Technology to Produce Sulphur in Large Scale.

TRANSLATION BY:

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August 18, 1989, Santiago

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Santiago, Chile

It is our pleasure to annex the presentation of the project "**Technology to Produce Sulphur in Great Scale**" at the thirteenth competition of the FDP.

Attentively

Wilda Gomez A.
Chemical and Metallurgic Area.

FOMENTO OF THE PRODUCTION CORPORATION
CHILE

Mr. Harold Gardner
Minexco Ltda.
Rancagua 0157-suite508
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We comunicate to you that "Of the fund for the production development"(CFDP) has chosen the project named: TECHNOLOGYS TO PRODUCE SULPHUR IN LARGE SCALE,to receive the request subsidy. In view of the date and because the formalization of the project depends on a speedy compliance with the execution agreements of the CORFO; we request that you see the executive secretary to transact this operation.

It be will necessary that the sponsor present the LEGAL BACKGROUND for a title search, so that CORFO may formalize the execution agreements, as preliminary information we require general basic information, also, it must introduce the reference terms elaborated from the original study, containig the points indicated in the instruction annex.

Since CFDP gave early delivery of the total approved subsidy, we do emphasis the obligation to provide guarantees for such resources which will be liberated partially in agreement with the advance reports. The sponsor may choose any of the following documents as a guarantee: a) Certificate of on Endorsable Deposit, b) Letter of Credit from a Banking Institution, c) Guarantee Policy; the favored document is a.

Attentively

Tomas Vial Vial
Executive Secretary
CFDP

CFDP
CHILE

DOCUMENTATION OF PROJECT FUNDS FOR THE PRODUCTIVE DEVELOPMENT

PROJECT _____ AREA _____ (uso interno)

1.- REGION ____
2.- TITLE *TECHNOLOGYS FOR THE PRODUCTION OF SULPHUR IN LARGE SCALE.*
3.- FINANCING (values in pesos).

TOTAL COST AND FINANCING OF THE PROJECT	CONTRIBUTION OF CFDP (a)	CONTRIBUTION RESOURCE FINANCIAL (b1)	CONTRIBUTION VALUE OF OTHERS CONT (b2)	TOTAL COST (a+b1+b2)
3.1 Research Personnal	1907500	1351600	300000	3559100
3.2 Support Personnal	1251000	834000	100000	2185000
3.3 Spending in services, Materials and others.	1325600	1014400	600000	2940000
3.4 Capital Goods	315900		300000	615900
TOTAL	4800000	3200000	1300000	93000000

4.- DURATION OF THE PROJECT(months) 10
5.- DEDICATION RESEARCH PERSONNAL 10000 Horas
6.- DEDICATION SUPPORT PERSONNAL 2100 Horas
7.- SPONSOR *SOCIETY COMERCIAL MINERAL MINEXCO LIMITED*
ADDRESS: *RANCAGUA 0157-508*
CITY: *SANTIAGO*

8.- RESPONSIBLE PARTY: *MR. HAROLD GARDNER*
ADDRESS : *RANCAGUA 0157-08*
CITY : *SANTIAGO*
PHONE : *2221188*

9.- EXECUTOR: *INTEC-CHILE*

10.- CHIEF'S PROJECT: *LUIS VIRGILIO*
PHONE : *2282083*

11.- SYNTHESIS OF THE PROJECT. (No more 290 characters)
IT IS PLANED TO EVALUATE THE FEASIBILITY OF ADAPTING AND TRANSFERRING TECHNOLOGY IN RELATION TO THE PROCESS OF CONTINOUS PURIFICATION. ALSO PLANED IS AN ALTERNATIVE FOR INCREASING THE EFFICIENCY OF THE PROCESS TO EXTRACTING FROM SULPHUR CALICHES, THAT ALLOWS PROFITABLE DEVELOPMENT OF THE RESOURCES IN EXISTENCE AND DEVELOPMENT OF THE NATIONAL SULPHER INDUSTRY.

12.- NAME AND SIGNATURE OF THE SPONSOR OR HIS AGENT.

_____
SIGNATURE

1.- SUMMARY

The National Sulpher Industry has had a litle development due mainly to the lack of proper Technology, not allowing the profitable exploitation of abundant caliches resources (30-40 sulphur percent in the mountan ranges). The climate and geographical conditions under which the sulphur will be exploitated cause the high cost of these operations. This last aspect is a factor of great importance in implementing this task on a large sacale; based on an efficient process that permits the sulphur production to be refined at competitive costs.

The study proposes to analyse the main operations associated with the process of extracting the sulphur in the caliches. It will also verify the feasibility and profitability of said resources; by implementing this task in a large scale of production (500 000 tons/year of refined sulphur).

Such alternatives are based on the adaptation and development technologies transference in other countries; mainly in relation to systems of continous fusion and refining concentrated sulphur; by methods of flotation using concentrated stages and of preconcentration caliche from 30-32 percent and 5-10 percent of sulphur respectively.

The adaption and transfer of suchs technologies to benefit chilean sulphur caliches would allow:

- To incerase productivity from methods which are in operation.

