BEIRA ALUMINIUM SMELTER STUDY

prepared for
The Government of Mozambique
December 1999

Overview and Presentation

FLUOR DANIEL
A FLUOR Company

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KAISER ALUMINUM
INTERNATIONAL

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1.1 Summary of the Enterprise

The proposed enterprise consists of an industrial facility located in Coastal Central Mozambique, using low cost hydroelectric power to produce primary aluminium ingot from imported feedstock materials.

The indicated capital cost of the facility is $1.2 billion, approximately 50% of which might be financed through various politically sponsored lenders.

The comparative competitive position of the facility is outstanding, with capitalization requirements indicated as one of the lowest in the last 15 years and operating cost projected as one of the world's best.

The indicated financial return of the project, expressed as an after-tax unleveraged Internal Rate of Return, is 20.3%. This calculation is based upon a conservative set of Base Case conditions. With the anticipated debt structure, IRR can be leveraged to 25.6% under the same base Case conditions.

The engineering and construction schedule is 34 months. The project becomes cash flow positive (on a discounted cash basis) after 5 years of operation, or about 8 years from the beginning of the project.

1.2 The Proposed Project

1.2.1 The Proposed Facilities

The proposed project consists of a primary aluminium reduction facility, complete with associated infrastructure, located in or near the city of Beira, Mozambique. At base load conditions, the facility will produce about 300,000 tonnes of primary aluminium ingot per year and cost approximately $1.2 billion to construct. The scope of the project includes a reduction facility (shown below), upgrades to the existing Beira port facilities, and power transmission lines to bring the required electrical power to the Beira region. The overall timeframe for designing and constructing the project will be approximately 33 months.

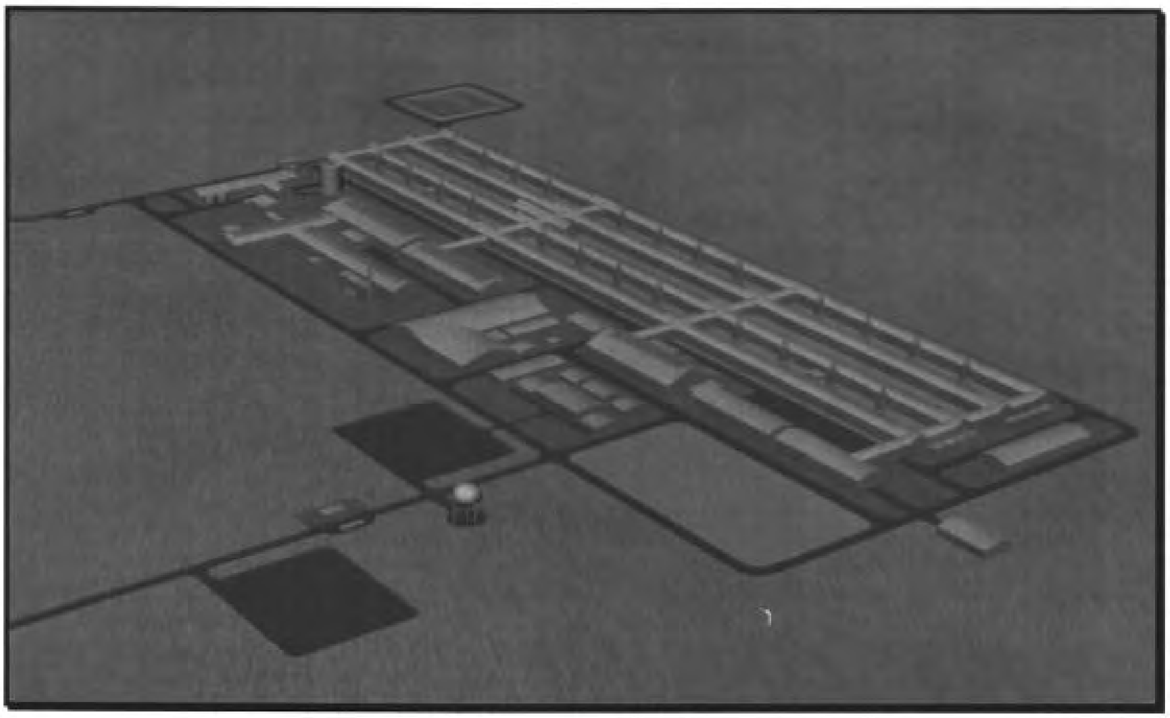

Figure 1: Beira Aluminium Reduction Facility

The reduction facility is based upon K220 technology supplied by Kaiser Aluminum, consisting of two potlines of 300 reduction pots each, anode production facilities, an ingot casting plant, and support facilities.

