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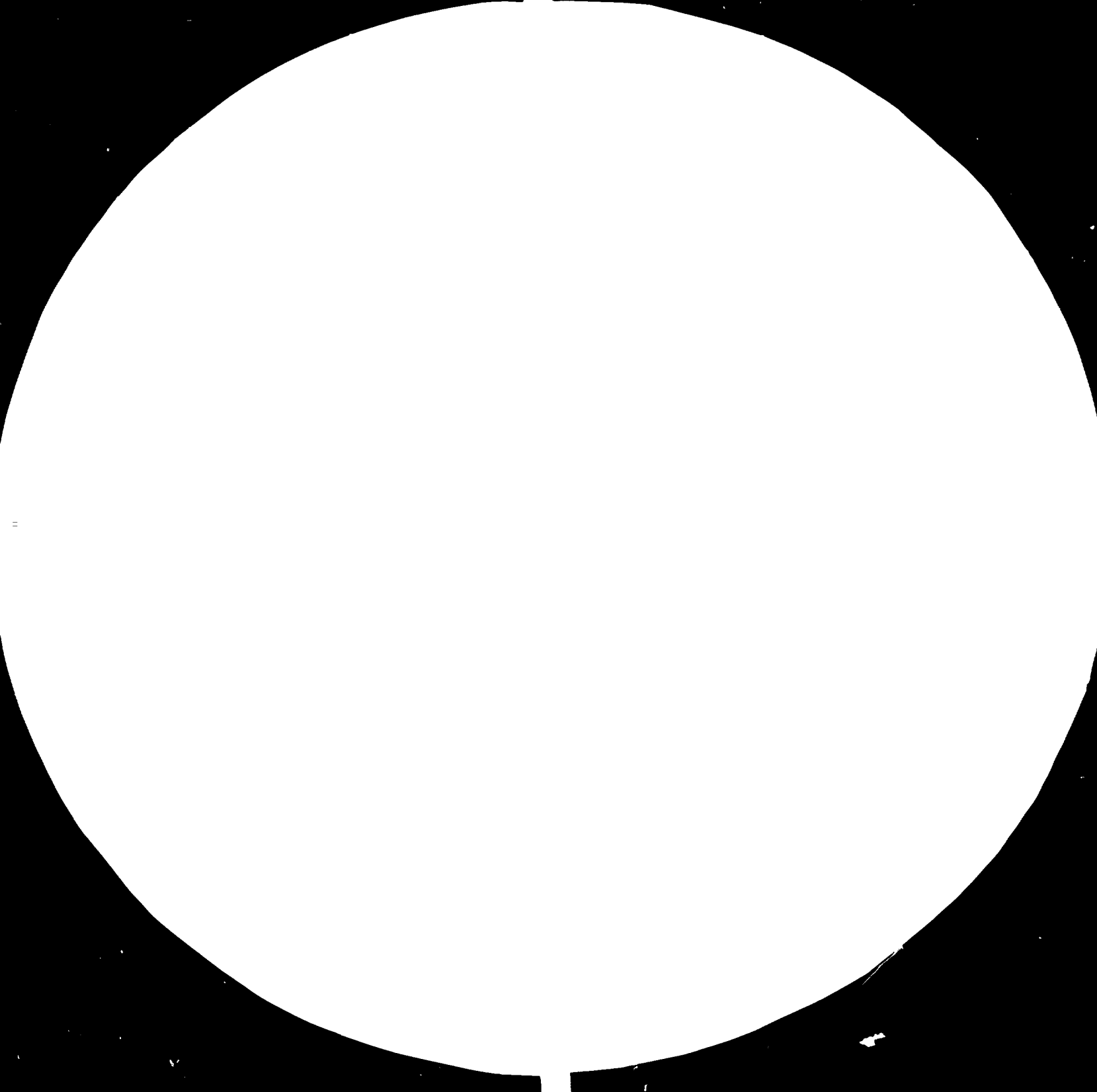
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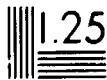
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2.5



Figure 1. Resolution test targets used in the experiment. The resolution of the test target is indicated by the number next to the target. The resolution of the test target is the number of cycles per degree of visual angle.

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Bolivia.

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UTILIZATION OF SULPHUR DIOXIDE FROM THE TIN
VOLATILIZATION PLANT AT LA PALCA

BOLIVIA

Report on technical advisory services and the
project identification mission *

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* This report was not edited, commented upon or cleared by UNIDO and therefore does not necessarily reflect the views of the Organization.

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1.0. INTRODUCTION

The Government Organization COMIBOL - Corporation Minera de Bolivia has established a low-grade tin ore processing plant at La Palca (approx. 600 km from La Paz). The production trials started in 1981, commissioning of the plant was successfully completed in June 1982.

During the first series of production trials of the unique technology and equipment applied it became evident that the off-gases of the plant which are vented through a stack into the ambient atmosphere excessively pollute the environment. Consequently, the concept emerged to eliminate the pollutant at the source for the production of sulphuric acid by utilizing the emitted sulphur dioxide, which is the major contaminating component of the off-gas.

Another Government company, COSSMIL, has established a sulphuric acid plant of 100 tons per day capacity at Eucaliptus (approx. 200 km from La Paz). The plant was in operation for a relatively short time between 1977 and 1979. It used indigeneous elemental sulphur as raw material but for lack of market outlets for sulphuric acid of the potentially available quantity operation of the plant has been shut down and the plant remains idle for almost 4 years.

The hypothetically correct concept to combine the two problems, i.e. to transfer the idle plant from Eucaliptus to La Palca, in order to eliminate the pollution at La Palca and gain financially through production of a useful basic chemical, led to the formulation of a request by COMIBOL for preparatory assistance of UNDP.

In this connection UNIDO has been approached to render direct technical advice prior to formulating a technical assistance programme which would be suitable for inclusion in the Bolivian Country Programme of UNDP and for financing basically from UNDP sources of funds.

Pre-project investigations were conducted by an ad-hoc UNIDO staff mission. Mr.S.R. Panfil, Senior Interregional Adviser (Office of the Director, Division of Industrial Operations) has been designated to undertake the mission, to provide immediate direct advice to the Government company COMIBOL, and to report on technical and organizational aspects of the Government's concept of the project, from the viewpoint of its viability.

2.0. CONCLUSIONS AND RECOMMENDATIONS

2.1. Conclusions

a) In consequence of environmental pollution problems encountered during start-up of the La Palca Tin Volatilization Plant COMIBOL requested technical assistance in February 1982, but the project proposal prepared by COMIBOL has not yet been approved by the Government. However, the Ministry of Planning and Coordination supports COMIBOL's request in principle.

b) The need for short and long-term technical assistance is fully justified on technical grounds, but the objectives and scope of preparatory assistance requested by COMIBOL must be modified in order to assure positive results of the techno-economic study to be conducted under the project.

c) The study shall concentrate on the following aspects (in order of practical importance):

- Pollution abatement at the La Palca Tin Volatilization Plant through application of recoverable or non-recoverable off-gas purification methods;

- Economy of sulphur or sulphur dioxide recovery from the off-gas purification unit necessarily to be installed at La Palca;

- Assessment of export market outlets and proposals for utilizing sulphuric acid in the country;

- Assessment of the feasibility of transfer of the existing sulphuric acid plant from Eucaliptus to La Palca, vis-à-vis the economic viability of its rehabilitation, provided the market study arrives at positive conclusions;

- Comparison of alternative technical options solving both problems: pollution abatement and production of sulphuric acid (preferably including concepts of direct utilization of the acid at Eucaliptus and/or La Palca).

d) The environmental pollution problem of the La Palca plant must be solved, first and foremost, even if all the technical concepts of producing sulphuric acid at La Palca would prove economically not feasible as compared to attainable production costs at the existing (rehabilitated) sulphuric acid plant using elemental sulphur as raw material.

e) The technical concept of the off-gas purification unit to be worked out under the P.A. project shall constitute the basis for immediate follow-up assistance towards physical implementation of a pollution abatement project by COMIBOL.

f) The assumption of COMIBOL, anticipating that sulphuric acid produced from off-gases (zero-cost sulphur dioxide) will be cheaper than the elemental sulphur based acid produced by the existing plant, is technically not realistic.

g) The study shall indicate under what conditions the transfer of the existing sulphuric acid plant to La Palca would reduce the investment cost of the pollution abatement project. It should be born in mind, however, that in practice environmental protection units of industrial plants entail financial sacrifices even if yielding useful by-products.

h) Reliable technical parameters which are needed to design the sulphur dioxide removal system are not yet available, owing to the very short operating experience. COMIBOL should conduct immediately from now onwards regular analytical assays and calculate the required materials balances of S, Sn and As (sulphur, tin and arsenic).

i) It appears not possible to adhere strictly to the environmental standards of the industrialized countries when designing the off-gas purification unit. Limits of permissible emission of sulphur and arsenic compounds need to be established by an environmentalist (short term consultant) taking into account viable design features of the unit, the location of the plant and the surrounding area affected by the emission. The expert shall be expected to make available to COMIBOL world-wide experiences relating to public health affected by long term exposure to low concentration of airborne arsenic poisoning.

j) As the original concept of COMIBOL (i.e. the transfer of the idle sulphuric acid plant from Eucaliptus to La Palca) is not straightforward technically viable and economically feasible, the Government should be cautioned against hasty contracting of expensive pre-investment studies prior to having established a viable technical concept by independent consultants.

k) The Government should be made aware that solving the air pollution problem at La Palca "post factum", after the plant has been established and put in operation, may overthrow the feasibility calculations which served

originally as justification for the establishment of the low-grade tin ore processing plant.