- To implement an alternative technology adequate for refining sulphur commercially and competitivly with a consequent increase in the National Economical Activity mainly orientated at exportations.

The central objective of the study is to verify the feasibility to adapt technological developments present that permit the cost effective exploitation of sulphuric caliches .

The methodology used will include a Chemical Physical characterization stage from samples representative of 30-32 percent and 5 10 percent

sulphur and experimented of comminution's flotation and fusion with the purpose of getting the background that will define the operational conditions that will apply in the second stage.

The alternivate technology proposed distinguished by the results obtained during the achivement of the study will be the base of the preliminary characteristics and will determine the projections and limitations of the project.

The economical evaluation corresponding to the implementation of a process of 8500 tons/day of caliche capacity from 30 percent sulphur and 75 percent metallurgic retrieval in the third chapter of this presentation.

THE ECONOMICS PARAMETER CORRESPONDING TO SAID EVALUATION ARE:

	PRIVATE EVALUATION	SOCIAL EVALUATION
VAN (US$)	16 071 000	105 618 700
TIR (percent)	27	37

The impact that it will have in the economic Industrial sector at a national level; and the implementation of the alternative technology proposed is based on the following considerations:

- The existence of large reserves of caliche between 30-50 percent sulphur estimated at 100 000 millon tons approximately which can extend the benefit of the project.

- Expectation from the international market based on the local characteristics of the sulphuric acid market, that leave important places for the commercialization of refined sulphur, is important to indicate, that the international transaction of sulphuric acid represents a small percent of the world's consumption.

2.- PROJECT'S DESCRIPTION.-

2.1 General explaination of the problem

Chile holds important reserves of sulphur caliche. However, the Geographical location of said reserves on the high ranges is a factor that has influenced significantly the scarce development of the National Sulphur Industry.

The refined sulphur production in Chile had been fluctuating because the prices of this product and the lack of new technology that will permit the cost effective extraction of sulphur from caliche.

The existing processing plants are inefficient and of limited capacity restricting the supply of refined sulphur to the internal market.

On the other hand because sulphuric acid is the form most often used it is necessary to emphasize that the commercialization of the sulphuric acid produced from fusion vapors, is complicated because of the requirements of installations and special ponds for transportation and storage. In this way the international market of sulphuric acid is characterized by being local, with captive productions and consumption, thus leaving important spaces for the commercialization of sulphur.

To achieve the development of the National Sulphur Industry it requires the implementation of new processes of greater capacity and efficiency that allow us to face the competitive conditions of the growing demand of sulphur that is projected in the next years.

Such process relating to continuing flotation and purification of sulphuric caliche are made up of different individual operations such as comminution and flotation. These are of vital importance since they represent a high percent of the global costs of the investment (about seventy percent).

As to the purification stage we create the application of processes based on the use of pressurized heated ponds combined with pressurized filtration or purification in a cross-current with pressurized water.

Of the different aspects shown a valid alternative, from the Technical and economic stand point is the development of processes of greater efficiency and capacity based on the combination of different individual operations that will create new expectations for the development of the National Sulphur Industry.

2.2. Objectives

The central objective of the study is to determine the feasibility of introducing improvements in the efficiency of the extraction process of the sulphur caliche by adapting technology that allows the development of a process of greater capacity.

The advantages derived from the application of the flotation process of low grade sulphur caliche in combination with continous purification processes that allows a substantial increase of the production levels of refined sulphur.

2.3 Work Plan

The work plan elaborated for the execution of the proposed study includes a first stage of chemical and low grade (30-32 percent and 5-10 percent, respectively), so as to obtain the necessay background to define the conditions of the different tests of flotation and purification at the semipilot level in the second part of the study.

The results obtained in the second part will be the basis for the preliminary design of a treatment plant with a predefined capacity with the corresponding selection of equipment.

A preliminary economic evaluation will permit the establishment of characteristics and projections of the technological alternatives that will be the results of this study.

2.3.1 Obtain Samples

The sponsor and INTEC-CHILE will determine the method of obtaining representatives samples of sulphur of differents contents (high and low grade) extracted from the deposit.

2.3.2 Background Summary

a) Bibliographic search. A bibliographic search will be conducted based on periodic publications relating to technological information and/or market and commercial productions.

b) Analysis of the present situation of the National Sulphur Industry. It includes the revision of technical information elaborated for different National Institutions, in order to evaluate the present situation of the National Sulphur Industry and its perspective developments.

c) Visit to differnt sulphur refinig plants.

2.3.3 Experimental Development at the Laboratory scale

The experimental development plan to obtain the proposed objectives in this study is based on the following stage:

- Chemical and physical characterization of samples. Include Chemical analisys of lead samples of head in relation to contents of sulphur and impurities. Granulometric analysis and sulphur liberations curves.

- Comminution samples. The results of the chemical and physical characterization will effect the studies of grinding and milling necessary to obtain the background that allow the adequate design in the comminution stage.

