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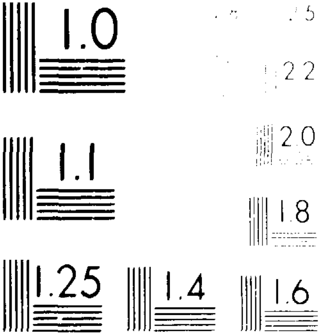
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10 November 1982.
English

ASSISTANCE TO THE ESTABLISHMENT OF AN ALUMINIUM INDUSTRY IN MOZAMBIQUE

DP/MOZ/80/022/11-01/31.8.A

Terminal report

Prepared for the Governement of the People's Republic of Mozambique by the United Nations Industrial Development Organization, executing agency for the United Nations Development Programme

Based on the work of Dr. Miklòs Kelènyi consultant on aluminium smelting technology

United Nations Industrial Development Organization

Vienna

This report has not been cleared with the United Industrial Development Organization, which does not, therefore, necessarily share the views presented.

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ABSTRACT

Data on project

- The title of the project is Assistance to the establishment of an aluminium industry in Mozambique.
- The number of the project is DP/MOZ/80/022/11-I/31.6.A.
- Purpose of the project is to contribute to the development of an aluminium industry in Mozambique based on available hydro-electric and other potential natural sources (bauxite, nepheline syenite, fluorspar etc.).
- The immediate objective is to assist the Aluminium Project Cabinet under National Directorate for Energy and Aluminium in Ministry of Industry and Energy, in strenghtening their technological and negotiations capabilities in techno-economic aspects of aluminium production and manufacturing, including direct processing of primary aluminium into semi-products.
- Duration of the mission being reported on is six months, which is second phase of split mission.

Main conclusions and recommendations

- Assistance both to smelting technology and industrial economics proved to be useful and inevitable. Executives of National Directorate for Energy and Aluminium make all the efforts to find the best ways possible for organization of preliminary activities regarding the establishment of the aluminium smelter.
- The Feasibility Study prepared by FATA-HUNTER of Italy is expected in Maputo by December 1982. or early 1983. The Soviet Feasibility Study is somewhat delayed and this too could be in Maputo by April/May 1983. That means both the Feasibility Studies should be available for examination and discussions in the second quarter of 1983. During the first quarter of 1983 both the Studies have to be examined, fully clarified and evaluated for the Government of Mozambique to take and investment decision.

  Expert assistance to the Aluminium Project Cabinet in Ministry of Industry and Energy is inevitable during this period, both on area of smelting technology and industrial economics.

For assignment of Industrial Consultant (Smelter Technologist) a suggestion on job description is given under Findings and Recommendations of this Report.

- It has to be emphasized again the need to start immediately to build-up a team of aluminium industry, to train Mozambiquean specialists and concentrate on this field for the smelter. This team should over the years needed be kept together during planning, facilities design and construction, commissioning and for ultimate operations. The team could be structured now within Aluminium Project Cabinet and become the base personnel in Aluminium Project Cabinet and transferred to the Aluminium Plant for operations. One of the important items to be attended to and finalised is the training programme for the senior and junior supervisors required for the Project since there is a shortage in trained engineers and technicians in Mozambique. Available possibilities in frame of existing bi-lateral agreements regarding education of Mozambiquean students at universities in foreign countries ought to be also utilized.

- The proposed smelter is based wholly on imported alumina since it will not have its captive alumina plant. Parallel to evaluation of Feasibility Studies actions are necessary to get in touch with the likely sources and agencies including various Governments for exploring and firming up financial resources. Special effort will have to be made to explore sources of export finance credit from among interested countries.
  For discussions on long-term agreements and on international cooperation aspects, short term consultant assistance to the Aluminium Project Cabinet is needed as it was useful earlier during discussions with the Indian delegation in March 1982.

- Feasibility Studies for downstream facilities based on the "Development Study on Aluminium Manufacturing and Use in Mozambique" would need and be commissioned during 1983. After decisions made based an these Feasibility Studies, design and construction should start immediately.

- In the third and fourth quarter of 1983. should be identified and selected the supplier firm of the know-how and Basic Engineering.

  This will also be an evaluation work and UNIDO assistance to Aluminium Project Cabinet during this period will also be needed. As to the activity of Smelter Technologist, it could take another six weeks.

- The pre - Feasibility Study on the mining and benefication of fluorite deposits to produce cryolite and aluminium fluoride for supplying smelter and for export was commissioned in October 1981 under the ageis of UNIDO for the Aluminium Project Cabinet. After receiving this study (which is expected shortly) examination and financial decision has to be made and design construction should start immediately.

- Before decisions are made on the sources of raw materials supply or the marketing outlets for the future metal or the choice of smelter technology, design and know-how, I strongly recommend again extensive and even repeated discussions with at least the top leaders in the aluminium industry.

  Talks with only 2-3 companies that may have shown interest to date with respect to the smelter design/construction is not a wise approach for either an investment that in the initial stages will require three quarter Billion US $ or which has ultimate potentials for Mozambique in the World Aluminium Industry to make Mozambique the leader in aluminium in the whole South African region.

- As I recommended during first phase of my assignment Japanese firms should be contacted. The Japanese aluminium smelters completely lost their international competitiveness because of their extremely high electric power cost. As they were forced into large production cutbacks and partial shutdowns of their plants promotion of overseas captive - import development projects is understandable.

Japanese firms might also be able to construct the Mozambiquean smelter on a turnkey basis.

- Taking into consideration all the local circumstances it is strongly recommended constructing the smelter on a turnkey basis supervised by an independent consulting firm.

- As to the preferable technology I recommend to choose one of the technologies of the seventies having performance data as follows

Amperage (current intensity)	165-185 kA
Pot voltage	4,1-4,3 V
Power consumption D.C.	13500-14500 kWh/t Al
Current efficiency	0,88-0,93
Net anode consumption	440-460 kg/t Al
Net fluoride consumption	12-15 kg/t Al
Production/pot, day	1100-1350 kg
Crust breaking/alumina feeding system	Central
Pot arrangement	side by side

Automation: medium sophisticated with microprocessors for individual pots or groups of pots and with central computer.

- Aluminium Project Cabinet should accept only a pot construction having performance data truly justified in an operating smelter during a period of one year at least.

Applying half-developed construction would result in bad experiences and extremely high operation costs while virtual savings in investment costs has to be considered doubtful.

Drilling

INTRODUCTION

Project background

- The country has a significant hydroelectric potential already in operation, the Cabora Bassa dam, with an installed capacity of 2 GW. A high voltage power line will be established at the end of 1983 from Cabora-Bassa to Tete, Caia and Mocuba.

- Out of the total present generation capacity of 2 000 MW, 1 600 MW is committed to RSA and therefore only 400 MW of theoretical power on a nonfirm basis is available. The II. phase of Cabora-Bassa Project envisaged additional generation of 1 600 MW and the time schedule of its implementation was indicated to be by 1986-1987. About 360 MW of firm power would be required for an aluminium smelter of a viable and economic size (100 000 - 180 000 MTPY) capacity.

- The reserves of bauxite deposits in the country are estimated at some 60 million tons. In addition, hundreds of million tons of nepheline syenite are reported to occur. Studies are under way with a view determine the exact reserves but uncertainty on quality and quantity on one side, huge investments required and relatively high production costs, on the other side, support the idea to rely, at least during the first period of operation, on import of alumina for feeding a new smelter, within the framework of international/regional industrial co-operation, based possibly on the new aluminium production to be created in Mozambique.

- The People's Republic of Mozambique has an estimated population of 12 million inhabitants and thus represents an important potential consumer's market for semi-manufactured and other value added aluminium products. At present there is only one small aluminium processing or manufacturing company in the country, ALUMOC, producing pots and pans from imported aluminium circles and sheets. Most urging and economic use of aluminium required for the developing of the national economy, local and regional needs of value-added, semifabricated aluminium products should be studied in parallel with and to be considered by the study and investment activities for the new smelter.

- One of the important and valuable materials required in considerable quantities for aluminium smelting are fluorite salts, cryolite and aluminium fluoride. Modern aluminium smelters of a capacity of 100 000 to 180 000 tpy use up to 6 000 tons of these materials annually, of a value of 5 - 6 million US dollars. Mozambique possesses considerable deposits of fluorspar which is the main raw material for producing fluorite salts by benefication and chemical processing. Mining of fluorspar deposits has also been carried out to some extent and the assessment of deposits, the pre-investment study of organizing industrial processing to the extent required for the new smelter are becoming actual.

- Considering all the above the Government considered with priority the need to create the most important conditions for the establishment of an aluminium industry to supply the local and external market making use of available electric energy and other natural resources as competitive factors with a view to facilite the growth of internal consumption and exports to international markets. A working group established in the National Directorate of Energy in Ministry of Industry and Energy is already working on this subject. The responsability lies with Aluminium Project Cabinet.

- The Aluminium Project Cabinet wanted also to contract the services of additional individual UNIDO experts to participate in studying and negotiating tasks and to complement the preparatory studies with additional pertinent technological, economical and financial information in preparation of the necessary documents to allow optimum investment decision.

Official arrangements

- The assistance was approved on 18.12.1980, by the Governement of Mozambique and by the Executing Agency on behalf of United Nations Industrial Development Organization.

- Starting date - according to Project Document: January, 1981.

- Activities began in September and October 1981. With starting preparation of study on requirements and techno-economic feasibility of developing an aluminium manufacturing industry in the country and pre-feasibility study on the mining, benefication of fluorite deposits to produce cryolite and aluminium fluoride for supplying a smelter and for export.

- Expert on the area of Aluminium Smelting Technology arrived in Maputo on 20.11.1981. and terminated first phase of assignment on 15.03.1982. second phase of his assignment started on 31.05.1982.

- Expert on the area of Industrial Economy arrived in Maputo on 02.12.1981.

- The name of co-operating agency is Aluminium Project Cabinet under National Directorate for Energy and Aluminium in Ministry of Industry and Energy.

Contributions

- UNDP inputs Stated in the Project Document: US$ 390.400 Government inputs: US$ 10.000 in local currency.

- UNDP inputs have been adjusted to US $ 435 162 + 302 000 for the years 1983 - 1984.

Objectives of the Project

- The immediate objectives are to assist the Aluminium Project Cabinet in the National Directorate for Energy and Aluminium in Ministry of Industry and Energy in the following fields:

- international industrial co-operation in aluminium production
- development of aluminium semi-products industry
- industrialization of fluorite deposits
- strenghtening the technological and negotiations capabilities of the Aluminium Project Cabinet in techno-economic aspects of aluminium production and manufacturing.

MAIN DUTIES OF JOB DESCRIPTION

Taking into consideration that original time of duration of mission has been reduced from 12 months to 11 months and changed to be split mission, duties fixedx in original job description also were devided into two phases.

The planned work programme for the second phase was accepted by Director of Aluminium Project Cabinet in Ministry of Industry and Energy, as follows:

The smelter technology consultant will particularly expected to

a) evaluate feasibility studies and proposals submitted on establishment of the proposed plant. The environmental loads and protection measures must also considered in this input

b) supply the necessary technical know-how required for an integrated view of the project including production of main materials, alumina, anodes etc.

c) collect relevant data specifically on the external market for aluminium and by-products, specified by areas and countries, medium and long-term consumption, forecast, prices and production tendencies

d) organize in cooperation with the Industrial Economist of Unido fielded in Maputo, a seminar for national cadres within the scope of the project, in fields such as world development and status of process technology and equipment of aluminium smelting, quality and quantity of material/energy input and economic operation, state of art of direct processing of molten metal to semi-fabricates, substantive background of economic calculations and mobility, internal and export market requirements etc.

e) advise on all technical matters concerning the smelter project

f) participate in discussions with potential supplier firms

g) travel to potential supplier's plants according to programmes for study tours worked out in first phase of mission, and advise Government Officials during the visits in smelter plants

h) prepare a preliminary and a final report on the results achieved with the preparation of the planned programme.

