial Projects Department
April 1975

CHILE: COPPER SECTOR PROJECT

FUTURE EXPANSION AND PRODUCTION OF THE COPPER SECTOR

A. Copper Potential of Chile

1. Chile posesses extremely large copper reserves; reportedly more than 20 percent of world reserves. The five large mines together possess more than 5 billion tons of proven reserves (60-70 years life at the existing rate of production) and have additional potential reserves of 3-1/2 - 6 billion tons. These are divided as follows:

Copper Reserves

Mine	Proven	Potential (in addition to proven)
	million tons (grade %)	
Chuquicamata	1,500 (1.2% Cu)	2,000-3,000 (1.2% Cu)
El Teniente	3,000 (1% Cu)	1,000-2,000 (1% Cu)
El Salvador	260 (1.3% Cu)	Not determined (small)
Exotica	185 (1.7% Cu)	Not determined (small)
Andina	120 (1.6% Cu)	Possibly 500-1,000
Total	5,365	3,500-6,000

2. In addition substantial reserves have been located in new deposits as listed below:

Deposit	Province	Potential Reserves
		million tons (grade %)
Cerro Colorado	Tarapaca	100 (1.0% Cu)
Mocha	Tarapaca	50 (0.8% Cu)
Quebrada Blanca	Tarapaca	150 (1.0% Cu)
Sierra Gorda	Tarapaca	30 (0.78% Cu)
Puntillas	Antofagasta	20 (0.9% Cu)
El Abra	Antofagasta	700 (0.9% Cu)
Pampa Norte	Antofagasta	100 (0.8% Cu)
Sierra Jardin	Atacama	Unknown
Punta del Cobre	Atacama	Unknown
Andacollo *	Coquimbo	300 (0.7% Cu)
Los Pelambres	Coquimbo	450 (0.8% Cu)
Disputada *	Santiago	Unknown
Total Reserves		At least 3 billion (0.7-1.0% Cu)

*Existing small scale operations.

3. Substantial reserves also exist as tailings and slag dumps. It is estimated that these amount to more than 1 billion tons as follows:

Dump	Reserve ----million tons (% grade)----
Chuquicamata selected mine waste dumps	300 (0.3% Cu)
Chuquicamata leach residues	500 (0.3% Cu)
Chuquicamata concentrator tailings	250 (0.2% Cu)
Potrerillos residues	25 (0.25% Cu)
Salvador concentrator tailings	50 (0.25% Cu)
El Teniente (Barahona) concentrator tailings	50 (0.2 Cu)
El Teniente (Cauquenes) concentrator tailings	300 (0.2% Cu)
Total at least	1,800 (0.2-0.3% Cu)

Thus, potential copper reserves in Chile amount to at least 10 billion tons averaging 1 percent Cu or 100 million tons of fine copper which represents 100 years life at the production level expected by 1978. Alternatively this represents 16-18 years of the 1973 total world production level. Clearly, Chile has major copper reserves, despite the fact that it has not been explored with as much intensity as many other regions of the world. It is important to note that 80% of these reserves are contained in the deposits now worked by the 5 companies of the Gran Minera.

B. Investment Needs

The Role of Chilean Production in Future World Supply [1/]

4. As indicated in Annex 3-1, the increase in world consumption of primary copper has averaged 4.3 percent over the past 20 years, or 3.8 percent for the period 1970-1973. This growth rate is expected to continue although projections on the basis of population growth and increase in per capita consumption indicate that 4.3 percent appears conservative. As indicated in Annex 3-1, paras 32, 33 and Table 17, such a rate of expansion will require a total investment by 1980 of $12 billion (in 1974 constant terms) to raise capacity to 9.6 million tons. In the order of $2 billion per year will be required to meet this target; a large amount of capital to mobilize and effectively spend.

5. Because of its significant reserve base and the economics of exploiting these reserves the options open to Chile in its role in future world supply are numerous; varying between a stagnant position at constant production to increasing capacity commensurate with its reserve position in the world. The production and investment implications of several (nominal) alternatives are listed below.

1/ This section has been extracted from "The Indispensibility of Chilean Copper" Alexander Sutolov, Director of R&D, CODELCO. Presentation to American Mining Congress, Las Vegas, October 1974.

Alternatives for Development of Copper Production
in Chile from 1971 to 2000

	Expansion at Chile's Historic 1951-73 Rate 3.1%/Year		Expansion at World Average Rate 1951-73 4.3%/Year		Expansion to Maintain 20% of World Capacity 6.7%/Year	
Year	Annual Average Production	Average Annual/1 Investment (US$10^6)	Average Annual/1 Production (000 ton)	Average Annual/1 Investment (US$10^6)	Average Annual/1 Production (000 ton)	Average Annual/1 Investment (US$10^6)
1971-75	740	-	740	-	740	-
1976-80	850	90	914	140	1,500	600
1981-85	990	110	1,130	180	2,250	600
1986-90	1,150	130	1,390	208	2,780	420
1991-95	1,335	150	1,720	260	3,430	520
1996-2000	1,655	260	2,120	320	4,230	640
Total Investment		3,660		5,520		13,900

/1 Investment costs estimated at $4,000/MT of annual production (1974 prices).

6. Each of these alternatives is feasible from the point of view of availability of copper resources. While in the next 25 years the world will consume approximately 400 million tons of copper (almost the totality of known resources), Chile is unlikely to deplete more than 50 percent of her presently known reserves. Furthermore Chile, deposits are of favorable grade, size and location to make them competitive with other copper deposits in the world. Hence, major expansion of Chile's production would apriori appear to be both technically and financially feasible. The major inhibiting factors would appear to be the availability of capital and the absorptive capacity of the industry. Both factors would clearly inhibit achieving the third alternative of expanding to 20 percent of world production, particularly in the short-term (one-five years), but also in the medium term (five-ten years) and possibly in the longer term. While no clear policy has yet been developed, the Government seems determined to develop the copper sector with a balance of private and public participation. Evidence is the new favorable investment code. Even without private foreign participation, the national companies, mainly CODELCO but also the medium mines should have sufficient financial resources (both internally generated and loan capacity) to finance an expansion rate of 4 to 5 percent per year which compares with the historical rate of 3 percent over the past two decades. It is important to note that in addition to the figures shown in the above table, capital investment of about $100 million/year is needed, merely to maintain existing capacity. However, these companies at present lack the absorptive capacity to efficiently

and effectively carry out such an expansion. To some extent this gap can be filled by technical assistance and subcontracting, but any major increase in rate of expansion over 5 percent (i.e., 6 or 7 percent) will require intensive use of foreign capital, technical and management inputs. Furthermore, the extent to which copper revenues are to be reinvested in copper, vis-a-vis being used in other sectors will depend upon capital availability for other sectors vis-a-vis the copper sector. Clearly, the copper sector has advantages in attracting foreign capital.

CODELCO'S Five Year Investment Programme

7. CODELCO's investment plan for the period of 1976 through 1980 is primarily aiming at maintaining its current copper producing capabilities. About 90% of the total investment of US$740 million for the period will be used to rehabilitate, maintain, and expand the present inadequate smelting and refining capability not so much for the purpose of increasing production of fine copper but accomodating the necessarily increased mine production due to falling ore grades. The following table summarizes the major investments itemized by producing mines:

TABLE 1

CHILE: COPPER SECTOR PROJECT
CODELCO's INVESTMENT PROGRAMME FOR THE 1976-1980 PERIOD
(US$ million)

	- - - Period 1977-1980 - - -			- - - Period 1976 - - -		
CHUQUICAMA	Local	Foreign	Total	Local	Foreign	Total
Basic Investments	46,685	64,500	111,185	18,050	24,350	42,400
New Smelter and Acid Plant	73,359	58,841	132,200	-	-	-
Solvent Extraction Plant (Oxides)	44,300	50,000	94,300	-	-	-
Improvement of Electrical System and Power Capacity	24,500	25,500	50,000	-	-	-
Other New Investments	34,000	48,000	74,000	-	-	-
Selenium Plant	1,629	686	2,315	150	150	300
Total	224,473	239,527	464,000	18,200	24,500	42,700
EXOTICA						
Basic Investments	1,500	3,500	5,000	300	700	1,000
Other New Investments	7,800	7,800	15,000	-	-	-
Total	9,300	10,700	20,000	300	700	1,000
SALVADOR						
Basic Investments	16,410	1,160	17,570	3,000	1,600	4,600
Other New Investments	22,200	14,800	37,000	-	-	-
Rehabilitation of Barquito Power Plant	3,090	17,340	20,430	900	2,100	3,000
Total	41,700	33,300	75,000	3,900	3,700	7,600
TENIENTE						
Basic Investments	37,166	31,606	68,772	23,100	6,300	29,400
Other New Investments	12,000	8,000	20,000	-	-	-
Future Mine	25,569	5,659	31,228	4,400	1,700	6,100
Total	74,735	45,265	120,000	27,500	8,000	35,500
ANDINA						
Basic Investments	17,500	17,500	35,000	3,500	3,500	7,000
Expansion Program	16,600	9,400	26,000	1,900	4,600	6,500
Total	34,100	26,900	61,000	5,400	8,100	13,500
GRAND TOTAL	384,308	335,692	740,000	55,300	45,000	100,300

Industrial Projects Department
January 1976

ENAMI Investment Programme

8. Unlike CODELCO, ENAMI's investment programme for 1976-1980 is much less formalized which is partly due to the recent history of uncertainty as to the future of this organization. The tentative five year investment plan foresees an investment of US$150 million of which about US$100 million will be spent for a new flash smelter, a sulfuric acid plant, and a refinery expansion at Ventanas. The remainder of the investment will mainly be used for expansions of the M.A. Matta and Juan Godoy concentrators for the treatment of Teresita and Punta del Cobre ores and Manto Verde ore respectively. These projects are also conceived to basically maintain copper output with greater reliability.

Industrial Projects Department
January, 1976

CHILE: COPPER SECTOR PROJECT

THE COPPER MARKET

1. Copper is one of the most important commodities traded in the world. The value of annual copper consumption exceeds that of all other metals with the exception of steel, representing almost US$20 billion in 1973. Copper can also be characterized by another feature, its price instability. Low short-term elasticities of demand and supply generate huge and volatile changes in prices when imbalances of supply and demand occur, and thus create problems for the consumers and, very importantly, the copper exporting LDC's.

A. WORLD COPPER RESERVES

2. Copper is found in association with other metals, such as nickel and platinum in ultrabasic intrusives; zinc, and cadmium in volcanic-sedimentary deposits; molybdenum in hydrothermal deposits; and cobalt in sedimentary deposits. All copper ores contain small quantities of gold and silver. The copper content of the ore varies widely from an average of 0.3-2% for intrusive deposits, 0.5-3% for replacement deposits and 0.5-5% for sedimentary deposits.

3. Geographically, copper deposits are found all over the world; however, four major copper areas can be distinguished:

1) The African copper belt, with deposits of up to 6.5% copper in Zambia and Zaire. These contain about 25% of the known copper reserves in the Western world;

2) Eastern Canada, accounting for about 5% of world copper reserves with deposits containing 0.5-2.0% copper;

3) The Western Hemisphere Mountain Chain including deposits in Alaska, British Columbia, western USA, Mexico, Peru, Bolivia and Chile which account for nearly 60% of copper reserves in the world (ex-CPE), containing 0.5-2.5% copper; and

This belt continues around the Pacific with deposits on

4) The East Asian Coast and island chain, particularly, the Philippines, Australia, Bougainville, Mainland China, etc.

Smaller but still significant reserves totalling about 20% of world reserves are found in U.S.S.R., Yugoslavia, Poland, Finland, Scandinavia, Turkey, Romania, Cyprus, Spain, Portugal, India and several other countries.

4. Published reserves have increased over the past years (as illustrated by the table below), while the average copper content of reserves have declined from an average of 2.5% in 1966 to an estimated 1.1% in 1972.

Published Proven Copper Reserves /1

	1966		1972	
	million tons copper content	%	million tons copper content	%
Canada	7.3	4.6	27.2	10.0
USA	29.9	18.6	73.5	27.0
Chile	42.6	26.5	50.8	18.7
Peru	10.9	6.8	20.0	7.3
Zambia	23.6	14.7	24.5	9.1
Zaire	18.1	11.3	18.1	6.6
Others	28.1	17.5	58.1	21.3
World (ex-CPE)	160.5	100.0	272.2	100.0

Source: US Bureau of Mines

/1 CPE - centrally planned economies.

The notable increase in published reserves is based on the discovery of new deposits as well as the inclusions of already known copper deposits whose exploitation became economically viable with more advanced mining and metallurgical technology. Clearly, published proven reserves are generally conservative estimates and there is no doubt that probable reserves represent several times the recoverable copper recorded as proven reserves. In the future, substantial additional reserves are likely to be discovered in the African, East-Asian, East-European-Turkish copper belts, as well as in deep sea nodules. If mine production were to continue at the present rate of exploitation (7 million tons per year) published proven reserves would be exhausted by the year 2014.

5. Copper reserves have not only increased with time, but they vary with copper price level, i.e., reserves depend on the financial return in copper exploitation. According to the US Bureau of Mines, in 1974, World copper reserves range from 304 million tons to 418 million tons for prices of 69 cents/lb. to 102 cents/lb. respectively, as illustrated below.

World Copper Reserves - 1974
(million tons of copper content)

	Prices 1974 US cents/lb of refined copper		
	69 cents/lb	82 cents/lb	102 cents/lb
North America			
Canada	30	34	40
USA	75	84	104
Others	20	22	27
South America			
Chile	53	59	73
Peru	21	24	29
Others	5	5	6
Europe	15	17	21
Africa			
Zaire	18	21	25
Zambia	26	30	36
Other	6	7	9
Asia	22	25	30
Oceania	13	14	18
WORLD (ex-CPE)	304	342	418

Source: US Bureau of Mines.
CPE - centrally planned economies.

B. COPPER SUPPLY AND DEMAND

A market flow chart of copper is given as Chart 2 at the end of this Annex.

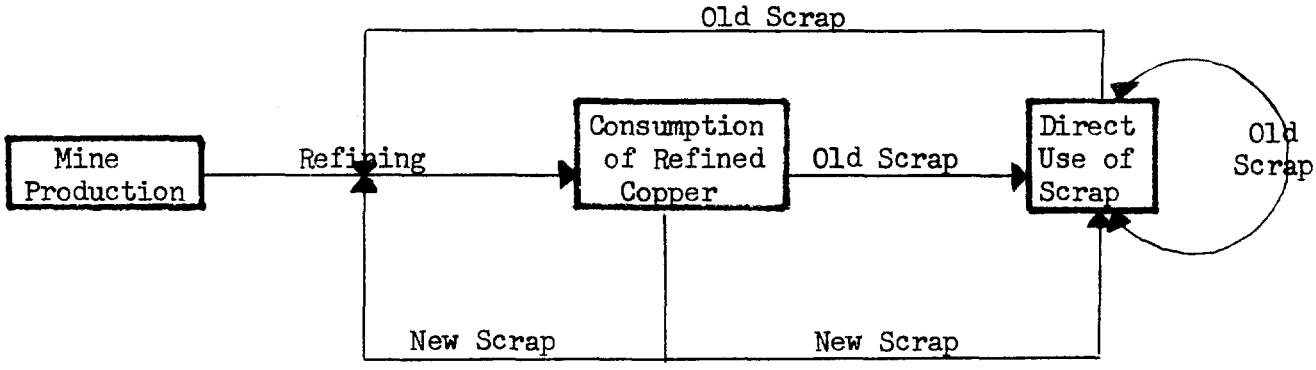
1. World 1/ Copper Supply

6. The world's copper supply comes from two main sources, either (i) from primary or mine production or (ii) from secondary or scrap recovery and is used in two different forms, i.e., either as (i) refined copper from

1/ In this Annex "world" refers to all counters but the "centrally planned economies".

primary or old or new scrap; or as (ii) scrap for direct use. This inter-relationship complicates past and projected copper supply statistics and can be illustrated as follows:

Chart 1: Copper Supply Pattern



New scrap is generated by the fabrication process and recovered at the manufacturer's plant or refinery. Both old and new scrap are recycled as refined copper or scrap for direct use by consumers. Most of the scrap recovered as copper alloy is used directly whereas pure copper scrap is refined a second time.

Primary or Copper Mine Production

7. Table 1 on page 5 of this Annex presents the world mine production of copper (1950-73) and Table 2 (pg. 6) indicates the shares of major copper producing countries. Copper mine production in the Western World increased by an average of 3.7% p.a. during the sixties and by 4.3% p.a. during the 1970-73 period. The 5 major copper mining countries, accounting for about 70% of world output (ex-CPE), are the USA, Canada, Chile, Zambia and Zaire. In 1973 36% of the world's primary copper production was mined in CIPEC-countries (for details on CIPEC see paras. 26-28) compared to 45.1% in 1959. The decreasing production share results from the relative low growth rates of the Chilean and Zambian mines (2.0% p.a. and 1.8% p.a.) during this period.