- Flotation studies at the laboratory level with the goal in mind to define the operational conditions and the feasibility to apply said technical in the processing of the following materials:

i) Caliche flotation of 30-32 percent sulphur that will obtain concentrations of 85-90 percent sulphur suitable for their subsecuent fusion and refinement.

ii) Caliche flotation of low grade (5-10 percent sulphur) is one stage of preconcentration used for the concentraton of these materials at levels of 30-32 percent sulphur.

iii) Flotation of wastes derived from the sulphur concentrated fusion. The characterization of the flotation concentrates in auto clave of the fusion sage to the coalition phenomenon and the elimination of impurities.

2.3.4 Semipilot tests

They will effect the next tests under predefined conditions in the laboratory stage.

- Semipilot tests of comminution. The evaluatation of a conventional process of grinding is being considered.

- Continous flotation at the semipilot level in order to obtain scaling critera and verification of the efficency of prototype cells adapted for the sulphur caliche flotation.

- Tests of continous fusion orientated at determining the main operational parameters and to obtain the necessary background to make estimates, of investment and operational costs.

- Refining tests in which the pressurized filtrationing of sulphur is fused and concentrated and washed in a continous process in order to prove industrial filter prototypes and to obtain technical and economical data of this operation.

2.3.5 Advance Report

The results of the differnt tests preformed will be reported as well as the main conclusions.

2.3.6 Preliminary design of the proposed process

Based on the results obtained in the first stage the preliminary design of one plant of a determined capacity, with the corresponding metallurgical and materials balance, will begin. It will contain a description of the main characteristics of design and operation of the equipment considered.

2.3.7 Economic Preliminary Evaluation

The proposed process will be the basis of a preliminary economic evaluation (calculation of economic indicators).

2.3.8 Final Report

The results and analysis will be discussed in relation to the proposed technological alternative.

2.4 Background and bibliography

Chile has abundant sulphur resources that are one potential source of income.

However, the sulphur production of Chile is low and variable compared to the conditions of the market. It has not reached the internal demand. In 1987 the sulphur production was 37 048 ton (4).

Chile consumes around 120 000 ton annually of refined sulphur, mainly for the production of sulphuric acid; Importation is approximately 50 percent the internal demand (1).

The production of sulphuric acid starting from the fusing gases does not seem to be least in the short term, a competitive substitute for the refined sulphur. This is due to the characteristic of the local market and the requirements of specialized installations for the storage and transportation of this.

In the sulphur refinement production the commonly used technology has been the Direct fusion of caliches with 50 percent or more primary sulphur, extracted selectively from the deposits.

The direct fusion in fixed retorts or in autoclave with pressurized water vapor have brought about products with 98 percent purity but with low recoverys and high costs.

For caliches of low grade, flotation has been used as a concentration stage to obtain 85 percent sulphur, which must later be refined.

The chilean autoclave brought about products of 99 percent purity but with recuperations of 40-50 percent because of Mechanical conditions from operation of the autoclave.

The development from a Japanese autoclave for a concentration process of flotation of 65-75 percent sulphur improved noticably the efficiently of the treatment process.

Said equipment allowed recuperations in the order of 80 percent with a product of high grade similar to those obtained in chilean autoclave.

But such technologies have a low capacity. This factor works negatively on the economics efficiency because of the high fixed costs of the production relation to the geographic location of the deposit.

As an alternative to these limitations fusion and the continous process of refinement from concentration have been studied such is the case of the batelle process implemented at the pilot scale to study the caliche sulphur process of the purico deposit (1) (3).

Said process is based on the following stages:

1).- Sulphur fusion in pulp form (50 percent solids) in a furnace type oven in which the pulp circulates at a certain pressure and heated externally with water vapour.

2).- The fused sulphur and the suspended gangue is pumped to a column of purification of 20' high and 8" of diameter heated externally with vapor.

3).- The fused sulphur enters at the upper part of the column from where it is circulated in a crosscurrent of hot, pressured water injected at the bottom part of the column. The hot water crosses the funded mass of sulphur by way of perforated plates that old the fused sulphur in its descent.

The gangue enters in liquid form and is carried away towards the upper part of the column where it is discharged.

The fused sulphur descends and is discharged from the bottom part of the column. Resulting in a product of 99.9 percent sulphur.

The column is similar to a distillation column, but in this case the heating is external in order to mantain a 130 centigrade degree.

This process was tested in a pilot plant at a rate of 25 ton/day from caliches with 50 percent sulphur and a production of 9 ton/day of purified sulphur. Tests have also been performed on hidrometalurgic process but these have not proceded because of problems in the costs and operations.

However, sucess has been seen using calcium chloride of low cost as it is a by product of the sodium-chloride industry in the eighth region near chillian. (1)

It is based on the process of 85 percent sulphur concentrates, thickened and mixied with a concentrated solution of more than 30 percent calcium chloride at 120-130 centigrade degree.

It maintains said temperture for 5-10 minutes in agitation and afterwards is emptied in a deposit or conduit with water at temperature.

The separation of sulphur from the gangue is done with AKINSS or DORR classifies.

Important advances have been made in the flotation process in conventional cells (3) and column types, which used in combination with a continous purification process result in greater capacity of treatment of caliche with a low content of sulphur.