[illegible] that by virtue of the nature of my job I had to render assistance and give proposals and not to make a study, the body of my report is an assembly of various memoranda and reports prepared and rendered over the period of my assignment (second phase of split mission). The initial official arrangements I reported in my Preliminary Report dated on 15.07.1982. (Annex 3.)

ACHIEVEMENT OF IMMEDIATE OBJECTIVES

My consultancy was requested continuously by the National Counterpart Staff in Aluminium Project Cabinet. I feel the results achieved are matching with the schedules and targets of the work plan. Assistance was rendered according to the modified job description. I was involved in all meetings and discussions related to the preparation work of establishment of Mozambique's Aluminium Smelter.

UTILIZATION OF PROJECT RESULTS

Assistance in field of aluminium smelter technology have been utilized during the period of my mission to the possible extent. Utilization of further assistance might be influenced advantageously by building up a strong Mozambiquean National Team in Aluminium Project Cabinet, for the preparation work of establishing the smelter.

This team could be the "Personnel Bank of All Know-how" relating to Mozambique's Aluminium Industry.

Dr. T. B. Singh, UNIDO Consultant on field of Industrial Economy dealing with world & regional projections & present status of aluminium demand & supply position, the major inputs, their sources & the techno-economic viability of a smelter complex both from the Capital & Operational cost point of view, worked simultaneously on his job. We formed a team and had an excellent cooperation for the benefit of Mozambique's Aluminium Industry.

FINDINGS AND RECOMMENDATIONS

- As the assistance, which was foreseen under the project, for Mozambique's smelter was essentially related to the technical planning aspects and my consultancy was requested continuously by my counterparts, the essence of my contribution was condensed in a series of memoranda, analyses and reports.

- At discussions, negotiations I was called upon to analyse, respectively make recommendations related to the specific topics dealt with. I took part in organization of Study Tours. My reports on Study Tour No. 1 is attached to this report.

- The second Study Tour could not be arranged due to administrative difficulties caused by financial problems.

  I took part also in a tour to Italy, where we continued discussions on feasibility study being prepared by NEW HUNTER ENGINEERING of Italy. During the period of the tour two smelters have also been visited. My report on the visits is attached to this Report under Annex 11.

- The most important recommendations I mentioned in the ABSTRACT of this report.

- For the assignment of Industrial Consultant (Smelter Technologist), I give below a suggestion on job description made it agree with Director of Aluminium Project Cabinet in Ministry of Industry and Energy on 08.10.1982.

Post title and purpose of project: unchanged
Duration: six (6) weeks,
Date required: first quarter of 1983
Duties: the smelter technology expert will particularly expected to:

a) eveluate the two Feasibility Studies submitted on establishment of the proposed plant from technology point of view. The environmental loads and protection measures must also be considered in this input.

b) supply the necessary technical know-how required for an integrated view of the project including production of main [illegible], [illegible], [illegible] etc.

[illegible]) advice on all technical matters concerning the smelter project

[illegible]) participate in discussions with Suppliers of Studies on technical matters if required

[illegible]) prepare for the Aluminium Project Cabinet a short report and comments on technical aspects of Feasibility Studies submitted.

Separate short report has been made by Dr [illegible].B. Singh and me on activities covered under Aluminium Project Cabinet between period November 1981 to November 1982 also projections for 1983 - 1984 which was handed over to Mr Goulart, UNIDO SIDFA.

The Development Study on Aluminium Manufacturing and Use in Mozambique was received in early August 1982. The UNIDO experts and the officers of Aluminium Project Cabinet have jointly studied this report and comments and recommendations were also handed over to Mr Goulart, UNIDO SIDFA.

During my assignment I made proposals, and recommendations initiated by discussions on different subjects and reports on study tours, as follows:

- Aspects to be studied during the Study Tours (guidelines) (Annex 4.)
- Comments on the "Development Study on Aluminium Manufacturing and Use in Mozambique (Annex 6.)
- Report and Comments on Study Tour No 1. (Annex 7.)
- Revised programmes and routings for participants in Study Tour No. 2 (Annex 9.)

- Primary Aluminium Production in Japan

  (Annex 10).

- Technical Report and Comments on smelters visited during the tour to Italy

  (Annex 11).

- Brief description of some common technical expressions used by personnel associated with aluminium smelting

  (Annex 12).

SENIOR COUNTERPART STAFF

MR. Francisco Caravela Director of National Directorate for Energy and Aluminium in Ministry of Industry and Energy

MR. Pedro Casimiro Director of Aluminium Project Cabinet under National Directorate of Energy and Aluminium

MR. Alexandre Zandamela Assistant to Director of Aluminium Project Cabinet

MRS. Paula Viana Senior Economist

ANNEX 2

NAMES AND FUNCTIONS OF PERSONS CONTACTED DURING THE PERIOD OF ASSIGNMENT (SECOND PHASE, FROM 04.JUNE THRU 10.NOVEMBER 1982)

Mr Karl Holt, National Directorate for Construction

Mr Gennaro De Rosa, Consulting engineer (FATA-HUNTER)

Mr Ing. Vittorio Magliocco, Commercial Director(Technimont)

Mr Giorgio Dazzi, Export Manager (FATA)

Mr Yves Salmon, Director of African Affairs (Pechiney)

Mr Jean Marie Pache, Head of Technical Assistance (Pechiney)

Mr Andre Dourat, Director, Saint Jean de Maurienne Plant (Pechiney)

Mr Roger H. Zanes, Sales Manager, Technology Marketing (ALCOA)

Mr Jack A. Lang, Manager Client Technology (ALCOA)

Mr Keith W. Parks, Mechanical Engineering Manager (ALCOA)

Mr Robert C. Mc. Cormack, Assistant Chief Mechanical Engineer(ALCOA)

Mr James A. Smith, Electrical Engineering Manager (ALCOA)

Mr M.J. Kazeef, General Manager (ALUMAX, Mt. Holly)

Mr Robert A. Cheatham, Plant Manager (ALUMAX, Mt. Holly)

Mr K. Farmer, Potroom Superintendant (ALUMAX, Mt. Holly)

Mr P. Campbell, Carbon Plant Superintendant (ALUMAX, Mt. Holly)

Mr A. Mazoni Andrade, Director Executive (IESA, Brasil)

Mr Domingos Sodre, Director Executive (IESA, Brasil)

Mr C. Dutra de Aboim, Director Commercial (IESA, Brasil)

Mr Duk Ki Kim, Metallurgist (IESA, Brasil)

Mr Luis de Soveral, Director (IESA, Brasil)

Mr Alvaro de Castro, Engineer, Metallurgist(IESA, Brasil)

Mr Nonato de Medeiros (IESA, Brasil)

Mr Claudio H. M. Mazoni Andrade, Assistant Executive Technical Director (VALESUL ALUMINIO S.A. SANTA CRUZ)

Mr Yoshitaka Sambongi, General Manager, SUMITOMO CORPORATION, MAPUTO LIAISON OFFICE

Mr Orlando A.Dos Santos, SUMITOMO CORPORATION, MAPUTO LIAISON OFFICE.

Mr. [illegible], [illegible], [illegible] & Co. Representative

[illegible] [illegible], Director, Engineering [illegible] of [illegible]

Mr [illegible], General Manager NEW HUNTER

Mr [illegible], Metallurgist, [illegible]

Mr Giuseppe [illegible], Engineering & Construction Manager, Alluminio Italia

Mr [illegible], Director of Porto Vesme Smelter, Alluminio Italia

Dr Giulio Guglielminetti, Sales Manager, NEW HUNTER ENGINEERING

Dr Antonio Serra, Technical Director, Fusina Smelter, Alluminio Italia

Mr Vladimiro Sobkowski, Commercial Director, NEW HUNTER ENGINEERING

Mr Giuseppe Callaioli, President, Alluminio Italia

Mr Di Rosa, Chairman, NEW HUNTER ENGINEERING

PRELIMINARY REPORT

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

(UNIDO)

SPECIAL INDUSTRIAL SERVICES PROJECT

FOR PEOPLE'S REPUBLIC OF MOZAMBIQUE

by Dr. M. Kelényi

Industrial Consultant

DP/MOZ/80/022/11 - I/31.8. A

Period: 31.05.1982 - 15.07.1982

The purpose ofProject is to contribute to the development of an aluminium industry in Mozambique. The immediate objective is to assist the Aluminium Project Cabinet in National Directorate of Energy (Ministry of Industry and Energy) in stenghtening their technological and negotiations capabilities in techno-economic aspects of aluminium production and manufacturing.

This is second phase of split mission, started on 31.05. 1982. Duration of assignment: six months.

The aim of this Preliminary Report is only:

1. To give an account of what has happened since arrival at UNIDO-Vienna and the Aluminium Cabinet in Maputo

[illegible]

1.1 During my briefing in [illegible] on my activities [illegible] Mr. [illegible], UNIDO Headquarters. I met also Mr. [illegible] (Training Section).

[illegible] job on preparation of Study Tours, but in lack of information on my participation all the preparations were made for counterpart participants only.

Further difficulties were caused by leaving out of consideration agreement regarding my travel expenses for Study Tours, put down in my Terminal Report, page 5. last paragraph.

I have to express the hope that all of these problems are solved (or will be solved in short time) and will not cause further disturbance in fulfilment of my duties.

1.2. Work office has been provided me very conveniently at new Headquarters of Aluminium Cabinet.

1.3 I met the representatives of [illegible] in Jakarta for collecting data needed for preparation of Smelter Feasibility Study. They promised to give me proper technical data on their technology by September 1982. The Feasibility Study will be ready by the end of this year.

1.4 During the period from 19 June through 12 July. 1982. we visited three smelters in France, USA and Brazil. Counterpart participants were Mr. A. P. Cendrawo, Director of Aluminium Cabinet and Mr. A. Zainal Assistant to Director of Aluminium Cabinet. We met some of the technology suppliers and users of these technologies. We dealt with

3

technical questions only, according to instructions got from UNIDO re UNDP Office in Maputo.
Tasks for Study Tour No 1. has been fulfilled, as were planned in January, 1982, except the visit to the Aluar Smelter at Puerto Madryn, Argentina, due to the war situation.
My Report on Study Tour No.1. has been handed over to Mr. Goulart, UNIDO SIDFA in Maputo and Mr Casimiro, Director of Aluminium Cabinet as well.
The Report will also be attached to my Terminal Report.

2.1 The work programme were planned according to the modified duties of job description, which is included in Terminal Report on my first phase assignment (page 9.)
During my briefing in Vienna (on 2nd June) I handed over a copy of the mentioned job description to Mr. K. Yoshino for sending it officially to UNDP Office, Maputo, but it has not yet received.

2.2 Due to the probable delay in preparation of Feasibility Studies, evaluation of studies can not be worked out during the period of my assignment. It has to be done in first quarter of year 1983.