Table 1

CHILE: COPPER SECTOR PROJECT

WORLD MINE PRODUCTION OF COPPER (1950-1973)
(000 tons copper content)

	U.S.	Canada	Western Europe	Japan	Other Developed	Total Developed	Chile	Peru	Zambia	Zaire	Other Developing	Total Developing	Total
1950	825	240	125	39	49	1,278	363	30	297	176	145	1,009	2,287
1951	842	245	129	43	51	1,310	381	32	319	192	150	1,074	2,384
1952	840	234	137	54	56	1,321	409	30	330	206	147	1,122	2,443
1953	841	230	131	59	73	1,334	361	35	373	214	142	1,125	2,459
1954	758	275	130	66	84	1,313	364	38	398	224	148	1,172	2,485
1955	906	296	133	73	92	1,500	433	43	359	235	161	1,231	2,731
1956	1,002	322	142	78	101	1,645	488	46	404	251	197	1,386	3,031
1957	986	326	151	82	105	1,650	479	55	436	243	228	1,441	2,091
1958	888	313	160	82	127	1,570	465	52	400	238	232	1,387	2,957
1959	748	359	157	85	148	1,497	545	50	543	282	237	1,657	3,153
1960	980	399	157	89	160	1,785	532	184	576	302	238	1,832	3,617
1961	1,057	398	171	96	152	1,874	547	198	575	295	224	1,839	3,714
1962	1,114	415	181	104	157	1,971	586	165	562	297	230	1,840	3,811
1963	1,101	411	181	107	172	1,972	601	180	588	271	264	1,904	3,875
1964	1,131	442	191	106	168	2,038	622	176	632	277	253	1,960	3,997
1965	1,226	461	186	107	152	2,132	585	180	696	289	268	2,018	4,150
1966	1,296	459	178	112	236	2,281	637	200	623	317	281	2,058	4,339
1967	865	556	182	118	217	1,938	661	193	663	322	286	2,125	4,063
1968	1,093	575	200	120	235	2,223	657	213	685	326	311	2,191	4,415
1969	1,401	520	237	120	258	2,536	688	199	719	364	334	2,304	4,840
1970	1,560	610	244	120	307	2,841	686	212	684	387	360	2,329	5,170
1971	1,381	655	278	121	335	2,770	708	213	651	407	409	2,388	5,158
1972	1,490	709	297	112	342	2,950	717	230	717	437	567	2,668	5,618
1973	1,560	800	n.a.	n.a.	n.a.	3,250	736	225	710	480	599	2,750	6,000

Notes: "World" excludes centrally planned economies. Western Europe includes Turkey and Yugoslavia.

Other Developed Countries = Republic of South Africa and Australia.

Other Developing Countries = North and South America, excluding United States, Canada, Chile, Peru; Africa, excluding Republic of South Africa, Zambia and Zaire, but including South West Africa; Asia, excluding Japan.

Source: Metallgesellschaft AG - Metal Statistics

Table 2

CHILE: COPPER SECTOR PROJECT

WORLD COPPER MINE PRODUCTION BY MAJOR PRODUCING COUNTRIES

	1959		1964		1970		1972		1973 /2	
	Production 000		Production 000		Production 000		Production 000		Production 000	
Country	tons	%	tons	%	tons	%	tons	%	tons	%
USA	748	23.7	1,131	28.3	1,560	30.2	1,490	26.5	1,560	26.0
Canada	359	11.4	442	11.1	610	11.8	709	12.6	800	13.3
CIPEC Countries /1										
--Zambia	543	17.2	632	15.8	684	13.2	717	12.8	710	11.8
--Chile	545	17.3	622	15.5	686	13.3	717	12.8	736	12.3
--Zaire	282	9.0	277	6.9	387	7.5	437	7.8	480	8.0
--Peru	50	1.6	176	4.4	212	4.1	230	4.1	225	3.7
sub-total	1.420	45.1	1,707	42.6	1,969	38.1	2,101	37.5	2,151	35.8
Others	630	19.8	719	18.0	1,029	19.9	1,315	23.4	1,489	24.9
TOTAL	3,153	100.0	3,997	100.0	5,170	100.0	5,618	100.0	6,000	100.0

/1 CIPEC (Conseil Intergouvernmental des Pays Exportateurs de Cuivre) was formed in 1967.
/2 Estimate.

Source: Table 1.

8. Primary copper production is basically a function of available productive capacity and demand for copper. In recent years actual primary production often fell short of primary production capacity because of strikes and other exogenous factors. Copper prices have some short-term influence on production as copper producers try to increase output at existing mines during high price periods. However, flexibility of output is not significant. Very low copper prices influenced primary production in 1960-63: producers cut down production to maintain a floor price of about 29 cents.

9. Copper prices influence investment decisions and, therefore, have a long-term impact on primary production. But in the last decade political factors were partly responsible for the timing of investment: Chile, Peru, and African countries had to change or clearly define their copper policies before prices and feasible projects alone did not provide sufficient incentives. In general, it takes between three and six years to open up a new copper mine or to substantially increase capacity of an existing one.

Table 3

CHILE: COPPER SECTOR PROJECT

WORLD PRODUCTION OF REFINED COPPER

	1960	1965	1968	1969	1970	1971	1972	1973
A. EUROPE								
Belgium	220	300	330	286	337	312	314	
West Germany	309	342	407	402	406	400	399	
Finland	31	30	36	34	34	32	38	
France	40	41	36	37	33	29	30	
Great Britain	213	227	198	98	206	188	181	
Yugoslavia	36	56	70	82	89	93	130	
Sweden	37	50	47	52	51	50	52	
Spain	42	59	79	76	83	73	89	
Others	46	52	59	62	68	63	60	
Sub-total	974	1157	1262	1229	1307	1240	1293	1382
B. ASIA								
India	9	9	9	10	9	10	10	
Japan	248	366	548	629	705	714	810	
Turkey	12	6	9	12	14	16	15	
Others	4	4	7	8	9	8	12	
Sub-total	272	387	573	659	738	749	847	991
C. AMERICAS								
Brazil	3	3	3	4	3	5	5	
Chile	226	289	394	453	461	468	461	
Canada	378	394	476	407	493	477	495	
Mexico	28	46	51	57	54	60	64	
Peru	30	40	38	34	36	33	39	
USA	1642	1957	1682	2034	2034	1780	1988	
Sub-total	2308	2729	2645	2989	3081	2823	3054	3069
D. OCEANIA								
Australia	84	93	121	139	145	163	174	
E. AFRICA								
Zaire	145	151	166	183	190	196	208	
South Africa	12	16	62	61	75	75	79	
Rhodesia	---	15	19	21	13	24	30	
Zambia	403	522	551	603	581	534	615	
Others	1	1	1	1	1		2	
Sub-total	560	706	800	870	870	847	943	984
TOTAL WORLD (ex CPE)	4198	5072	5401	3886	6141	5822	6431	6592

Refined Copper Production

10. World production of refined copper increased by an average of 4.1% per year over the 1960-73 period and reached 6.6 million tons in 1973 (see table 3, page 7). A comparison of the geographical location of the world's mine production and refinery output (see tables 1, 2, 4) clearly shows that traditionally refining facilities were located near to consumer markets, such as Europe, North America and Japan. However, refining facilities in Africa and South America are being expanded. For example copper mine production in Africa multiplied by 2.4 from 1952-72 whereas production of refined copper quadrupled during the same period. The biggest expansion of refinery capacity occurred, however, in Japan where refined copper output has been increasing by an average of 11% per annum during the sixties.

Table 4: Geographical Distribution of World Copper Mine and Refining Production (1970)

	Mine Production		Refined Copper Production		Annual Production Increase
	(000 tons)	(%)	(000 tons)	(%)	(1960-70)
USA	1,547	30	2,033	27.0	2.2
Canada	613	12	593	7.9	2.7
Zambia	684	13	581	7.7	3.7
Chile	685	13	461	6.1	7.4
Zaire	386	7	189	2.5	2.8
Australia	145	3	145	1.9	5.7
Japan	119	2	705	9.4	11.0
West Germany	1	-	406	5.4	2.8
Great Britain	-	-	206	2.7	0
Belgium	-	-	337	4.5	2.0

Scrap

11. The supply of copper scrap is rather volatile and fluctuates with the price of refined copper, recovery cost and the degree of scarcity of certain copper products on the market. As indicated in table 5 the production of new and old scrap decreased by 10% from a high of 3.5 million tons in 1969 to 3.1 million tons in 1972. Scrap is primarily used directly by manufacturers, so that secondary refined copper amounted to only 24% of total scrap production.

Table 5

CHILE: COPPER SECTOR PROJECT

WORLD SCRAP PRODUCTION AND CONSUMPTION (1952-72)

	Secondary Refined Copper			Scrap for Direct Use			LME Price
		% of Refined Copper			% of Refined Copper		
	000 tons	Production	Consumption	000 tons	Production	Consumption	(US cents/lb)
1952	455	16.2	16.2	1,226	43.6	43.7	32.4
1953	530	17.9	20.0	1,310	44.4	49.4	31.4
1954	605	20.0	21.2	1,362	45.0	47.6	31.1
1955	665	20.0	20.5	1,562	47.0	48.1	32.8
1956	583	16.5	17.5	1,472	41.7	44.3	43.9
1957	539	15.3	16.2	1,375	39.0	41.4	41.1
1958	561	16.4	16.8	1,321	38.5	39.5	27.4
1959	601	16.6	17.0	1,503	41.6	42.4	24.7
1960	618	14.6	16.2	1,489	35.1	38.7	29.8
1961	674	15.4	16.6	1,595	36.6	38.6	30.8
1962	629	14.4	15.2	1,651	37.7	40.0	28.7
1963	658	14.8	14.9	1,763	39.6	40.0	29.3
1964	800	16.8	16.3	2,035	42.8	41.4	43.9
1965	942	18.6	18.7	2,103	41.6	41.7	58.5
1966	984	19.0	18.8	2,065	39.9	39.4	69.3
1967	965	20.2	19.7	1,933	40.5	39.5	51.0
1968	1,014	18.8	19.6	2,104	39.0	40.7	56.2
1969	1,128	19.2	19.7	2,370	40.4	41.4	66.4
1970	1,147	18.7	19.8	2,179	35.5	37.5	49.1
1971	823	14.1	14.5	2,193	37.7	38.5	48.6
1972	743	11.8	12.0	2,314	36.7	37.4	80.6
Average 1952-72		16.9	17.4		39.7	40.7	

Source: SGM estimate

Table 6

CHILE: COPPER SECTOR PROJECT

WORLD REFINED AND SCRAP COPPER PRODUCTION
(million tons)

	1960	1965	1969	1970	1971	1972
Refined Production						
Primary	3.58	4.13	4.76	4.99	5.00	5.69
Secondary	0.62	0.94	1.13	1.15	0.82	0.74
Sub-total	4.20	5.07	5.89	6.14	5.82	6.43
Direct Use of Scrap	1.49	2.10	2.37	2.18	2.19	2.31
Total	5.29	7.17	8.26	8.32	8.01	8.74
Scrap Recovery /1	2.11	3.04	3.50	3.33	3.01	3.05
% of total	39.8	42.4	42.4	40.0	37.5	35.0

/1 Secondary refined copper and scrap for direct use.

In the long-run scrap will account on the average for not more than 40% of the world copper production. Scrap has been recovered primarily from cables, transformers, motors etc. so that with growing substitution of copper by aluminum the availability of scrap is likely to decline. However on the other hand improvements in scrap recovery technologies may make the production of secondary copper more economical.

Copper Stocks

13. Copper stocks play an important role as market indicators and can generally cause respective price movements. At the London Metal Exchange (LME) warehouse stocks were of the order of 20,000 tons in mid-June 1974 compared to about 200,000 tons at the beginning of 1973. However, information on total stocks held by producers, trade and users is difficult to obtain and its analysis causes some problems. Stocks are also being held by some governments. The most important government stockpile used to be held in the U.S. For many years the stockpile target stood at 750,000 short tons but actual stocks of 250,000-350,000 short tons were held. In early 1974, a decision was taken to sell all stockpiled copper and the sales program completed, without any market disruption as supply was very tight. Stockpile sales were made according to bids received and selling prices were considerably higher than the US producers' price. The rapid build up of stocks by Japanese producers had by mid 1974 become a dominant force in the market exerting downward pressure on the price.

2. World Copper Demand

Uses of Copper

14. Copper's technical qualities, mainly its electric conductivity, corrosion resistance, thermal conductivity, malleability, ductibility and

easiness of join, make it one of the most important materials of modern industry. The use of copper and its alloys is universal. They are practically synonymous with all things electrical and have myriad uses in electrical equipment and supplies, construction, transportation, communications, appliances, utensils, jewelry and other applications.

The breakdown of copper consumption in different industrial sectors is shown below. It does vary only slightly between countries and no marked differences exist between consumption patterns in developed and developing countries.

Table 7: Copper Consumption by Sector

Sector	USA /1 (%)	West Germany /2 (%)	UK /2 (%)
Electrical	52.0	56.8	43.0
Construction	18.0	15.4	24.0
Machinery	12.4	14.5	12.5
Transportation	9.4	9.2	14.5
Other	8.2	4.1	6.0

/1 1972 industrial survey.
/2 1967 figures.

The largest use of copper is in electrical equipment and supplies, communications, including electronics, telephone and telegraph wire and cable. The manufacture of electric motors, power generator sets, dynamotors, fans, industrial controls, power distribution systems and electrical instruments require large quantities of copper for the best electrical performance. While aluminum is used for virtually all high-voltage overhead power transmission lines, copper presently dominates in underground line and small wire markets, since copper is corrosion resistant.

15. The noncorrosive properties of copper and its alloys result in many uses in building construction for roofing, plumbing, builders' hardware and functional decorative applications. Copper finds also widespread application in the production of many types of nonelectrical industrial machinery, such as heat exchangers, turbines, oil baffles, check valves, plates, sheets, bars and copper tubing. About 10% of the copper consumed in the world is used in transportation including motor vehicles, railroads, and marine uses. This results both from the trend toward greater convenience and comfort such as power windows, seats, brakes, steering and airconditioning, but also from the more utilitarian uses in radiators, heaters, defrosters, oil lines, etc.

Substitution

16. While the properties of copper are almost irreplaceable in some applications it faces competition in other areas of consumption from alumunum, plastics, steel, glass, and other materials. In many uses requiring conduction of heat or electrical energy, aluminum has displaced copper. There has been an accelerated shift to the use of steel for brass in shell cases and printed electrical circuits have come into the field as substitute of copper wire.

17. Aluminum and stainless steels have also reduced the use of copper in the building industry. Technology has furthered substitution for copper by the introduction of the numerous cladmetals, including copper clad which use proportionally less copper per unit. Plastic tubing substitutes for some copper pipe in many applications in the building and automotive industries.

18. The reasons for substitution are not only periods of short supply of copper resulting in high price levels but also sustained price fluctuations which creates uncertainty among manufacturers. Reverse substitution is relatively difficult. Substitution for an end-user involves extensive retooling and planning so that reverse substitution is only likely to occur if there are unforeseen problems with substitute materials.

19. Substitution has not been clearly felt because copper consumption has been growing in absolute terms. This has been mainly due to the over-proportional growth of the electrical and transport sectors where copper has an established position. As this dynamism is likely to continue, there should be scope for both further substitution and steady growth of copper consumption. The impact of higher energy cost on aluminum and plastic prices cannot yet be assessed. On the one hand if copper prices increase less rapidly than prices of its substitute materials, the substitution trend may halt or even reverse, on the other hand new production processess, for aluminum for example, could reduce costs substantially in the next 5-10 years, while no great technological breakthrough is expected in the copper industry.

Consumption Pattern

20. World copper consumption increased steadily over the past 20 years. Tables 10-12 give the world's past consumption for primary, refined and total copper demand during the 1952-73 period and their growth rates are summarized below (Table 9).

Table 9

CHILE: COPPER SECTOR PROJECT

WORLD COPPER CONSUMPTION GROWTH RATES
(% per year)

	1952-58	1958-68	1968-73
Primary Copper Consumption	3.6	4.4	5.5
Refined Copper Consumption	4.4	4.4	4.6 /1
Total Copper Consumption /2	3.6	4.5	4.1 /1

/1 1968-72 period only.
/2 including secondary copper (scrap).