BIBLIOGRAPHY.-

1).- Research of Sources of Sulphur as the Industry Raw Material.
CIMM, June 1987.

2).- Mineral Facts and Problems
1985 Edition

3).- Evaluation of the Batelle Process and Continous Refining
INTEC-CHILE, 1977

4).- Abridgement of the Chilean Mining
1987-1988

3.- JUSTIFICATION OF THE STUDY

The justification of the study is based on the economic analysis of the potential impact derived from the technological innovations proposed.

The study analyse the estimation of the net development (V.A.N) and internal rate of return (T.I.R) of the investment created for the implementation of a treatment process 8 500 ton/day caliches of 30 percent grade, which includes mine extraction stages size reduction, flotation, fusion and refinement. Fig. 3.1

The values of the metallurgic parameters were estimated based at analysis of the technical background obtained from different sources of the sponsor.

The Investment and operational costs were calculated in accordance to the background that are indicate following. Table 3.1

TABLE 3.1.- PARAMETERS OF ECONOMIC EVALUATION

PARAMETERS	REFERENCE VALUE	
Treatment Capacity	2 295 000	ton/year
Production Program	8 500	ton/day; 9 month/year
Medium Grade Sulphur	30	percent
Production of Refined Sulphur	540 000	
Grade of Refined Sulphur	95.5	percent
Global Metallurgic Recuperation	75.0	percent
Price of Refined Sulphur	100	US$/Tton
Investments	83 224 000	(US$)
Global Operation Cost	11.4	US$/ton
Discont Rate-Private	20	percent
Discont Rate-Public	10	percent
Public Price Holdings	13	percent above the value of the central Bank exchange rate.

FIGURE 3.1
SIMPLIFICATION OF THE PROPOSED PROCESS

EXTRACTION MINE

GRINDING PLANT

CAPACITY	:	8500.0 TON/DAY
GRADE OF S.	:	30.0 PERCENT
MET. REC.	:	100.0 PERCENT

GRINDING PLANT

MILLING PLANT

CAPACITY	:	9528.0 TON/DAY
GRADE OF S.	:	32.0 PERCENT
MET. REC.	:	120.0 PERCENT

FLOTATION PLANT

FLOTATION REJECTIONS

CAPACITY	:	3028.0 TON/DAY
GRADE OF S.	:	9.8 PERCENT
MET. REC.	:	25.0 PERCENT

FUSION-REFINE

CAPACITY	:	3028.0 TON/DAY
GRADE OF S.	:	80.0 PERCENT
MET. REC.	:	95.0 PERCENT

FUSION-REFINE PLANT

PRODUCTION OF REFINED SULPHUR

CAPACITY	:	2000.0 TON/DAY
GRADE OF S.	:	95.5 PERCENT
MET. REC.	:	75.0 PERCENT

FUSION DEBRIS

CAPACITY	:	1028 TON/DAY
GRADE OF S.	:	50 PERCENT
MET. REC.	:	20 PERCENT

3.1 Economic Evaluation

The investment calculation, operation cost and necessary income to elaborate the cash flow corresponding to the Economic Evaluation has been based on the following points:

3.1.1. Investments US$ 83 224 000

The total cost of the project has been calculated considering the following tems:

- Fixed Investments of the mine US$ 17 950 000

It includes the main equipment and necessary machinery for the extraction (perforation equipment, trucks, buldozers and other minor equipment); construction of road and annexed instalations (fine gunpowder and camp). Table 3.2

- Fixed Investment Plant US$ 45 168 000

The estimated value includes the main equipment for one grinding, milling, flotation fusion and refining with their respective costs and assembly. Table 3.3

- Preinvestment studies US$ 11 385 000

The cost of preinvestment studies related with the mine considers the spending in the preparation, development and engineering before the exploitation. These equal 9 months of mine operation costs, in the order of 3 US$/ton. (US$6 885 000)

The preinvestment studies of the plant project include principally the engineering cost, which is estimated at US$ 4 500 000 equal approximately to 10 percent of the value of the fixed investment.

- Work Capital US$ 8 721 000

The Work Capital caculated is equal to 3 months of the total mine and plant operation costs estimated at 11.4 US$/ton extracted.

- Residual Value US$ 1 727 000

It is estimated that the Residual Value be equal to 5 percent of the valueof the main mining plant equipment.

3.1.2 Income

The Income is estimated at an annual production of 1 540 000 tons of refined sulphur with a FOB value of 100 US$/ton placed in a port.

3.1.3 Expenses

The annual Expenses are estimated on a global cost of a mine-plant operation of 11.4 US$/ton extracted which includes expenses for administrative concepts, commercialitation and sales. Table 3.4

TABLE 3.4 ESTIMATES OF OPERATIONALS EXPENSES.