1) The indispensable supplementary investment needed to design and install the off-gas purification unit at La Palca will be relatively large (not suitable for inclusion in a UNDP project). Likewise, the additional operating costs of the pollution abatement system need to be considered realistically as a burden on the production cost of the tin oxide. The socio-economic effects should be assessed on their own merits in order to properly justify the capital investment and higher production costs.

2.2. Recommendations

a) UNIDO shall present to COMIBOL the findings and conclusions of the mission in a technical report (in Spanish).

b) The draft P.A. project document prepared by UNIDO shall be submitted to the Government, as soon as deemed opportune by UNDP after reconstitution of the Government bodies in connection with presently on-going changes of the political and economic management of the country.

c) UNIDO shall continue its cooperation with COMIBOL (by correspondence through UNDP) in order to monitor the preparatory analytical work carried out at the La Palca plant for collecting an adequately large number of reliable physical and chemical parameters which are indispensable as basic technical data for the study. In this connection COMIBOL is expected to put into operation the gas chromatograph which has been supplied by the contractor.

d) Apart from the foregoing pollution abatement project, the Government should request to prepare a project concept on technical assistance relating to plant modifications needed to solve the spare parts supply problem. Simultaneously search for non-IPF funds should be initiated in order to provide a realistic prospect for the implementation of the project. (The Government's request may be expected to follow by mid 1983).

e) The Government should be encouraged to request assistance in rehabilitating the sulphuric acid plant of COSSMIL at Eucaliptus, provided the market study and technical study on local utilization of sulphuric acid would prove the feasibility of putting the plant back into operation.

2.3. Proposed interim follow-up work programme

- (i) Preparation of the Technical Advisory Report;
- (ii) Translation of the report into Spanish and submission to the Government;
- (iii) Completion of the Project Document for Preparatory Assistance and the TOR for subcontracting of the study on pollution abatement and utilization of sulphur dioxide at La Palca;
- (iv) Translation into Spanish and submission of the document to the Resident Representative;
- (v) Preparation of a draft project document on technical assistance to COMIBOL for the modification of the La Palca plant in order to solve the spare parts problem;
- (vi) Search for funds from bilateral aid sources for the implementation of the new separate project mentioned under (v);
- (vii) Monitoring of La Palca's analytical work for collecting reliable data and parameters for the basic design of the SO₂ purification unit;
- (viii) Continuation of contacts with COMIBOL (by correspondence through UNDP) in order to promote from both sides the P.A. project so that implementation could begin as soon as the data base for subcontracting of the conceptual engineering design study for the La Palca plant is ready.

3.0 BACKGROUND AND ACTIVITIES OF THE MISSION

COMIBOL requested UNDP to provide the technical assistance needed to solve the atmospheric pollution problem at La Palca. The request was submitted to UNDP on 3 February 1982 (Annex 3). On 15 June 1982 COMIBOL submitted the request to the proper Government authorities, i.e. the Ministry of Planning and Coordination while having in the meantime received the support of the Ministry of Mines (Annex 4). The two documents had not been copied to UNIDO because the official endorsement of the request was awaited. The project proposal attached to the request (Annex 3) contributes to the understanding of the background of the project, but it was insufficiently specific to formulate workable Terms of Reference for the very complex consulting services required.

At the first reaction the involvement of UN-OPE was considered because in 1980/81 a metallurgical expert of OPE worked at La Palca on start-up problems and provided general advice relating to the tin-ore processing technology. However, as he was not a chemical expert and his terms of reference did not cover aspects of utilization of the sulphur dioxide emitted in large quantities by the plant.

The Resident Representative of UNDP La Paz suggested that preferably UNIDO should take up the matter as executing agency of the project. However, the exchange of cables * on the subject between 12 May and 13 August 1982 and the letter of 5 July 1982 by which some background information was submitted to UNIDO, did not immediately lead to a positive reaction. From the valuable but insufficient technical data on the subject presented by letter of 5 July 1982, UNIDO understood that the problems involved are of a very complex nature. Under these circumstances the formulation of a substantive-ly and formally correct preparatory assistance project document was considered not possible, unless all the indispensable technical information would become available to UNIDO.

Pursuant to the Resident Representative's reiterated request to take up the matter UNIDO confirmed its preparedness to organize the preparatory work and decided to dispatch at short notice a professional staff member mission. This was communicated to UNDP La Paz by cable 328313 of 24 August 1982. Mr. S.R. Panfil, Senior Interregional Adviser of the Division of Industrial Operations, attached to the Office of the Director and the Chemical Industries Branch, has been designated to undertake the mission as soon as available.

Mr. Panfil was expected to collect relevant information and possibly also to formulate the P.A. project document if the conclusions would warrant substantiation of the Government's request. In principle, it was understood at HQ that the designation of UNIDO to implement the project as suggested by the Resident Representative was the right option, because of the technical complexity of the project which would require continuity of assistance after completion of the preparatory phase, and possibly also some separate but interlinked other assistance projects to the two plants.

* misc 590 of 12 May, misc 752 of 16 June, misc 796 of 28 June, misc 835 of 7 July, misc 971 of 13 August 1982. All cables addressed to DPC and PC/FIELD.

The second option of UNDP La Paz, indicated in prior correspondence i.e. execution of the P.A. phase by UNDP-OPE, though functionally correct, would not lead to fulfilment of this condition in an organizationally practical way within the UN system. It goes without saying that UNIDO is properly equipped to deal directly with this kind of complex technical issues and would be ready to organize follow-up work as normally requested by Governments on completion of P.A. projects.

On the basis of technical data on the subject available to UNIDO prior to the mission, with respect to the apparently uncomplicated original concept of COMIBOL, it was, however, evident from the technical viewpoint that some of the issues would have to be dealt with differently in order to arrive at viable solutions covering all aspects of the Government's problem areas at both plants, Eucaliptus and La Palca.

The UNIDO mission arrived at La Paz on 14 September 1982 on its return from Jakarta/Indonesia. While its terms of reference were implied by the background described in chapter 1.0., i.e. to undertake the task of project identification and formulation, it was found on arrival that there is rather need for direct advisory services relating to the Government's concept. The mission fulfilled this duty, as well in its capacity as technical adviser and specialist in technology, engineering and operation of basic chemicals plants.

As requested by the Resident Representative a separate pertinent technical report on this subject shall be prepared by the mission (Original English and Spanish translation) for submission to the Government. The report will repeat all those essential statements, findings and conclusions of this UNIDO mission report, which are deemed important for consideration by the Government prior to submitting the finally valid request for assistance.

During its stay in Bolivia the mission's work was confined to discussions with persons at La Paz who could contribute to the understanding of the substance of the COMIBOL's problems at La Palca and at the sulphuric acid plant of COSSMIL. Because of the general strike which started on 15 September and continued till the last working day of the mission it was not possible to travel in the country to the two remote plant sites. Nevertheless, through the contacts arranged by the UNDP Office and the efficient assistance rendered by the UNIDO JPO the mission was in a position to carry out all its duties to the extent necessary at this stage in the short time available.

The list of key persons met is attached (Annex 1). The chronology of the mission appears in (Annex 2). Details of the discussions held at La Paz, findings and technical information collected, and conclusions arrived at by the mission are presented in the following chapters.

In addition to its prime tasks outlined above, the mission investigated the status of the Government's action on project SI/BOL/82/802 "Planta de Fertilizantes Santa Cruz", and discussed the pyrethrum development project on which some exchange of views took place earlier this year by correspondence indicating a potential interest of the Government to receive UNIDO's assistance. Reporting on these two subjects is covered by Interoffice Memoranda addressed to the backstopping officers concerned, and does not appear in this report.

The purpose of the present report is of internal organizational nature and, therefore, in its present form it shall not be submitted to the Government. With reference to chapter 9.0. it may be indicated here that the draft P.A. project document (Annex 7) and the terms of reference for the subcontract (Annex 8) shall be retained at the UNDP office at La Paz, awaiting an opportune moment for its submission to the Government, which presently is being re-constituted in connection with the expected change from military to democratic/parliamentary rule. Consequently, at this stage only the aforementioned separate technical report on the direct advisory services of the UNIDO adviser's mission shall be conveyed to the Government.

Annexes 7 and 8 will be detached and submitted under separate cover as they are expected to undergo some modifications taking into account the views of COMIBOL and the Ministry of Mines and Metallurgy for final endorsement by the Ministry of Planning and Coordination.

4.0. REVIEW OF TECHNICAL INFORMATION

4.1. Sulphur dioxide emission problems of the La Palca Tin Volatilization Plant

4.1.1. Source of data: The following assessment of the present situation at COMIBOL's La Palca Plant is based on background and plant performance data contained in the Technical Report of the UNDP-OPE consultant Dr. Thomas S. Mackey (project BOL/80/002 Assistance to COMIBOL under Subcontract by OPE to Key Metals and Minerals Engineering Corporation, Texas City, USA).