2.3 Programme of Study Tour No. 2 has been modified due to the delay mentioned above. Tentative programme enclosed and to be dispatched to Mr. Sean Hand (Training Section) for processing travel authorization. Participants are the same as in case of Study Tour No.1. (Mr. A. P. Casimiro Director of Aluminium Cabinet, Mr. A. Zandamela Assistant to Director of Aluminium Cabinet and Dr. M. Kelényi UNIDO expert).

2.4 I am planning and proceeding on the basis of making my Project Terminal Report simply the assembly of various memoranda reports etc. prepared and released over the period of my assignment.

[illegible] 2.2. and 2.3 (including annexes) has been [illegible] [illegible] was accepted by him.

[illegible] has not been checked [illegible] and does not therefore necessarily [illegible] the [illegible] presented.

Attachments: Annex 1. and 2.

[illegible] Shen

ANNEX 1.

Tentative programme for Study Tour No. 2. (revised)
DP/MOZ/80/022

Mr. A. P. Casimiro (counterpart)

	Needed days	Number of days
Travel Maputo - Vienna - MonteCarlo - (discussions at UNIDO Heodquarters, participation in Aluminium Congress in Monte Carlo) - Turin	8	1 - 8
Travel Turin - Porto Vesme	1	9
Visit to smelter.	1	10
Travel Porto Vesme - Rome - Tokyo	3	11 - 13
Discussions in Tokyo	2	14 - 15
Travel Tokyo - Toyo (Matsuyama)	1	16
Visit to smelter	1	17
Travel Toyo - Niigata (Miike)	1	18
Visit to smelter	1	19
Travel Niigata (Miike) - Tokyo	1	20
Travel Tokyo - Frankf - Sofia - Maputo	3	21 - 23
reserve	2	
Total	25	

Air tickets to be paid in Metikais: Maputo - Vienna
Sofia - Maputo

Date of departure 16.09.1982. (planned)

ANNEX 2.

Tentative programme for Study Tour No. 2. (revised)

[illegible]/80/[illegible]

Mr. A. [illegible] (counterpart)
Mr. H. [illegible] (UNIDO)

	Needed days	Number of days
Travel Maputo - Paris - Turin	2	1 - 2
Discussions in Turin ([illegible])	3	3 - 5
Travel Turin - Porto Vesme	1	6
Visit to smelter	1	7
Travel Porto Vesme - Rome - Tokyo	3	8 - 10
Discussions in Tokyo	2	11 - 12
Travel Tokyo - Toyo (Matsuyama)	1	13
Visit to smelter	1	14
Travel Toyo - Niigata (Miike)	1	15
Visit to smelter	1	16
Travel Niigata (Miike) - Tokyo	1	17
Travel Tokyo - Frankf - Sofia - Maputo	3	18 - 20
reserve	2	
Total	22	

Air tickets to be paid in Meticais: Maputo - Paris
Sofia - Maputo

Date of departure: 19.03.1982. (planned)

MEMORANDUM

09.06.1982 MAPUTO

Enclosed I give some of the aspects to be studied during the study tours. I have to underline, that so much data can not be collected during a short visit in general. The plants management dont like to answer certaim questions relating to performance data.

We have to try to find out some details seeing the equipment in operation, if possible.

The material prepared could be a guideline to be followed during the visits.

ASPECTS TO BE STUDIED DURING STUDY TOURS

By Dr.M.Kelonyi UN expert

1. Technical aspects

a. Total plant: product selection, capacity by departments, area of total plant/ specific area of the smelter source of water supply, plant demand m^3/day source of electric energy, power demand MW climatic, meteorologic conditions table of plant organization, number of employees

b. Potlines and pots

Production capacity of reduction plant
Number of potlines
Number of potrooms/potline
Operating pots/potline
Amperage/potline
Potline voltage
Type of pots
Pot arrangement
Current efficiency
Power consumption DC KWh/t Al
Power consumption AC for the total reduction plant
Alumina consumption t/t Al
Aluminium fluoride consumption Kg/t Al
Other additives:
Cryolite consumption (Na_2O content in alumina) Kg/t Al
Fluorspar C. Kg/t Al
Soda ash C. Kg/t Al

Type of used alumina (spec. surface)
Anode consumption gross t/t Al
Anode consumption net t/t Al
Size of anode butts %
Weight of cathode insulation
" shell
Weight of anode (total)
Weight of busbars/pot
Current density in busbars
Dimensions of potrooms
Anode effect frequency/pot day

Manpower for reduction plant hours/t Al

Dimensions of potrooms

Building structure of potrooms

Number of cranes/potroom

Special (ECL)

Common

Break - feed system, cycle of operation

Pot tending:

anode changing, cycle

anode sliding, cycle

metal tapping, cycle

Molten metal transport

Size of tapping laddles, number/potroom

Pot life-time

Pot relining, in place or in separate shop

Cathode baking system

Process control software

Pot resistance

Alumina feed

Detection, announciation and suppression of anode effects

Resistance control during tapping

Compensation for heat loss during anode changing

Data collection reporting

Potline load control

Plant electrical demand control

Origin of process control hardware

Gas cleaning system (primary, secondary)

Applied equipment

Values of clean gas: F gas mg/N m^3

F dust mg/N m^3

Total dust mg/N m^3

Means of environmental control

Quantity of fluoride recovered by cleaning system (ifany)

Alumina supply and handling system

Unloading and storage

Primary alumina storage for ....days supply ....t

Alumina tanks feeding potroom fume control

for.... days supply ....t

Alumina tanks downstream from fume control

for....days supply.... t

Pot day tanks for .....hours supply .....t

Work schedule: potrooms shift/week, hours/shift
potroom service " - " -

c. <u>Anode plant</u>

Net production t/year
Petroleum coke consumption
Pitch consumption
Gas/oil consumption Nm^3/t anode
Heting value of used fuel K J/Nm^3, t

Water demand m^3/hour
Number of production lines
Number of baking furnaces
Number and type of special cranes
Type of baking furnaces
Type of mixers
Gas cleaning system
Removal of hydrocarbons %
" of fluorides %

Used materials:

Calcined petroleum coke
Specific density Kg/dm^3
Bulk " "
Sulphur content %
Screen analyses (8 - 1mm)
Chemical analyses Si, F, V
Coal tar pitch (liquid or solid)
Specific weight g/cm^3 min
Sulphur content % max
Coking value Conradson

Green carbon manufacture
mode of forming anodes
green density

Carbon Baking and cooling
Carbon rodding
Transport and storage

Coke silos for .... months supply ,...t
Pitch silos for.... months supply ....t

Baked anodes

Rodded anodes

Working schedule

Rodding	hours/shift,	shift/week
Carbon plant	"	"
Baking furnace firemen	"	"

d. <u>Foundry</u>

Product selection

Production data

Equipment according to the product selection

Rod casting

Strip casting

Rolling slabs - ingots

Extrusion billets

Remelt ingots

Number of mixing - melting furnaces

Capacity " " "

Number of homogenizing furnaces

Capacity "

Required area for foundry building

e. <u>Electrical</u>

Energy supply system and rectifier stations

Number of incoming lines

Step down station voltages KV/KV

Number of main transformers

Power factor and its improvement

Number of distribution voltage substations

Number and capacity of rectifier stations

Number and type of units/station

Standby/station

Cooling of rectifiers (water demand if any)
Regulation system DC (constant current, power etc)
Mode of regulation (common, individual, transductors, tapchanger)
Range of regulation (off-load ranges, onload ranges)
Back reaction to the network
Rectifier efficiency (transducers if any, saturated)
Required area for switchyard, rectifier stations, main busbars
for feeding the potlines

Control room equipment
Manpower requirement for supervision and maintenance

f. Harbour Facilities (if any)

Capacity of alumina silos
Capacity of coke silos
Ship unloading
- Capacity of unloader (Al_2O_3) t/h
- Capacity of unloader (coke) t/h
- Unloaders type

Transport to transfer silos

2. Construction

History of construction
Engineering and main contractor firms
Time schedule followed during construction period
Control/monitor system in planning the construction (CPM, PERTH)
If there were overrun (or spill over) in the original time schedule. If so, its main reasons and also its impact on techno - economic aspects

Number and area of subcontractors involved in construction activity

Manpower requirement during construction

a. Owners organization
b. Consultant/contractors organization
c. Mechanism of interfacing

Training of personnel (in house training facilities)
Supervision by technology seller during

Construction
Start-up
Steady operation

3. <u>Techno - economic</u>

Possibilities of supplying

technology
detailed engineering
supervision for the period of first years
operation

Ensuring training possibilities in seller's plants for

management
engineers
supervisors
skilled workers

Transfer future development of technology bought
Possibilities of supplying raw materials for the smelter

Possibilities of cooperation in establishing the smelter, based on mutual interest concerning requirements of Mozambique for aluminium smelting vis-a-vis long term metal delivery.

Approximative prices for available

Technology know-how (fee)
Detailed engineering
Supervision
Alumina
Petroleum coke
Pitch

Their views on main techno-economic factors relating to a 150 000 MTPY smelter (or near about) to the extent they may be willing to reveal and indicate

a. Optimum size at a given contest
b. What should be the realistic time schedule for setling up the smelter in developed and developing country
c. What should be the power price (maximum limit) to keep the smelter viable (in 1982 and 1987)
d. How modern or outdated the smelter technology can be
e. What should be the internal rate of return of the smelter

MEMORANDUM

10.06.1982 MAPUTO

Enclosed you will find a draft suggestion of the reply to be sent to the firm Sumitomo Aluminium Smelting CO. The suggestion was made after a discussion with Mr Casimiro, Director of Aluminium Cabinet.

I have to draw your kind attention to Memorandum on the same subject handed over on 04.01.1982.

I should repeatedly emphasize the importance of getting contacts with Japanese firms, taking into consideration the existing energy problems in Japan, their aluminium demand and last but not least the advanced technology know-how available through them.

Draft suggestion

SUMITOMO ALUMINIUM SMELTING CO. LTD.

7-9, NIHONBASHI 2 - CHOME, TOKYO 103 JAPAN

Mr. T. Machida

Manager, License Coordination
Technical and Development Dept.

10.06.1982 Maputo

Dear Sir,

Refer to your letter dated 14. April 1982. We understand, you are willing to study our inquiry and ready to supply the know-how needed for an aluminium smelter of required plant size.

We have got some information on your advanced smelter technology and therefore we took into consideration your Company as a potential supplier of technology know-how.

For the estimation the size and scope of the work to be required, we give the information as follows:

Plant size: 150 000 MTPY, together with anode plant of a capacity matching with smelter capacity, and foundry for producing ingots, billets for extrusion, properzi rods and wide strips.

Scope of assistance expected from know-how supplier would consist of engineering, supervision during period of construction, training of personnel and supervision during start-up and first years of steady operation.

We are also interested in buying raw materials from the Know-how supplier on basis of long - term agreements.

We are at a stage of preparing Feasibility Studies and of evaluating the sources, terms, prices and reliability of potential suppliers of smelting technology and raw materials for the smelter facility.

To make easier our preparatory work, you are kindly requested to receive our officials for a short visit in second half of September 1982 to your Toyo Smelter.

More detailed information on progress on our smelter to be established also would be given during this short visit.

We would appreciate your responses at an early date.

Very truly yours.

16.06.1982 Maputo

COMMENTS ON THE "DEVELOPMENT STUDY ON ALUMINIUM MANUFACTURING AND USE IN MOZAMBIQUE"

The study has been worked out in the frame of the assistance in the establishment of an Aluminium Industry in Mozambique.

Number of the Project: DP/MOZ/022

The consulting firm studied the requirements and techno - economic Feasibility of developing an aluminium manufactoring industry in the country and taken into consideration to the possible extent the local and regional/export market demands, possibilities for economic substitution of other (imported) materials by aluminium.