ITEM	COST FACTORS	COST(US$/TON)
Extraction	- Perforation (petroleum,lubricant steels and accessories)	0.4
	- Blasting (accessories and explosives)	0.5
	- Loading and transportation (petro - leum,lubricant, accessories and spa- re parts for maintenance)	0.7
	- Salaries (manpower salaries with an average cost of 700 US$/month for 150 people in production jobs and support personnal)	0.4
	- General spending (includes camp maintenance administration and miscellaneous.	1.0
	SUBTOTAL MINING	3.0
Transport Mine-Plant	- Distance 7Km (transport cost 0.03 US$/ton-Km	0.2
Flotation-Plant	- Milling drinding (energy,maintenance and steels)	1.2
	- Flotation (water, maintenance, reagents)	2.2
	- Salaries (manpower salaries with an average cost of 700US$/month of the 40 people)	0.1
	- General expenses (includes camp, maintenance, administration and miscelaneous)	0.5
	SUBTOTAL FLOTATION PLANT	4.0
	- Fusion Refinement (fuels, electric energy and maintenance)	1.9
	- Salary (manpower-salary of 700US$/month average and 40 people in productives job and support per- sonnel)	0.1
	- General expenses (include adminis- trative expending, camp maintenance and miscelaneous)	0.5
	SUBTOTAL FUSION-REFINEMENT PLANT	2.5

Sales and commrcialization.	- Transportation of refined sulphur to port (transport cost 0.02 US$ /ton km; distance 120 km).	0.6
	- Shipment (shipment and storeroom commission and rights).	0.8
	- Administratives costs and miscellaneus.	0.3
	SUBTOTAL SALES AND COMMERCIALIZATION.	1.7
	TOTAL OPERATIONS COST.	11.4

TABLE 3.2 EQUIPMENT VALUATION AND MAIN INSTALATION OF MINE

	I T E M	VALUE (US$)
6	Perforation Equipment	520 000
15	Trucks of 40-50 ton	5 000 000
6	Frontals carriers 4-5 Yd	2 700 000
2	Bulldozers	1 000 000
	Minor vehicles	200 000
	Compressors	450 000
	Construction and camp entlitement	225 000
	Road constructions	600 000
	Fine gunpowder	68 000
	Unexpected (40 percent total cost)	7 187 000
	TOTAL	17 950 000

TABLE 3.3 EQUIPMENT VALUATION AND MAIN INSTALLATION OF PLANT.

I T E M	VALUE (US$)
Chancado-Milling Plant	
- Main Equipment(grinders, mill)	5 830 000
- Minor Equipments (classifier, straps, bombs), (20 percent of the value of main equipment)	1 166 000
- Civil works and equipment assembly (20 percent value equipment)	1 400 000
TOTAL GRINDING-MILLING PLANT	6 396 000
Flotation Plant	
- Flotation cells	8 600 000
- Bombs conditioner, agitator. (20 percent value flotation cells).	1 720 000
- Civil works and equipment assembly (20 percent value equipments)	2 064 000
- Others (Filters) (include assembly)	2 000 000
TOTAL FLOTATION PLANT	14 384 000
Fusion-Refinement Plant	
- Main equipment (fusion, purification, bolier,etc)	7 365 000
- Civil works and equipment assembly (20 percent value of equipments)	1 473 000
TOTAL FUSION-REFINE PLANT	8 838 000
SUBTOTAL PLANT	31 618 000
UNEXPECTED (30 percent investment total)	13 550 000
	45 168 000

3.2 PRIVATE EVALUATION ECONOMICAL

3.2.1 Cashflow

ITEM/PERIOD	YEAR 0	1	2	3	4	5	6	7	8	9	10
FIXED INV. MINE		17 950 000									
FIXED INV. PLANT		45 168 000									
PREINVESIMENT SID	11 385 000										
WORK CAPITAL		8 721 000									-8 721 000
											-1 727 000
TOTAL INVESIMENT	11 385 000	71 839 000									-10 448 000
TOTAL INCOME			54 000 000	54 000 000	54 000 000	54 000 000	54 000 000	54 000 000	54 000000	54 000 000	54 000 000
OPERATIONALS EXPENDITURES			26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000
DEPRECIATION			5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000		
TOTAL EXPENDITURES			31 163 000	31 163 000	31 163 000	31 163 000	31 163 000	31 163 000	31 163 000	26 163 000	26 163 000
DUTY (10 percent Profit)			2 283 700	2 283 700	2 283 700	2 283 700	2 283 700	2 283 700	2 283 700	2 783 700	2 783 700
ANNUAL CASHFLOW	-11 385 000	-71 839 000	25 553 300	25 553 300	25 553 300	25 553 300	25 553 300	25 553 300	25 553 300	25 053 000	35 501 300

3.2.2 PARAMETERS OF ECONOMICAL PAYABLE

The values of the actual net developments and internal rate of return of the private evaluation are:

V.A.N (20 percent) : US$ 16 071 000
V.A.N (15 percent) : US$ 34 489 000
T.I.R : 27 percent.