Following the decrease of copper consumption between 1970-71, world consumption of refined and total copper has grown by about 8% per year. (Tables 10-12).

Table 10

CHILE: COPPER SECTOR PROJECT

WORLD REFINED COPPER CONSUMPTION (1950-1972)
(000 tons of copper content)

	Developed Countries										
			Western Europe								
	USA	Canada	EEC	UK	Other W. Europe	Total W. Europe	Japan	Other Developed Countries	Total Developed Countries	Developing Countries	Total
1950	1,292	97	442	410	154	1,006	60	51	2,506	104	2,610
1951	1,285	122	492	410	155	1,057	91	57	2,612	135	2,747
1952	1,342	118	480	429	171	1,080	96	55	2,691	116	2,807
1953	1,356	96	468	327	161	956	95	51	2,554	99	2,653
1954	1,138	93	689	455	203	1,347	98	55	2,731	128	2,859
1955	1,363	126	756	504	204	1,464	105	68	3,126	120	3,246
1956	1,380	132	756	510	226	1,492	147	64	3,215	108	3,323
1957	1,227	107	828	516	255	1,599	168	78	3,179	146	3,325
1958	1,135	111	875	543	265	1,683	147	86	3,162	186	3,348
1959	1,327	118	870	487	265	1,622	219	85	3,371	170	3,541
1960	1,225	107	1,062	560	309	1,931	304	98	3,664	180	3,844
1961	1,327	129	1,132	529	342	2,003	373	90	3,922	195	4,117
1962	1,459	138	1,062	526	329	1,917	301	107	3,922	205	4,127
1963	1,590	160	1,087	558	333	1,978	352	114	4,194	218	4,412
1964	1,690	190	1,200	633	353	2,186	457	133	4,656	255	4,911
1965	1,846	209	1,169	650	352	2,171	427	135	4,788	255	5,043
1966	2,158	248	1,082	592	338	2,012	482	138	5,038	199	5,237
1967	1,798	205	1,123	514	342	1,979	616	116	4,714	182	4,896
1968	1,701	232	1,284	539	355	2,178	695	132	4,938	233	5,171
1969	1,944	222	1,405	547	393	2,345	807	140	5,458	264	5,722
1970	1,854	229	1,486	554	435	2,475	821	157	5,536	268	5,804
1971	1,823	220	1,433	511	401	2,345	826	144	5,358	332	5,690
1972	2,023	224	1,535	525	427	2,487	954	145	5,833	360	6,193
1973	2,175	248	1,670	546	435	2,651	1,167	176	6,417	382	6,799

Notes: "World" excludes centrally planned economies.
Refined copper includes copper refined from old and scrap material.
Other Western Europe and Total Western Europe include Yugoslavia.
Other Developed Countries: Republic of South Africa and Australia.
Developing Countries: North and South America except United States and Canada; Africa except Republic of South Africa, and Asia (excluding Japan but including Turkey).

Source: Metallgesellschaft AG, Metal Statistics.

Table 11

CHILE: COPPER SECTOR PROJECT

WORLD PRIMARY COPPER CONSUMPTION (1950-1972)
(000 tons of copper content)

	Developed Countries										
			Western Europe								
	USA	Canada	EEC	UK	Other W. Europe	Total W. Europe	Japan	Other Developed Countries	Total Developed Countries	Developing Countries	Total
1950	1,073	97	309	341	132	782	12	51	2,015	101	2,116
1951	1,135	122	358	336	118	812	41	57	2,167	131	2,298
1952	1,203	118	358	353	142	853	51	55	2,280	111	2,391
1953	1,162	96	327	247	131	705	68	51	2,082	94	2,176
1954	951	93	522	374	174	1,070	56	55	2,225	122	2,347
1955	1,144	126	560	403	168	1,131	73	66	2,540	117	2,657
1956	1,143	132	579	407	194	1,180	113	49	2,617	105	2,722
1957	1,012	107	692	426	224	1,342	134	66	2,661	141	2,802
1958	911	112	737	452	233	1,422	126	70	2,641	180	2,821
1959	1,100	118	697	403	228	1,328	180	75	2,801	167	2,968
1960	960	107	878	465	275	1,618	243	87	3,015	177	3,192
1961	1,072	129	974	446	292	1,712	299	74	3,286	191	3,477
1962	1,211	137	881	441	285	1,607	243	96	3,294	203	3,497
1963	1,329	160	934	455	297	1,686	309	97	3,581	214	3,795
1964	1,387	190	1,040	523	316	1,879	398	112	3,966	252	4,218
1965	1,456	209	982	532	302	1,816	362	100	3,943	256	4,199
1966	1,729	248	884	458	276	1,618	397	115	4,107	193	4,300
1967	1,440	205	938	395	274	1,607	549	87	3,888	179	4,067
1968	1,337	232	1,061	403	292	1,756	624	98	4,047	230	4,277
1969	1,516	221	1,171	398	336	1,905	699	103	4,444	263	4,707
1970	1,420	229	1,237	397	371	2,005	718	115	4,487	268	4,755
1971	1,487	220	1,219	373	364	1,956	723	118	4,504	313	4,817
1972	1,676	224	1,339	404	378	2,121	850	103	4,974	352	5,326

Notes: Data usually represent production plus imports minus exports plus or minus changes in stocks to the extent that information is available, i.e, they represent the quantity of crude metal apparently available for consumption. However, in the case of countries which now compute either deliveries of crude metal to consumers or output by works of the first processing stage, the figures thus obtained are used.

"World" excludes centrally planned economies.

Western Europe includes Yugoslavia; data for Turkey not separately available.
Other Developed Countries: Republic of South Africa, Australia and Oceania.
Developing Countries: North and South America, except United States and Canada; Africa except Republic of South Africa, and Asia except Japan

Source: Metallgesellschaft AG, Metal Statistics

Table 12

CHILE: COPPER SECTOR PROJECT

WORLD COPPER PRODUCTION AND CONSUMPTION /1
(million tons of copper content)

	PRODUCTION	CONSUMPTION				
	(Mine)	Refined Copper	Scrap Direct Use	Total Consumption	Scrap Consumption Total	Scrap Consumption %
1952	2.44	2.81	1.23	4.04	1.67	41
1953	2.46	2.65	1.31	3.96	1.84	46
1954	2.48	2.86	1.36	4.22	1.96	46
1955	2.73	3.25	1.56	4.91	2.22	45
1956	3.03	3.32	1.47	4.79	2.05	43
1957	2.09	3.32	1.37	4.69	1.91	41
1958	2.96	3.35	1.32	4.67	1.89	40
1959	3.15	3.54	1.50	5.00	2.10	43
1960	3.62	3.84	1.49	5.33	2.11	39
1961	3.71	4.12	1.60	5.72	2.26	39
1962	3.81	4.13	1.65	5.78	2.27	39
1963	3.88	4.41	1.76	6.17	2.42	38
1964	4.00	4.91	2.03	6.94	2.83	41
1965	4.15	5.04	2.10	7.14	3.04	42
1966	4.34	5.24	2.06	7.30	3.14	43
1967	4.06	4.90	1.93	6.83	2.89	42
1968	4.41	5.11	2.10	7.27	3.38	46
1969	4.84	5.72	2.37	8.09	3.49	43
1970	5.17	5.80	2.18	7.98	3.21	40
1971	5.16	5.69	2.19	7.88	3.01	38
1972	5.61	6.19	2.31	8.50	3.15	37
1973	6.00	6.80	n.a.	n.a.	n.a.	n.a.

1/ "World" excludes centrally planned economies

Source: Metal Statistics, SGM estimate

21. Consumption of refined copper is heavily concentrated in the developed countries. In 1973, the USA, Canada, Western Europe and Japan accounted for nearly 92% of western world consumption of refined copper. Growth of refined copper consumption is closely correlated with growth of industrial production 1/ and averaged 4.4% for the developed countries during the 1952-73 period. Although the long-term growth pattern has been steady during the sixties and seventies regional growth rates varied substantially as indicated below:

Table 13: Refined Copper Consumption Growth in Selected Areas
(% per annum)

Developed Countries	1952-73	1968-73
USA	2.5	5.1
Canada	3.7	1.2
EEC	6.1	5.4
UK	1.2	0.4
Western Europe	4.4	3.9
Japan	13.4	9.5
Total Developed Countries	4.4	5.37
Developing Countries		
Brazil	7.6	19.6
Total Developing Countries	5.6	10.5
WORLD	4.43	5.4

22. Copper consumption increased substantially in developing countries with the beginning of industrialization. In Brazil copper consumption grew about 60% more rapidly than other economic indicators--a phenomenon which had been observed in Japan during the coming decade and to correlate more closely with industrial production growth as in Europe and the USA. The portion of Europe's refined copper consumption in the Western World which reached 50% in 1958, appears likely to stabilize now at about 40%.

3. International Trade

23. Almost all international transactions of copper are made in primary copper. Exports of scrap seldom occur, and are limited nearly exclusively to U.S. exports. International trade of copper as represented by net ex-

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1/ On average the copper growth rate has been equivalent to 80% of the industrial production growth rate. However, copper growth rates may exceed industrial growth in rapidly expanding economies.

ports 1/ includes shipments of concentrates, blister and refined metal. The trade matrix given in Table 14 indicate the ranking of copper importing and exporting countries. In 1970, the major importing countries were West Germany, UK, Belgium, the USA and Japan, while Zambia, Chile and Zaire lead the copper export countries.

24. As illustrated by Table 14 below net export of copper concentrates, blister and refined metal amounted to 3.42 million tons in 1973 compared to 2.74 million tons in 1969, or an increase of 7% per annum.

During the seventies the major increase of exports occurred in ores and concentrates from developed countries, such as Canada and the USA and non-CIPEC developing countries such as Papua-New Guinea and the Philippines. Net exports of ore and concentrates grew at an average 24%.

25. It is debatable if the trend of shipping concentrates will continue. On the one hand, the copper consuming countries Japan, Europe, and the U.S. have expanded their smelter and refining capacities over the past years and are anxious to sign long-term delivery contracts for concentrates. The cheaper and more efficient handling and transport techniques have made it possible to shift smelting and refining of concentrates from the mine sites to the consumer countries' ports. On the other hand, the copper exporting countries will try to maximize export earnings and domestic value added and encourage the mining companies to expand smelting and refining on site. In addition, strict pollution control in developed countries particularly the USA and Canada may favor treatment of the copper concentrates in developing countries, although smelters have been able to operate competitively in Europe for many years under pollution regulations that have just been adopted in the U.S.

CIPEC

26. CIPEC (Conseil intergouvernemental des pays exportateurs de cuivre) was formed in 1967 by Zambia, Chile, Zaire and Peru. In 1972, these four countries accounted for 37.5% of the world's copper mine production, 20.6% of refined copper production and 57% of copper exports, as detailed in Table 15. During the CIPEC conference in Lima in November 1975, Indonesia was accepted as a full member and Australia and Papua/New Guinea as associates. As a consequence all CIPEC countries together could account for about 70% of copper exports.

1/ Net exports is defined here as total exports minus exports of the net importer countries.

Table 14

CHILE: COPPER SECTOR PROJECT

NET COPPER EXPORT (1969-73)

Countries	Ores and Concentrates				Blister				Refined				Total			
	1969		1973		1969		1973		1969		1973		1969		1973	
	000 tons	%	000 tons	%	000 tons	%	000 tons	%	000 tons	%	000 tons	%	000 tons	%	000 tons	%
Developed Countries	163	38	398	39	109	14	108	15	270	17	394	23	524	20	900	26
CIPEC	100	23	177	17	623	82	560	80	1259	82	1275	75	1982	72	2012	59
Other Developing countries	166	39	449	44	31	4	27	4	18	1	35	2	215	8	511	15
	429	100	1024	100	763	100	695	100	1547	100	1704	100	2739	100	3423	100
% of Type of Product in Total Net Exports	16%		29%		28%		19%		56%		52%		100%		100%	

CHILE: COPPER SECTOR PROJECT

COPPER PRODUCTION AND EXPORTS OF CIPEC COUNTRIES (1972)
(000 tons)

	Mine Production		Refined Production		Net Exports	
	000 tons	%	000 tons	%	000 tons	%
CIPEC						
Zambia	717	12.8	615	9.6	710	20.5
Chile	717	12.8	461	7.2	634	18.3
Zaire	437	7.8	208	3.2	433	12.5
Peru	230	4.1	39	0.6	203	5.8
Sub-Total	2,091	37.5	1,323	20.6	1,980	57.2
World (EX-CPE)	5,618	100.0	6,431	100.0	3,460	100.0

27. The objectives of this organization are the development of the copper industry in these countries, the maximization and stabilization of copper export earnings and the manufacture of copper products in CIPEC countries. In the past CIPEC has not been very successful in achieving these goals. There have been recurrent statements by CIPEC member countries and expectations in the copper trade that CIPEC would try to "stabilize" the copper price or at least introduce a floor price. It is argued that cooperation between CIPEC and major integrated copper producers in industrialized countries could produce an OPEC-type action with good chances for success. However, copper producing countries are not in as strong a position as the OPEC countries: first; substitution of copper by other metals would be a major reason for limited price increases; second; the foreign exchange reserves of the CIPEC countries are relatively low, so that the risks of taking sustained actions will be considerable; and third; in view of widely different interests between CIPEC members and copper companies in the developed countries, the formation of a copper cartel or coordinated oligopolistic action of copper producers is unlikely in the near future.

28. It is noteworthy in this context that production costs in CIPEC countries show substantial differences. At the same time all CIPEC members recently announced major expansion plans and some new projects are already being implemented. Many of the new projects are being developed in cooperation with copper companies based in developed countries. It does not appear that, as yet, there is any coordination of expansion plans.

Table 16

CHILE: COPPER SECTOR PROJECT

PROJECTED WORLD CAPACITY OF MINE PRODUCTION (1980)
(000 tons of copper content)

	Actual Production in 1972	Projected Capacity in 1980 Low	High	Most Likely
Developing Countries				
Latin America				
Bolivia	8	10	20	10
Chile	717	1,000	1,200	1,1000
Mexico	79	140	275	200
Peru	217	400	500	450
Panama	0	0	100	0
Others	9	10	20	15
Sub-total		1,560	2,115	1,775
Africa LDC				
Rhodesia	32	35	45	40
Mauritania	15	20	25	20
Zaire	437	700	850	780
Zambia	718	900	970	900
S.W. Africa	22	55	130	
Others	19	45		100
Sub-total	1,243	1,755	2,020	1,840
Asia/Oceania LDC				
Philippines	214	265	300	280
Iran	0	100	140	100
Indonesia	5	70	70	70
Papua N.G.	124	175	270	220
Others	46	115	130	115
Sub-total	389	725	910	785
LDC Total	2,662	4,040	5,045	4,400
Developed Countries				
W. Europe	297	445	500	445
Japan	112	50	100	75
USA	1,510	2,030	2,130	2,030
Canada	709	1,000	1,150	1,000
Australia	181	260	350	260
S. Africa	162	200	240	220
Sub-total	2,971	3,985	4,470	4,030
World (excl. CPEs)	5,633	8,025	9,515	8,430

Notes on Assumptions and Sources:

Mine Production in 1972 - World Bureau of Metal Statistics
Chile: High - estimated by IBRD Latin America Region; Low - only a gradual progress to be made in 1974 - 1980.
Mexico: High - completion of both La Verde and La Caridad; Low - completion of La Verde only.
Peru: High - Cuajone, Cerro Verde, Tintaya, Antamina plus an additional capacity; Low - only Cuajone and Cerro Verde. No expansion of existing facilities.
Panama: High - partial completion of Cerro Colorado; Low - none.
Zaire: High - GECAMINES expanding capacity up to 620,000 tons by 1980, plus completion of Kinsenda (60,000 tons) and Tenke-Fungurume; Low - completion of the GECAMINES expansion plus a part of Tenke-Fungurume in operation.
Zambia: High - IBRD East Africa Region projects 900,000 tons for 1978; an additional 70,000 tons to be completed by 1980; Low - The planned 900,000-ton capacity to be completed by 1980.
Other African LDC's: High/Low - estimates by Commodities and Export Projections Division.
Philippines: High - completion of Dizon and Inco-Capayang plus a further 35,000-ton capacity.
Iran: High - completion of Oalhe Zari and Sar Chesmeh; Low - Oalhe Zari plus partial completion of Sar Chesmeh.
Indonesia: High/Low - full production from Ertsberg.
Papua New Guinea: High - full production of Bougainville plus Kennecott's Ok Tedi; Low - full production of Bougainville only.
Other Countries: High - Khetri/Kolihan and Rakha in India, Mamut in Malaysia plus an arbitrary addition of 15,000-ton capacity somewhere, possibly in Thailand; Low - Only Khetri/Kolihan, Rakha and Mamut.
Western Europe: Low - existing capacity (310,000 tons) plus Bor/Krivelj in Yugoslavia, Outokumpu/Vuonos in Finland, Boliden/Aitik in Sweden, Avoca in Eire, RTZ's Cerro Colorado in Spain, and Bakibaba/Espiye/Kure in Turkey; High - in addition to the projects mentioned above, an arbitrary addition of 55,000 tons.
Japan: High/Low - estimates by the CMPD taking account of pollution problems and possible government policies to support high-cost mines.
USA: Low - taking account of all the projects listed by the Phelps Dodge (PD)'s latest survey of projects assumed to be in operation by 1976, plus additional 18,000 tons; high - the "low" estimate above plus an arbitary addition of 100,000 tons to allow for possible new projects to be completed in 1977-80.
Canada: Low - assumed production from all the projects listed by PD for 1973-76 minus 40,000 tons; high - projects listed by PD for 1973-76 plus an arbitrary 110,000 tons to allow for possible new projects.
Australia: Low - Mt. Isa and Peko-Warrego in 1973, Cobar-CSA in 1974, Cobar-Chesney, Pacific Copper-Cadia and Jododex in 1975, no further additions in 1976-80; High - above-mentioned projects plus an arbitrary 90,000 tons to allow for possible new projects.
South Africa: Low - full production from Prieska, no further projects; High - production from Phelps Dodge's Cape Province property (40,000 t).