The report dated 14 December 1981 covers in principle the period 17-31 October 1981. However, the consultant has visited the plant several times and has prepared also a preliminary report on observations made earlier in 1981.

He investigated all the essential technical and organizational factors which have led to the difficulties encountered during the initial start-up trials of the plant in 1981. Furthermore, he presented his general observations covering but not limited to: background of the project and contract; plant engineering, construction and erection; the performance of the contractor; evaluation of the tin refining technology applied; trial operations; economic data on the entire project; as well as conditions and prospects of achieving the required level of productivity, technological efficiency and financial profitability of the plant.

The report of the UN-OPE Consultant did not specifically deal with the problem of recovery of sulphur from the raw material (low-grade tin ore and tailings from beneficiation operations). However, the technical descriptions contained in the report and the data expressed in figures, which appear to be ^{of} first hand statistical nature, enabled the UNIDO mission to draw substantive conclusions regarding the Government's concept of using the sulphur dioxide containing off-gases of the plant as feedstock for a sulphuric acid plant.

4.1.2. Review of the OPE consultants' views on the sulphur removal problem. The author of the report indicated on p.3 the following very valid conclusions (Quotation):

"The problems of sulphur dioxide and arsenic in the exit gases must be addressed immediately, as they could have a severely damaging effect on the local countryside and its residents. Arsenic, sulphur and silver metallurgical balances should be started immediately" (end quotation) This task can easily be performed by a properly equipped chemical and physio-chemical laboratory. As a basic laboratory seems to exist at the site it might only be necessary to provide supplementary instruments, descriptions of analytical procedures, and introductory expertise (on-the-job training of analysts by an expert).

Another indication relating to the subject is presented on p.10/11 of the same report (Quotation):

" The original reports indicated that the metallurgical balance on tin would have 84.5 percent in the arsenic cake, and 2.2 percent mechanical losses".

"The proposed arsenic balance indicated 30.5 percent in the finished flue dust, 3 percent in slag, 63 percent in the cake and 3.5 percent mechanical loss. The actual figures remain unknown".

" The proposed sulphur balance indicated 1.3 percent in the finished tin dust, 13.3 percent in slag, 3 percent in the arsenic cake and 77.4 percent in form of SO₂ in gases up the chimney. The actual figures are unknown" (end quotation).

As the original design of the plant did not comprise environmental aspects, there seems to be no data available on the meaning of "mechanical losses". Apart from true losses in form of dust around the plant, it may well be possible that to a considerable extent these losses appear in form of dust in the stream of gases in the vent stack.

Further on p.11 of the report it is mentioned (quote):

"To date there has been no check on the loss of tin in the gases going up the chimney by any method of instrumentation. The Seller had guaranteed 0.1 to 0.5 grams of tin per normal cubic meter in the stack gases" (unquote).

Consequently, both the arsenic and tin content in the off-gases in solid form makes the gas anyway unsuitable for direct processing in a sulphuric acid plant unless a proper dust removal unit scrubber is installed. This unit might not be necessary, however, if a complete sulphur dioxide adsorption or absorption - desorption system would be the final choice.

As regards possible variations of the sulphur content of the raw material (preconcentrate of tin ore) which were evidently unavoidable from the outset of the engineering design of the volatilization plant the following statement made in the preliminary draft report of the consultant indicates that there is no way of assuring a constant flow of off-gases containing sulphur dioxide in a narrow range of concentration. (quotation):

" The average feed to the fuming furnace has ranged from 16 to 19 percent sulphur (see Attachment A) and Seller stated in Contract Addition No.1 dated 5 June 1972 that the plant could run 350 mt per day at 25% S average and 300 mt per day at 30% S average" (End quotation).

From this statement it may be understood that from certain mines or certain seams of a given mine tin ores of much higher sulphur content must have been received and considered suitable for processing. Although

as it appears now from recent operation reports of the plant the presently actual range is 22-25 % S.

The sulphur content of the raw material, as stipulated in the contractual documents, leaves some open questions regarding the exact design basis of the volatilization plant. However, these discrepancies are essential from the viewpoint of establishing a design basis for^a sulphur removal system to be designed.

Item 6. of the Aide Memoire of January 1982 included in the aforementioned preliminary draft report maintains that during the implementation of the project and contract there was a change of the indicative (nominal) sulphur content of the raw material from 15 to 30 percent which the plant should be able to accept for processing. COMIBOL had sent a sample of 500 tons of the material for processing by the Seller of the plant, whereby the sulphur content was 25 percent. (The Seller made a report in 1979 in connection with the substitution of fuel oil by natural gas. The calculations referring to various concentrations of tin in the feed material took into account a sulphur content of 25 to 30 percent). Contract Addition No.1 set the average of processing capability at 21 percent sulphur content.

Item 18. of the Aide Memoire recommends to reduce the average content of sulphur dioxide in the off-gas to below 0,10% and the arsenic component to a maximum of 0,15%. As this recommendation of the consultant is not specific enough in relation to the concept of eliminating sulphur dioxide for production of sulphuric acid, the UNIDO mission does not support the above-mentioned presumed target level of emission. An optimally attainable level must be established by an in-depth study of conditions and costs, whereas the permissible level of concentration or quantitative emission must be defined by a specialist in this field (chemical environmentalist).

The mission, however, supports the recommendations of the OPE consultant presented under item 19 of the Aide Memoire (Quotation):

"Commission a feasibility study to evaluate various methods to separate SO₂ from the exit gases including but not limited to:

A. Nonregenerable systems

1. Lime and limestone scrubbing
2. Sodium scrubbing (Double alkali process)

B. Regenerable systems

1. Sodium scrubbing for sulphuric acid production
2. Dimethylaniline /xylidire process for liquid SO₂ production
3. Sodium citrate process for elemental sulphur production
4. Sulphuric acid production converting SO₂ into SO₃ after separation of solids, gas drying followed by absorption

5. Other methods, such as: Matte formation by the addition of metallic scrap iron to form iron sulphur matte with an expectation to remove the excess sulphur incoming to the fuming furnace. The possible addition of scrap iron can pull off the excess sulphur and the sulphuric iron could be removed from the system in form of matte. The Seller has indicated a 10% sulphur removal in matte. The Buyer can expect a much higher percentage of sulphur removal, which can reduce the pollution considerably"(end quotation)

As there are many technically conceivable ways of reducing the sulphur content in the off-gases the subject needs to be seriously studied from the viewpoint of practicalities, consumption of auxiliary chemicals, operating costs, and last but not least the capital investment requirements.

The list of possible ways of solving the problem (A-1,2 and B-1,2,3,4,5,) quoted above should be considered as guidance only, as some of the methods, though hypothetically suitable, are not applicable because of the large quantities of sulphur to be absorbed and the cost of chemicals needed.

There are many new technologies available with specialized companies dealing with metallurgical processing and environmental protection. As regards item B-4 it appears unlikely that contractors and/or licensors of sulphuric acid plant will be in a position to offer a SO₂-gas extraction and purification process suiting the particular operating conditions of the La Palca plant.

4.2. The existing idle sulphuric acid plant at Eucaliptus

Little information was available at La Paz on the sulphuric acid plant. Nevertheless, for evaluation of the Government's concept to transfer the plant to La Palca, the mission wishes to draw attention to two three sets of data available at La Paz.

- (i) operating parameters of the sulphuric acid plant presented in the draft project document for preparatory assistance prepared by COMIBOL (ref. Annex 3);
- (ii) the opinion expressed by the Bolivian Government consultant Mr. Zavaleta regarding the physical state of the existing plant (ref. Annex 5);
- (iii) the production cost sheet (ref. Annex 6).

The plant seems to be in relatively good condition, although some parts are corroded, the catalyst may be no longer active and the hardness of the cooling water seems to have considerably scaled the heat exchangers, thus necessitating a major repair or costly replacement of the condensers.

The plant seems to have been capable of producing 100 tons/day sulphuric acid (consumption of approx. 33-35 tons). The flow-sheet, however, appears rather simplified (single absorption system ?) because the conversion efficiency stated is only 86 percent. (In Annex 6 the conversion attained in February 1978 was only 76%). The presently attained efficiency of new sulphuric acid plants using the double contact double absorption process (DC/DA) is as high as 99,7 percent in order to prevent environmental pollution problems. (The balance of unconverted sulphur appears in form of sulphur dioxide emission of tail gas after absorption). If the indicated figure of 86 percent is correct, there must have been also an air pollution problem at the Eucaliptus plant. Standard single absorption plants attain normally a conversion of 97-98% percent.

The indicated concentration of SO₂ in the sulphur burning gas prior to conversion of the Eucaliptus plant is in the normal range for elemental sulphur processing plants (Eucaliptus: 9,3%, standard: 9-10%). This, however, makes the plant unsuitable for processing low concentration SO₂ gas. Pyrites processing plants yield a SO₂ feed gas of 3-5 percent whereas the SO₂ content in the off-gas of the La Palca plant may vary between 1 and 4 percent. (Ref. Chapter 6.0). The higher volume of gas to convert the same quantity of SO₂ into SO₃ and further to sulphuric acid would cause a proportional decrease of plant throughput. Otherwise, it would be necessary to increase accordingly the volume of plant equipment. It is a known fact that for this reason the investment cost of sulphuric acid plants using SO₂ from pyrites roasting is at least 50 percent higher than

the cost of a comparable plant using SO₂ from a sulphur burning unit (the cost of roasting or burning units not included).