3.3 PUBLIC ECONOMICAL EVALUATION

3.3.1 Cashflow

ITEM/PERIOD	YEAR 0	1	2	3	4	5	6	7	8	9	10
FIXED INV. MINE		19 970 000									
FIXED INV. PLANT		47 200 000									
ESTIMATED PREINV.	11 385 000	8 721 000									
WORK CAPITAL											- 8 721 000
RESIDUAL VALUE											-1 727 000
TOTAL INVESTMENTS	11 385 000	76 621 000									-10 448 000
TOTAL INCOME			61 020 000	61 020 000	61 020 000	61 020 000	61 020 000	61 020 000	61 020 000	61 020 000	61 020 000
TOTAL EXPENDITURES			26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000	26 163 000
ANNUAL CASHFLOW	-11 385 000	-75 621 000	34 857 000	34 857 000	34 857 000	34 857 000	34 857 000	34 857 000	34 857 000	34 857 000	43 305 000

3.3.2 PARAMETERS OF ECONOMICALS PAYABLES

The values of the actual net developments and internal rate of return of the social evaluation are:

V.A.N. (10 percent) : US$ 105 618 700
T.I.R. : 37 percent

4.- SCHEDULE OF ACTIVITIES

The description of the stage and activities of the project are in the table 4.1

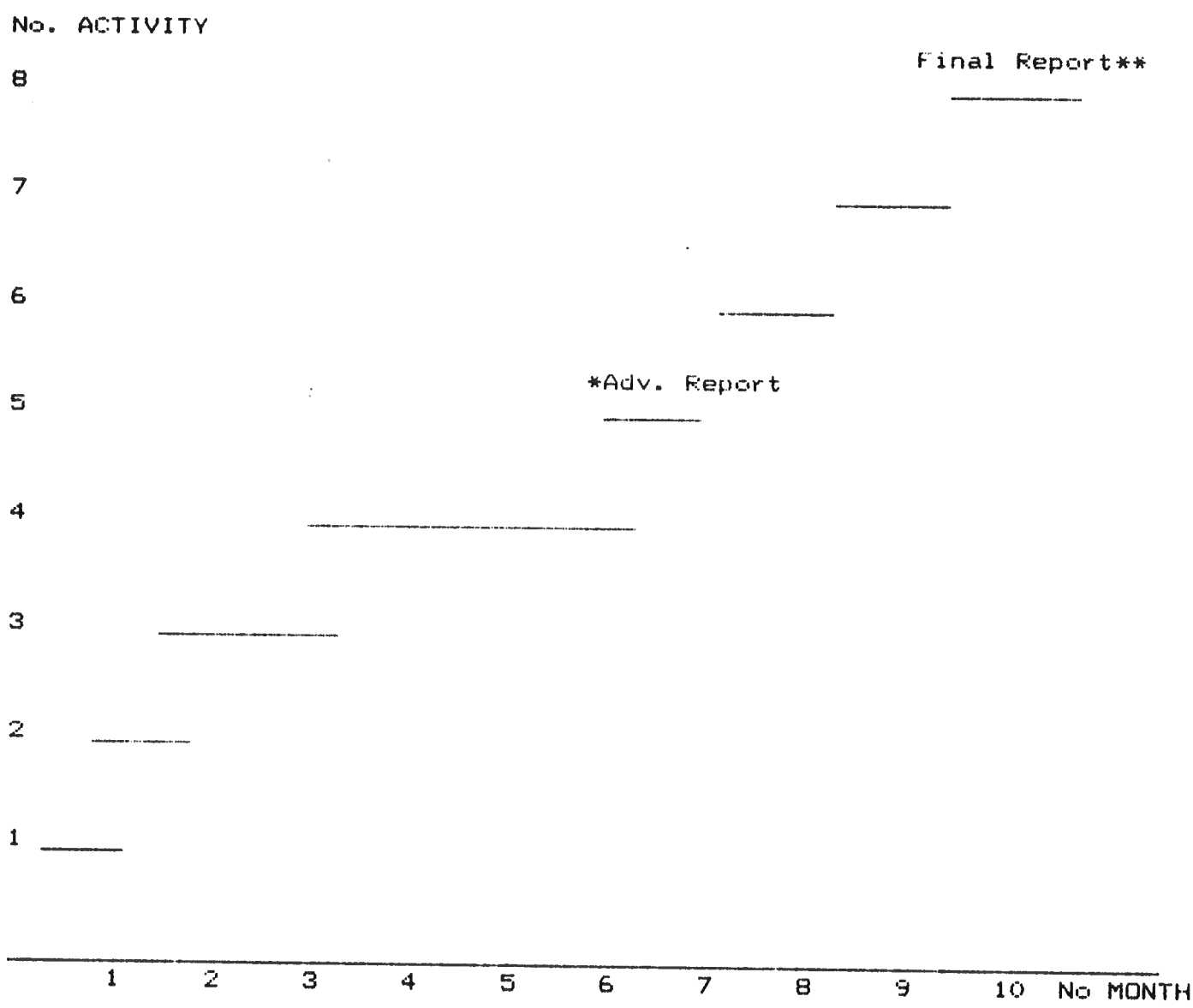
The sequence of activities is indicated in the annex Gantt Letter.

TABLE 4.1 SCHEDULE OF ACTIVITIES.