They elaborated on present consumption of aluminium and production and consumption forecast for aluminium until the year 2000, analysed the world's aluminium production and consumption, and gave price trends of aluminium and other structural materials.

Short term program for manufacturing aluminium finished products, production capacities, raw material, power and water consumptions, staff requirements investments and operation costs, suggested time schedules also included in body of the report.

Manufacturing of semi-products recommended on the production in Mozambique comprising of

rolled products
cast and rolled products
extruded and drawn products
wire and cables
forgings
remelting facilities

has also been detailed. They submitted basic details on techno-economic aspects to the needed extent.

[illegible]

[illegible]

[illegible] of increasing the aluminium consumption, [illegible] developing the aluminium industry [illegible]

[illegible]

[illegible]

[illegible] for domestic consumption

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.2

In general, while working the study out, all the requirements specified by terms of reference were taken into consideration to the [illegible].

[illegible] during the period of preparatory work relating to the development of the aluminium industry in [illegible].

3

Data and findings related to the marketing aspects will be helpful in solving the problems of lack of proper data needed for the preparatory activity mentioned above.

Depending on decisions, design and construction activities could begin at the end of 1982 and in 1983, according to time schedules given in Fig. 3. and Sig. 5. It could be advisable to use part of UNDP contribution to the Project DP/MOZ/80/022 for financing design work in frame of subcontracts.

Dr. Miklos Kelényi
UN expert

[illegible]

[illegible] No. 1.
([illegible] - [illegible])

By Dr.M.Kolenyi UN expert

[illegible] July we visited three [illegible] [illegible]. Counterpart participants were Mr. [illegible], Director of Aluminium Cabinet and Mr. [illegible], Assistant to Director of Aluminium Cabinet. We met some of the technology suppliers and users of these technologies. We had discussions with them on technical details on operation and [illegible] of applied technology equipment as well.

We dealt with technical questions only, according to instruction got from UNIDO [illegible].

[illegible] Study Tour No. 1. as were planned in January 1982 has been fulfilled except the visit to Aluar smelter in Argentina, [illegible]. Besides the original program, during our stay in New York, we had discussions with representatives of United Nations Centre on Transnational Cooperations, as have been advised by UNIDO.

In chapter A. I give a summary and comments on information collected during the visits, chapter B. contains details on the same.

A. Summary and comments

Table 1. summarizes some of the data characteristic to technologies applied to visited smelters. Also contains calculated specific figures and data relating the construction as well.

All of the technologies use coarse grade alumina and dry scrubbing systems of high cleaning efficiency. Technology and equipment of auxiliary shops (carbon plant, baking shop, foundry) are similar to each other and up to date (except old parts of St Johns smelter, where experience of personnel balances disadvantages of old equipment).

Based on comparison of data given in table 1. and on details given in chapter B. of this report, Alcoa's Mt. Holly plant has to be preferred to the other two plants.

Differences between performance data on St. Jean's and Mt. Holly's plant are not significant, but Alcoa's pots have the advantage of possibility to raise production by approximately 3,5 per cent simply by raising the amperage. Suitable arrangement of pots on ground level results in lower building costs. Using continuous air slide pot bin feeding, number of ECL cranes can be reduced by one half, working conditions will be improved as well.

The Reynolds technology is one of the best technologies, but performance, construction and investment cost data given in table 1. and details in chapter B. indicate higher consumption of raw materials and energy as well as higher investment cost.

Economic size of smelter:

Pechiney, 180 KA				
	1 potline,	204 pots:	99 000 MTPY	MAX.
	2 potlines	360 pots:	175 000 "	MIN.
Alcoa, 180 KA				
	1 potline,	204 pots:	100 000 "	MAX.
	2 potlines,	360 pots:	178 000 "	MIN.
190 KA				
	1 potline,	204 pots:	104 000 "	MAX.
	2 potlines,	360 pots:	184 000 "	MIN.
Reynolds, 155 KA				
	1 potline,	216 pots:	86 000 "	MAX.
	2 potlines,	432 pots:	172 000 "	MIN.

Data to be collected during Study Tours No. 2. (under preparation) will give the possibility to work out a complete evaluation of technologies available at world market.

Tender invitation can be prepared based on experiences gathered during Study Tour No. 1 and No. 2. and on market studies of Feasibility Studies.

[illegible]	St. Jean [illegible]	[illegible]	[illegible]
Total production MTPY	25 000	170 700	[illegible] ([illegible])
Number of potlines	1	2	1
Number of potrooms	2	4	2
Total number of pots	80	300	216
Total area of potrooms m²	[illegible] 000	56 384	26 000
Amperage kA	[illegible]	100	105
Anode current density A/cm²	0,77	0,75	0,80
Current efficiency %	93,3	92,5	88
Pot voltage V	[illegible],77	4,07	4,3
D.C. power consumption kWh/t Al	13 324	13 640	14 470
Gross anode consumption kg/t Al	577	563	700
Net anode consumption kg/t Al	437	435	480
Net fluoride consumption kg/t Al	12,5	16,[illegible]	15
Cryolite consumption kg/t Al	–	–	15
[illegible]	[illegible]	[illegible]	[illegible]
Weight of steel/pot t	113,2	105	112
Production/pot, day kg	1 [illegible]	1 300	1 100
Potroom level	raised	ground	raised
Number of employees, total	not characteristic	705	583
Total investment cost 10^6 $	n.a	300 *	304 **
Construction period months	14 (not Ch.)	15	51
Specific data per al. production			
Investment cost $ per MTPY	–	2 015	4 465
Area of potrooms m² per 10^3 MTPY	297	315	325
Carbon in pots t per 10^3 MTPY	12[illegible]	120,[illegible]	1[illegible],3
Steel in pots t per 10^3 MTPY	234	211,5	2[illegible]1,3

* December 1980

** end of 1981

B. Detailed information on discussions and visits

1. Aluminium Pechiney and the St Jean de Maurienne smelter

Persons contacted: Yves Salmon
Director of African Affairs

- Jean Marie Pache
Aluminium Division
Head of Technical Assistance Service

- André Dourat
Director of Maurienne Plant

According to information got from Mr. Y. Salmon at Pechiney's Headquarters in Paris, Pechiney is ready to supply:

Technology know-how
Besic engineering
Training of key personnel in Pechiney's facilities
Supervision during construction
Supervision during Start-up
Supervision during first period of steady operation

They estimated 42 months for a green-field smelter construction. Construction period could be significantly reduced in case of turn key project. Investment cost would be about 2700 - 3500 $ / 1000 MTPY capacity, excluding infrastructure.

The F serie of Saint Jean's smelter was built up as an extension of the existing smelter capacity. Potrooms, dry scrubbing system, new rodding shop and a new open pit furnace were built during the construction of F line. Because of the significant increase in overall power consumption they had to construct a new substation designed to be able to take over the whole of the power supply to the plant.

The potline came on stream at the end of year 1979, The construction work embracing the new line, the electrical substation, baking furnace and various ancillary shops took 14 months.

Present capacity of F series is 27.000 MTPY, which is one third of the plant's total capacity only. This section consists of two potrooms, each [illegible] metres long and 20 metres wide, housing [illegible] pots in side by side arrangement. In the future each potroom will comprise [illegible] pots and capacity will be increased to 30 000 MTPY.

Potroom buildings are of steel structures, the main outside walls consist of vertical prepainted corrugated aluminium elements separated by translucent natural lighting strips. Roofings are also made of corrugated aluminium elements. The pot tending levels in potrooms are raised some 3 metres above ground level. Inside the buildings a brick wall was built up to the heigth of crane rails (approximately 5 metres). The lower structure of potroom sidewalls comprise perforated bricks.

Ancillary buildings (rodding shop, storages, computer centre etc.) are of the same materials and finished in the same colours.

Alumina (coarse grade) supplied by La Barrasse Plant (in the immediate area of Marseilles), transported to central silos of St Jean's plant by train. Petrol coke and pitch are also transported by train. From central silos alumina is transported to the series by special trucks each having a capacity of 30 t. Pot bins are fed by ECL cranes.

Reduction plant

Potline

Production (1981)	29 050 MTPY
Potline voltage	270 V D.C.
Amperage	176,5 KA
Pot voltage	4,17 V
Current efficiency	93,3%
Power consumption DC	13 324 kwh/t Al
Power consumption AC	14 242 "
Alumina consumption	1 950 kg/t Al
Specific surface of alumina	35-40 m^2/g
Gross anode consumption	577 kg/t Al
Net " "	437 " "
Net Al. fluoride "	12,5 "

Additives, CaF2 content of electrolite	4,82%
Al-production/pot, day	1 326,4 kg
Anode current density	0,77 A/cm^2
Number of anodes/pot	2x8
Size of anodes	1000x1430x530 mm
Anode butts (% of fresh anodes)	24 %
Material of rods	Al
Number of studs/anode	6
Type and number of feeders/breakers per pot	4-4 point feeders/ breakers
Number of hooding elements	2x9
Weight of busbars/pot	62,5 t
" " steel/pot	113,2 t
Number of anode effects/pot, day	0,8
Anode effect voltage	25 V
Fe content of metal tapped	0,22%
Si " " " "	0,03%
Lifetime of anodes	21,3 days
Tappi[illegible] cycle	32 hours
Capacity of tapping laddles	1,8 t
Anode beam raising cycle	2 weeks
Exhausted gas	2,3 m^3/second, pot
Number of ECL cranes/potroom	1 (for full serie 2)
Number of heavy duty cranes/potroom	1

Pot tending operations

Replacement of spent anodes by fresh ones, crust breaking, raising the anode beams (using special ECL equipment) filling the pot bins with alumina, addition of alumina flugride and other additives and tapping the metal is done by ECL cranes. They remove the large blocks of bath crust by hand tools instead of ECL crane. Set the height of fresh anodes also using separate instrument. Transport of butts and fresh anodes by using pallets (4 anodes/pallet). Bottom surface of butts are flat enough but some anodes are spiked containing protrusion on the active surface. Anode changing took 10-12 minutes. Tapping of the metal is done by laddles equipped with compressed air operated vacuum injector. Transport of molten metal to foundrey in 6t laddles by special trucks. Besides ECL cranes which [illegible] operation, heavy duty travelling cranes are used to [illegible] the potroom via [illegible] to a special shop, where cathodes are lined [illegible] for maintenance [illegible] also the special [illegible] mentioned above.

For baking cathodes, electrical method was adopted (baking period [illegible] hours).

[illegible]

[illegible] controlled by a microprocessor which monitors the electric parameters of pot and controls.

Pot resistance
Alumina feed and crustbreaking
Detection, annunciation and possible suppression of anode effect
Resistance during removal of metal from pot

The potline microprocessors are connected to a central computer which controls

Collection and reporting of potline data
Potline amperage to a desired setpoint value
Shift and daily print-out of potline performance data

Process control software worked out by aluminium Pechiney, hardware supplied by Alsthom and Merlin-Gerin companies.

Gas cleaning

The Pechiney - Air Industrie system has been installed in the reduction plant. The system is one of the best dry scrubbing system. The courtyard between the potrooms contains a control building which houses the electrical switchgear and a control room from which the process can be monitored and controlled through lights, pressure and various other control devices.