If considering the hypothetical availability of S in form of SO₂ from the La Palca plant (70,4 tons/day), the processing capacity of the conversion system of the sulphuric acid plant needed would be at least twice the capacity of the Eucaliptus plant. (This figure was arrived at by assuming:

capacity of the La Palca Plant: 400 tons/day

sulphur content - average - target: 22 percent

sulphur in form of SO₂ reaching the chimney: max 80 percent of total S input).

The most serious problem, however, is inherent in the standard design of the Eucaliptus plant. It must be fed with a SO₂ containing gas of 9-10 percent concentration at a steady flow rate. Otherwise the operation of the plant will not be economical. Standard design in this context also means that the feed gas must be dust-free and free from substances which would "poison" the conversion catalyst. Therefore in any case for combining the La Palca plant with a sulphuric acid plant a gas purification unit is indispensable.

5.0. SUMMARY OF SALIENT POINTS AND FINDINGS (Technical aspects)

a) The engineering design of the La Palca plant did comprise an off-gas purification system which, as one of many technological options, could have been expected to yield sulphur in a recoverable form. Presumably the investment cost factor was the decisive argument which led that the off-gas treatment section was not purchased and installed.

b) If applying present-day standards of environmental protection of the industrialized countries, the plant would not be permitted to operate unless measures are taken to reduce considerably the emission of sulphuric and arsenic compounds into the atmosphere. The rate of emission presently experienced at La Palca is far beyond any known permissible limits.

c) The very expensive supplementary off-gas treatment unit now needed to solve the environmental pollution problem, for technical reasons, cannot simply be replaced by installing a new standard sulphuric acid plant or by transfer of the existing small plant from Eucaliptus. (if the concept would be to remove only part of SO₂ to the extent possible when using the Eucaliptus sulphuric acid plant without major increase of its gas processing volume and throughout capacity).

d) The La Palca plant "as is, where is" cannot be considered as a reliable source of sulphur dioxide feedstock for a standard sulphuric acid plant which would be expected to operate continuously and profitably by using a "no cost" raw material.

e) The dual problem of environmental protection and sulphur recovery will have to be solved by applying a technical compromise, taking into account:

- the discontinuity of work of the volatilization furnace owing to frequent shut-downs and maintenance problems;

- the discontinuity of the fuming process (batch operation) which results in periods (1 - 1,5 hrs) of high-to-low SO₂ flow followed by periods of almost zero flow of SO₂ (between the batches);

- the lack of any possibility to control the sulphur dioxide content in the off-gas stream within limits safeguarding trouble-free continuous operation of the sulphuric acid plant;

- the basic technological condition of the volatilization plant which must process a wide variety of available raw materials (suitable for tin oxide separation) whatever the variation of sulphur and arsenic content in the supplied material might be;

- the selection of a viable system for removal of sulphur, sulphur dioxide arsenic compounds and residual tin oxide dust from the off-gas of the plant. The system shall not be complicated as regards operating conditions and shall be inexpensive as far as investment cost and consumption of auxiliary chemicals are concerned;

f) In this context the design target of the S/As/Sn separation unit should then be to produce an intermediate product, as usual in desulphurization plants, from which sulphur dioxide or elemental sulphur can be recovered, while the environmental effect of this operation will be favourable if properly designed. Because of the inherent cost factor it appears therefore not advisable to attempt designing a gas purification plant which would be expected to strictly eliminate all the pollutants to a permissible threshold level according to European or American standards.

g) While a technically viable solution can surely be found, fulfilling the conditions indicated under item (e) and (f) above, the economic feasibility of the combination of gas purification and production of sulphuric acid is not so evident in a straightforward way as originally anticipated by the COMIBOL.

h) A precondition to any considerations on this complex subject is the knowledge of the composition of the off-gas throughout normal operation of the volatilization plant for at least half a year. Normal conditions in this context include correct operation according to the operation manual, emergency situations, start-up and shut-down operations, and last but not least any malfunctioning of the tin sulphide oxidation and separation system (i.e. higher dust load, tin sulphide appearance in the gas, variations of the arsenic component and possibly entrainment or precipitation of elemental sulphur in some places of the metallurgical system).

i) By using the analogy of purifying sulphur dioxide from pyrites roasting plants a conceptual engineering design study should be carried out. The study can be undertaken immediately by using the design data of the existing plant, but making allowances for wide variations of the composition of the off-gas and quantitative irregularities of the flow of sulphur dioxide.

j) As it will be necessary to subcontract the study to a third party, the permission of the supplier of the volatilization plant is needed prior to making the documentation of the plant available to the third party. COMIBOL must carefully analyze the wording of the secrecy clauses relating to the licence and know-how of the contract with the Supplier of the plant. While the basic contract was signed 10 years ago it might also be possible that the secrecy conditions have expired. Otherwise, it may also be attempted to waive the conditions, because the plant has been considered as an experimental unit. In such cases the owner of the plant becomes naturally an owner of the technological know-how resulting from pilot operations, and hence, secrecy clauses would no longer be applicable.

6.0. SUMMARY OF DISCUSSIONS WITH REPRESENTATIVES OF COMIBOL

6.1. The La Palca Plant

The La Palca plant is presently in full operation as there are no problems with raw materials availability of the range of tin and sulphur content which under prevailing climatic conditions can now be processed.

Regarding the start-up trials and initial intermittent production period of 1981, the report presented by end 1981 by the UN-OPE consultant is a valid document. Most of the technical problems which caused discontinuity of plant operations have been solved, and still some further

modifications and improvements are being made. (Anyway, as reported by the consultant, the Contract and its Additions No. 1-15 indicated that the first year of operation of the plant was to be considered as a process piloting period.

Because of environmental pollution problems it was not possible to operate the plant during the rainy season December 81/February 82. From March 82 onwards the plant was operated at full design capacity and above, i.e. 400-435 tons per day input. During this period also further plant adjustment were made so that full continuity of production was not possible.

The sulphur content of the raw material was higher than the assumed optimum (target) level of 21/22 percent (rather in the range of 24-25 percent). Material of the highest available sulphur content has also been tried out, but because of the severe atmospheric pollution problems entailed it has been determined that certain limits of permissible S content in the feed material, empirically established by the company, will have to be observed. As regards operation of the plant during the rainy season there is little flexibility for choice of parameters to operate the plant at optimum economical input/output capacity. Either the feeds to be processed must be especially selected and mixed from those sources which assure low S content, or the plant capacity (throughput) has to be reduced.

In June the plant performance test took place over a period of 25 days. All the important guarantee parameters were attained to the satisfaction of COMIBOL and the Supplier of the plant. The parameters are as follows:

<u>Parameter</u>	<u>Contract</u>	<u>Guarantee test</u>
Recovery of tin (efficiency)	93,5-94,5%	95%
Capacity	400 tons per day	408 tpd average over 25 days
Sn content in the tinpowder (final product)	over 50%	55-56%

The metallurgical performance of the plant has thus been demonstrated in a contractually valid form. Under mutual agreement between the Buyer (La Palca/COMIBOL) and the Supplier the mechanical equipment guarantees which

formally expired long time ago, because of delays in plant erection and start-up, have been extended till end October 1982. The Supplier has agreed to make some improvements at his own cost during the continued presence of his project management team. (Originally 54 persons, now 40, and as from November 1982 further to be reduced to 25 engineers for 6 more months). On-the-job training of operators is being continued.

The plant is in operation since July 82 (after the performance test), however a number of strikes caused interruptions. Nevertheless, there were three relatively long continuous production periods of full load daily capacity utilization. Except for possible political unrest which it is hoped will cease soon the company's management rests confident that plant operations will continue at the design rate of 400 tons/day.

The planning figure for operating days of the plant is 275 days per year. This figure was arrived at by assuming monthly working days 22-25 (plus maintenance) and one full month of annual turnaround (annual shut-down for maintenance).

It is planned to operate the plant continuously throughout 1983, as there is a sufficient stock of raw materials of different grades available from a number of sources. It may not be possible for environmental reasons to operate the plant fully for 275 days, but raw materials supplies will not cause bottlenecks. There are some new mining projects under consideration (feasibility stage and search for capital investment funds) with the aim of utilizing existing stockpiles of tailings from other ore beneficiation operations in many locations. The composition of some of these tailings appears to be favourable (13% S, 3-4% Sn). Logistics and access to suitable piles are the major problem areas.

The S content of the mined material has a less favourable prospect, as the low sulphur/high tin content sources are being exhausted, while e.g. the material from one mine has a S content of 35-37 percent which makes it difficult to maintain the technologically recommended S/Sn ration. The realistically long term target of S in the feedstock is 22 percent. At present it seems possible to operate in the 22-25 percent range while the technological optimum assuring high tin recovery is only 18 percent.

During the recent production period analytical data have been collected in order to arrive at reliable material balances. The following figures are of indicative nature and shall not be considered as basic average parameters for the design of the sulphur removal and utilization system. Work on the subject is being continued, in particular as the gas chromatograph provided by the supplier of the plant to conduct semi-continuous analyses of the off-gases has not yet been put into operation.