No. ACT.	DURATION (WEEKS)	GOALS	ACTIVITIES
1	4	Obtain Samples	- Visit terrain - Definition of Master System - Definition of Samples sizes - Reception, Identification, and Preparation of Supplies.
2	4	Background Summary	- Bibliographic Search - Analisys Technical Background - Visit Terrain
3	8	Laboratory Test	- Chemical and Physical Characterization - Cyanide Test - Flotation Test - Fusion Test
4	12	Semipilot Test	- Conminution Test - Flotation Test - Continous Fusion Test - Refinement Test
5	4	Report Elaboration	- Analysis of Results obtained in characterization stage and Laboratory test. - Alternative Definition to implement at semipilot scale.
6	4	Preliminary design Process	- Results and Background Analysis. - Flow Chart definition - Materials and Metallurgic balance. - Selection of Equipments.

7	4	Economical Evaluation	Cost Estimate of: - Investment and Operation - Calculation Parameter VAN, TIR - Sensitivity Analysis in regard to principal variables - Market Profile
8	4	Last Report	- Analysis and presentation of results obtained in differents tests. - Economicals Projection Analysis of proposed process and conclusions.

G A N T T L E T T E R



Distributions of Contributions

* CORFO	$ 4 170 000
Sponsor	$ 2 780 000
Total first stage	$ 6 950 000
** CORFO	$ 630 000
Sponsor	$ 420 000
Total second stage	$ 1 050 000
TOTAL CORFO	$ 4 800 000
TOTAL SPONSOR	$ 3 200 000
TOTAL	$ 8 000 000

TABLE 4.1 : SUMMARY OF THE F.D.P PROJECT EXECUTION AND ORIGEN OF ITS FINANCING.
(NUMBERS EXPRESED IN PESOS)

	ANNUAL COST OF EXECUTION			TOTAL	FINANCING		
						SPONSOR PAYMENTS	
	1 year	2 year	3 year		PAYMENTS FDP	FINANCIAL RESOURCES	VALUE OF OTHER RESOUR.
OF RESEARCH	3 559 100	-	-	559 100	1 907 500	1 351 600	300 000
	3 451 600	-	-	3 451 600	1 800 000	1 351 600	300 000
G EXPENSES	107 500	-	-		107 500	-	-
PERSONNEL SUPPORT	2 185 000	-	-	2 185 000	1 251 000	834 000	100 000
	2 185 000	-	-	2 185 000	1 251 000	834 000	100 000
G EXPENSES	-	-	-	-	-	-	-
SERVICES EXPENSES	2 940 000	-	-	2 940 000	1 325 600	1 014 400	600 000
Y ANALYSIS	360 000	-	-	360 000	360 000	-	-
ON SERVICES	-	-	-	-	-	-	-
ATION	300 000	-	-	300 000	-	-	300 000
	1 685 000	-	-	1 685 000	891 000	594 000	200 000
	595 000	-	-	595 000	74 600	420 400	100 000
OF CAPITAL GOODS	615 900	-	-	615 900	315 900	-	300 000
AND EQUIPMENT	300 000	-	-	300 000	-	-	300 000
	315 900	-	-	315 900	315 900	-	-
	9 300 000	-	-	9 300 000	4 800 000	3 200 000	1 300 000

TABLE 4.2 : DISTRIBUTION OF PERSONNAL SERVICE COST

ACTIVITIES	PAYMENTS FROM DEVELOPMENT FUND $			PAYMENTS FROM SPONSOR $			TOTAL CONTRIBUTION ($)
	COST LABOUR INVESTIGATOR INTEC	COST LABOUR PERS-SUPPORT INTEC	SUB-TOTAL	COST LABOUR INVESTIGATOR INTEC	COST LABOUR PERS-SUPPORT INTEC	SUB-TOTAL	
Obtaining samples	212 000	-	212 000	149 000	-	149 000	361 000
Background compiling	165 000	-	165 000	116 000	-	116 000	281 000
Laboratory tests	458 000	419 000	875 000	322 000	283 000	605 000	1 480 000
Semipilot tests	478 000	834 000	1 312 000	336 000	566 000	902 000	2 214 000
Advanced report	180 000	-	180 000	127 000	-	127 000	307 000
SUB-TOTAL FIRST STAGE	1 493 000	1 251 000	2 744 000	1 050 000	849 000	1 899 000	4 643 000
Preliminary design process	192 000	-	142 000	98 000	-	98 000	240 000
Economic evaluation	90 000	-	90 000	62 000	-	62 000	152 000
Final report	182 500	-	182 500	126 600	-	126 600	309 100
SUB-TOTAL SECOND STAGE	414 500	-	414 500	286 600	-	286 600	701 100
T O T A L	1 907 500	1 251 000	3 158 500	1 351 600	834 000	2 185 600	5 344 100

4.3 : DISTRIBUTION OF SERVICES COST AND OTHERS.