The upgraded port facilities consist of ship unloading equipment, storage silos for petroleum coke and alumina, and supporting infrastructure. The aluminium ingot produced will be exported through the existing container terminal at the Port of Beira. Alumina and coke will be received through upgraded facilities at Quay 8, both shown below.

Figure 2: Beira Container Terminal

Figure 3: Port of Beira, Quay 8

1.2.2 Power Supply for the Smelter

Power supply requirements will be met by upgrading the existing overland electrical transmission systems. For the purpose of the study, the selected upgrade option is approximately $170 million. This option is the most practical and cost effective for the smelter's needs, and though actual system upgrades may be more extensive, the evaluation of this project is based on the $170 million figure.

Capital cost of power transmission infrastructure will not be part of the facility's required capitalization, but will be covered through power transmission ("wheeling") fees throughout the life of the project. The planned power transmission upgrades are shown in the following figure.

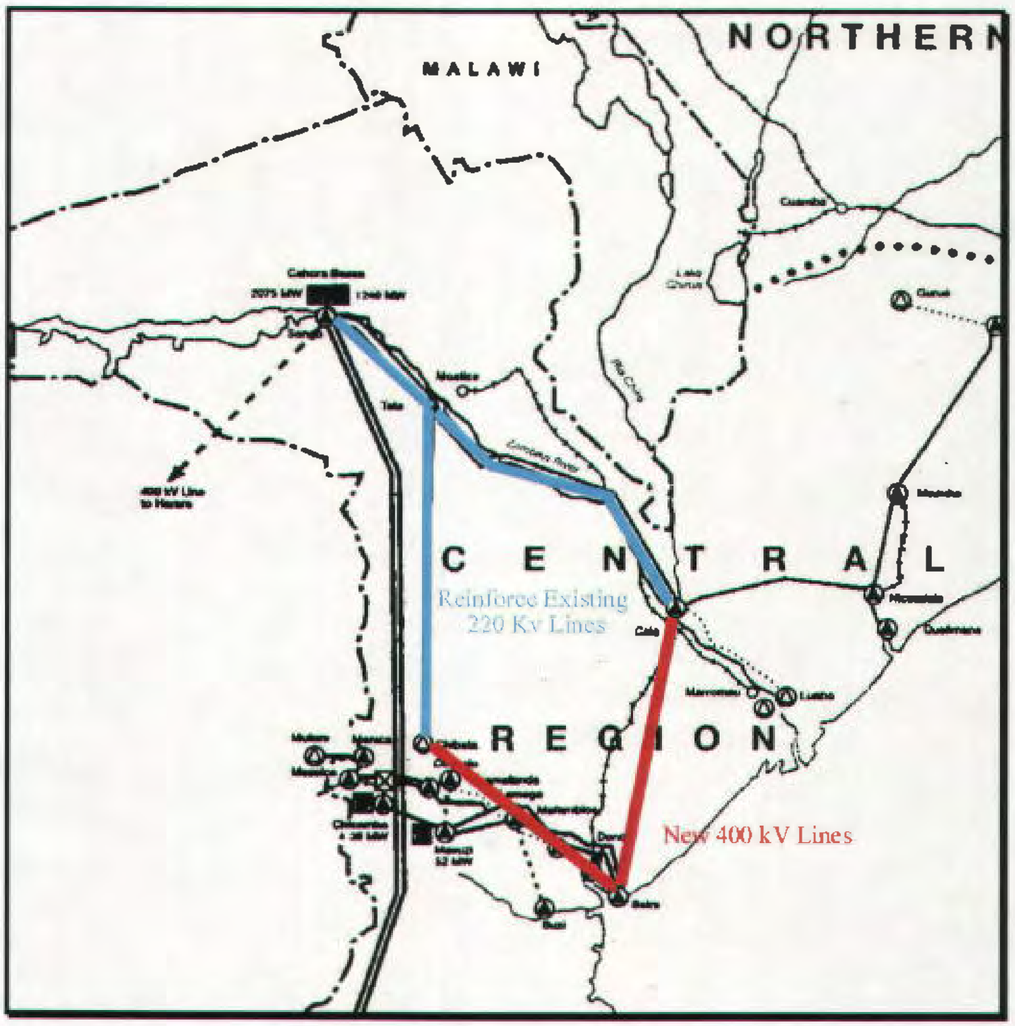

Figure 4: Planned Power Transmission Upgrades

1.2.3 Capacities, Throughput and Operations

The baseline production capacity of the facility is approximately 300,000 metric tonnes per year of unalloyed and unwrought primary aluminium ingot. To sustain this level of production, the plant requires approximately 700,000 tonnes per year of raw materials and almost 500 megawatts of power as illustrated below.

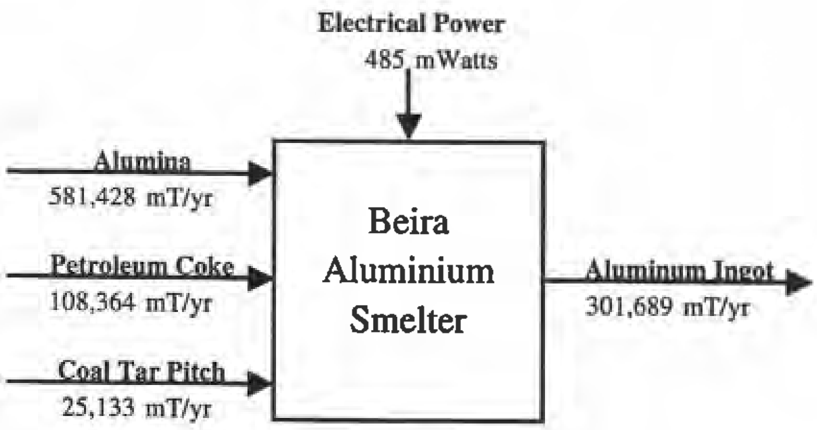

Figure 5: Simplified Material Flow Diagram (180 kA Operation)

Kaiser K220 technology is designed to operate at production levels higher than the baseline after start-up is completed and operating staff fully trained. This report uses baseline performance to determine project viability, but under optimal conditions, the plant could produce as much as 360,000 tonnes per year, or about 20% greater than baseline, as shown below.

	Kaiser K220 Technology Performance Level	