The stack gases

Volumetric quantity (flow-rate)	37,5 cu.m/sec.
Temperature	53°C
Arsenic compounds	0,6 g/sec (as As)
Solids-total	1g/sec (equiv. 15 mg/cum)
CO ₂	6,7 vol % (ORSAT)
H ₂ O	22,0 vol %
SO ₂	3,9 vol %
O ₂	3,7 vol %
N ₂	63,7 vol %

These figures differ considerably from the design data given by COMIBOL (Ref. Annex 3). In particular the flow-rate and SO₂ content cast doubts on the accuracy of measurements. The calculated average of SO₂ at the given flow rate, equivalent to a throughput of 400 tons/day of raw material would be much less than 3,9 %.

The material balances of S and As are being prepared. As a rough indication the distribution of Sn, S and As may be calculated from the following figures:

25% S in feedstock, (85% of the feed material is disposed of in form of slag) ;

Production of Sn powder 25 tons per day, containing 2-3% S;

(Arsenic) As in Sn powder 1,5%; S content in Arsenic cake 5-10%, 16% As.

(95% percent of total As is in the As cake). These random figures, however do not permit to construct a complete material balance.

A new problem area has emerged: The Fluor content in the raw material causes rapid corrosion of refractory bricks and linings. This corrosion problem is of importance for the sulphur removal and utilization project. Analytical data is not available as yet.

The fundamental problem area from which the request for assistance stems remains the pollution of the ambient atmosphere with SO₂, Arsenic compounds and (little but also containing As) tin-oxide dust.

The Supplier of the plant was (reportedly) assumed to design the plant in accordance with the Pollution Abatement and Control Standards of his country. However, investment cost savings necessitated by the Buyer, eliminated proper technical solutions from the scope of engineering design and equipment supply.

The Supplier is now required to propose a relatively simple and inexpensive solution to eliminate hardship situations. He will do so by providing the engineering calculations at his expense, while La Palca agreed to bear the construction cost of necessary plant modifications. It is intended to relocate the exhaust stack to a new location (20-30m higher base) while maintaining its original height 120 m (not 200 m as disputed for some time, but anyway would not solve the problem of environmental pollution of the surrounding densely inhabited area during the rainy season). The Supplier promised to give preferential treatment to eventual supplementary equipment orders.

The Supplier has not been asked by COMIBOL to redesign the plant with the aim of incorporating a complete sulphur dioxide and arsenic removal system, which anyway would go beyond the presently still valid scope of his contractual obligations. Consequently, the issue is open and can be taken up under a UNIDO assistance project involving a third party. In this connection the UNIDO mission draw the attention of representatives of COMIBOL and La Palca to the necessity of investigations to what extend the secrecy clause expired in 5 or 10 years as from 1972 i.e. after signature of the contract.

In any event, it will be indispensable to obtain the Supplier's authorization in writing prior to making the documentation of the plant accessible to individual UNIDO experts or subcontracted consultants. Another option would be to include a clear statement or waiver of the clause in the hand-over take-over document of the plant on termination of the contract. This would largely facilitate future action of UNIDO and eliminate the threat of infringement on the contractual know-how and licensing agreement between the Buyer and Supplier.

As transpired from the discussions the COMIBOL - La Palca plant will need and COMIBOL may request technical assistance by mid next year with the objective of modifying some items of equipment of the plant in order to solve persisting spare parts supply problems. The UNIDO mission supported the idea as it appears opportune already at present to prepare a project document for implementation in 1984, apart from any other project relating to the sulphur removal and utilization project.

6.2. The sulphuric acid plant of Eucaliptus

The discussion briefly dwelled on the concept of translocation from Eucaliptus to La Palca of the existing sulphuric acid plant which is out of operation since almost 4 years. The plant was engineered and constructed by a Mexican Contractor who used MONSANTO technology. The contract dates back to 1972 whereas the plant became operational in 1977. Since then the plant worked only for few months because of lack of market outlets for the product. The nominal capacity of the plant is 100 tons per day (conc. H_2SO_4). The absorptive capacity of the market is between 7-18 tons per day only.

The owner of the plant, COSSMIL, is a Social Security Enterprise of the Military. The question why the plant was located in a distance of 600 km from the source of indigenous sulphur in Bolivia San Pablo De Napa could not be answered by COMIBOL. The fact remains that operation of the plant proved uneconomic and it had to be shut down (see also notes on the report of the Bolivian Consulting Engineer, Chapter 7.0. of this report and Annex 5). The plant appears to be in good shape, except for some corroded components and possibly out-dated catalysts. The consensus of engineers at the meeting was that even if the concept of translocation would be viable, the capacity of the plant is definitely too small to absorb the total volume of waste SO_2 gases emitted by the La Palca Plant.

7.0. DISCUSSION WITH THE BOLIVIAN CONSULTING ENGINEER

Pursuant to COMIBOL's request for technical assistance (Annex 3) prepared in February 1982 the Government requested Mr. Zavaleta, a private consulting engineer on chemical plants and refineries to investigate into the background and justification of COMIBOL's concept of using the Eucaliptus plant for solving the pollution problem of the La Palca plant. He visited the two plants and submitted his report in April 1982 (Ref. Annex 5).

The discussions focussed on the content of the report and the conclusions arrived at by the consultant. The consensus was that pollution abatement at La Palca has to be given highest priority, apart from any considerations regarding the utilization of sulphur dioxide for production of sulphuric acid. The UNIDO mission expressed its concern over COMIBOL's concept which did not take into account the investment and production cost factors of making the waste gas mixture suitable for feeding a standard sulphuric acid plant. While in any case a SO₂ purification and "flow-plus-concentration-equalization-unit" is needed to assure smooth operation of a captive sulphuric acid plant, the production cost of the acid cannot be competitive to the cost of elemental sulphur based acid.

The consultant did see encouraging prospects of increasing market outlet for sulphuric acid, but admitted that foreign trade options are beyond his field of professional experience. He indicated that the concept of using the acid for manufacture of single-superphosphate based on indigenous phosphate rock would not be viable because of the distances involved and little progress or not success in geological research in this field. Known deposits of phosphate rock are small, of low grade, and in remote places.

The UNIDO mission fully concurred with the conclusions of the consultant's report. He stated that unless reliable analytical data are available on the flow of gas to the stack, and on the amount of SO₂ and other contaminants discharged, it is not possible to make concrete proposals or recommendations. Therefore, his only but strongly emphasized recommendations at this stage concentrate on putting into operation the gas chromatograph (purchase of carrier gases, specimen of analytically pure gases for calibration of the chromatograph, sampling devices, training of the analyst etc.). It was regretted that his recommendation has not yet been implemented by COMIBOL. Therefore, through the UNIDO mission report it is hoped that the implementation of his recommendation is expedited as otherwise the urgently needed technical assistance project on environmental protection would be jeopardized.

The consultant appears to be highly qualified. The UNIDO mission would, therefore, suggest to consider his involvement in UNIDO projects, and in particular, in the expected assistance programme to COMIBOL and possibly also to COSSMIL.

8.0. MEETING WITH THE LATIN AMERICAN REPRESENTATIVE OF SIMON CARVES
(CANADA) Ltd.

With reference to the letter of Simon Carves Canada Ltd. (SCAN), dated 17 June 1982 addressed to the Resident Representative of UNDP at La Paz, (Ref. copy on UNIDO's file), the discussion dwelled on the origin of the company's offer to render engineering services for the establishment of a sulphuric acid plant at COMIBOL's La Palca Tin Volatilization Plant.

The mission learned that it was SCAN's sole initiative to draw the attention of COMIBOL to the vast experience of SCAN in the field of sulphuric acid plants. Moreover, it was known to the Latin American Representative through other business contacts with Bolivian companies that the basic concept of COMIBOL in this context was to transfer the existing sulphuric acid plant of COSSMIL to La Palca. As the COSSMIL plant was engineered on the basis of MONSANTO technology of which SCAN is a licenseeholder, the offer has an obvious inherent advantage from the professional viewpoint.

The UNIDO mission indicated that according to its findings the problems to be solved at La Palca are primarily connected with pollution abatement at the metallurgical plant and not as originally conceived to produce cheap sulphuric acid from waste sulphur dioxide. As the Latin American Representative is a commercial specialist and not a chemical engineer, the discussion concentrated on the experience and references of SCAN to solve environmental problems, while it was known to the UNIDO mission from earlier contacts with Simon Carves that beyond any doubts SCAN is excellently qualified to undertake the study on establishment of a new plant or redesign and transfer of the existing sulphuric acid plant.

The principles of subcontracting technical services by UNIDO, in connection with technical assistance projects, have been explained. The procedure of international competitive bidding was mentioned as well as the possibility of involvement of SCAN under the proviso that their references on the subject matter would be sufficient.

The mission received later a complete set of reference information on industrial projects executed by SCAN for the metallurgical industry of industrialized and developing countries. Numerous examples of studies on environmental protection were presented in the brochure of SCAN, thus having answered the mission's query. The mission is of the opinion that

SCAN may be considered as a well experienced candidate for the study (under different terms as compared to those offered by SCAN previously). However, no arrangements nor commitments regarding cooperation between SCAN, COMIBOL and UNIDO were made at this stage as it was premature to discuss the matter further, prior to having the activities of the P.A. project firmly agreed upon with COMIBOL and approved by UNDP.