4. Supply/Demand Prospects

World Supply of Primary Copper

29. A projection of world copper mine capacity is subject to a more than usual uncertainty at this time. Based on estimates made by industry sources and by Bank staff, world mine capacity in 1980 has been projected by region and by country as presented in Table 16. "Low", "High" and "Most Likely" estimates are shown for major countries and regions for 1980. World mine capacity is projected to increase from 6.6 million tons at the beginning of 1974 to 8.1-9.5 million tons by 1980. No detailed projection by country or region is possible for 1985.

30. Latin American capacity depends largely on developments in Chile in the coming 6 years; mine capacity could increase to 1.16 million tons or could increase only moderately to 1.0 million tons by 1980. Peru also will be a significant factor with numerous projects in the planning stage. Peru and Chile present the largest uncertain factor on the supply side of the world copper market for the next several years. Beyond 1980, possible developments in Panama present additional uncertainty due to the possible development of a large copper mine project, the Cerro Colorado. However, for the present it seems unlikely that this mine will be in operation by 1980. Other uncertainties in this region exist in Mexico.

31. Among the developed countries, significant expansions are possible in the United States, Canada, Australia and South Africa. However, recent trends in Canada and Australia towards reorientation of their mineral investment policies could have serioud dampening effects on the pace of investments in copper mining capacity in these countries.

32. One of the problems for a rapid expansion of the world copper mine capacity is the availability of capital. Capital investment required to establish a capacity to produce refined copper is estimated at around US$4,000 (in 1974 constant terms) for each annual ton of capacity. 1/ Thus, if the "high" estimate of projected capacity, i.e., 9 million tons per annum, is to be realized by 1980, $12 billion (in 1974 constant terms) would be required to build the additional 3.0 million-ton capacity needed. It is fully expected that financing constraints will restrict new capacity to about 8.4 million tons (Table 16) with total investment requirements of $5 billion.

1/ Sir Ronald L. Prain gave an estimate of about 3,000 dollars per ton of refined copper in his speech given in 1971 ("The International Outlook for Copper", American Metal Market Forum, London 1971). Allowing for the inflation that has occurred since 1971 and for estimated extra costs needed for pollution controls in smelting and refining, a rule-of-thumb estimate of US$4,000 per ton of capacity has been arrived at. This may be an overestimate to the extent that new capacity results from an expansion of already existing capacity.

33. Table 17 indicates the implications of various possible magnitudes of annual investment in the world copper industry for (i) additional capacity to be created by 1980, (ii) total capacity available at the beginning of 1980 and (iii) mine production in 1980. Between the end of 1968 and the end of 1973, world mine capacity increased from 4.98 million tons to 6.61 million tons, by 0.41 million tons per annum, or at 7.2% per annum.

Table 17: Investment and Capacity Creations in the World Copper Industry

Annual Investment in Copper Industry in 1974-1979 US$ million /1	Additional Capacity (incl. metallurgical capacity) by 1980 /2	Total Capacity at beginning of 1980	Probable output in 1980, implied by capacity /3
	million tons per year		
1,000	1.5	8.1	7.5
1,200	1.8	8.4	7.8
1,400	2.1	8.7	8.1
1,600	2.4	9.0	8.4
2,200	3.3	9.9	9.2

/1 In constant 1974 dollars.

/2 Capacity at the beginning of 1974 is 6.6 million tons. Each annual ton of capacity is assumed to require an investment of 4,000 dollars.

/3 Estimated at 93% of capacity available at the beginning of the year.

Source: IBRD Commodities & Export Projections Division.

Supply/Demand Balance

34. At this time copper demand projections are extremely difficult. On the one hand, a continuing economic slow down in the developed countries may limit copper consumption growth, while on the other hand, copper may also benefit from the relatively more rapid increase in the prices of aluminum and petrochemicals. Although it will probably not regain markets previously lost to aluminum, copper's competitive position vis-a-vis aluminum and plastics, have now improved as a result of sharp increases in petroleum prices.

For the purpose of this report two hypotheses for future refined copper consumption will be analyzed:

a) Hypothesis I assumes that while economic growth in developed countries and non-oil-exporting developing countries might somewhat slow down in the

coming decade, industrialization in oil-exporting countries would accelerate in the future and therefore consumption of refined copper will grow at 4.5% per annum in line with the long-term growth trend of consumption over the 1950-73 period.

b) Hypothesis II assumes that world consumption of refined copper will increase by 3% per annum until 1977 and 4.0% per annum, thereafter in view of the present economic stagnation and inflation. Hypothesis II represents the most likely demand forecast.

35. As presented in table 14, world refined copper consumption would increase by 1980 to 9.2 million tons under hypothesis I and 8.8 million tons under hypothesis II. In contrast, projected refined copper supply for the Western World is estimated at 9.3 million tons in 1980. During the seventies there is a slight possibility of an oversupply of refined copper ranging from 100,000 tons per year to 700,000 tons depending on the accuracy of projected consumption growth rate. An additional reservation must be made: The supply/demand balance assumes that over the coming 5 years the supply of secondary refined copper will remain at about 15% of total refined copper production. However, since the supply of secondary copper has been extremely price elastic, it may well be that with falling prices during an oversupply situation the supply of secondary refined copper would drop, and thus exact a new market equilibrium.

C. PRICES

1. Pricing System

36. Copper is priced in three main markets, the London Metal Exchange (LME) the Commodity Exchange in New York (COMEC) and the producer controlled markets.

LME

37. The London Metal Exchange is the most important "pricing" market for copper. Less than 10% of copper sales are actually delivered from LME stocks, but the bulk of copper's international trade is refined copper is undertaken directly by producers and consumers at prices prevailing at the LME around the date of shipment. Metal dealers also quote LME prices for their transactions. The LME operates on both cash and future contracts which allows hedging operations against inventory losses and currency realignments. During 1973 and 1974 there has been an increase in non-industry speculations in copper to hedge against inflation and exchange rate changes.

38. The LME is European biased since it reflects mainly the short term supply-demand outlook in Europe, where its warehouses are located (UK, Germany, Holland and Belgium). Due to its physical thinness and marginal character speculation exaggerates ups and downs on a very short time basis, so that daily up and downs of more than 5% are not uncommon.

39. Usually, sales contracts for refined copper are signed on an annual basis and specify twelve monthly quotas to be shipped by the seller. Prices are related to the LME's settlement price (wirebars' moving seller cash prices) on a cif basis. The typical buyer can price his quotas during a 2 month period (covering the shipment date) selecting the prices of any particular day and communicate it to the seller not later than noon of the following day. Certain restrictions to this pricing mechanism do exist, e.g., not more than 25% of a monthly quota can be priced in one day and not more than 50% in one week. On the average the buyers can gain a fraction of a cent per pound by carefully choosing the pricing days. Copper concentrates are bought on long-term contracts which can be as long as 10-15 years, but will generally be at the order of 3-5 years. Pricing is usually based on the monthly average of the LME cash wirebar quotations/minus treatment costs.

COMEX

40. The Commodity Exchange in New York is smaller and far less significant than the LME, but trades cash and future contracts of up to 114 months. Prices are influenced by the U.S. producer price. Due to arbitration, COMEX quotes differ usually not more than a few cents/lb. from the LME price quotation.

Producer Prices

41. The U.S., Canada and the COMECON countries trade copper on the basis of producer prices, a selling price fixed by the producers which is generally kept unchanged for several months. Chile and Zambia quoted producer prices until 1967 when the CIPEC countries decided to trade according to LME price quotations. The following table compares producers and LME prices during the 1960-73 period.

2. Past Copper Price Development

42. Copper prices have not fallen appreciably below the 30 cent level since the end of the Korean war, except briefly in 1957/58. Annual averages of both U.S. Producer and London Metal Exchange (LME) prices fluctuated in a range of 29-32 cents per pound (33.5-37.0 cents per pound at 1968 prices) form 1953/54 to 1964. They rose about 40 percent above this range (to over 40 cents per pound) in 1955/56, and fell about 15-20 percent below it in 1957/58 (to 25.8 cents per pound in the U.S. and to 24.7 cents per pound on the LME).

43. During the 1953-63 period the copper trade generally believed that major primary producers regarded 30 cents per pound in the U.S. (and a slightly lower LME quotation) as a target price. In the early 1960's non-US producers intervened directly in the LME to hold the price above 29 cents at a time when excess capacity caused all major producers to cut production. In 1965, non-US producers set a price of 29.5 cents independently of the LME.

44. Since 1965 copper prices have risen far above the earlier "normal" level. Even in the U.S. where Government pressure held the domestic copper price to 36 cents until the end of 1966, it subsequently rose to 61 cents by April, 1970. Outside the U.S. prices have risen much faster. Since the outset of 1965 the LME price has never been less than 45 cents. In March 1966, when producer pricing was abandoned, LME spot price quotations reached 85 cents per pound. This was followed by a decline and then another peak at 78 cents in March, 1968 during the U.S. copper strike. Prices declined in the spring and summer of 1968 after the strike was settled, but another rise started in mid-1968, continued over 1969, and in 1970, reached monthly averages of 73 cents in January; 75 cents in February; and 79 cents in March. The LME average price for 1970 was 64 cents, only slightly below the 1969 average of 66 cents. However, prices had started a new decline in April 1970, falling to 47 cents in December of that year. Industrial production slowed down, copper stocks increased, and only production difficulties in some producer countries kept prices above the 45 cents average. This situation did not basically change in 1972. Stocks continued to increase and the LME price averaged 49 cents for the year. The dispute between Kennecott and Chile brought an additional element of uncertainty to the world copper market which helped maintain price levels despite the increase in stocks. Early in 1973 the problems in Chile, various strikes at mines and refineries elsewhere and transport problems in Zambia pushed copper prices upwards. The new monetary crisis, the devaluation of stocks and substantial increase in the free gold price added to the pressure on copper prices. During January-March 1973 the LME price averaged 59 cents and daily quotations went above 70 cents in March for the first time since 1970. Other extraordinary events followed, including the largest number of "forces majeure" in any year since 1945, the highest rate of international economic growth in many years, and strong world inflation. All these factors played a role in pushing LME prices to $1.20/lb. in early December. Price escalation was encouraged by massive speculation in commodities which accompanied the monetary and the oil crises.

45. The volatility of the world copper market in the period 1964-72 was due to a number of factors, the most important of which were: a) uncertainties connected with the 1964 presidential elections in Chile, and with Zambia becoming independent in 1965; b) a U.S. maritime strike in 1965; c) miners' strikes in Chile (1965/66), the U.S. (1967/68), and Canada (1969); d) sales from the U.S. copper stockpile (1966); e) delayed implementation of copper expansion programs; f) monetary crises leading to devaluations of sterline (1967), and of the French franc (1968), as well as revaluation of German mark (1969), and new currency alighnments at the end of 1971 and early in 1973; g) copper purchases by Communist China and the USSR; h) the economic boom in industrial nations in 1969, the general slump in economic activity in 1971/72, and the signs of the new industrial boom appearing late in 1972; i) the substantial shortfall of Chile's copper production from previously announced expansion targets; and production or export problems elsewhere (Zambia, 1971 and 1973; Belgium and Canada, 1973); and j) the impact of US pollution controls on refinery production (1972/73).

46. Prices remained high during the first five months of 1974, averaging about $1.20/lb. However, in real terms copper prices in 1973 were lower than in 1969 and 1970. Even back in 1966 copper prices in real terms had been 33 percent higher than in 1973 and, however, the early 1974 price of $1.20/lb. is still slightly above the record high of 1966 (see table 20). The recent extraordinary price increase seemed to be influenced mainly by the following factors: first, uncertainty about the impact of the oil crisis; second, the unknown size of investment in copper as a hedge against devaluation; third, the increased demand from China which has been a copper purchaser to a far greater extent than ever before, though actual figures are not yet available; fourth the uncertain outlook for a reduction of inflation rates in all industrialized countries, and finally the possibility of a major strike in the US copper industry after June 1974 when the 3 year labor contracts were up for renegotiation.

47. Copper prices started to decline after June 1974, fell to 62 cents/lb by October 1974, and continued to drop to less than 55 cents/lb in early 1975 as industrial production slowed down. For the first six months of 1975 the average price has been 56 cents/lb. With the current dramatic drop in copper prices, most copper producers have cut back production. In many cases, this has resulted in the closure of high cost mines or inefficient facilities. The Cipec countries agreed to reduce export by 10% in November 1974, then 15% in April 1975. These production and export cutbacks were designed to bring supply closer to demand. However, they have not influenced the current market because of the substantial decline in demand.

3. Price Projections

48. It would appear that price projections, considering the present uncertainties in the world economy, are even more hazardous than usual. A number of factors, however, would suggest that the violent price fluctuations of the past couple of decades may be somewhat dampened in the long term. The

trend to increased state ownership may result in expansion plans more attuned to national planning rather than cyclical development in the market. The large integrated producers who dominated the market in the past traditionally financed expansions from their own cash generation. The drops in market cycles reduced cash flows and forced postponements of investments, which in turn tended to compound the cycles. The huge increases in capital costs in real terms over the past decade have led to an ever increasing use of debt financing for new projects. This would also lead to ivestment decisions primarily based on the long term merit of the project regardless of current price conditions. As far as copper's position vis-a-vis its main competitors, aluminum and plastics is concerned, copper due to the recent substantial increases in energy cost, should be in an overall improved situation. Therefore, no accelerated substitution against copper seems likely.

49. In the short term, prices will, due to the considerable overhang of accumulated stocks (in excess of 1 million tons), not move substantially in 1976 although an improvement in the world economy for 1976 is generally forecast. The price for 1975 can now fairly accurately forecast to average about 56¢/lb. Although prices are forecast to move upward in 1976, they are expected to average around 67¢/lb in 1976 (in current dollar terms).

50. The medium-term prospects would indicate further price improvement for the 1977-1979 period, but according to widely accepted forecasts of the cyclical demand/supply, the price would decline thereafter. However, the timing of the price downturn would depend on factors such as (i) strength and duration of economic recovery; (ii) possible US copper strike in 1977; (iii) effectiveness of producer measures to reduce output; (iv) conclusion of an international copper agreement, and (v) solution on deterioration of transport problems in the African producer areas.

51. Over the long-term expectations are that copper market will fall in historical patterns of supply and demand. Increased costs of production will determine the price level. It is generally accepted that copper prices of about 80 to 85¢/lb (in 1975 dollars) are necessary to bring forth the necessary investment for sufficient supplies of copper which also would include an adequate return on investment.