Efficiency on particulates	99,5%
Efficiency on gaseous fluoride	99 %
Fluoride emission 0,6-0,7 kg F/t Al	

Power consumption of gas cleaning system 274 kWh/t Al

Carbon plant and rodding shop

A shop in existence prior to the construction of F line continues to be used for preparation of the carbon paste for anode production, and supplies green anodes also for the old potlines. Paste plant is equipped with Buss continuous mixers. Green anodes are shaped by Fives-Cail vibrating forming machine.

Specific apparent density of anodes 1,55-1,60 kg/dm^3. For supplying the proper large size anodes needed for operation at high amperage in F line, a Setaram open pit anode baking furnace has been built, comprising 14 Sections. Baking furnaces are fired by oil. Specific heat consumption 700 000 kcal/t baked anode. Baking cycle 28 hours. Fuel oil contains 2% Sulphur content of used petroleum coke is 2,7 %. Gas cleaning equipment was not installed for the anode plant.

The anode rodding shop has been made to cover the rodded anode demand for the whole future extension (+ 120 pots) and provided with up to date equipment on a high degree of automation. For the time being less than one shift production is enough for feeding the potlines. Rodding shop seems to be oversized. Butt stripping machines are prototypes, not matching with capacity needed.

Power supply

The substation is fed by two incoming 220 KV lines. Two 220/42 KV step down transformers were installed. The rectifier station for supplying D.C. power to the F serie consists of five units, each of 50 KA, 780 V capacity. Primary voltage of regulating transformers is 42 KV. Regulation by tapchangers (typeJansen) and saturable reactors. Rectifier cooling: natural convection. Equipment supplied by Alsthom. Type of DC. current transformers: Halmar.

Manpower

Reduction plant is operating in three shifts, 24 hours/day, 7 days/week. Carbon plant is two shifts, 16 hours/day, 5 days/week. Rodding in one shift/day, 5 days/week. Total number of employees 759.

[illegible]

[illegible] Inc.

Persons Contacted: Alcoa — [illegible], Jr.
Sales Manager
Technology [illegible] Division

[illegible] A. [illegible]
[illegible], [illegible] Technology
Primary Metal Division

[illegible]
Mechanical Engineering Manager
Potrooms

Robert [illegible]
Assistant Chief Mechanical Engineer

[illegible]
Electrical Engineering Manager

Alumax — M.J. [illegible]
General Manager

[illegible] A. [illegible]
Plant Manager

K. Farmer
Potroom Superintendent

P. Campbell
Carbon plant superintendent

During discussion at Alcoa's Headquarters in Pittsburgh, Alcoa's representatives showed interest to Mozambiquean smelter project. They gave short information on the Mt. Holly plant of Alumax.

[illegible] Alcoa's services, [illegible] supplying technology know-how, Alcoa's services could range all the way from simply providing a "[illegible]" ([illegible] basic engineering) through providing completed engineering drawings with field construction [illegible] to a completely engineered, [illegible], constructed [illegible] all types of training in suppliers plant and on the job as well. They are ready to supply continuing technical assistance in the use of Alcoa's technology, including improvements. Five year continuing technical assistance contract can be offered.

They estimated 36 months for construction of a smelter of Mt. Holly's size to be built abroad. Construction period could be significantly reduced in case of a turn-key project. Mt. Holly's plant has been constructed in 15 months. Total investment cost came to 360 million $. In this case besides supplying complete engineering, equipment and materials have been bought by Alcoa, and a prime contractor company was responsible for the construction (Yeargin Construction Company). Alcoa is ready to supply alumina from United States or from Australia based on long-term agreement.

The Mt. Holly green-field establishment started with site preparation in September, 1978. Construction of carbon plant started in March 1979, that of the potrooms in June 1980. 100 per cent of the plant was in operation in December, 1980. The construction field manpower peaked at 2 300 people. The Mt. Holly plant produces T ingots, billets, slabs and pigs.

Reduction section consists of two potlines. Potlines comprise two potrooms, each 671 metres long, and 21 metres wide, housing 90-90 pots in side by side arrangements.

Potroom buildings are of steel structures, the outside walls consists of vertical prepainted corrugated aluminium elements with translucent lighting strips. Roofings are also made of corrugated aluminium elements. Potroom level is not raised above ground level, inside the sidings are not applied brick walls. Ancillary buildings are of the same structure and materials.

Alumina (coarse grade sandy type, specific surface $45m^2/g$) received at the plants own wharf located 30 kmetres from the smelter. Port facility equipped with pneumatic unloader (Alusuisse) of 410t/hour capacity. Alumina vacuumed from the hold of ship and transferred to the twin alumina silos by covered conveyor belt.

[illegible] silos [illegible] each. One ship per month comes from Australia (Alcoa Alumina Plant near Perth) with a capacity of 33 000 tons of alumina. Alumina is transported to the plant by the [illegible] rail car system of Alumax. Alumax has a 28 car fleet, the plant receive 14 cars/day. Main silo of the plant is of 32 000 t capacity. Transfer of alumina from storage facility into the plant through air slide system. Two silos of 13 600 t capacity serve the potrooms. Pot bins are fed by ECL cranes. Petroleum coke received by rail and stored in 3 silos of 7000 capacity each. Pitch received in liquid state.

Reduction plant

Total plant production	1[illegible]5700 MTPY
Number of potlines	2
Number of potrooms/potline	2
Number of pots/potroom	90
Potline voltage	600 V D.C.
Amperage	183 KA
Pot voltage	4,25
Current efficiency	92,5%
Power consumption DC	13 640 kWh/t Al
Alumina consumption	1 945 kg/t Al (coarse sandy, 45 m²/g)
Gross anode consumption	563 kg/t Al
Net anode consumption	435 kg/t Al
Aluminium fluoride consumption (net)	10,8 kg/t Al
Aluminium production per pot per day	1 360 kg
Anode current density	0,75 A/cm²
Number of anodes/pot	2x12
Size of anodes	711x1423x500 mm
Anode butts (% of new baked anodes)	22%
Material of rods	copper
Number of studs	2
Type and number of feeders/breakers per pot	4 central point feeders/breakers

Number of hooding elements	2x12
Weight of busbars/pot	60 t
Weight of steel/pot	105 t
Number of anode effects/pot, day	1,4
Anode effect voltage	10 V
Fe content of metal tepped	0,2%
Si content of metal tepped	0,03%
Lifetime of anodes	24 days
Tapping cycle	24 hours
Capacity of tapping laddles	14 t
Anode beam raising cycle	2,5 weeks
Time of anode beam raising	15 minutes
Life time of pots	6 years
Exhausted gas	2,5 m^3/pot, second
Number of ECL cranes/potroom	2
Number of heavy duty cranes/potroom	2

Pot tending operations

Replacement of spent anodes by fresh ones, crust breaking, raising the anode beam (using special US made equipment) filling the pot bins with alumina, addition of aluminium fluoride and tapping the metal is done by ECL cranes. Remove large blocks of bath crust by hand tools and set the height of fresh anodes using separate instrument instead of ECL cranes. Transport of butts and fresh anodes by using pallets and platform trucks (six anodes/pallet). Surfaces of butts are excellent. Changing anode took 10 minutes. Tapping laddles are carried by crane and at the end of potrooms picked up by self loading crucible carrier. Capacity of laddles: 14 t (3 laddles/potroom + 8 reserve). Transfer gantries were provided between potrooms and maintenance shop for cranes and cathode relining shop. Alumax did not followed Alcoa's advice to use airslide system for feeding pot bins. This decision resulted in double number of ECL cranes, and dust settled in potrooms. According to management of Alumax it was a wrong decision. Cathode baking is done by system using gas.

[illegible]

[illegible] control and [illegible]. The system controls the following.

[illegible]:

Pot resistance control to entered setpoint
Alumina feed control/crust breaking
[illegible]
Resistance control during tapping the metal
Compensation for heat loss during carbon change on pot
Detection and annunciation of pot problems [illegible]
Collection and recording of pot data for 2 hour [illegible] hour and [illegible] hour periods.
Potline amperage control to a desired setpoint value. Data records for periods as above
Total plant electrical demand within an imposed limit by regulation of the power to the potline
The computer annunciates alarms and information to potroom personnel via a [illegible] voice system working in conjunction with paging system.

Software worked out by Alcoa, hardware together with PDP-11 computers supplied by Digital Equipment Corporation.

Gas cleaning system

Wheelabrator-Frye Co. (Engineering CH2M Hill) gas cleaning system has been installed in the reduction plant, which is the best dry scrubbing system today. The process reduces the fluoride additions by one half. Two separate gas cleaning units have been installed. For monitoring air pollution, 30 sample taking stations were built at different points of the plant.

Efficiency of gaseous and of particulate fluorides [illegible] %
Fluoride emission 0,45 kg/t Al
Power consumption of gas cleaning system 220 kWh/t Al

Carbon plant and rodding shop

Green anode plant uses petrol coke with 3% Sulphur content. Receives liquid pitch. Mixers are of continuous type (Baker - Perkins). Green anodes are shaped by vibration forming machine. Apparent density of green anodes is 1,57 - 1,59. One open pit baking furnace was installed per potline. The two furnaces have altogether 64 sections. Baking furnaces are fired by natural gas. Baking shop is equipped with two ECL cranes.

Specific heat consumption: 500 000 Kcal/t baked anode
Baking cycle 24 hours. Gas cleaning equipment is of dust collecting type. Efficiency: 98%.

In the rodding shop spent butts have anode covering material removed, clean butts move through machines that automatically straighten bent anode rods, shot blast clean the butts, strip carbon and cast iron, blast clean the contact surfaces, coat the studs and position them in the new carbons while cast iron is poured, all highly automated operations. The rodding shop operating in one shift/day, supplies proper quantity of rodded anodes to the potrooms.

Power supply

Rectifier stations for each potline are fed by separate overhead lines. Primary voltage of regulating transfermers 34 KV. Load interrupting switches in the regulators are of vacuum breaker types. Rectifiers are of air cooled silicon diode type. Each station consists of 6 units of 35 KV, 1 000 V capacity. Rectifiers manufactured by Westinghouse. Regulation for constant power.

Type of D.C. current transformors: Halmar

Manpower

Reduction plant is operating in three shifts/day, 5 days/week, rodding in 1 shift/day, 5 days/week.

Number of total plants employees:

Staff service	100
Production	375 unskilled (but trained)
	40 supervisors
maintenance	135 skilled workers

[illegible]

20 trainees (trained)

[illegible]

[illegible]

Alcoa trained key personnel in Badin works, for a period of 3 weeks. Further training has been ensured to the needed extent on the job. [illegible] plant [illegible] aluminium industry. Alcoa sent 10 supervisors to the plant to overcome initial difficulties. As to Mozambiquean smelter, Alcoa suggested to employ expatriates for operating the smelter for a longer period.

3. IESA and VALESUL Smelter (Reynolds technology)

Persons contacted: IESA	Alberto Mazoni Andrade Fº. Director Executive
	Domingos Sodré Director Executive
	Claudio Dutra de Aboim Director Commercial
	Duk Mi Kim Metallurgist
	Luis de Loveral
	Alvaro de Castro Engineer, Metallurgy
	Raymundo Monsto de Medeiros
	Rodolfo de Cerqueira Filho Engineer, Metallurgy
Valesul Aluminio S.A.	Claudio H.M. Mazoni Andrade Assistant Executive Technical Director

IESA is a Brazilian engineering consulting firm participated in most major project developed in Brazil in the last 30 years. IESA has more than 3 000 employees, one third of which are university graduates.