Apart from discussions with the representative of SCAN the mission is of the opinion that LURGI CHEMIE/FRG should also be considered as a candidate for the study.

9.0. CONCLUDING DISCUSSION WITH THE RESIDENT REPRESENTATIVE OF UNDP

The mission reported on the discussions held and the conclusions arrived at on the basis of the information and technical data collected. The Resident Representative advised the mission how to proceed with further preparatory work on the project. However, he indicated that at present it is not recommendable to take immediate action by urging the Government to send the official request on the basis of the modified terms of reference for the study proposed by the mission. Continuing strikes and the expected personnel changes at all Government bodies do not permit to anticipate which sectors and projects will be given priority under the Country Programme.

In order to continue the contacts established to-date on the subject, the Resident Representative requested the mission to prepare a technical report (in Spanish) for submission to the Government, while the project document and TOR of the subcontract will only be presented to the new authorities once the reconstitution of the government is completed.

The mission understood that funds for the preparatory assistance are available under IPF/ABL for 1982, and that the concept of continuing UNDP's support after completion of the P.A. stage is in principle acceptable. But, as there are many uncertainties and financial imbalances foreshadowing, discussions on details, scope, timing and cost of the possibly large-scale, long-term follow-up project were considered premature.

ANNEX 1.

LIST OF KEY PERSONS MET AT LA PAZ

1. Mr. Narciso CARDOZO Rodriques
Asesor de Proyectos Metalurgicos Especiales
Corporación Minera Bolivia COMIBOL
2. Mr. Juan MENDOZA
Subgerente Construccion de Plantas - La Palca
3. Mr. Sibino MONTEZ de OCA
Superintendente de La Palca
4. Mr. Ronanth ZAVALETA
Consultant to the Government
5. Mr. Carlos SALAMANCA
Entrepreneur (ex-UNDP Resident Representative - emeritus)
6. Mr. Michael G. WOOLGAR
Latin American Representative LARSA Ltd.
President, Representative of Simon Carves Canada Ltd.
7. Mr. Luis R. MONTOYA CH.
Ingeniero Industrial
8. Mr. Pedro MERCADER
Resident Representative a.i.
UNDP
9. Mr. Anreas E. LENEL
Junior Professional Officer
UNIDO

ANNEX 2.

CHRONOLOGY - TIME SCHEDULE OF THE UNIDO MISSION

- 14/9 Arrival from Jakarta (14.00).
Initial contact with UNDP/UNIDO JPO Mr. Lenel.
Establishment of tentative programme (including travel to Eucaliptus and La Palca).
- 15/9 Discussions at UNDP on the projects and plants.
Review of prior reports (Dr. Thomas S. Mackey's Preliminary Study on the La Palca Tin Volatilization Plant.
Discussion on UNIDO project SI/BOL/82/802 Planta de Fertilizantes Santa Cruz.
Unofficial discussions on the pyrethrum development project (Mr. Salamanca)
- 16/9 (General Strike)
Meeting at COMIBOL and substantive discussions on the concept (Messrs Cardozo, Mendoza and Montez).
Collection of technical data.
Meeting with Mr. Zavaleta, Government Consultant (private).
- 17/9 Discussions on the offer of technical services submitted by SIMON CARVES CANADA Ltd. (Mr. Woolgas).
Meeting with the UNDP Resident Representative a.i. (Mr. Mercader).
Discussion on conclusions of the mission and further cooperation with COMIBOL through UNDP.
- 18/9
19/9 Weekend - Report writing
- 20/9 Second meeting at COMIBOL and discussions with the representative of La Palca. Presentation of summary of findings and conclusions of the mission.
- 21/9 Departure (6.40 a.m.)

ANNEX 3.

Febrero 3, 1982

T-128/82

Señor
Krishan G. Singh
Representante Residente de
Naciones Unidas para Bolivia
PRESENTE

Muy señor Mio:

Me es grato hacer llegar a usted, el documento de Asistencia Preparatoria para el Proyecto de una Fábrica de Acido Sulfúrico, que sería instalada en nuestra Planta - de Volatilización de Estaño de La Palca, en base de los gases sulfurosos que emanarían de la chimenea, cuyos datos generales según proyecto son los siguientes:

1. Volumen de gases en condiciones normales $V = 22.4 \text{ Nm}^3/\text{seg.}$
2. Temperatura $t = 53^\circ\text{C}$
3. Volumen útil de los gases $V_p = 49.0 \text{ m}^3/\text{seg.}$
4. Temperatura promedio de los gases $t_p = 66.5^\circ\text{C}$
5. Análisis químico promedio
 - $\text{CO}_2 - 5.4 \%$
 - $\text{H}_2\text{O} - 22.6 \%$
 - $\text{SO}_2 - 1.0 \%$ 3.99%?
 - $\text{N}_2 - 62.0 \%$
 - $\text{O}_2 - 9.0 \%$
6. Cantidades de materias nocivas descargadas en los gases

SO_2 $G_{\text{SO}_2} = 720 \text{ g/seg.}$

AS $G_{\text{As}} = 0.65 \text{ g/seg.}$

Polvo $G_{\text{polvo}} = 1.8 \text{ g/seg.}$

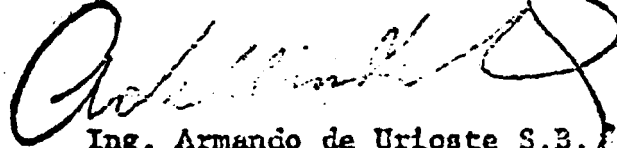
Pág: 2

Ref: T-128/82

Los datos reales referentes a los gases de salida de la chimenea, serán determinados cuando la Planta de Volatilización esté en operación a partir del 15 del presente mes de febrero.

Agradeciéndole de antemano sus buenos oficios en esta cooperación que requerimos con urgencia, saludo a usted muy atentamente,

CORPORACION MINERA DE BOLIVIA



Ing. Armando de Urioste S.B.
GERENTE GENERAL

ARG.
NCR./ntm.

PROGRAMA DE LAS NACIONES UNIDAS PARA EL DESARROLLO

PROYECTO DEL GOBIERNO DE BOLIVIA

DOCUMENTO DE ASISTENCIA PREPARATORIA

Título:	Asistencia Preparatoria para el Proyecto de una Fábrica de Acido Sulfúrico en la Planta de Volatilización de Estaño. "LA PALCA"	Fecha de iniciación: 15 de febrero de 1982
Número:		Duración: 3 meses
Sector:		Clasificación; y Código del PNUD
Organismo Gubernamental de Ejecución:		Corporación Minera de Bolivia
Organismo de Ejecución:		Gerencia Técnica de COMIBOL
Insumos del PNUD:		1 Experto en cálculo, diseño, montaje y operación de Fábricas de Acido Sulfúrico
Insumos del Gobierno:		Contraparte técnica, apoyo logístico en diseño y secretaría.
Aprobado:		Fecha:
En nombre del Programa de las Naciones Unidas para el Desarrollo		

ANTECEDENTES -

La Corporación Minera de Bolivia, el 6 de junio de 1972 suscribió un contrato con Machinoexport de la U.R.S.S., para la implementación de una Planta de Volatilización de Estaño, que después de aproximadamente diez años entró en operación esporádica de pruebas en los meses de marzo, octubre y noviembre de 1981, alcanzando en este último mes la capacidad máxima de tratamiento de 390 T.M.N./día de preconcentrados de estaño con un contenido promedio de 3.97 Sn. y 26 % S.

Lamentablemente, en éste último mes de operación de prueba, emanaron de la chimenea gases nocivos, provocando la contaminación ambiental con perjuicios notables en la agricultura de la zona, mal-estar de la gente y una visible reacción en la superficie de la tierra vegetal que presentó pátinas blanquesinas, por efecto del ácido sulfúrico generado por la lluvia precipitada en esos días.

Lo indicado, provocó una reacción natural de la población que se opone a la operación de la planta, si no se buscan las soluciones adecuadas para evitar el malestar de la población proveniente de los gases nocivos SO₂; SO₃; As₂ O₃, de la volatilización, que seguramente están saliendo de la chimenea con porcentajes superiores a los indicados en el proyecto.

En lo que corresponde al As y SO₃, está previsto que se mejorarán las instalaciones para el lavado de gases por parte de los fabricantes; pero el SO₂ que debe expulsarse por la chimenea, representa el 80% del azufre contenido en la carga para volatilización del estaño, correspondiendo a una expulsión diaria de 80 T.M. de azufre que puede ser aprovechado para fabricar aproximadamente 200 T.M. de ácido sulfúrico de 66°Be por el método de contacto.

OBJETIVOS DE LA EMPRESA -

Después de un análisis cuidadoso de los problemas surgidos como consecuencia de la contaminación ambiental y los últimos acuerdos con Machinoexport, COMIBOL se ha fijado una meta como solución de urgencia, en la necesidad de elaborar un proyecto de factibilidad para instalar una fábrica de Acido Sulfúrico en corto plazo, bajo las siguientes posibilidades:

1. Conseguir en transferencia la fábrica de Acido Sulfúrico de Eucaliptus de propiedad de la Corporación del Seguro Social Militar "COSSMIL", que hacen cuatro años se encuentra paralizada debido a su excesiva capacidad de producción 100 T.M./día de H₂SO₄ y su alto costo proveniente del alto precio del azufre refinado que utiliza como materia prima y el pequeño consumo \pm 18 T.M./día, motivo por el que trabajaba solamente

dos meses por año.