CTIVITY NO.	ACTIVITY	DEVELOPMENT FUND ($)				PAYMENTS FROM SPONSOR ($)				CONTRIBUTION ($)
		CHEMICAL ANALYSIS	MATERIALS	EQUIPMENT	S-TOTAL	CHEMICAL ANALYSIS	MATERIALS	EQUIPMENT	S-TOTAL	
1	Obtaining Samples	-	-	-	-	-	-	-	-	-
2	Background Compiling	-	56 000	13 000	69 000	-	37 300	21 200	58 500	128 500
3	Laboratory tests	141 000	500 000	71 000	712 600	-	334 000	117 000	451 000	1 149 600
4	Semipilot test	219 000	334 400	78 000	631 400	-	222 900	127 600	350 300	987 700
5	Advanced Report	-	-	13 000	13 000	-	-	21 200	21 200	41 200
	SUB- TOTAL FIST STAGE	360 000	891 000	175 000	1426000	-	594 000	287 000	881 000	2 307 000
6	Preliminary design process	-	-	108 000	108 000	-	-	67 000	67 000	187 500
7	Economic Evaluation	-	-	54 500	54 500	-	-	33 200	33 200	98 200
8	Final Report	-	-	53 000	53 000	-	-	33 200	33 200	63 200
	SUB- TOTAL SECOND STAGE	-	-	215 500	215 500	-	-	133 400	133 400	348 900
	TOTAL	360 000	891 000	390 500	1641500	-	594 400	420 400	1014 400	2 655 900

: SUMMARY OF THE F.D.P PROJECT EXECUTION AND ORIGEN OF ITS FINANCING.

(NUMBERS EXPRESED IN PESOS)

	ANNUAL COST OF EXECUTION			TOTAL	FINANCING		
						SPONSOR PAYMENTS	
	1 year	2 year	3 year		PAYMENTS FDP	FINANCIAL RESOURCES	VALUE OF OTHER RESOUR
.- SUBTOTAL OF RESEARCH	3 559 100	-	-	559 100	1 907 500	1 351 600	300 000
.1 PAYMENTS	3 451 600	-	-	3 451 600	1 800 000	1 351 600	300 000
.2 TRAVELLING EXPENSES	107 500	-	-		107 500	-	-
.- SUBTOTAL PERSONNEL SUPPORT	2 185 000	-	-	2 185 000	1 251 000	834 000	100 000
.1 PAYMENTS	2 185 000	-	-	2 185 000	1 251 000	834 000	100 000
.2 TRAVELLING EXPENSES	-	-	-	-	-	-	-
.- SUBTOTAL SERVICES EXPENSES	2 940 000	-	-	2 940 000	1 325 600	1 014 400	600 000
.1 LABORATORY ANALYSIS	360 000	-	-	360 000	360 000	-	-
.2 COMPUTATION SERVICES	-	-	-	-	-	-	-
.3 TRANSPORTATION	300 000	-	-	300 000	-	-	300 000
.4 MATERIALS	1 685 000	-	-	1 685 000	891 000	594 000	200 000
.5 OTHERS	595 000	-	-	595 000	74 600	420 400	100 000
.- SUBTOTAL OF CAPITAL GOODS	615 900	-	-	615 900	315 900	-	300 000
.1 MACHINERY AND EQUIPMENT	300 000	-	-	300 000	-	-	300 000
.2 OTHERS	315 900	-	-	315 900	315 900	-	-
.- TOTAL $	9 300 000	-	-	9 300 000	4 800 000	3 200 000	1 300 000

5.-PROJECT COST

The total value of the study is $ 9 300 000 considering a financing of 51.6 percent from productive development fund.

The breakdown of funds for the project is in the annex chart.

6.- BACKGROUND OF THE SPONSOR

The commercial mining society MINEXCO LTDA is a private enterprize devoted to activities of exploitation and exploration of mining deposits, especially sulphur.

Said enterprize (Mineral Exploration Corporation of the Americas, of USA) initiated its activities in Chile in 1987.

Now, MINEXCO is carrying out the feasibility study of a project of investment for the explotation of reserves from sulphur caliche in the sector Piedra Parada in the Third Rigion.

The General Manager of said enterprise is Mr. Fernando Zavala Araya. Mr Harold W. Gardner, whose curriculum is annex. Will act as Technical Coordinator.

7.- BACKGROUND OF THE EXECUTOR

The project presented will be performed by INTEC-CHILE, institute dependent on the CFDP, whose executive director is Mr. Bartolome W. Dezerega.

Said institute has the experience and the necessary infrastructure and development of the proposed study.

In this matter, it is important to emphasize the participation of INTEC-CHILE in the project development for BATELLE-CORFO at the pilot scale in Arica City in 1977.

Also in last period INTEC-CHILE has developmed different study of extraction processes from sulphur caliches for private enterprise, specially in reference to a flotation process.

The supervisor of the project will be Mr. Carlos Molina V. Civil Metallurgic Engineer of the University of Chile and head of the Chemical Industry and extractive metallurgy of INTEC-CHILE.

The equipment will be integrated by the investigators of the area, Mr. Luis Virgilio, Industrial Engineer of Mining of the Technical University of the State; Mrs. Wilda Gomez and Miss. Carla Thumm both Civil Mining Engineer of the Chile University. Mr. Luis Virgilio will be the head the project, included is the curriculum of the aforementioned work equipment.