IESA offers specialized services at all stages of project implementation, studies, techno-economic evoluations, basic design, detailed design, procurement and project management. Cost of design--engineering would come to 5-10% of investment cost. Main areas of activity: hydroelectric power

Infrastructure

Industrial projects

Control and support

They gave us general information on projects under preparation, among others on the Recife VAW smelter plant, and on Albras smelter project. They just finished the feasibility report for the Recife plant, smelters technology and international market study supplied by VAW, Capacity of the proposed plant 110 000 MTPY. The Albras smelter will have a capacity of 160 000 MTPY, using Mitsubishi smelting technology (135KA, 88% efficiency, 13.880 kwh/t DC power consumption, 480 pots). Plant will be located in State Para.

IESA is ready to deal with Mozambiquean smelter project, in frame of engineering services, based on smelting technology know-how, basic engineering and training facilities of the choosen technology supplier. Continuing services could only be bought from technology supplier.

The Valesul aluminium plant is located at Santa Cruz, State of Rio de Janeiro. It is a green-field establishment. Shareholders Companhia Vale do Rio Doce (CVRD) 52%, Shell do Brasil S.A. 44%, Reynolds International Inc. 4%. The plant has been constructed in 51 months. Out of 216 pots only 73 pots are on stream. By August 1982. number of pots in operation will be increased to 108 (half serie).

The investment costs came to 348 million $.
The plant was planned to produce slabs, billets, T ingots and pigs total of 86 000 MTPY. For the time being they produce only pigs. Plant area is 450 000 m^2.
The potline consists of two potrooms, 700 metres wide each, housing 102 - 108 pots in side by side arrangement.

Potroom buildings are of steel structures, the outside wall consist of vertical corrugated aluminium elements with translucent lighting strips. Potroom levels are raised some 3 metres above ground level. Ancillary buildings are of the same structures and materials.

Alumina (coarse grade, specific surface 40 m^2/g) received at the plant's own wharf located 25 kmetres from the smelter. The Sepetiba port facility is equipped with pneumatic unloader (made in Brasil, two pneumatic heads). Alumina vacuumed from the hold of ship and trnferred to the twin alumina silos by covered conveyor belt (800 m long). Capacity of transfer silos 15 000 t each. Alumina comes by sea from Guayana and Surinam. Capacity of ships 40 000 tons. Alumina transported to the plant by road. Main silo of the plant is of 30 000t capacity. Pot bins are fed by ECL cranes.
Petroleum coke storoge capacity 2x1,5 t. Liquid pitch is used, strorage capacity 3x1,2 t.

Reduction plant

Production/year	86 000 MTPY (planned)
Number of potrooms	2
Number of pots/potroom	108
Potline voltage	900 (planned)
Amperage	155 KA
Pot voltage	4,3 V
Current efficiency	88% (initial 83%)
Power consumption DC	14 470
Alumina consumption	1 950 kg/t Al (coarse, 40 m^2/g)
Gross anode consumption	700 kg/t Al
Net anode consumption	460 " "
Aluminium fluoride consumption (net)	15 " "
Cryolite consumption	15 " "
Aluminium production/pot, day	1 100 kg (planned)
Anode current density	0,80 A/cm^2
Number of anodes/pot	2x9
Size of anodes	790x1320 mm
Anode butts (% of new baked anodes)	34 %

Material of rods	Al
Number of studs	2
Type and number of breakers	1 central breaker bar
Number of hooding elements	2x12
Weight of busbars/pot	67 t
Weight of steel/pot	112 t
Number of anode effects/pot, day	1,0 t (initial 3)
Anode effect voltage	25-45 V
Fe content of metal tapped	0,6%
Si content of metal tapped	0,17%
Lifetime of anodes	18 days
Number of ECL cranes/potroom	2 (+1 reserve)
Number of heavy duty cranes	1 (+1 reserve)

Pot tending operations

Pot tending is done by ECL cranes according to technology prescriptions. Higher number of broken anodes due to lack of proper experience. Bottom surface of butts on older pots are satisfactory. Changing anode took 15 minutes. Tapping laddles are of 6,5 t capacity (10 laddles). Self loading crucible carriers are used to transport the laddles to the foundry. Transfer gantries were provided between potrooms, maintenance shop for cranes and cathode relining shop, similar to Mt Holly's Plant.

Bath removal from butts in separate place, by special equipment. Cathode baking is done by system using gas.

Process control

Control system is similar to Alcoa's computer control system. Two Modcomp computers control the process. Softwore worked out by Reynolds.

Electrical parameters of pots taken by improved methods compared to Hamburg smelter, (measuring points by anodes).

Gas cleaning system

Dry scrubbing system has been instelled

Efficiency on gaseous fluoride	99 %
on particulate fluoride	98,5 %
Fluoride emission is less than	1 kg/t Al

[illegible]

[illegible] building according to [illegible] technology ([illegible], West Germany) [illegible]. Sulphur content of used petrol coke is 2,[illegible]-2,5 %.

Green anodes are shaped by vibrating forming machine. Apparent density of green anodes is 1,56. In anode baking Riedhammer furnace [illegible] (but not the cheapest) type of furnace. [illegible] sections. [illegible] cycle [illegible] hours. Furnace is fired by oil. The shop is equipped with 2 ECL cranes. The used oil [illegible] was applied. Efficiency 90,5%. Oil consumption 75 litres/t anode. The rodding shop highly automated, similar to [illegible]'s rodding shop. They use aluminium spray for coating anodes. Equipment is indigenous [illegible].

[illegible]

Substation is fed by 130kV lines. Rectifier station comprises 6 units of 35 KA, 1 000 V capacity each. Regulation for constant current by tapchangers (type Jansen) and saturable reactors. Rectifiers are of air cooled silicon diode type.

Manpower

Reduction plant is operating in three shifts, 24 hours/day, 7 days/week, carbon plant in 2 shifts/day, 6 days/week, rodding in one shift/day, 6 days/week.

Number of total plant employees:

Production and maintenance
Including 46 engineers

Reduction	200
carbon plant	64
foundry	110
mechanical group	170
electrical "	110
laboratories	22
computer	6

Management	6
Planning and control	11
Engineering group	12
Administration	250
Total	983

Training and continuing assistance

70 persons, key personnel were trained for 2 - 7 months period. Engineers (30 persons) were trained in Hamburg, (West Germany, HAW smelter) and in Oregon (USA, Reynolds's facility), foremen in Venalum smelter (Reynolds, Venezuela).

During the design period 6 Reynolds smelter experts were staying at IESA Headquarters in Rio de Janeiro. During construction period the number of experts were increased to 12 persons.
From period of start-up 40 Reynolds employees are staying at Valesul smelter 11 of them are engineers.

Annex 8

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Overseas Planning Division

Draft suggestion

04.08.1982. Maputo

Dear Sir,

The Ministry of Industry and Energy of Mozambique initiated investigations on the building of a large Aluminium primary metal smelter in Mozambique. The capacity of the smelter would be approximately 150 000 mt per year.

The plant site is under evaluation for this new Aluminium works based on cheap electric power using Mozambique's huge energy resources.

We are at the stage of evaluating the sources, terms, prices and reliability of potential suppliers of smelting technology know-how, alumina, petroleum coke, pitch etc. for the smelter facility.

As we understand that your Company has the needed technology and produces one or more of needed raw materials on a large scale, we would appreciate your initial comments as to your interest in supplying these on a regular contractural basis.

Scope of assistance expected from know-how supplier would consist of engineering, supervision during period of construction, training of key personnel and supervision during start-up and first years of steady operation.

Our representants dealing with the preparatory work will stay in Tokyo from 03. thru 10 October 1982.

2

You are kindly requested to receive our officials at your Headquarters for an informative discussion related to the Mozambiquean Aluminium Project, and to make a short visit possible to your Miike (Ohmuta) smelter.

We would appreciate your reply at an early date (by telex as far as possible).

Very truly yours

Telex: 6 - 389 ALUMP MO

ANNEX 9.

[illegible]

13.0[illegible].1982. Maputo

Herewith please find Programmes and routings for Study Tour No 2. which are revised versions of the programmes attached to my Preliminary Report dated 15.07.1982.

According to the discussions with Mr. P. Casimiro, Mr. A. Zandamela's travel programme would be the same as that of Dr. Helényi. It has been made in different form for UNIDO approval/authorization only, taking into consideration the different sources of finance.

Fares indicated has been worked out by LAM office, Maputo.

Attached: Annex 1.
Annex 2.

[signature]

ANNEX 1.

PROGRAMME AND ROUTING FOR STUDY TOUR No. 2. (2nd revision)

Mr. A. P. Casimiro

Mr. A. Zandamela

	DATE	No. OF DAY	FLIGHT No.	No.OF DAYS NEEDED
Travel Turin - Tokyo TRN - FRA - TYO	02.Oct.	6	LH 283 LH 650	1
Arrival in Tokyo	03.	7		2
Travel Tokyo - Matsuyama TYO - MYJ Discussions in Toyo	04.	1		3
Discussions in Toyo and visit to the smelter	05.	2		4
Travel Matsuyama - Ohmuta Discussions	06.	3		5
Discussion in Ohmuta and visit to Miike smelter Travel Ohmuta - Matsuyama- - Tokyo MYJ - TYO	07.	4		6
Discussions in Tokyo	08.	5		7
Saturday	09.	6		8
Travel Tokyo - Paris TYO - PAR	10.	7	JL 425	9

NEEDED AMOUNTS FOR EXPENSES IN US$ (TRAVELLERS CHEQUES):

For DSA	2 x 8 x 99 =	1584 $
Terminal expenses	2x100 =	200 $
		1784 $
Air tickets	2x2608 =	5216 $
	TOTAL	7000 $
		======

+ Rail tickets: Toyo - Ohmuta - Toyo.

ANNEX 2.

PROGRAMME AND SCHEDULE FOR STUDY TOUR No. 2. (2nd revision)

Mr. H. [illegible] UNIDO expert

	DATE	No. OF DAY	FLIGHT No.	No. OF DAYS NEEDED
Travel Maputo - Paris MPM - PAR	18.Sept.	6	TM 734	1
Arrival in Paris	19.	7		2
Travel Paris - Budapest PAR - BUD	20.	1	AF 557	3
Discussions in Budapest accompanied by an official of Aluminium Project Cabinet	21.	2		4
	22.	3		5
	23.	4		6
Travel Budapest - Turin BUD - TRN	24.	5	MA 410 AZ 1403	7
Saturday	25.	6		8
Sunday	26.	7		9
Discussions in Turin on Feasibility Report prepared by Brigaz-HUNTER and visit to Porto Vesme and Porto Marghera smelters	27.	1		10
	28.	2		11
	29.	3		12
	30.	4		13
	01	5		14
Travel Turin - Tokyo TRN - FRA - TYO	02.Oct.	6	LH 203 LH 650	15
Arrival in Tokyo	03.	7		16
Travel Tokyo - Matsuyama TYO - MYJ Discussions in Tyo	04	1		17
Discussions in Toyo and visit to the smelter	05.	2		18
Travel Matsuyama - Omuta Discussions	06.	3		19

Discussion in Ohmuta and visit to Miike smelter Travel Ohmuta - Matsuyama - Tokyo MYJ - TYO	07.	4		20
Discussions in Tokyo	08.	5		21
Saturday	09.	6		22
Travel Tokyo - Paris TYO - PAR	10.	7	JL 425	23
Arrival in Paris	11.	1		24
Travel Paris - Maputo PAR - MPM	12.	2		25
Arrival in Maputo	13.	3		26

NEEDED AMOUNTS FOR EXPENSES IN US$ (travellers cheques):

Air tickets for route MPM - PAR - BUD - TRN and PAR - MPM will be paid by Mozambiquean Government.