	Baseline	Optimal
Number of Reduction Cells	600	600
Nominal Operating Amperage (kA)	180	220
Annual Production (tonnes)	301,689	364,852
Power Requirements (mW)	485	651
Raw Material Requirements (tonnes)	717,544	867,407

Figure 6: Kaiser K220 Technical Performance

The project incorporates comprehensive safety, technical and managerial training programs to assist in providing human resources for both construction and operations. The ongoing programs assist in the migration of management and technical expertise from expatriate personnel to local personnel. Socioeconomic impact and ongoing community relations are monitored by a special focus group, also incorporated into the project's scope.

1.2.4 Project Cost and Implementation

Based upon the stated scope of the project and exclusive of any capital costs associated with high voltage power transmission systems (which are included as part of the power tariff), the estimated total capital cost of the Beira Aluminium Smelter is $1.184 billion, including $95 million of contingency protection, as summarized in the following figure.

BASS Aluminum Reduction Facility Capital Cost Estimate Revision 2.3 (12 November, 1999)		
100000	REDUCTION PLANT	$437,945
200000	ANODE MANUFACTURING	$152,082
300000	METAL PRODUCTS	$6,400
400000	MATERIAL HANDLING AND RECEIVING	$38,992
500000	PLANT POWER AND UTILITIES	$84,858
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700000	SITE DEVELOPMENT AND FACILITIES	$78,124
800000	OFF-SITE FACILITIES	$4,000
900000	INDIRECT COSTS	$265,956
990000	CONTINGENCY AND ESCALATION	$95,000
	TOTAL FACILITIES	**$1,183,814**

Figure 7: Summary Capital Estimate
Notes: Values shown in thousands of dollars; Escalation not included in estimate

The overall timeframe for designing and constructing the project will be approximately 33 months. First metal is expected 30 months into the schedule and full production at month 36. The following chart shows the overall project schedule assuming that the site preparation will proceed simultaneously with the funding arrangements and pre-engineering work.