November, 1975
Industrial Projects Department

Table 20

CHILE: COPPER SECTOR PROJECT

NOMINAL AND REAL PRICES OF COPPER (1948-1975)
(In US cents per lb)

Year	Nominal Copper Price LME, Spot Electr. Wirebar (1)	International Price Index (1973=100) (2)	Real Copper Price, LME Annual (1)÷(2) (3)	Real Copper Price, LME 5-year moving averages (4)
1948	24.1	48.8	49.4	
1949	21.9	46.8	46.8	
1950	22.4	49.0	45.7	50.5
1951	27.5	55.5	49.5	52.2
1952	32.4	53.2	60.9	53.4
1953	31.4	54.1	58.0	61.0
1954	31.1	54.1	57.5	65.2
1955	43.9	55.5	79.1	62.3
1956	41.1	58.2	70.6	58.9
1957	27.4	59.5	46.1	57.3
1958	24.7	59.8	41.3	51.6
1959	29.8	60.6	49.2	46.8
1960	30.8	60.6	50.8	47.1
1961	28.7	61.3	46.8	48.2
1962	29.3	61.8	47.4	52.3
1963	29.3	62.4	46.9	60.5
1964	43.9	63.2	69.5	72.5
1965	58.5	63.8	91.8	78.6
1966	69.3	64.9	106.8	86.6
1967	51.0	65.5	77.9	92.7
1968	56.2	64.6	87.0	92.2
1969	66.4	66.8	99.4	83.8
1970	64.1	71.3	89.9	79.8
1971	49.1	76.0	64.6	78.6
1972	48.6	83.7	58.1	74.0
1973	80.8	100.0	80.8	64.3
1974	93.2	121.7	76.6	-
1975	56.0	134.9	41.5	-

SOURCE: (1) Engineering and Mining Journal;
(2) IBRD

Industrial Projects Department
September 1975

CHILE: COPPER SECTOR PROJECT

MARKETING OF CHILEAN COPPER

1. Under the laws at present in force, the Chilean Government holds an export monopoly on copper and its by-products, which is exercised through CODELCO and ENAMI.

A. Sales Organization

2. ENAMI is responsible for the marketing of all copper produced by the medium and small mines, (Mediana y Pequena Minerias), while CODELCO is responsible for the sale of all copper produced by the Gran Mineria. Centralization of the marketing process was designed to prevent harmful competition, and to provide maximum flexibility in relations with the market. Furthermore, ENAMI is responsible for supplying the Brazil and Argentine markets with electrolytic copper, whereas CODELCO is responsible for the sales of refined copper to the rest of the world, and for the sales of all other products to all countries, including all the production not marketed by ENAMI to the two countries. Hence, CODELCO in addition to selling the production of the large mines, also sells the blister from the Paipote Foundry and the Compania Mineria Disputada. Some of the larger private mines may make direct sales, but each contract requires the prior approval of CODELCO.

3. The sales effort by CODELCO is controlled through the Sales Department with the assistence of sub-agents appointed by CODELCO to handle specific markets, to act as consultants to CODELCO, to negotiate on CODELCO's behalf with clients and to carry out various administrative tasks. These sub-agents are:

Sub-Agent	Regional Responsibility
W.O. Bergmann	Germany, Holland, Austria
Chile Copper	U.K., Scandanavia
Minerais et Metaux	France, Belgium
G. Schwendimann	Italy
Katsu Ueda	Japan
O.Kofmehl	Switzerland
Sodeco	Spain
Philipp Brothers	Argentina, Brazil
Mitra	India
Cerro Corp.	U.S.A.

B. Sales Procedures

4. The sale of copper is principally made by means of annual contracts for supply on a regular basis. During September and October of each year, what has traditionally been called a Sales Promotion campaign is carried out. This consists in visits to both regular and new clients to fix the terms of sales contracts for the coming year. Agreement is reached on the type of

copper the client will buy, the quantities to be delivered annually and monthly, the procedure for determining price, the place of delivery, the form and currency of payment, as well as other details of lesser importance. This sales campaign is normally organized well in advance, on the basis of estimated production from the mining concerns, and in collaboration with the sub-agents on a proposed marketing plan and strategy.

5. Approximately 80-85% of the total production is marketed through this process. The remainder (15-20% of total production) is traded and sold during the year, providing permanent contact with the market and taking full advantage of favorable opportunities which may arise. Sales are made to final consumers and to dealers.

C. Price Policy

6. Chile like the majority of world copper producers except the United States uses the daily quotations on the LME in determining the price of copper sold to its clients. The quotation followed is the official seller's cash price for bars of electrolytic copper. At present, and until Chile adopts some other method of determination, this figure constitutes the "Chilean Producer's Price", the term applied in contracts to the base selling price of Chilean copper.

D. Destination of Sales

7. Chile sells its copper on a wide geographic basis. According to 1973 figures, the most important markets are: West Germany (18.1%); Japan (14.2%); U.K. (12.8%); U.S. (8.9%); Peoples Republic of China (8.4%); Italy (7.0%) (see table on the following page).

8. The sales commitments for 1974 follow the same pattern. Chile will continue to diversify its markets and thus decrease its dependence on a small number of buyers.

CHILE: COPPER SECTOR PROJECT

CHILE'S COPPER EXPORTS
('000 metric tons of refined copper)

Country	1968	1969	1970	1971	1972	1973	1974
Western Europe	389,9	444,6	467,3	448,2	381,6	349,4	389,7
Fed. Rep. of Germany	125,3	136,2	169,1	166,7	138,8	119,1	127.6
Austria	1,1	1,1	1,1	1,4	1,1	1,0	2.5
Belgium	10,0	11,8	23,6	14,5	9,4	9,7	6,1
Denmark	1,1	1,7	1,9	1,8	1,7	2,5	2,4
Spain	13,3	21,5	14,3	13,7	12,8	13,1	13,1
Finland	3,2	1,5	2,1	1,7	1,3	1,1	5,9
France	33,9	51,0	49,9	46,9	32,1	22,9	38,4
Greece	-	-	0,5	0,6	17,9	27,1	19,7
Holland	1,1	0,9	5,8	6,9	4,6	1,8	2,3
England	110,7	112,2	98,6	101,4	82,6	84,3	87,1
Italy	50,2	65,3	66,7	65,7	54,4	46,1	67,4
Norway	3,2	4,6	2,3	1,9	1,4	2,3	1,9
Sweden	33,5	33,7	28,3	22,0	21,1	17,6	14,3
Switzerland	3,3	3,1	3,1	3,0	2,4	0,8	1,0
European Communist Block	2,2	0,4	1,3	7,3	14,6	42,1	48,2
Democratic Rep. of Germany	0,6	-	0,4	-	1,7	12,6	15,5
Czechoslovakia	-	-	-	1,0	0,3	-	-
Bulgaria	-	-	-	-	-	-	5,5
Hungary	-	-	-	-	-	4,5	6,2
Poland	1,6	0,4	-	0,5	-	4,6	10,0
Rumania	-	-	0,9	-	3,3	6,3	9,0
USSR	-	-	-	-	8,0	14,1	-
Yugoslavia	-	-	-	5,8	-	-	2,0
Others	-	-	-	-	1,3	-	-
America	190,4	150,3	137,0	98,9	103,7	114,8	225,9
Argentina	20,6	28,9	24,3	29,6	28,2	32,3	37,9
Bolivia	0,1	-	(a)	-	-	(a)	-
Brazil	8,0	10,4	11,0	10,5	7,9	12,1	41,5
Canada	-	-	-	2,4	-	10,1	37,3
Colombia	0,5	0,4	0,4	0,3	0,3	0,4	1,2
Cuba	-	-	-	0,8	-	-	-
U.S.	161,1	110,5	101,3	51,8	67,3	58,7	105,7
Mexico	-	-	-	3,9	-	1,2	2,3
Uruguay	0,1	0,1	-	0,1	-	-	-
Africa							
Mozambique	-	-	-	-	-	-	19,1
Asia	53,1	61,2	63,2	129,6	130,9	148,6	170,8
China	-	-	-	16,3	45,3	55,4	41,5
North Korea	-	-	-	0,5	2,9	-	-
South Korea	-	-	-	-	-	-	3,8
Japan	53,1	61,2	63,2	112,8	82,1	93,2	125,5
Singapore	-	-	-	-	0,6	-	-
Australia	0,3	-	-	-	-	1,7	4,5
Total	635,9	656,5	668,8	684,0	630,8	656,6	858.2

(a): under 50 metric tons

Industrial Projects Department, December 1975

CHILE: COPPER SECTOR PROJECT

THE PROJECT

A. REHABILITATION OF BARQUITO POWER PLANT

1. PROJECT DESCRIPTION

1. Objectives: The objective of the Project is to replace and install additional power generating units at Barquito to improve security of the service and reduce the operating costs. The Barquito Plant is located on the coast 110 km from the Salvador Mine and Concentrator and the Potrerillos Smelter.

2. Power Demand: The present peak demand for the Salvador system (60 Hz insulated system) is 46 MW. However, this is anticipated to increase to 60 MW within three years. This increased demand will be needed when existing processing installations have to be expanded due to lower ore grades and, therefore, increased volume of ore to be treated.

3. Existing Power Generating Capacity: The generating capacity of Barquito consists of: (a) Four steam turbines producing 7,500 KW each, and a smaller unit producing 3,000 KW. These turbines are limited to a maximum of 31 MW due to the boilers capacity. These are all old units installed in 1926, which have a low output, but still provide a reasonably safe base load, (b) One Fairbanks Morse diesel prototype unit with rated capacity of 8,600 KW but only capable of producing for short periods of emergency a maximum of 5,000 KW. This unit, installed as a part of the expansion program of 1968, has experienced continuous failures, operating availability is extremely low, since this model line was discontinued spare parts are impossible to obtain, (c) 8 Fairbank Morse medium (750 rpm) speed diesel units each with a rated capacity of 2,000 KW. These units are more suited to supply peak loads but should not be used for base load, and (d) one recently installed 23 MW gas turbine generator unit.

4. In addition, Salvador has installed two small diesel units located at Salvador with 1,500 KW each. This is only for emergency. Two small Hydroelectric plants: Montandon and Salvador each have a capacity of about 1,700 KW. The Salvador unit is being replaced by a new unit with a rated capacity of 3,400 KW.

5. In summary, the present generating capacity is:

a) Units for base load:

Steam Plant	31,000 KW
Hydroelectric Plant (including the new Salvador unit)	4,900 KW
Gas turbine	23,000 KW
	58,900 KW

b) Units for Peak Load:

Barquito Diesel Plant	19,400 KW
Salvador Diesel Plant	3,000 KW
	22,400 KW

6. Taking into account the losses in transmission lines and consumption in auxiliary services, the amount of base power available is reduced to about 50 MW. The Diesel capacity is unreliable and can only be used for emergencies and programmed maintenance. Furthermore, it should be pointed out that the Diesel Plant and the Gas Turbine cannot be operated simultaneously due to limitation in the existing substation.

7. Proposed New Generating Capacity: To supply the future demand and to reduce the operating costs, a two-phased course of action is planned. The first phase will be the immediate installation of a waste heat recovery boiler for the gas turbine exhaust gases and of a fuel preparation plant to burn heavy oil in the gas turbine.

8. The second phase contemplates the expansion of the power supply with generating units totaling 15-20 MW capacity, capable of supplying basic power needs with high reliability, and low cost. Total generating capacity would then rise to about 50-55 MW of modern, reliable and low cost units. The existing steam units would be used as standby, and the fast diesels for peak load periods. The consultants, McLelland and Partner (UK) have been engaged to conduct a full study on the proposed investment program, and have analyzed the alternatives on the basis of technical and economic evaluation. Recently a new alternative to develop hydroelectric generating capacity has been found and is being studied. The hydroelectric potential requires a study which will take a year to be completed. It should then be compared with other possible alternatives to further increase the generating capacity.

2. PROJECT IMPLEMENTATION SCHEDULE

9. A tentative implementation schedule is presented below:

Activity	Timing	
	Phase I	Pha e II
(a) Preliminary study by Consultants	Oct. 1974	Oct. 1974
(b) Consultant's Report completed	Jan. 1975	Jan. 1975
(c) Engineering and Bid Specifications	Nov. 1975	Jan. 1976
(d) Equipment Bidding	Jan. 1976	Mar. 1975
(e) Procurement	Jul. 1976	Sep. 1976
(f) Equipment Delivery	Jul. 1977	Mar. 1978
(g) Erection and Start-up	Late 1977	Early 1979

3. PROJECT MANAGEMENT

10. Project preparation and evaluation has been completed by the consultants, McLellan and Partners, who will also undertake the engineering design, bid specifications, and procurement. Civil construction and equipment erection will be undertaken by local contractors, supervised by the engineering department of Salvador, with the continued assistance of McLellan. This is considered a satisfactory arrangement.

4. PROJECT CAPITAL COSTS

11. Capital cost estimates are as follows:

Item	Estimated Cost (US$ million equivalent)		
Phase I	Local	Foreign	Total
Equipment			
- One (1) waste heat boiler		1.20	1.20
- One (1) fuel preparation plant		1.00	1.00
Freight and Insurance		0.40	0.40
Civil works/erection	0.30	0.05	0.35
Start up costs	0.10	0.05	0.15
Sub-total	0.40	2.70	3.10
Phase II			
Generator unit (steam)		8.00	8.00
Freight and Insurance		0.80	0.80
Civil works/erection and start up costs	2.00	1.00	3.00
Sub-total	2.00	9.80	11.80
Physical contingencies	0.36	1.87	2.23
Price escalation /1	0.33	1.97	2.30
Total Fixed Costs	3.09	16.34	19.43
Working Capital	1.00	-	1.00
Interest during construction		1.00	1.00
Total Financing Required	4.09	17.34	21.43

12. The project costs are based on quotation for similar equipment received during 1975. The costs are considered to be representative, with adequate provision for contingencies and price escalations. 1/

1/ Assuming price escalation as follows:

	1976	1977	1978
Equipment	12%	10%	8%
Civil Works	16%	14%	12%

5. PROCUREMENT

13. The equipment items will be procured by international competitive bidding (ICB), following Bank guidelines.

6. FINANCING PLAN

14. The project will be financed as follows:

	Local Currency	Foreign Currency	Total
		US$ million	
Codelco Internal Cash Generation	4.09	1.00	5.09
IBRD	-	16.34	16.34
	4.09	17.34	21.43

The Bank funds will be used to procure the foreign equipment including spares, and freight. All local currency costs, interest during construction, will be financed out of CODELCO's cash flow.

7. FINANCIAL ANALYSIS OF THE PROJECT

15. The major benefits from the project will be:

(a) Reduction of fuel consumption

(b) Lower maintenance costs

(c) Secure supply

16. Operating Cost: The existing plant has the following fuel costs:

Steam Plant - 430 gm of Bunker C/Kwh $133/ton) = 5.7 ¢/Kwh
Diesel Units - 250 gms of Diesel/Kwh $206/ton) = 5.2 ¢/Kwh
Gas Turbine - 315 gms of Diesel/Kwh $206/ton) = 6.7 ¢/Kwh

The future plant with recover boiler, fuel treatment system and modern generating unit should have the following fuel costs:

Gas turbine - 260 gms heavy oil/Kwh x $150/ton = 3.9 ¢/Kwh
New gen. unit - 190 gms heavy oil/Kwh x $133/ton = 3.9 ¢/Kwh

17. Assuming a 40 MW base load with 85% load factor, total annual power consumption is presently 300 million Kwh. Existing annual fuel costs are:

	Kwh/Year	US$ million
Gas turbine	60	4.0
Staem units	230	13.1
Diesel units	10	0.5
TOTAL		17.6

The new units are expected to incur annual fuel costs of US$12.0 providing an annual saving in fuel costs US$5.6 million (in 1975 prices).

18. Maintenance Costs: Maintenance costs for the existing steam and diesel units are very high. The steam units are now almost 50 years old and it is difficult to obtain spare parts, some require fabricating at considerable cost. A substantial saving is expected with the new plant.

19. Secure Supply: Given the unreliability of some of the units of the existing plant, a loss of copper production is a real possibility. The El Salvador complex produces about 85,000 tons of refined copper per year or 240 tons per day. Hence a loss of production for one day due to electrical failure, in addition to shutdown and startup costs which are considerable would result in a loss of revenue of US$0.3 million. Hence, plant breakdown or loss of output for any period of time could be very costly. This is a very real possiblity.

20. Net Cash Flow Projection:

1975 Prices US$ Million

	1976	1977	1978	1979	1980	1981
Capital Costs	0.6	3.0	11.5	2.0		
Fuel Savings	-	-	2.8	2.8	5.6	5.6
Maintenance Savings	-	-	0.5	0.5	1.0	1.0
Net Cash Benefits	(0.6)	(3.0)	(8.2)	1.3	6.6	6.6

21. The project is highly profitable and has a payback period of little over 3 years after start-up on savings in fuel cost and maintenance cost alone. The project displays a discounted cash flow rate of return in excess of 35% (in real terms) without using any savings from possible plant shutdowns under the existing unreliable system.

22. The project, therefore, has little financial risk, and will serve to importantly secure the output of the Salvador mining and smelting complex (i.e. 85,000 tons of refined copper per year).