Air tickets TRN - TYO - MYJ - TYO		2 608 $
terminal expenses	~	150 $
	~	2 750 $

+ Rail tickets: Toyo - Ohmuta - Toyo.

NOTE:

Dr Kelényi has to get his DSA in advance in US $ (travellers cheques) for the period of being in travel status, according to Staff Rules.

Dlle

09.09.1982. Maputo

MEMORANDUM

Herewith please find the abstract of an article dealing with the situation of Japanese primary aluminium production and its outlook.

The abstract gives some explanations on Japanese promotion of overseas captive import development projects.

PRIMARY ALUMINIUM PRODUCTION IN JAPAN

Abstract made by Dr. M.Kelenyi UN expert

The year of 1981 was one of great trial for the aluminium industry, surrounded as it was by an extremely severe environment. The world economy in general, and particularly in Europe and the United States, remained stagnant; and because of the sluggishness in the construction, land transportation and related industries that comprise the major users of aluminium, the demand for aluminium dropped sharply.

Consequently, full-scale production cutbacks were made, principally by the major U.S. firms, from mid-year, but these were not sufficient to cope fully with the slowness in the market. Thus, the figures throughout 1981, apart from a few limited periods, were consistently below those of the preceding year in both quantity and price level.

Foreign smelters and metal traders, therefore, used the surplus spot metal to launch an export offensive directed at Japan where the demand was relatively strong. Amidst these adverse conditions in overseas markets, transactions were conducted at prices that appeared to be even below production cost.

Meanwhile, the Japanese aluminium smelters completely lost their international competitiveness because of their extremely high electric power cost; despite wide-ranging efforts, the differential between Japanese and imported aluminum remained great.

CHART 1. MAJOR NORTH AMERICAN ALUMINUM SMELTER EARNINGS (1981)

(Unit: US$ million)

	Sales		Net Earnings	
Company	Value	Compared to 1980	Value	Compared to 1980
ALCOA	5,032	-3%	296	-37%
ALCAN	4,978	-5%	264	-51%
Reynolds	3,481	-5%	87	-52%
Kaiser	3,342	-7%	133	-46%

CHART 2. JAPAN'S SMELTER PRODUCTION, SHIPMENT AND INVENTORY

(1981)

Company	Production (MT)	Operation rate* (%)	Imports etc. (MT)	Total (MT)	Shipment (MT)	Yearend inventory (MT)	1st of year inventory (MT)
Nippon Light Metals	153,607	58.4	89,250	242,857	235,487	60,669	53,219
Showa Aluminum Industries	91,533	36.9	98,335	189,868	18[illegible],498	53,271	47,801
Sumitomo Aluminum	203,143	42.1	70,710	273,853	230,063	100,396	52,606
Mitsubishi Light Metals	125,872	42.8	35,777	161,649	144,920	57,400	10,660
Mitsui Aluminum	103,683	59.4	26,783	130,446	121,132	35,056	25,722
Sumikei Aluminum	92,664	72.0	10,[illegible]36	103,466	104,015	916	1,361
Total	770,502	49.3	331,791	1,[illegible]2,293	1,02[illegible],124	307,[illegible]	[illegible]

Note: * December 1981 monthly average.

Because of the large inflow of low-priced spot metal, shipments of the Japanese smelters dropped drastically. The Japanese smelters were forced into large production cutbacks and partial shutdowns of their plants.

To cope with this critical situation in which the very survival of the Japanese smelting industry is at stake, the Ministry of International Trade and Industry reopened the Aluminum Committee of the Industrial Structure Council, and in October, the committee prepared a report proposing measures for the relief of the smelting industry based upon a "Japanese smelting industry structure with a 700,000 MT annual production capacity".

CHART 3. JAPAN'S PRIMARY ALUMINUM SUPPLY AND DEMAND

(Unit: 1000 MT)

Item	1979	1980	1981
Inventory at outset.......	341	230	470
Production	1,010	1,091	771
Imports	694	841	981
(Total supply)............	(2,045)	(2,162)	(2,222)
Domestic demand	1,802	1,637	1,571
Exports	2	4	8
(Total demand)	(1,804)	(1,641)	(1,579)
Inventory at yearend	230	470	740

While the Japanese smelters give due credit to the fact that such a relief program has been decided upon within the current political climate, it is seen as a mere "drop in the bucket" in light of their current straits.

And so, amidst the great upheaval of a reduction in smelting operation and increased dependence upon imported metal, the Japanese smelters face 1982 with the vital issue still unsolved of whether or not they are in fact going to succeed in opening new prospects for the future while restructuring a new order within the industry.

CHART 4. JAPAN'S IMPORTS OF ALUMINUM INGOT (99%. 99.9% PURITY)

(Customs Clearance Basis)

(Unit: MT/cal yr)

Country	1980	1981
Bahrain	15,721	24,906
Norway	2,428	6,770
France	550	1,427
Spain	17,755	25,162
Poland	—	—
USSR	13,923	8,666
Czechoslovakia	—	—
Hungary	52	1,480
Yugoslavia	250	660
Greece	—	3,016
Rumania	5,018	2,993
Canada	111,603	102,862
U.S.A.	238,474	243,527
Egypt	993	15,307
Ghana	34,803	30,859
Cameroon	498	1,747
S.Africa	956	99
Australia	23,500	52,107
New Zealand	92,346	104,040
Surinam	5,473	3
Argentina	32,902	56,285
Venezuela	130,923	159,866
U.A.E.	2,400	49,506
Others	959	30,231
Total	731,593	921,671

With the drop in demand, foreign smelters intensified their production cutback from the beginning of autumn last year. The rate of operation of all U.S. aluminum smelters at the end of December 1981 dropped to 3,820,000 ST, or 69.5%, of the full capacity of 5,510,000 ST. Canada's rate of operation dropped to 86.3%.

There still are no signs of economic recovery in Europe and the United States, and the future is not clear. In particular, there are no hopes for a rapid recovery in new housing construction and automobile production, both industries which have a big influence upon the aluminum market.

Meanwhile, the cutback in production or postponing of new projects, principally by the major companies, will continue this year, but it probably will not be after the third quarter before any substantial effects are seen.

For Japanese smelting companies, a very severe situation surpassing even that of last year will continue, and it is possible that their very existence may be endangered. It is also very unlikely that overseas demand will recover, and thus the price differential between Japanese and overseas primary aluminum will continue, leaving the domestic smelters no choice but to carry out large-scale cutback in production, including even the abandoning of some facilities, and to bear the burden of enormous inventories, and to sell their product at below production cost. It is believed that it will be difficult to maintain even the 700,000 MT level on which the report of the Aluminum Committee of the Industrial Structure Council is based and that the production for this year will drop below 500,000 MT.

There are no major factors to indicate a market recovery during 1982. From the standpoint of supply and demand, a full-fledged recovery is likely in the third or fourth quarter of the year. However, with aluminum assuming the characteristics of a commodities market item in recent years, and with only a small inventory held by independent aluminum consumers in Europe and the United States, it is possible that the free market price might zoom up even before a recovery in the supply and demand situation.

(Source: Non-Ferrous Metals in Japan Sumitomo Co. 1982)

Annex 11.
ANNEXURE

Confidential

TECHNICAL REPORT ON THE SMELTERS VISITED DURING THE TOUR TO ITALY FROM 26.09.1982 THRU. 04.10.1982

.o.

By Dr.M.Kelényi UN expert

PERSONS CONTACTED IN FUSINA SMELTER:

- Dr. Antõnio Serra
  Technical Director
- Mr. Giuseppe Toia
  Engineering and Construction Manager

PERSON CONTACTED IN PORTO VESME SMELTER

- Mr. Nicola Angelucci
  Director
- Mr. Boato
  Process Engineer

.../

ALUMETAL SMELTER - FUSINA

The Fusina smelter located some 6 kms from Venice is the biggest smelter of Alumetal, with a capacity of 36 000 MTPY. Other Alumetal smelters: Mori, 20 000 MTPY and Bolzano, 50 000 MTPY.

The Fusina plant has been put into operation in 1971. The smelter is under reconstruction. which is done continuously according to the schedule for renewing of pots. The new pots were developed in Fusina and have new anode construction, cell feeding and dry scrubbing system.

Presently one third of the pots built in the potline are of the new type. There is an experimental pot in the potline equipped with four central point feeders/breakers, which will come on stream next month for testing. All the pots are in end to end arrangement.

The potroom building is of concrete structure with horizontal lighting strips. The pot tending level in the potroom is raised above ground level. Ancillary buildings are of steel structures with aluminium sidings.

Alumina (coarse grade but well on the lower limit) is supplied by their own plant. Capacity of central alumina silo is 15 000 t. The petrol coke silo is of a capacity of 7 000 t.

DATA ON POTLINE

Production	36 000 MTPY
Number of pots in the potline	100
Number of potrooms	1 (pots in two rows
Amperage	150 KA
[illegible]	[illegible] V D.C.
[illegible]	[illegible],2 V

.../

Current efficiency	0,9
Power consumption D.C.	14 000 KWh/t Al
Alumina consumption	1 930 kg/t Al
Net anode consumption	449 kg/t Al
Net fluoride consumption	25 kg/t Al
Aluminium production/pot day	986 kg
Specific surface of alumina	35 m^2/kg
Anode current density	0,7 A/cm^2
Number of anodes/pot	16
Number of blocks/anode	2
Number of studs/block	2
Type of central feeder/breaker ..	Line/breaker bar
Number of anode effects/day, pot.	1,5
Lifetime of anodes	32 days
Area of potroom	13.200 m^2

The pot tending operations are done by using special cranes but alumina and fluorides are transported to the pots by special trucks.

The process control system hardware includes one microprocessor for each ten pots. The microprocessors are connected to the central computer. Software includes:

Pot resistance control to entered setpoint
Alumina feed control/crust breaking
Resistance control during tapping the metal
Noisy pot detection
Collection and recording of potline data

ANCILLARY SHOPS:

The plant has his own carbon plant, rodding shop and foundry of capacity matching with the primary aluminium production.

In the green anode plant contin ous mixer (Buss) is applied. They use petrol coke having a sulphur content of 3%.

.../

Green anodes are shaped by vibration forming machine. Apparent density of green anodes is 1,6. One closed type baking furnace has been installed (Italian made), comprising 36 sections. The furnace is fired by oil. Fuel oil contains 2,5% sulphur. Specific heat consumption is 500 000 Kcal/t baked anode. Baking cycle is 28 hours. The anode baking shop is equipped with one NKM crane. Anode baking process is computer controlled.
The green carbon plant and the rodding are operating in two shifts /day, five days/week.

ALSAR SMELTER - PORTO VESME

The Porto Vesme smelter is located at the south coast of Sardinian Island. The smelter has come on stream in 1972.It was designed between 1960 and 1970 and represents the smelting technology of the sixties. The pots are of side by side arrangement.

The plant has its own power station of 2 x 170 MW capacity. The power station is fired by oil/coal. The plant has also its own wharf, where receives petrol coke and pitch and fuel for the power station. The nominal production capacity of the smelter is 120 000 MTPY but due to the known market situation only 75% of the capacity is in operation.

All the buildings are of steel structures. The pot tending level of the potrooms are raised some 6 metres above ground level, cathode shells are transported through ground level for relining in a separate relining shop.

Alumina (coarse grade but well on the lower limit) is supplied by Eralumina plant located next to the smelter. Alumina is transported by conveyor belt. The petrol coke is stored in four silos each having a capacity of 7 000 t.