2. Comprar una fábrica nueva con capacidad de producción de 200 T.M./día, con el fin de aprovechar la totalidad del SO₂ producido diariamente.
3. Estudiar la factibilidad del proyecto preferentemente en base de la transferencia de la fábrica de Eucaliptus, cuyas instalaciones se encuentran en buen estado y en permanente mantenimiento.

Un detalle general de las instalaciones disponibles en la Fábrica de Eucaliptus, es el siguiente:

- Horno de combustión

Entrada de aire	120 °C
Gases de salida	840 °C

- Caldera de proceso

Domo presión Kg/cm ²	
Alimentación de agua	21
Vapor	18

- Intercambiador de calor

Temperatura gases de salida 348 °C

- Convertidor (Catalizador Pentóxido de Vanadio)

Temperaturas del gas en proceso en las 4 camas

1er. paso Entrada 449 °C Salida 584 °C

2do. paso Entrada 450 °C Salida 556 °C

3er. paso Entrada 450 °C Salida 498 °C

4to. paso Entrada 450 °C Salida 468 °C.

- Torre de absorción

Entrada de gases	246 °C
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Entrada ácido	80 °C
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- Torre de secado
 - Entrada de aire 17 °C
 - Entrada de ácido 53 °C
- Torre de bombeo de ácido
 - Concentración 98.3 %
 - Dilución Lt./min 8.5
- Enfriadores Acido - Agua
 - Presión Kg/cm² 1
 - Temperatura 41 °C
 - pH 8.6
- Economizador
 - Presión de salida Kg/cm² 17
 - Temperatura de entrada 60 °C
 - Temperatura de salida 205 °C
- Análisis Reich - Convertidor SO₂ %
 - Entrada primer paso 9.3 %
 - Salida cuarto paso 1.35 %
 - Conversión 86 %
- Panel de control para todos los procesos de la fabricación
- Instalación completa para tratamiento de aguas procedentes del Río Desaguadero
- Dos estanques de almacenamiento de ácido sulfúrico c/u. con capacidad de 3.000 T.M.

Esta planta trabajó solamente 4 meses en periodos de 2 años cada vez.

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OBJETIVOS DE LA ASISTENCIA PREPARATORIA -

Dentro de la práctica regular que desarrolla Naciones Unidas en el campo de la Asistencia Técnica, los objetivos de la Asistencia Preparatoria serían los siguientes:

1. Con la asistencia de un experto en cálculo, diseño y operación de fábricas de ácido sulfúrico, estudiar la posibilidad de fabricar ácido sulfúrico en base de los gases sulfurosos provenientes de la volatilización de estaño en la Planta de La Palca-Potosí.
2. En función de las posibilidades favorables, estudiar el mercado propio con sus correspondientes proyecciones a futuro y el mercado de los países vecinos.
3. En base del mercado identificado y las posibilidades favorables de fabricar ácido sulfúrico a partir de los gases sulfurosos de La Palca, elaborar el Proyecto de Factibilidad, considerando preferentemente las instalaciones de la Fábrica de Eucaliptus con las adiciones necesarias que la tecnología aconseje.
4. Preparar los documentos necesarios para tramitar el financiamiento requerido.

ACTIVIDADES -

El experto contratado por el organismo de ejecución, en colaboración con la Gerencia Técnica, realizará las siguientes actividades:

- 15 - 18 Febrero: Inspección Fábrica de Eucaliptus, Planta de Volatilización La Palca, evaluación instalaciones industriales Eucaliptus y aforo-muestreo gases sulfurosos La Palca.
- 1º - 10 Marzo: Estudio mercado local y países vecinos.
- 15 Marzo - 7 Mayo: Elaboración del Proyecto de Factibilidad.
- 10 - 15 Mayo: Revisión y entrega Proyecto de Factibilidad a PNUD y COMIBOL.

INSUMOS -

PNUD - Asistencia Técnica equivalente a 3 meses/hombre en la siguiente especialidad:

Un experto en cálculo, diseño y operación de fabricas de ácido sulfúrico en base de gases sulfurados provenientes de procesos pirometalúrgicos.

GOBIERNO

DE BOLIVIA - El Gobierno proveerá técnicos de contrapartida para las especialidades que requiera el estudio del proyecto de factibilidad, asimismo proveerá servicios de laboratorio para análisis químicos, gabinetes de diseño, oficinas y apoyo secretarial.

La Paz, Febrero 3 de 1982



ANNEX 4.

CORPORACION MINERA DE BOLIVIA

Casillas 349-674 y 1414 — Direcc. Telefónica COMIBOL — La Paz — Bolivia

Junio, 16 de 1982

T-606-82

	Acción
D.R.	<i>[Signature]</i>
D.R.R.	<i>[Signature]</i>
A.R.R.	<i>[Signature]</i>
I.P.	

Fecha:
17 JUN 1982

BOL/80/002

Señor
Krishan G. Singh,
REPRESENTANTE RESIDENTE DE
NACIONES UNIDAS PARA EL DESARROLLO
Presente.

Estimado señor Singh:

Adjunto a la presente, me es grato hacer le llegar, fotocopia de nuestra carta T-603/82 de fecha 15 de junio del año en curso, con la que requerimos al señor Ministro de Planeamiento y Coordinación, ratificar nuestra solicitud de Asistencia Preparatoria para el Proyecto de una Fábrica de Acido Sulfúrico en la Planta de Volatilización de Estaño "La Palca", que presentamos a vuestro despacho en fecha 3 de febrero de 1982, asimismo, le adjuntamos también para su amable conocimiento fotocopias de las notas cursadas al respecto, con el señor Ministro de Minería y Metalurgia, Cnl. DIM. Carlos Morales Nuñez del Prado.

Con este motivo y a la espera de sus atentas noticias, le reitero las seguridades de mi consideración más distinguida.

CORPORACION MINERA DE BOLIVIA

[Signature]
Ing. Arnaldo Rivero Gutiérrez
GERENTE GENERAL a.i.

ADJ: Lo citado



CORPORACION MINERA DE BOLIVIA

Casillas 319 — 674 y 1114 — Direc. Telegráfica COMIBOL — La Paz - Bolivia

Junio, 15 de 1982

T-603-82

Señor
Ing. Adolfo Linares Arrayaj
MINISTRO DE PLANEAMIENTO Y COORDINACION
Presente.

Señor Ministro:

Me es grato hacer llegar a usted fotocopia de la solicitud de Asistencia Preparatoria para el Proyecto de una Fábrica de Acido Sulfúrico en la Planta de Volatilización de Estaño "La Palca", que nuestra Institución presentó a la oficina del Programa de Naciones Unidas para el Desarrollo "PNUD" en fecha 3 de febrero de 1982; asimismo, adjunto también copias de las notas cursadas al respecto con el señor Ministro de Minería y Metalúrgia, Cal. DIM. Carlos Morales Nuñez del Prado, quién en su carta N° 292 de 19 de abril, recomienda continuar con las gestiones pertinentes.

Como es de rigor, y, a fin de oficializar el indicado trámite, insinúo a su autoridad, ratificar nuestra solicitud ante "PNUD", que por su parte ya tiene adelantadas gestiones en su oficina central de Nueva York.

Con este motivo, reitero al señor Ministro, las seguridades de mi consideración distinguida.

CORPORACION MINERA DE BOLIVIA

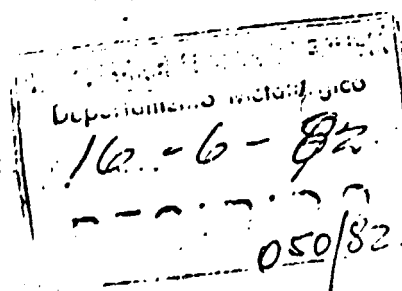
ORIGINAL FIRMADO

Ing. Arnaldo Rivero G.

Ing. Arnaldo Rivero Gutiérrez
GERENTE GENERAL a.i.

ADJ: L. citado

c.c. Inga Cardozo



ANNEX 5.

La Paz, 5 de Abril de 1982.

Señor
Andreas Lenel
NACIONES UNIDAS
Presente.-

Estimado Sr. Lenel:

Tengo el agrado de adjuntar a la presente el informe del viaje realizado a las instalaciones de La Palca, a fin de evaluar la posibilidad de prestación de servicios de acuerdo a los términos de referencia elaborados por la Corporación Minera de Bolivia.

Sin otro particular, aprovecho la oportunidad para saludar a Ud. con la mayor atención.

Ronanth Zavaleta M.