B. REHABILITATION AND MODERNIZATION OF ENAMI SMELTING AND REFINING OPERATIONS

1. PROJECT DESCRIPTION

23. Objective: Bank funds will be used to finance three urgently needed equipment components which form part of ENAMI's broader rehabilitation program for its principal smelting and refining operations at Ventanas and Paipote. The objective of the above program is primarily to assure the continuation of production from ENAMI's smelting operations as well as to bring about a moderate increase in installed production capacity; significant production losses have been caused by plant breakdowns which have been occurring with increasing frequency. Since the shortage of installed smelting capacity is a major constraint to increasing Chile's refined copper production, ENAMI's smelting facilities play an important role in processing copper concentrate from Gran Mineria operations in addition to processing the concentrate purchased from the small- and medium-scale producers.

24. Smelting and Refining Operations:

(a) Paipote Smelter: This smelter is located in the Atacama Province, about 10 kms from the town of Copiapo. The plant was originally built to smelt gold-containing mineral ore. The plant began operations in 1952 and over the years the original design has been modified. At present the smelter produces 48,000 MT of blister copper per year. The copper concentrate which is treated in the Paipote smelter is from the Gran Mineria (principally Chuquicamata) and from the small- and medium-scale producers. The actual plant comprises:

(i) Crushing and mineral preparation section;

(ii) Smelting facilities, consisting of reverberatory furnace with a present capacity of 440 tons/day, three convertors, and blister casting facilities;

(iii) Thermoelectric plant; and

(iv) Sulphuric acid plant (120 tons per day capacity).

(b) Ventanas Smelter and Refinery: This plant is located 50 kms north of Valparaiso on the coast, has a smelter built in 1964 and a refinery built in 1966. The Ventanas plant consists of a crushing operation, storage yards for concentrate, a reverberatory furnace with a capacity of 650 tons of fused charge per day and two wasteheat boilers; a third is being added to increase the capacity at the

reverberatory furnace. The smelter is modern and conventional but was originally designed for only 3,000 tons/month of blister copper. However, annual production is is approximately 72,000 MT/year, which means the smelter is run on double design capacity. Almost 50% of the copper concentrate that is treated at Ventanas is from the Gran Mineria; the remainder is from the small- and medium-mining operations.

The Ventanas plant has a refining capacity of about 120,000 MT/year; a fourth component is being added to the electrolytic refinery which is expected to increase installed capacity to 145,000 MT/year. In addition to refining blister copper produced at Ventanas, almost 50% of the blister copper at El Teniente is subsequently treated at the Ventanas plant. The other sections of the Ventanas plant comprise a small power plant, a small copper sulphate production plant, and a nobel metals plant (recovery of selenium, gold, silver, palladium and platinum from the anode slimes).

The Ventanas modernization and expansion program aims at increasing installed capacity by about 40,000 ton/year of electrolytic copper. The program contemplates an increase in smelting capacity to approximately 80,000 MT/year. The expansion is expected to be completed by 1978.

25. Specific Equipment Components:

The three equipment components to be financed are the following:

(i) Modification to Burners: Both the Ventanas and the Paipote smelters use a petroleum-based fuel to heat the furnaces, which is the major cost component of the entire smelting operation. It is now proposed to design a system which would permit greater flexibility so as to use either petroleum or Chilean coal. The additional equipment required would consist of crushing equipment, sieves, ventilation equipment, pumps, etc.

(ii) New equipment to prepare cathode starting sheets: The electrolytic refinery presently uses two semi-automatic machines to prepare cathode starting sheets for the refining operation. These machines, in operation since 1966, have a limited capacity which will impose a constraint on refining capacity when the refinery expansion is completed, and are obsolete in that spare parts are difficult to obtain. Two alternative solutions are being studied to solve the limitations of present equipment: a new, fully automatic

machine with a capacity of 700 cathodes per hour, or two modern, semi-automatic machines, each with a capacity of 350 cathodes per hour.

(iii) Anode casting equipment for the Paipote Smelter: Two anode casting wheels currently are used at Paipote, each with a capacity of 10 tons/hour. The equipment is approximately 25 years old and it is extremely diffiuclt to find spare parts. Furthermore, the present equipment is a limiting factor in increasing smelter capacity at the Paipote plant. The new casting equipment would have a capacity of 40-50 tons/hour, and would have automatic weighing systems.

2. PROJECT IMPLEMENTATION

26. A tentative implementation schedule is as follows:

		Procurement of Equipment	Completion and Start Up
(i)	Burners (Paipote, Ventanas)	Jan. - March 1976	Dec. 1977
(ii)	Starting Sheet Cathodes	Feb. - April 1976	June 1977
(iii)	Blister Copper Casting (Paipote)	Jan. - March 1977	June 1978

This is a reasonable and attainable schedule.

3. PROJECT MANAGEMENT

27. The implementation of this modernization and rehabilitation program will be the responsibility of ENAMI staff. The engineering design and civil construction will be undertaken by ENAMI's engineering group with the assistence of local consultants. ENAMI's engineering staff is considered to have sufficient technical competence and experience, particularly at Ventanas.

4. Capital Costs

28. The capital costs of the Ventanas and Paipote programs are estimates as follows:

Item 1	Local Currency	Foreign Currency (US$ 000)	Total
Modification of Burner for Coal Use (Ventanas and Paipote)			
Equipment		1,078	1,078
Freight and Insurance		65	65
Erection and Startup	270	—	270
Subtotal	270	1,143	1,413
Physical Contingency (10%)	27	114	141
Price Escalation (10%/year)	46	195	241
Total	343	1,452	1,795
Item 2			
Cathode Starting Sheet Preparation Machine (Ventanas)			
Equipment		595	595
Freight and Insurance		68	68
Erection and Startup	40	14	54
Subtotal	40	677	717
Physical Contingency (10%)	4	68	72
Price Escalation (10%/year)	5	75	80
Total	49	820	869
Item 3			
Anode Casting Equipment for Paipote			
Equipment		533	533
Freight and Insurance		64	64
Erection and Startup	325	—	325
Subtotal	325	597	922
Physical Contingency (10%)	33	60	93
Price Escalation (10%/year)	79	128	207
Total	437	785	1,222
Item 4 Interest during construction	-	20	20
Grand Total Items 1,2,3 & 4	830	3,080	3,910

29. The capital costs of the specific equipment items are based on actual recent quotations. The costs are considered to be representative, with adequate provision for contingencies and price escalation.

5. PROCUREMENT

30. The Bank funds will be used exclusively to finance the foreign exchange costs of the equipment, including freight and spares. International competitive bidding will be followed for these equipment items.

6. FINANCING PLAN

31. The Company's investment in the Paipote and Ventanas smelters and refinery totaled US$28.5 million from 1970 to 1975. Total estimated costs for further investments during the period 1976 and 1977 are scheduled to be US$26.4 million. Within this investment program, the three equipment components are financed as follows:

	Local Currency	Foreign Currency	Total
		(US$ 000)	
Enami Funds or Government Contribution	830	20	850
IBRD	—	3,060	3,060
Total	830	3,080	3,910

7. PROJECT BENEFITS

32. Economic evaluation of the rehabilitation program is made difficult by lack of a clearly defined benefit or revenue streams. The present equipment, particularly in the smelting operations at Paipote, and to a lesser extent at Ventanas, is old and obsolete. Plant breakdowns have been frequent and have led to production losses; where it may be necessary to do maintenance and repair work, spare parts have been difficult to find. A goal of the rehabilitation program is to assure future production at ENAMI's smelting and refining operations.

The benefits directly attributable to the specific equipment items are as follows:

(a) New Burner System

The major benefits which will accrue from the installation of the new burners at both Paipote and Ventanas are in foreign exchange savings. In the light of dwindling domestic oil reserves, the coal replacement project adds great operational

flexibility to the furnace without losing the ability to burn petroleum. Furthermore, the replacement of imported petroleum with domestic coal - a major cost component - will have a beneficial effect on the depressed domestic coal market.

Taking February 1975 prices for diesel oil and coal, it can be shown that fuel savings at Paipote amount to $24 per MT of blister whereas they amount to $4.45 for Ventanas. Taking the average daily blister production figures for the first two quarters of 1975 (180 MT for Ventanas, 150 MT for Paipote), the total amount of foreign currency savings in a year would accrue to US$1.3 million or about 70% of the total project cost.

(b) Starter Sheet Manufacturing Equipment

Cathode starting sheet equipment has normally a useful life of 10 years. The Ventanas equipment is already 11 years old and performs increasingly unreliably. New high density current equipment is typically used for 20 hours per day or at 80% availability. Such equipment would produce 150,000 MT of copper per year. The present starter sheet equipment could theoretically be pushed to a 75% daily availability which means that 7,500 MT of copper per year would not be treated without installation of additional equipment. Since the refining charge amounts to US$108 per MT of copper which is equivalent to a loss of US$810,000 per year, the entire project cost would be recouped in one years time.

However, it should be understood that an availability of 75%, due to accelerating deterioration, will most likely not be maintained emphasizing the urgency of this investment.

(c) Blister Copper Casting Equipment

Spare parts cannot be obtained for the existing equipment since it is more than 25 years old. Moreover, the present capacity of blister copper castings is a constraint to any future expansion of the Paipote smelting operation. Both these problems will be alleviated with the new equipment.

C. EL TENIENTE: UNDERGROUND CRUSHING STATION FOR PRIMARY ORE FUTURE MINE (MINA FUTURA)

1. PROJECT DESCRIPTION

33. Background: El Teniente constitues a classical porphyry copper deposit consisting of an oxidized or leached zone on the top of an intermediary secondary enriched zone underlain by a primary zone. As described in Annex 2-3, page 14, the mining method used is block caving, which is also by far the most economical method in underground mining. The block caving technique makes use of the fact that large ore blocks (in El Teniente's case dimensions are 60m x 60m x 100m, containing 1.5 to 2 million tons) can be collapsed as one unit provided the in situ rock is already suffiently fractured by geological events. Fracturing characteristics in the secondary ore zone are excellent from where, until recently, all production came.

34. Mining operations from 14 levels incoporating two transportation levels and four new shafts which currently produce about 55,000 tons per day have by the large ignored the lower grade (1.0% Cu) primary ore 1/. Although there is still a 400 million ton reserve of secondary ore available, production of primary ore has now become a necessity as mine development and production levels have entered the primary ore zone. The first block of primary ore lower grade ore was caved in 1974 and it became immediately evident that fracturing characteristics of the lower grade ore are far inferior. The maximum size of fractured rock in the secondary ore zone is 13.5 inches whereas fractured lower grade ore breaks typically in blocks of 30 to 40 inches. The existing ore shoots are not equipped to handle ore that size necessitating secondary blasting, which is difficult and costly. This is drastically demonstrated by a 90% productivity decrease per man shift (250 tons in upper secondary ore zone versus 20 to 30 tons in the lower primary ore zone).

35. If the current system is continued to be in use, it can be predicted that, at least from 1978 on, projected tonnage levels will not be reached:

	1975	1976	1977	1978
Codelco Forecast in MT/day	54,800	56,000 2/	57,000 2/	57,000

In order to accommodate the above forecast figures (57,000 tons) El Teniente will have to produce about five million short tons or 19.6% from the primary ore zone. This translates into a daily production of 12,500 tons, which means that the management would have to add 500 men to the work force on the basis of the current 23 ton per man shift performance. This would compare to the present 280 miners who now produce 55,000 tons per day in the secondary zone. However, the introduction of substantially more labor is physically impossible

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1/ Secondary ore grade: 1.5% Cu.

2/ Increase in ore throughput does not automatically mean increase in refined copper produced. As the incremental volume of lower grade primary ore increases, it will need more ore to produce the same amount of copper.

as ventilation and transportation facilities would not permit a further crowding of the mine which leaves as the only alternative the underground crushing system.

36. Objective: El Teniente is the biggest underground mine and the only major one featuring no underground primary crusher. The current mining system is extremely efficient and should be maintained in the future if possible. Regardless of what mining system is finally employed (for instance sublevel caving), the need to reduce the size of this much less friable, hence blockier ore will remain since the existing infracture system is not equipped to handle ore bigger than 13.5 inches in size. The installation of an underground primary crusher becomes, therefore, an absolute necessity if productivity is to be maintained and forecast production levels are to be achieved. Handling the primary ore blocks necessitates ore shoots considerably larger in diameter to prevent blockage of the ore passes. The crusher, fed by a new primary ore shoot system, will reduce the ore size to accommodate the existing handling system.

37. Project Components and Design: The primary El Teniente ore will be fed through two separate dumping stations on to the vibrating classifier feeder which in turn supply the gyratory crusher (54" x 75") which reduces the block size to 7". Design capacity of the crushing station is 1,630 short tons per hour. Three ore passes (two for the vibrating classifier undersize and one for the main crusher output) lead into the loading hopper chambers which will be constructed in a run-around above El Teniente's main haulage level. From here the ore will be dropped to the usual 100 ton mine cars through a chute system similar to the ones used for secondary ore.

2. PROJECT IMPLEMENTATION

38. Due to the obvious urgency to solve the increasing ore handling problems at El Teniente, implementation of the "Future Mine" (Mina Futura) project has already started in a minor way (access drifts, etc.). However, major excavations for the crusher system emplacement will commence towards the end of the year. The project is scheduled to be operational by mid-1978.

3. PROJECT MANAGEMENT

39. The project's construction and operational phase will be managed by El Teniente's operational and engineering staff. From a technical standpoint, this is basically a simple project and El Teniente's engineering staff appears to be quite capable of executing this project. It is generally said that El Teniente's engineering group is the most experienced and efficient within Codelco.

4. CAPITAL COST

40. The capital cost of the project is estiamted as follows:

	Item	Local Currency	Foreign Currency US$ '000	Total
A.	Rail Transportation System (Haulage Level 1 Retram)			
	- Engineering, Civil Works	655.7	35.8	691.5
	- Equipment and Supplies (Development only)	-	-	-
	Subtotal	655.7	35.8	691.5
B.	Dumping Station (Level 1 Retram)			
	- Engineering, Civil Works, Erection	361.4	10.2	371.6
	- Equipment and Supplies	22.4	36.8	59.2
	Subtotal	383.8	47.0	430.8
C.	Vertical Ore Shoots (to Crusher)			
	- Engineering, Civil Works, Erection	2,015.7	44.6	2,060.3
	- Equipment and Supplies	59.0	-	59.0
	Subtotal	2,074.7	44.6	2,119.3
D.	Rail Transportation System (Level 5)			
	- Engineering, Civil Works, Erection	3,632.4	342.9	3,975.3
	- Equipment and Supplies	534.8	878.6	1,413.4
	Subtotal	4,167.2	1,221.5	5,388.7
E.	Dumping Station (Level 5)			
	- Engineering, Civil Works, Erection	509.6	8.1	517.7
	- Equipment and Supplies	38.1	62.6	100.7
	Subtotal	547.7	70.7	618.4
F.	Underground Primary Crushing Station			
	- Engineering, Civil Works, Erection	4,011.4	295.4	4,306.8
	- Equipment and Supplies	1,306.8	2,145.0	3,451.8
	Subtotal	5,318.2	2,440.4	7,758.6
G.	Ore Shoot System (to Level 6)			
	- Engineering, Civil Works, Erection	2,294.5	20.2	2,314.7
	- Equipment and Supplies	49.0	82.0	131.0
	Subtotal	2,343.5	102.2	2,445.7
H.	Feeding System (to Level 8)			
	- Engineering, Civil Works, Erection	7,750.0	239.3	7,989.3
	- Equipment and Supplies	-	-	-
	Subtotal	7,750.0	239.3	7,989.3
I.	Various			
	- Construction and Electrical Equipment	732.8	730.4	1,463.2
	- Ventilation	1,265.9	315.1	1,581.0
	- Consulting Services	330.0	413.0	743.0
	Subtotal	2,328.7	1,458.5	3,787.2
	TOTAL ESTIMATES	25,569.5	5,660.0	31,229.5
	Physical Contingency 10%	2,557.0	566.0	3,122.9
	Price Escalation 10% per year	5,039.7	1,317.0	6,346.8
	PROJECT TOTAL	33,166.2	7,533.0	40,697.7
	Working Capital	1,000.0	-	1,000.0
	Interest During Construction	-	1,000.0	1,000.0
	TOTAL FINANCING REQUIREMENTS	34,166.2	8,533.0	42,699.2

41. The capital costs are July 1975 costs and are based on fairly detailed engineering and design plans. Most of the local cost are for engineering, civil works and erection in which the engineering staff has considerable experience. Therefore it is felt that contingencies of 10% are ample. Price escalation is estimated to be 10% per year.