.../

DATA ON REDUCTION PLANT:

Production	120 000 MTPY
Number of potlines	2
Number of potrooms	2 (pots in two rows)
Total number of pots	324
Amperage	150 KA (operating at 145 KA)
Pot voltage	4,3 V
Current efficiency	0,9
Power consumption D.C.	14 000 KWh/t Al
Alumina consumption	1 930 Kg/t Al
Net anode consumption	460 kg/t Al
Net fluoride consumption	50 kg/t Al
Aluminium production/pot, day	1015 kg
Number of anodes/pot	16
Number of block/anode	1
Number of stud/anode	4
Size of anodes	1560 x 900 x 620 mm
Anode current density (at 15oKA)	0,67 A/cm^2
Number of anode effects/pot, day	1,3
Lifetime of anodes (days)	32
Anode butts (% of fresh anodes)	20%
Weight of busbars/pot	30 t
Weight of steel/pot	40 t
Lifetime of pots	2 600 days
Total area of potrooms	52 000 m^2
Number of semi-gantries/potroom	3
Number of heavy duty cranes/potroom ...	2
Spicific Surface of Alumina	35 m2/g

The pot tending operations are done by using semi-gantries, pots are not equipped with central feeding/breaking.

Process control therefore does not include the above operations. Hardware is similar to that of the Fusina smelter. In the Porto Vesme computer centre two IBM 1800 computers have been installed

.../

one for the power station, one for the smelter. The software includes:

Pot resistance control to entered setpoint
Resistance control during tapping the metal
Noisy pot detection
Collection and recording of potline data.

The pots are of open types, and the wet scrubbing secondary gas cleaning system has been applied in the smelter.

Efficiency on	particulate	85%
Efficiency on	gaseous fluoride.....	95%

ANCILLARY SHOPS:

The anode plant has been constructed using KHD technology. Green anode plant has two lines equipped with continuous mixers (Buss). Green anodes are shaped by a Von Roll press. Apparent density of anodes 1,7 kg/dm^3. Sulphur content of used petrol coke is 3%. Two closed type baking furnaces of 36 sections each have been installed in the baking plant. Furnaces are fired by oil. Sulphur content of oil is 1 - 2%. Specific heat consumption is 336 000 kcal/t baked anode. Baking cycle is 24 hours. For gas cleaning Luigi electrofilter equipment has been applied. The rodding shop has been designed to cover the rodded anode demand of ten potlines, process is highly automated. They use aluminium spray for coating anodes. Aluminium consumption is 25 kg/anode.

Green anode plant operates in 3 shifts/day, 5 days/week, while the rodding 2 shifts/day, 5 days/week.
The rectifier stations for supplying D.C. power to the potlines consist of four units each. Capacity of one unit is 53,5 KA, 850 V. The rectifiers are water cooled (Siemens).

.../

In the foundry 8 homogenizing-casting furnace units have been installed. Each unit consists a homogenizing furnace of 50 000 t capacity and two casting furnaces of 25 000 - 25 000 t capacity. Foundry is equipped with all the machines needed for producing slabs, billets, T ingots and pigs as well.

COMMENTS

In table 1. are given some of the performance data on pots and some other data on smelters collected during the Study Tour nº 1 and during the tour to Italy as well.

In course of comparison of data shown in the table, we have to take into consideration, that Italian smelters visited represent the smelting technology of the sixties, improved to the extent possible.

We have also to remark that performance data given by the management in Porto Vesme are better than what we could conclude from our observations relating to the real operation of the reduction plant.

We can work out a comparison more realistic after getting the complete talian feasibility study indicating the source anddata on technology offered.

.../

SOME DATA ON DIFFERENT

Data on smelter	St. Jean de Maurienne Pechiney
Total production MTPY	29050
Number of potlines	4
Number of potrooms	2
Nos of pots/potroom	[illegible]
Total area of potrooms m^2	8600
Amperage KA	176,5
Anode current density A/cm2	0,77
Current efficiency %	93,3
Pot voltage	4,17
D.C. power consumption KWh/t Al	13324
Net anode consumption kg/t Al	437
Net fluoride consumption kg/t Al ..	12,5
Production/pot, day .... kg.	1326,4
Pot tending level	raised
Central feeding/breaking	point
Gas cleaning	dry

TABLE [illegible]

SMELTERS VISITED

Mt. Holly Alcoa	Valesul Reynolds	[illegible] Montedison	Porto V[illegible] [illegible]
178700	86000	36000	[illegible]
2	1	1	2[illegible]
4	2	1	2
1	1	2	2
56364	28000	13200	52000
183	155	1[illegible]0	1[illegible]0
0,75	0,80	0,7[illegible]	0,[illegible]
92.5	88	[illegible]	8[illegible] ?
4,25	4,3	4,2	4,[illegible] ?
13640	14470	14000	14[illegible] ?
435	460	449	[illegible]
10,8	15	25	[illegible]0
1360	1100	986	1015 ?
ground	raised	raised	raised
point	Line/bar	Line/bar (partly)	none
dry	dry	dry (partly)	wet

MEMORANDUM 19.10.1982. MAPUTO

Here below I give brief description of some common technical expressions used by personnel associated with aluminium smelting.

- Hall - Heroult process (presently used): electrolysis of a solution of aluminium oxide (alumina Al_2O_3) dissolved in molten cryolite (Na_3AlF_6) at about 975°C.

- Alumina, Al_2O_3: major categories may be classified as follows

	Fluory	Sandy	Under-calcined
% fines passing 45 μ mesh	20-50	less than 10	10-20
Median particle size μ	50	80-100	50-80
Angle of repose	more than 45°	30-35	30-40
Specific surface m^2/g	less than 5	more than 35	more than 35
Bulk density g/cm^3	less than 0,75	" " 0,85	" " 0,85

The sandy type allows a production increase and a dry scrubbing of the pot fumes. Its solubility in the cryolitic bath is better than that of the fluory alumina, potentially resulting in a substantial gain as for pot current efficiency. Its bulk density allows additional storage capacity for a given investment cost and also allows a significant saving on freight cost.

Desirable criteria for an up to date application will be as follows
Specific surface of 40-60 m^2/g
Proportion of alpha alumina (one of the crystalline form of alumina) less than 20%

Proportion of fines passing a 45 μ mesh 7% max.

Seen in this light, under-calcined aluminas represent no more than a transitional phase towards a product to be classified as "sandy".

Sandy and under-calcined aluminas are often called "coarse - grade" also.

- Current efficiency η% : The ratio of metal produced in the cell /pot/ compared to that theoretically expected from Faraday's Law. According to the Law at 100% current efficiency 1 A of current passing through the pot would produce 0,335 gs of aluminium each hour.

With this

$$N = \frac{\text{Aluminium per pot day kg}}{8{,}05 \cdot \text{average current}} \cdot 100\%$$

Current efficiency is influenced by:

Temperature
Current density
Interpolar distance
Composition of electrolyte
Cell design

In modern industrial cells the average current efficiency for metal production varies between 80-94% of the theoretical amount. The extent that the current efficiencyis lower is determined by a number of variables mentioned above.

- Pot: An operating electrolitical cell, production unit of a reduction plant. Main parts of a pot of pre-baked type:

Cathode shell comprising steel shell
intermediate shell/cathode insulation
internal shell /cathode carbon/
collector bars /steel/
cathode busbars /aluminium/

Anode assembly comprising: anode structure/steel/ with raising mechanism
feed hopper /alumina reservoir,pot bi
rodded anodes
crust breaker system
anode busbars /aluminium/
fume hoods /aluminium cover/

- Potline: a series of pots fed by a common rectifier station. Potline voltage depends on the number of pots built in.

- Cryolite: $Na_3Al\,F_6$. It is the predominant constituent of electrolyte comprising at least 80% of the total electrolyte weight, and is essential for the dissolution of alumina.

- Additives: various additions to the cryolite modify its phisical and chemical properties and thus improve the cell performance.

  The most important additives used commercially are as follows:

  - aluminium fluoride, AlF_3, constitutes only about 2-10 Wt % of the electrolyte but it is the electrolite component that is consumed at the greatest rate in the pots.

  - calcium fluoride, $Ca\,F_2$, constitutes up to 8 Wt % of the electrolyte. Calcium is present as an impurity in the alumina feed, so can be sufficient to maintain the operating concentration.

  Both of these additives lower the freezing point of the electrolyte. Any additive to the electrolyte has to keep the density lower than that of the liquid aluminium, which is 2,3 g/cm^3 at 1000 ^oC.

- Pot voltage: Total voltage drop of a reduction cell, 4-5 V, is comprised of three separate contributions:
  decomposition voltage ($\simeq$ 1,2V)
  polarization voltage ($\simeq$ 1,8V)
  ohmic voltage drops

- Anode current density:
  The amount of current passing through a certain area of the anode. Usually expressed as amperes per square cm (A/cm^2)

[illegible] aluminium, [illegible] current [illegible]

- [illegible]: The phenomenon that occurs when the electrolyte [illegible] in alumina (normally between [illegible]-2,5 wt %). [illegible] is normally manifested by a sudden increase in cell voltage up to [illegible] volts. [illegible] to eliminate. This involves breaking the crust and feeding alumina into the pot. Upper limit of alumina content is about 8 Wt %.

- [illegible]: Liquid [illegible] used in the pot.

- [illegible]: A carbon [illegible], often [illegible] to describe [illegible].

- Green anode: The anode formed by compressing and shaping the coke and pitch mixture prior to baking.

- Butt: The residual anode carbon when the pre-baked anode [illegible] (21-2[illegible] days) in the cell and has been taken out.

- Carbon consumption:

Carbon anodes are used in pots.
[illegible] carbon consumption is generally expressed as

$$\frac{\text{Weight of anodes taken to pots kg}}{\text{1 t of aluminium produced}}$$

While net carbon consumption is

$$\frac{\text{Weight of anodes taken to pots kg} - \text{weight of butts kg}}{\text{1 t of aluminium produced}}$$

Consumption increase is inversely proportional to current efficiency.

- Noisy pot: A pot with a fluctuating voltage which is caused by a turbulent metal pad

- [illegible]: The liquid [illegible] resting on the cathode lining

- Scrubbing systems: Wet scrubbers: can remove soluble gases such as hydrogen fluoride with high efficiency and particulate matter with moderate efficiency. If off-gases treated by a wet system, the liquid undergoes a treatment to remove the fluoride material before the water can be reused or discharged.

  Dry scrubbers: Certain types of alumina used in the reduction process have a high affinity for gaseous fluorides and can be as a gas scrubbing medium. Dry scrubbing systems are designed to contact the cell off-gases with alumina before the gases are passed through bag filters for particulate removal. This type of gas cleaning permits significant operation saving through the recovery of fluoride and alumina, reducing aluminium fluoride consumption by as much as 50%.

- Rodding: Fixing the anode stud assembly into the anode carbon block with molten iron. Rodding shop includes all the machines needed to prepare and finish this operation.

- Baking shop: Shop for baking the green anodes in the baking furnace(s), at 1100-1300°C. The cycle of placing green anodes, preheating, firing, cooling and removal is approximately 28-30 days.

- ECL cranes: Special cranes made by Electrification Charpente Levage, France, for special pot tending operations.

- NKM cranes: Special cranes made by Nederlandse Kranbouw Maatschappij, Holland, for special baking furnace tending operations.

- Air slide system: A system for transporting alumina with the help of air (through pipelines)

C-176

3.08.09

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