PNU	
	Acción
R.R.	<i>[Handwritten initials]</i>
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Fecha: - 5 APR 1982	

BOL/80/002

INFORME PRELIMINAR DEL VIAJE REALIZADO A LA PLANTA DE
VOLATILIZACION DE LA PALCA Y LA PLANTA DE ACIDO SULFURICO
DE EUCALIPTUS

INTRODUCCION

Entre los días 22 y 24 de Marzo del año en curso, se realizó un viaje a las instalaciones de la planta de volatilización de estaño de La Palca, y la planta de ácido sulfúrico de Eucaliptus, a efectos de verificar en el terreno, la posibilidad física de realizar los trabajos contenidos en el plan de trabajo "Alcance de Trabajo para la asistencia técnica preliminar por parte de PNUD para el proyecto de una fábrica de ácido sulfúrico en la planta de volatilización de estaño La Palca de propiedad de COMIBOL", preparado por la Corporación Minera de Bolivia en fecha 26 de Febrero de 1982, copia del cual se adjunta a la presente.

COMENTARIOS GENERALES

De los puntos contenidos en el alcance de trabajo mencionado, los tres siguientes presentar los mayores problemas para su realización:

- Determinación del volúmen útil de gases sulfurosos provenientes de la volatilización de estaño de La Palca.
- Muestreos y análisis químicos de los gases sulfurosos.
- Evaluación de los gases sulfurosos para fabricación de ácido sulfúrico.

Los problemas se relacionan fundamentalmente con la imposibilidad presente de realizar análisis químicos cuantitativos de los gases de venteo de La Palca, lo que obedece a las siguientes razones:

- Si bien se dispone de un cromatógrafo de gases dotado de 5 columnas de adsorción, que posiblemente permitiría realizar análisis de los gases emitidos en La Palca, cabe mencionar que este aún no se halla operable, en primer lugar por no haber sido todavía instalado, y en segundo por no disponerse de los gases estandar requeridos para la calibración del mismo, a fin de poder obtener de este equipo, los análisis cuantitativos de gases que son requeridos.

- Tampoco se dispondría de gas portante (helio o hidrógeno químicamente puro) que es imprescindible para la operación del cromatógrafo.
- No se tiene seguridad de que los dispositivos de muestreo de gases de chimenea y otros sean los más adecuados.

La información anterior fué proporcionada por personal técnico boliviano trabajando en La Palca, y lamentablemente no pudo complementarse con conversaciones con especialistas rusos, por hallarse estos ausentes en el momento de la visita. Se acordó que la información adicional requerida sería enviada una vez que dicho personal se constituya en La Palca, lo que permitirá verificar el presente informe preliminar y plantear las soluciones pertinentes. Sin embargo, en base a los datos disponibles, se puede aseverar ya, que de momento, resulta imposible cubrir los puntos mencionados con anterioridad, y que son lamentablemente, lo mas relevante del alcance de trabajo elaborado por la COMIBOL para esta primera fase.

En lo que se refiere a la fábrica de ácido sulfúrico de Eucaliptus, ésta se halla sin operar desde hace unos 3 años aproximadamente. Su capacidad nominal de producción de 100 toneladas métricas por día de ácido sulfúrico concentrado, no permitiría utilizar sino una fracción de los gases emitidos por la planta de La Palca trabajando a plena capacidad, por lo que tampoco representaría una solución total. Otra interrogante adicional se refiere al contenido de arsénico de los gases tratados, ya que aún en cantidades muy pequeñas sus compuestos son capaces de desactivar rápidamente los catalizadores más comunes, entre ellos los de vanadio, que son utilizados en Eucaliptus. Este aspecto es especialmente importante y debería ser estudiado en su verdadera magnitud.

Por lo demás la vuelta a operaciones de esta planta requeriría de inversiones importantes especialmente para reemplazar equipo destruído (tales como ser las piscinas de fusión de azufre y el equipo de filtrado de azufre fundido), para realizar operaciones a fondo del equipo de intercambio de color,

muy deteriorado por la excesiva dureza del agua utilizada (proveniente del Rio Desaguadero). Posiblemente tendría también que reponerse el catalizador del pentóxido de vanadio, que después del tiempo transcurrido difícilmente estaría operable, a pesar de informaciones en contrario suministradas por los encargados de mantenimiento de la planta. Sin embargo de alimentarse la planta con los gases de La Palca, podría obviarse la sección de fusión y filtrado de azufre.

RECOMENDACIONES

Como primer paso debería ponerse operable el cromatógrafo de gases, para cuya calibración se requieren los siguientes gases, en botellones pequeños y en grados para análisis:

Anhidrido sulfuroso
Anhidrido carbónico
Monóxido de carbono
Nitrógeno
Oxígeno
Oxidos de nitrógeno

Estos gases no se encuentran en el mercado local y deberán necesariamente ser importados, para lo que se tiene máxima premura. Se deberá conseguir también suministro constante de botellones de gas helio o hidrógeno para gas portante del cromatógrafo.

Deberá también asegurarse de disponer del equipo de soporte suficiente, como ser microjeringas en el rango de 5 a 20 microlitros, y material de mantenimiento adecuado. Deberá también garantizarse la disponibilidad de equipo confiable de muestreo de gases, y desarrollar una marcha de recolección y análisis cuantitativo de compuestos de arsénico contenidos en las muestras gaseosas que se tome, a efectos de determinar el contenido por metro cúbico de gas, parámetro importante para la toma de decisiones respecto a la utilización de la planta de ácido sulfúrico de Eucaliptus.

Lo anteriormente expresado hace poco factible la prestación inmediata de servicios de acuerdo al alcance de trabajo planteado por COMIBOL. Si bien se podría ir avanzando en aspectos tales como la determinación de la demanda del ácido en Bolivia y países vecinos, y la determinación del estado de la planta de

ácido sulfúrico, de momento tendría que dejarse de lado el aspecto fundamental del problema, consistente en los puntos planteados de comienzo, con el consiguiente alargamiento del tiempo de servicios requeridos.


Ronanth Zavaleta M.

La Paz, Abril 2 de 1982.



CORPORACION MINERA DE BOLIVIA

Casillas 349-674 y 1414 - Direcc. Telefónica COMIBOL - La Paz

	Acción	Inf.
REVISADO	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
APROBADO	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
A.A.	<input type="checkbox"/>	<input type="checkbox"/>
FECHA:	26 FEB 1982	

ALCANCE DE TRABAJO PARA ASISTENCIA TECNICA PRELIMINAR POR PARTE DE "PNUD" PARA EL PROYECTO DE UNA FABRICA DE ACIDO SULFURICO EN LA PLANTA DE VOLATILIZACION DE ESTAÑO "LA PALCA" DE PROPIEDAD DE "COMIBOL"

EXPERTO : Dr. Ronanth Zavaleta Mercado

DURACION: 1 mes

Bol/59/002

El experto contratado para el trabajo preliminar que será completado por el experto solicitado a "PNUD" con carta T-128/82 de fecha 3 de febrero de 1982, deberá cumplir en 1 mes, las siguientes tareas, en colaboración con técnicos especialistas dependientes de la Gerencia Técnica:

Del 1° al 5 de Marzo: Acopio de informaciones sobre fábricas de ácido sulfúrico instaladas en el país. Estudios de mercado propio y países vecinos.

Del 8 al 12 de Marzo: Estudio en detalle del estado de la Fábrica de Acido Sulfúrico de Eucaliptus para su posible traslado a la Planta de Volatilización de La Palca

Del 15 al 26 de Marzo: Determinación del volumen útil de gases sulfurosos, provenientes de la Volatilización del estaño en La Planta de La Palca.

- Muestreos y análisis químico de los gases sulfurosos
- Temperatura promedio de los gases expulsados por la chimenea.

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CORPORACION MINERA DE BOLIVIA

Casillas 349-674 y 1414 — Direcc. Telefónica COMIBOL — La Paz — Bolivia

- 2 -

- Evaluación de los gases sulfurosos para fabricación de ácido sulfúrico.

Del 30 de Marzo al 2 de Abril: Elaboración del informe preliminar y su presentación a "PNUD" y "COMIBOL"

La Paz, 26 de febrero de 1982

ANNEX 6.

Total de Producción de la Planta
de Eucaliptus en periodos de 2 -
meses

10.459.834 kilos

DETALLES DE PRODUCCION E INSUMOS CORRESPONDIENTE AL ULTIMO
PERIODO (MES DE FEBRERO DE 1978)

<u>PRODUCCION</u>	<u>CANTIDAD KILOS</u>	<u>COSTO DE PRODUCCION \$b.</u>
Acido Sulfúrico	1.929.550	863.03
Concetración	98,3 %	
Densidad Promedio	1,84	
Rendimiento	76,57 %	
Días trabajados	28	

INSUMO DE MATERIA PRIMA Y REACTIVOS QUIMICOS PARA EL TRATAMIENTO
DE AGUA

	<u>Cantidad</u> <u>Kilos</u>	<u>Precio</u> <u>Unit.</u>	<u>Total</u> <u>\$b.</u>
Azufre refinado 99,5 %	702.380	1,264	887,808,32
Carbonato de Sodio	2.300	7,60	17,480.00
Sulfato de Aluminio	1.464	5.5	8.066.64
Diatomita	120	14.12	1.694.40
Fosfato Disódico	156,5	7.18	1.123.67
Sulfito de Sodio	280,5	11.00	3.085.50
Hidróxido de Sodio	229	10,62	22.748.20
Cal	10	3.06	30.60
Fosfato trisódico	216	8.883	1.920.02
		<u>Total \$b.</u>	<u>946.389.33</u>

La Paz, 20 de Enero de 1982