5. FINANCING PLAN

42. The project will be financed as follows:

	Local Currency	Foreign Currency	Total
	---	US$ million	---
Internal Cash Generation	34.167	1.000	35.167
IBRD		7.533	7.533
	34.167	8.533	42.700

43. The Bank fund will be used to procure the foreign equipment including spares and freight amounting to 18% of the total project cost. All local currency costs, including all basic engineering and interest during construction are financed out of Codelco's cash flow.

6. PROCUREMENT

44. International competitve bidding will be used for the large equipment items such as dump, cars, classifier feeders, crusher and conveying systems which will be about 90% of the loan amount. Some smaller equipment and supply items will be procured by international shopping.

7. FINANCIAL ANALYSIS OF THE PROJECT AND BENEFITS

45. Production Forecast: Although CODELCO forecasts a ten percent production increase from 1977 over and above the 1975 figures, it is probably more prudent to assume that, with the introduction of the project, the projected level of production in 1975 can be maintained:

	1975	1976	1977	1978	1979	1980
Production (000 MT of Refined Copper)	250	250	250	250	250	250
Production without the Project (000 MT)	250	250	250/1	225	200	175
Incremental Loss of Production (000 MT)				10%	20%	30%/2

/1 The forecast of no loss of production in 1976/77 without the project would in reality probably not be achieved. As accessibility to the secondary ore zone becomes more difficult due to the fact that no primary ore can be mined, a greater effort of secondary ore pre-production development has to be made, thereby diverting mining machines and manpower which in turn would result in a drop of production.

/2 Constant after 1980.

	Production Cost per Metric Ton US¢
a) Operation	
Material and Supply	0.236
Energy	0.740
Wages	1.024
Sub-total	2,000
b) Maintenance	
Rehabilitation of Equipment	14,325
Salaries and Wages	0,236
Sub-total	14,551
Total Cost to Operate and Maintain the Project	16,515 = US$0.17/MT

c) Depreciation Costs

Civil works and construction amounting to US$23 million are depreciated over a 20-year period, whereas equipment and supplies of US$8 million are depreciated over 5 year, both on the basis of 75,000 MT of copper per year production.

	US$/MT
i) Civil Works and Construction	17.3
ii) Equipment and Supplies	21.3
	38.6

Except for depreciation, incremental costs are negligible, but even with depreciation, additional costs amount to under two US cents per lb of contained copper.

47. With the implementation of the project, production is estimated to be constant at 250,000 MT of refined copper per year from 1975 onward. Current production costs are $0.42 per lb and have been estimated to increase annually by 10% from 1976 onward. Without the project (as stated in paragraph 49), production is expected to gradually drop to 175,000 MT per year and then remain constant after 1980 1/.

48. Cost Benefit Stream (Copper prices in constant 1975 US dollars)

Case 1 With the Project	1975	1976	1977	1978	1979	1980
				US$ million		
Sales	314.2	336.3	369.3	496.1	468.7	380.4
Investment Cost	0.5	10.0	25.2	7.0	-	-
Production Costs /2	234.3	259.1	292.2	330.8 /3	363.8	402.4
Surplus(Deficit)	79.4	67.2	51.9	158.3	104.9	(22.0)
Case 2 Without the Project						
Sales	314.2	336.3	369.3	446.5	374.9	266.3
Investment Cost	-	-	-	-	-	-
Production Cost	234.3	259.1	292.2	314.2 /4	347.3	380.4
Surplus/Deficit	79.9	77.2	77.1	132.3	27.6	(134.1)
Incremental Cash Surplus (Deficit)	(0.5)	(10.0)	(25.2)	26.0	77.3	112.1 /5

/1 The assumption is that eventually the mine will develop a different mining method which will be less efficient than block caving, but nevertheless will stabilize production.

/2 Allowing Annual escalation of 10%

/3 Includes incremental production cost from 1978 onwards.

/4 Excluding incremental cost but otherwise kept on level of case (1) as even with assumed lost of production substantial additional labor is necessary to keep mine running.

/5 Savings in losses (due to depressed price forecast for 1980)

49. The project is clearly highly profitable and will have repaid the capital cost of the project in the first quarter of 1979. Thereafter, as production without the project would result both in increased costs and a drop of production of about 75,000 metric tons 1/ per year, the annual incremental benefit would be about US$100 million per year under the forecast prices.

D. CHUQUICAMATA: SELENIUM RECOVERY PLANT

1. PROJECT DESCRIPTION

50. Objective: Both the Chuquicamata and El Salvador ores contain small quantities of Selenium which during the course of processing the ores to refined copper, ends up in the anode slimes in the copper refinery. The objective of the project is to recover this selenium for sale as a commercial grade selenium (99.5%), whereas it is now sold in the slag.

51. Concept: The slimes from the two aforementioned refineries are processed at the Nobles Metal plant at Chuquicamata to recover gold and silver. An analysis of this plant has shown that 93% of the selenium entering the plant as slimes can be found in the subproducts of the Dore Furnace; i.e. in the oxidized slag and dust and wash solution from the gas cleaning system and from the electrostatic precipitator. Of this up to 98% can be recovered. (i.e. an overall recovery of 91%).

52. Process Design: The project will consist of a plant to recover the selenium from the subproducts of the Dore Furnace. The subproducts are collected and leached in tanks, and a pregnant pulp formed. The pulp is then neutralized with sulfuric acid and sodium chloride to a ph of 6-7 and filtered, providing a solution free from impurities which is then acidified with purified sulphuric acid, thus precipitating selenium. Precipitation is carried out hot, through agitation with the additon of sulfur dioxide in the presence of iron sulfate. The selenium is collected in filter presses, washed and dried. The powdered selenium thus obtained is of commercial quality (99.5%).

53. Plant Size: The plant will be constructed in two steps. First a 9 ton pilot plant will be constructed. Second this will be expanded to a commercial plant with 35 ton capacity. The expanded plant will be designed to treat 700 tpy of anode slimes; 530 tpy from Chuquicamata; 160 tpy from El Salvador, with an average content of 6-7% of selenium. For each ton of copper refined from the Chuquicamata and El Salvador ores 0.15-0.20 lbs. of selenium which is collected in the anode slimes at the respective refineries (i.e. Selenium is available in the ores at a ratio of 1 part to 12,000-15,000 parts of contained copper).

54. Test Work: Extensive test work on recovering the selenium from the anode slimes was carried out on a laboratory scale by CIMM, by two experts with extensive selenium recovery experience in Canada. Two major alternative processes were considered; a) recovery by leaching the anode slimes before they are fed to the Dore Furnace in the Noble Metals Plant - the method used at

Furnace - the method selected. The selection was made on the basis of an economic and technical evaluation. Both processes required a similar capital investment, but the latter had lower operating costs. Both processes have a recovery ratio of 90%. The test results indicate the technical viability of the project. Nevertheless, to assure the correct process design parameters are obtained it was concluded that a pilot plant be first constructed.

2. PROJECT IMPLEMENTATION SCHEDULE

55. A tentative implementation schedule is presented below.

1. Engineering and Installation of Pilot Plant (20 months)	February 75 - December 76
2. Pilot Plant Trials (3 months)	January 77 - March 77
3. Engineering and Expansion to full Commercial Plant (12 months)	April 77 - April 78
4. Run in of Expansion (2 months)	May 78 - June 78
5. Plant completion	July 78

56. This schedule is realistic, but could be subject to slippage if there is any delay in taking the decision to proceed, and the possible unavailability of the two experts.

3. PROJECT MANAGEMENT

57. The project construction and operational phases will be managed by the Chuquicamata operational and engineering staff. Assistance in design and the earlier test work. This should be a suitable arrangement.

4. CAPITAL COST

58. The estimated capital cost of the project is given in the following page:

Item	TOTAL COST		
	Local	Foreign ($ 000)	Total
Equipment (c.i.f.)	131	123	394
Spares	-	20	20
Erection	134	-	134
Instrumentation	-	118	118
Buildings	171	-	171
Civil Works	96	-	96
Piping	37	85	122
Electricity	34	-	34
Other Services	102	-	102
Engineering and Supervision	274	-	274
Subtotal	979	486	1,465
Physical Contingencies (15%)	150	70	220
Price Escalation	300	120	420
TOTAL FIXED COSTS	1,429	676	2,105
Other Working Capital	200	-	200
Interest During Construction	-	10	10
TOTAL FINANCING REQUIRED	1,629	686	2,315

59. Project costs based upon preliminary design, and equipment lists were made in June 1974. A contingency allowance of 15% is considered adequate, plus allowances for escalation as follows:

Price Escalation Factors

	1974	1975	1977	1978
Equipment	14%	12%	10%	8%
Civil Works	18%	16%	14%	12%

With these allowances, the capital cost estimates are considered to be representative.

5. PROCUREMENT

60. The equipment items can all be considered off-the-shelf-items: leach tanks, piping, pumps, filters, scrubbers, fans, etc., with values less than $50,000. Hence, full international competitive bidding is not warranted, and international shopping (from 2 or more suppliers) would be more appropriate. The Bank funds will be used to finance equipment and supplies, cif Chilean port.

6. FINANCING PLAN

61. The project will be financed as follows:

	Financing		
	Local Currency	Foreign Currency	Total
	(US$1000)		
Internal Cash Generations	1629	10	1639
IBRD	---	676	676
	1629	686	2315

62. Expenditures are estimated to be as follows:

	Local	Foreign (US$ 000)	Total
1975	150	150	300
1976	850	200	1050
1977	629	336	965
	1629	686	2315

63. The Bank funds will be used to cover 99% of foreign exchange costs or 29% of total project cost. All local currency costs will be covered by cash generation.

7. PRODUCTION COSTS

64. Raw Material and other inputs to produce 35 tons of Selenium per year are as follows:

			Unit Cost	Cost/ton of Selenium
Sulphuric Acid	385 ton	11 ton/ton of Selenium	$10/ton	$110
Sodium Chloride	220 ton	6.3ton/ton of Selenium	$50/ton	$300
SO_2 gas	36 ton	1 ton/ton of Selenium		$ 10
Labor-2 shifts of 5 workers			$500/month	$1700
1 chemical analyst			$1000/month	$340
1 supervisor/shift			$1000/month	$340
Maintenance 7% of Fixed Capital	$84,000			$2400
Services: 65 psi steam	60,000 kg	1700kg/ton of Selenium		$50
Distilled water	1,200 m^3	34 m^3/ton of Selenium		$10
Electricity	9,000 kwh	257/ton of Selenium	$0.12/kwh	$32
			TOTAL	$5292

The above cost estimates are very preliminary but indicate that the operating costs will lie in the order of $5.3 per kilogram (in late 1974 prices).

65. Financing charges will add a cost of $65,000/year or $1857/ton or $1.86/kg. Depreciation charges at 8% an additional $96,000 or $2742/ton or $2.74/kg. Overhead should not amount to more than $8000/year or $142/ton or $0.14/kg (in late 1974 prices).

66. Hence total production costs are estimated at $10 per kg. which compares with the costs at the Ventanas smelter of $10-$12 per kg.

8. FINANCIAL ANALYSIS OF THE PROJECT

67. Price: The future Selenium price is expected to remain at the recent high levels of $30-40/kg. The lower figure $30/kg is used in the following projections (for late 1974 prices, escalated at 5% per year for current prices): Prices used in the projections are $31.5, 33.0, 34.8, 36.5, 38.3, 40.2, 42.2, 44.3, 46.5, for years 1975 to 1983 respectively.

68. Production Projections: The output from the project is expected to follow the following pattern:

	1977	1978	1979 onwards
Output	5 tons	28 tons	35 tons

69. Cash Flow Projections: On the basis of the above figures the following projections have been derived (in current prices):

Source of Funds	1975	1976	1977	1978	1979	1980
			(US$000)			
Revenue	---	-	174	1022	1340	1407
CODELCO financing	285	656	714	---		
Debt Financing	20	400	230			
TOTAL SOURCES	305	1056	1118	1022	1340	1407
Application of funds						
Capital Expenditures	300	1050	965	---	---	---
Operating Costs (Cash) /2	---	---	80	252	272	294
Overhead Costs	5	6	6	7	7	8
Interest Charges	---	10	55	60 /1	55	50
Debit Repayment	---	---	---	54	54	54
TOTAL APPLICATIONS	305	1066	1106	373	388	406
NET CASH SURPLUS	---	---	12	649	952	1001

/1 Interest declines from $60,000 in 1978 to 2700 in 1990 after which debt is completely repaid.

/2 Cash costs from para 7 above, escalated at 8% per year, with allowances for poor productivity and normal start-up problems during the earlier years of operation.

70. The project is highly profitable, having a payback period of less than 2 years after start-up. (i.e. the capital investment would be fully recovered by the end of 1978). The project displays a discounted cash flow rate of 35% (in real terms). A sensititivy analysis produced the following results:

	DCF Rate of Return
1. Base case	35%
2. Double operating costs	22%
3. Half sales price	8%

Thus the project has little financial risk, even under very adverse conditions.

71. The project will provide net foreign exchange earnings of close to $1 million per year.

F. TECHNICAL ASSISTANCE PROGRAM FOR CODELCO

1. OBJECTIVES

72. As discussed in Annex 2-3, CODELCO as a company needs considerable strengthening, to make up for the loss of large numbers of engineers following nationalization, to replace the services originally provided by the former owners from their parent companies in the USA and, importantly, to improve management efficiency and prepare a fully integrated development plan for the CODELCO Group of Companies.

2. DESCRIPTION OF THE PROGRAM

73. To meet these objectives a substantial technical assistance program has been proposed as follows:

(a) Planning Systems, Project Preparation and Evaluation
- team of 10 experts for two years (20 man-years)

(b) Specific Studies

(i) Development of Smelting and Refining Strategy for Chile

- Four people for a 6-month study (2 man-years)

(ii) El Teniente Long Term Mining Plan

- A large team including 5 man-years of foreign expertise

(iii) Chuquicamata Long-Term Mining Plan

- A team including 3 man-years of foreign expertise

(c) Specific Experts

- trouble shooting and problem solving particularly in Metallurgical field - (4 man-years)

(d) Organization and Structuring of CODELCO Group

- reinforcement of an ongoing program by adding 5 man-years of foreign expertise

(e) Internal Procedures

(i) cost accounting systems

(ii) inventory control systems

(iii) data collection systems

(iv) production control systems

- this is coupled with a computing development program, and will require 18 man-years of foreign expertise

74. Planning Systems, Project Preparation and Evaluation: Prior to nationalization, most project identification, preparation and evaluation was performed by the personnel of the parent USA companies, owners of the local Chilean companies. Hence, upon nationalization and the withdrawal of this staff, virtually no expertise was left within the CODELCO Group. The inability to prepare and present projects for management decision is very obvious, and at present decisions are taken on the basis of, at best, a superficial evaluation. As such, management has considerable difficulties establishing investment priorities.

75. Also with the nationalization of the companies and the formation of the CODELCO Group, it becomes very necessary to coordinate the investments and planning of each of the companies. Decisions can no longer be made in isolation. The investment decisions need to be reoriented away from the needs and objectives of the former parent companies to the needs of Chile, and specifically CODELCO. Project priorities have to be assigned not only within the individual companies but between the companies. This requires the setting up of a complete and coordinated planning function.

76. The program as now envisaged is to engage an integrated and balanced team of experts to in effect establish an integrated planning function within the CODELCO Group along the principles of good corporate management. The group will work very closely with the counterparts, and a major part of its task will be to train the counterparts in project evaluation and planning. The team will be made up of mining, metallurgical and civil engineers, economists and financial analysts, all conversant and experienced in project evaluation. Some members of the team will, along with their counterparts be assigned to the individual mines/plants to identify projects and direct their preparation and evaluation. Projects will be evaluated on the grounds of technical, financial and commercial viability, management needs, expertise needs, infrastructure requirements, linkages with other operations and projects. Prefeasibility studies will be prepared and fed into the planning unit for project scheduling and assigning priorities. To the extent full feasibility studies can be done in-house, this will be started, otherwise terms of reference will be prepared and consultants engaged.

77. The end result of this program is to be:

(a) an operating planning function will be set up within the CODELCO Group;

(b) a definitive 5 year production and investment program will be established (not just a project list but full schedules);

(c) a development strategy for the CODELCO Group for 10 years will be developed; and

(d) a system for project evaluation will be established.

78. While major emphasis will be placed upon training counterpart personnel it is expected that even at the end of the two year consultant contract, additional assistance will be required. The financing for such assistance would come from CODELCO cash flow.

79. Development of Smelting and Refining Strategy for Chile: Chile has a severe shortage of smelting and refining capacity and requires considerable investment in these areas. There are, however, several alternative courses of action, in terms of type of smelting process, location of smelter and refinery, size of installation, and timing for investment. The objective of the study is to evaluate the possible alternatives, and develop an optimum strategy, taking into account the total sector requirements, not just of CODELCO but also of ENAMI and the private mines. Factors such as infrastructure investment needs, the use of by-product sulphuric acid, availability of operating staff, training requirements, investment needs, technical assistance needs etc. will be taken into account.

80. Obviously, this study must be fully coordinated with the planning unit discussed above. A team of four experts, working in collaboration with counterparts from CODELCO and ENAMI should be able to complete the study within 6 months.

81. El Teniente Long-Term Mining Plan: The El Teniente Mine is the largest underground mine in the world, and has over the past 50 years operated very successfully, using the block-caving mining method. However, the operations to date have been in the secondary ore zones where the ore is friable and fractures readily providing an output of more than 300 tons per grissly shift with block caving, whereas an output of only 30 tons per grissly shift can be obtained in the harder primary ore zones. This 10 fold reduction in output can have very serious ramification on the Teniente Mine, in terms of the number of blocks requiring simultaneous development (hence capital investment), number of employees, operating costs and capacity of the mine. Sufficient reserves of friable ore remain to ensure production at the existing levels for about 5 years, hence by this time a new method must be developed and ready for production. This means immediate research into alternative methods if mine production is to be maintained.

82. The objective of the technical assistance is to provide two or three mining experts with considerable experience to study alternative methods of mining El Teniente's primary ore. Such methods as sublevel caving, open stoping prefragmentation of the block caves, etc. would be reviewed. This will require longhole drilling and blasting trials, trial stope preparation, and possibly equipment trials. This study would be carried out in conjunction with a team of CODELCO engineers and production crews, and would continue through to the production stage, 5 or more years. Only the initial two years of this program are considered here as part of the technical assistance program.

83. Chuquicamata Long Term Mining Plan: The Chuquicamata pit has reached a state - advanced by the lack of adequate pit planning over the past 4 years, some improper practices, and a major slide - where it has become necessary to develop a long-term mining plan. This is necessary not only to improve pit efficiency, but also to improve recoveries. A priori, any major increase in Chile's copper output should initially come from the Chuquicamata pit, and for such it is necessary to develop careful plans. It is expected that 2 experts working in conjunction with counterparts could complete this plan within 18 months. At present the concentrator forms the bottleneck whereas the pit equipment has excess capacity which could be increased with improved scheduling and operation. Now is an opportune time for using this excess capacity for overburden removal to develop new reserves for subsequent expansions of the processing facilities. This study will be coordinated with the planning unit.

84. Specific Experts: With the loss of engineers over the past several years CODELCO faces considerable problems particularly in the mineral processing and metallurgical areas, for which it does not have the expertise to solve these problems. What is envisaged here, is for CODELCO to engage several such experts on a retainer basis, who will be on call as problems arise.

85. Reorganization of the CODELCO Group: As discussed in Annex 2-4, the present organization of CODELCO evolved rather than having been created by design. Hence, its operation as an integrated holding company is made difficult by confusion of functional and line linkages. The lines of responsibility are not clearly defined and much ambiguity and redundancy prevails. The need for head offices of each of the companies to be located in Santiago seems questionable. Their closure should be considered to strengthen the CODELCO financing, planning, production control and administration functions. A local consultant firm has been engaged to review the total corporate structure and recommend re-structuring. However, since CODELCO is now the largest copper company in the world outside the USSR, it is considered necessary to engage a team of foreign experts with considerable experience in the administration and operation of large integrated resource companies, to collaborate with those consultants, in recommending a new organizational, operational, financial and legal structure. More importantly these experts will be required to assist CODELCO senior management implement the changes. A considerable streamlining of the organization should be possible. It is expected that it would take up to 2 years to implement the major changes, but the program would by necessity continue for several years thereafter. The major barrier will be the unavailability of suitable personnel to fill some of the middle and upper middle management levels. A gap in the senior management levels will also be difficult to fill.

86. Internal Procedures: Coupled with a program for reorganization is a program for revising the internal corporate procedures. The cost accounting procedures vary between the operating units depending upon the former owners. Improvement and standardization of these procedures is required. The inventory control systems in use are generally antiquated and need considerable improvement. Coordination between the operating units can help to minimize inventory levels, improve service and thus reduce the costs of holding stocks and

reduce lost production. The collection and distribution of data is at present a piecemeal process. In many cases, there is a lack of information available to the decision makers, and the data base is often not accurate. There is very definitely a need to revamp the total information system of the CODELCO Group. New measuring devices and systems are required, standardization of data and reports is needed, and careful assessment of the flow of information and reports is needed. Coupled with this is the need to improve production and budgetary control systems. The concept of profit centers and manager accountability should very importantly be introduced. At present, there is an obvious lack of cost consciousness among the operators, and considerable scope exists for reducing costs for all operations.

87. Therefore a technical assistance program is justified. Experts are required in cost accounting, inventory control, data collection, data processing, information systems, budgetary control, production control and computer operation. The company is proceeding with the installation of electronic data processing equipment: a program that will take about 5 years to complete. The proposed technical assistance program supplements this program. Emphasis of this assistance is to be upon designing and implementing the new systems, and training the counterparts. The program is complex and could best be handled by a team under the direction of a project manager reporting to senior CODELCO management.

3. EXECUTION

88. All parts of the program will be joint efforts between foreign experts and local counterparts. Emphasis is to be placed upon implementation and training. Teams would be formed for each component, with clearly defined terms of reference, and lines of responsibility. Coordination between the teams will be very important and directed through a senior official designated by CODELCO. Coordination between the CODELCO head office and the companies and between the departments will also be crucial to the success of the program which thus has to be directed from the top.

4. SCHEDULE

89. A tentative schedule is as follows:

	Timing for Activities			
	Preparation of Terms of Reference	Selection of Consultant	Field Work	Completion of Program
Planning, Project Evaluation	May-June'76	Sept'76	Oct-76-Oct'78	Continuing
Development of Smelter Strategy	May-June'76	Sept'76	Oct'76-Mar'77	Mar'77
El Teniente Mining Plan	May-June'76	Sept'76	Oct'76-Aug'78	Continuing
Chuquicamata Mining Plan	May-June'76	Sept'76	Oct'76-May'78	May'78
Specific Experts	---------- No fixed schedule ----------			
Reorganization	May-June'76	Sept'76	Oct'76-Sept'78	Continuing
Internal Procedures	May-June'76	Sept'76	Oct'76-Sept'78	Continuing

5. COST

90. The cost of the program is estimated as follows:

	Local Currency	Foreign Currency	Total
	(US$ Million)		
a) Foreign Experts $5,800/mm)			
- Planning Project Evaluation (20 my)	-	1.39	1.39
- Smelter Strategy (2 my)	-	0.14	0.14
- Teniente Mining Plan (5 my)	-	0.35	0.35
- Chuquicamata Mine Plan (3 my)	-	0.21	0.21
- Specific Experts (4 my)	-	0.28	0.28
- Reorganization (5 my)	-	0.35	0.35
- Internal Procedures (18 my)	-	1.25	1.25
Sub-Total	-	3.97	3.97
b) Counterpart Staffing /1 $1,500/mm)			
- Planning, Project Evaluation (30 my)	0.54	-	0.54
- Smelter Strategy (2 my)	0.04	-	0.04
- Teniente Mine Plan (20 my)	0.36	-	0.36
- Chuquicamata Mine Plan (5 my)	0.09	-	0.09
- Reorganization (5 my)	0.09	-	0.09
- Internal Procedures (40 my)	0.72	-	0.72
Sub-Total	1.84	-	1.84
c) CODELCO Contribution in Kind			
- Transport, Vehicles, Facilities, Subsistence	0.35	-	0.35
d) Air Travel	0.10	-	0.10
Sub-Total	2.29	3.97	6.26
Contingencies (Local 20%, Foreign 10%)	0.43	0.41	0.84
Price Escalation (10%/Year)	0.26	0.61	0.87
Total Program Cost	2.98	4.99	7.97

/1 Most of this will be existing staff and thus not represent additional staffing cost.

91. In addition it will be necessary to purchase equipment for the Teniente Mining study, the nature and cost of which can only be determined during the study itself.

6. PROCUREMENT

92. The consultants will be recruited on an international basis, and selection made on the basis of a technical evaluation of proposals submitted. Prices would then be negotiated.

7. FINANCING PLAN

93. The technical assistance program will be financed as follows:

	Local Currency	Foreign Currency	Total
		(US$ Million)	
IBRD	-	4.99	4.99
CODELCO Funds	2.98		2.98
Total	2.98	4.99	7.97

8. BENEFITS

94. The benefits from the program are expected to be very significant. Improved planning and project evaluation will result in a better selection of projects, earlier project implementation and improved financial planning. The smelter and refinery study could result in very large savings in terms of future investment and operating costs. The Teniente mining plan has to be undertaken if the mine is to continue operating at its present level. The Chuquicamata Mining Plan is similarly a prerequisite to future operation expansion. The specific experts are expected - by assisting in eliminating processing bottlenecks and problems - to save substantial amounts in terms of lost production and production cost. Reorganization and implementation of the internal procedures should provide an enormous payoff in terms of cost savings and increased production.

95. Without a program such as this the absorptive capacity of CODELCO would restrict future expansion programs, production increases and CODELCO's ability to remain competitive.

G. TECHNICAL ASSISTANCE: PROGRAM FOR ENAMI

1. BACKGROUND

117. While the sector accounts for less than 20 percent of mineral production it provides employment for more than 10,000. Furthermore, the livelihood of a multiple of this number depends upon this sector. ENAMI has

overall responsiblity for this sector (see Annexes 2-2 and 2-4), and has in the past assisted by providing credit and technical assistance to the private miners. Also a substantial effort was directed to establishing regional concentrating plants. The two ENAMI smelters also custom treat the ores and concentrates of the private and small state mines.

2. PURPOSE

The purpose of the technical assistance program for ENAMI will be threefold:

(i) to improve present planning procedures;

(ii) to finance specific technical and economic feasibility studies; and

(iii) to assist ENAMI in diversification of its mineral production.

3. SCOPE OF ENAMI TECHNICAL PROGRAM

The proposed technical assistance program would comprise three major components:

a) Technical Assistance Directed at Improving Investment Planning and Project Preparation Procedures

ENAMI's planning department is weak and has very limited experience in carrying out project preparation and evaluation work. These deficiencies are not attributable to an exodus of professional staff or to the fact that these functions were once carried out by foreign owners--as was the case of the Gran Mineria companies--but to the lack of a good planning tradition within ENAMI since its formation. The proposed technical assistance program envisages engaging a team of consulting experts--analagous but independent to what is proposed for CODELCO in paragraphs 95-99--which would improve the present planning functions of ENAMI. A team of mining engineers, economists and financial analysts would work closely with ENAMI counterparts in identifying specific investment projects and in preparing terms of reference. The objectives of this program would be to:

a) to establish an efficient planning group within ENAMI, including a standard system for project evaluation;

b) prepare a five-year investment program for ENAMI's present and future operations;

c) collaborate with the Ministry of Mines, CODELCO and other government entities in the elaboration of a development strategy for the small and medium mining sector.

The proposed program would include training of ENAMI personnel.

b) Technical Assistance for Technical and Economic Feasibility Studies

In addition to the need to improve overall investment planning, project preparation and evaluation, financing is required to contract consulting services to examine a small number of concrete problems, some of them technical, which ENAMI is currently experiencing and which could lead to specific investment projects employing new technologies. These possibilities include:

(i) Juan Godoy Plant - the feasibility of utilizing solvent extraction techniques in the exploitation of copper oxide mineral ore. The difficulties being experienced by ENAMI in assuring a ready supply of scrap iron for the production of copper cement after prior leaching of the copper oxide minerals has focussed attention on the possibility of employing a different technological process--solvent extraction--to confront these problems arising from the world shortage and high cost of scrap iron. ENAMI has begun preliminary studies on this matter and requires technical assistance to evaluate in depth the technical and economic feasibility of installing such a plant on a small scale to produce approximately 10,000 tons per year of fine copper using the relatively new technology of solvent extraction. ENAMI would study the applicability of this process in the Juan Godoy Plant currently being constructed. A possible second stage would examine the feasibility of extending the scope of this process to other ENAMI processing plants. The total cost of the study is tentatively estimated to be US$150,000.

(ii) Use of Iron "Sponge" to Precipitate Copper from Leaching Solutions. The possibility of using iron "sponge" as a substitute for scrap iron has been given consideration. However, it has not yet been possible to study the behaviour of different kinds of iron "sponge" in the precipitation of copper cement. It is proposed to investigate the feasibility of using such a material on a pilot plant scale first before considering its possible application in an industrial-sized plant. This would be done in collaboration with CIMM.

(iii) Compaction of Copper Cement

Substantial losses of copper occur in the form of copper cement due to the physical characteristics of this product as finely pulverized dust. The objective of the study is to transform the copper precipitates into a more compact material that is both easier to handle and to transport while at the same time being economically feasible. The

technical feasibility of studies (ii) and (iii) would be carried out in collaboration with CIMM, the applied research and development center in the copper mining sector.

c) Technical Assistance Aimed at Diversidication of Chile's Mineral Production

A major element in ENAMI's future role in the mineral sector will be to encourage the exploitation of Chile's considerable, but as yet poorly defined, mineral reserves outside of copper. Recovery of significant non-copper metallic by products already takes place from ENAMI's smelting operations. Emphasis in the future will include the exploitation of:

(i) Lead and Zinc

The size and grade of Chile's lead and sinz containing mineral reserves have not been well delineated. Although IIG has been recently active in geological prospection work very little exploitation of these reserves is currently taking place (the Silva mine in Aisen accounting for 70% of national production). Considerable geological work remains to be done and foreign expertise will be required to define the real potential of these mineral reserves. Copper mineral is the principal product of Cutter's Cove mining development in the far south of Chile (present capacity 400 tons/month). Both lead and zinc are not presently recovered during the flotation process. An additional circuit is being considered for the existing plant aimed at recovery of these two metals. Foreign consulting services will be needed to collaborate in undertaking the feasibility and basic engineering work.

(ii) Gold

Chile has numerous ore deposits which contain appreciable quantities of gold-containing minerals. In the past, exploitation of these deposits has depended on rudimentary methods and it is estimated that the greater proportion of Chile's reserves remains still undeveloped. Outdated technologies and extraction methods, sketchy geological information, and the absence of water in the northern desert areas, have contributed to preventing a systematic and efficient exploitation of Chile's gold-containing mineral reserves. It is proposed to contract foreign consulting services which would endeavour to rationalize present exploitation methods as well as introduce more appropriate extraction methods (e.g., the concentration of gold-containing minerals without the use of water) and a greater degree of mechanization.

4. EXECUTION

The various components of the technical assistance program would be undertaken by teams of consultants and technical experts, the majority of which are expected to be foreign experts although some may be obtained from local consulting firms. Any pilot plant studies that need to be undertaken would be carried out in collaboration with CIMM.

5. SCHEDULE

The tentative schedule for the program is as follows:

Timing for Activities

	Preparation of Terms of Reference	Seclection of Consultant	Field Work	Completion of Program
(i) Planning, project evaluation	June-July 76	Sept. 76	Oct. 76-Oct. 77	Oct. 77
(ii) Technical-economic feasibility	June-Oct. 76	Aug-Dec 76	Nov. 76-Dec. 77	Dec. 77
(iii) Diversification of mineral production	June-Oct. 76	Nov. 76-Nov. 78	Nov. 76-Nov. 78	Nov. 78

6. COSTS

The estimated foreign exchange costs of the technical assistance program are as follows:

		(US$)
(i)	Planning systems, project evaluation (2 experts for 1 year)	130,000
(ii)	Technical/economic feasibility studies	220,000
(iii)	Diversification of mineral production	50,000
		400,000

Total costs are:

	Local Currency	Foreign Currency	Total
Foreign experts	-	300	300
Counterparts	60	-	60
Other costs	-	30	30
Subtotal	60	330	390
Contingencies (10%)	6	35	41
Price escalation (10% year)	6	35	41
Total	72	400	472

7. PROCUREMENT

The consultants and technical specialists will be recruited internationally, and selection made upon the basis of a technical evaluation of the proposlas submitted.

8. FINANCING PLAN

The study will be financed as follows:

	Local Currency	Foreign Currency	Total
IBRD	-	400	400
ENAMI funds	72	-	72
Total	72	400	472

9. BENEFITS

The benefits of the technical assistance program can be expected to considerably increase planning efficiency, improved investment program making and, in certain cases, increased production efficiency of minerals.

Industrial Projects Department
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