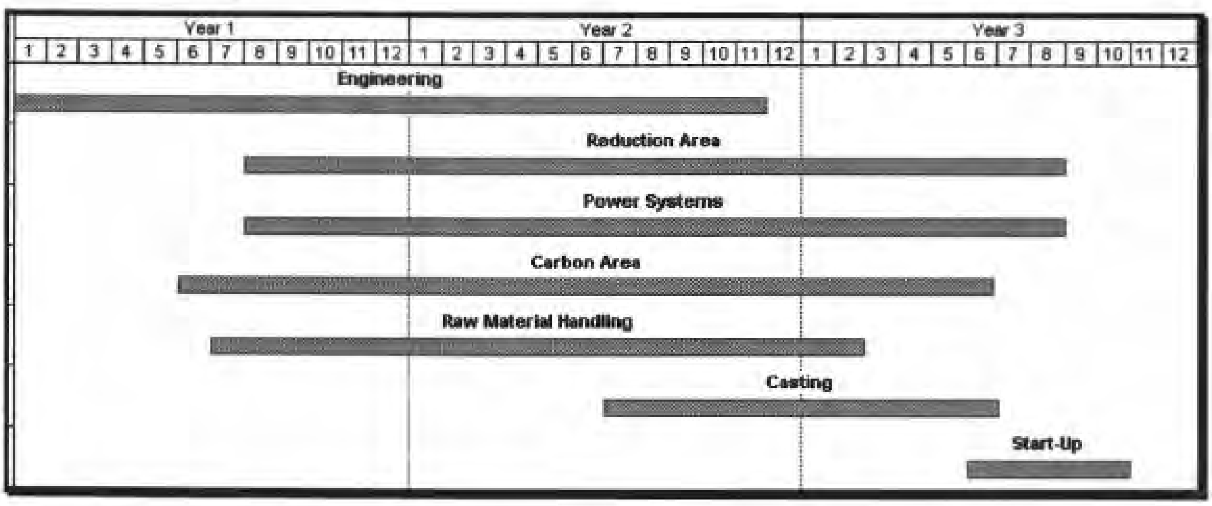


Figure 8: Summary Project Schedule

1.3 The Feasibility Study Report

The assessment of the proposed project is presented in the report entitled "Beira Aluminium Smelter Feasibility Study" (December, 1999). In addition to this executive summary, the report consists of four volumes as follows:

Volume 1 **Feasibility Study Report**, containing the chapters

1. Background Information
2. Critical Project Criteria
3. Plant Location
4. Technical Description
5. Regulatory Requirements
6. Environmental Impact
7. Estimate of Capital Cost
8. Estimate of Operating Cost
9. Project Execution Plan
10. Market Analysis
11. Financing Plan
12. Project Impact
13. Financial Analysis

Volume 2 **Attachments to the Report**

A. Plant Material Flow Basis and Diagram
B. Environmental Performance Indicators
C. Kepner-Tregoe Analysis for Site Evaluation
D. ABB Power Transmission Systems Assessment Report
E. ABB Flakt Gas Treatment System Description
F. Project Schedule
G. Capital Cost Estimate
H. Range Estimate Contingency Analysis
I. Operating Cost Basis
J. Staffing Plan
K. Proforma Balance Sheets and Income Statements
L. Sensitivity Tables for Financial Analysis
M. London Metal Exchange Aluminium Ingot Specification
N. Reference Drawings

Volume 3 **Kaiser Aluminum Design Control Specifications, Book One**

Volume 4 **Kaiser Aluminum Design Control Specifications, Book Two**

The report was sponsored and partially funded by the United States Trade and Development Agency ("USTDA"). The consortium of Kaiser Aluminum, Asea Brown Boveri and Fluor Daniel performed the study and provided the remainder of the required funding.

The Study is on file with the USTDA and available through their government document distribution protocol.

1.4 Project Development in Mozambique

1.4.1 Mozambique Background

The Republic of Mozambique is located on the eastern coast of Southern Africa. Maputo is the capital city and the Country is divided into 10 administrative provinces, each with it's own capital city. Beira, where this project will be located, is the capital of Sofala province. With a population of 300,000, Beira is the Mozambique's second largest city and the gateway to the land-locked countries of Zimbabwe, Zambia, Malawi, Botswana and southern Democratic Republic of the Congo.

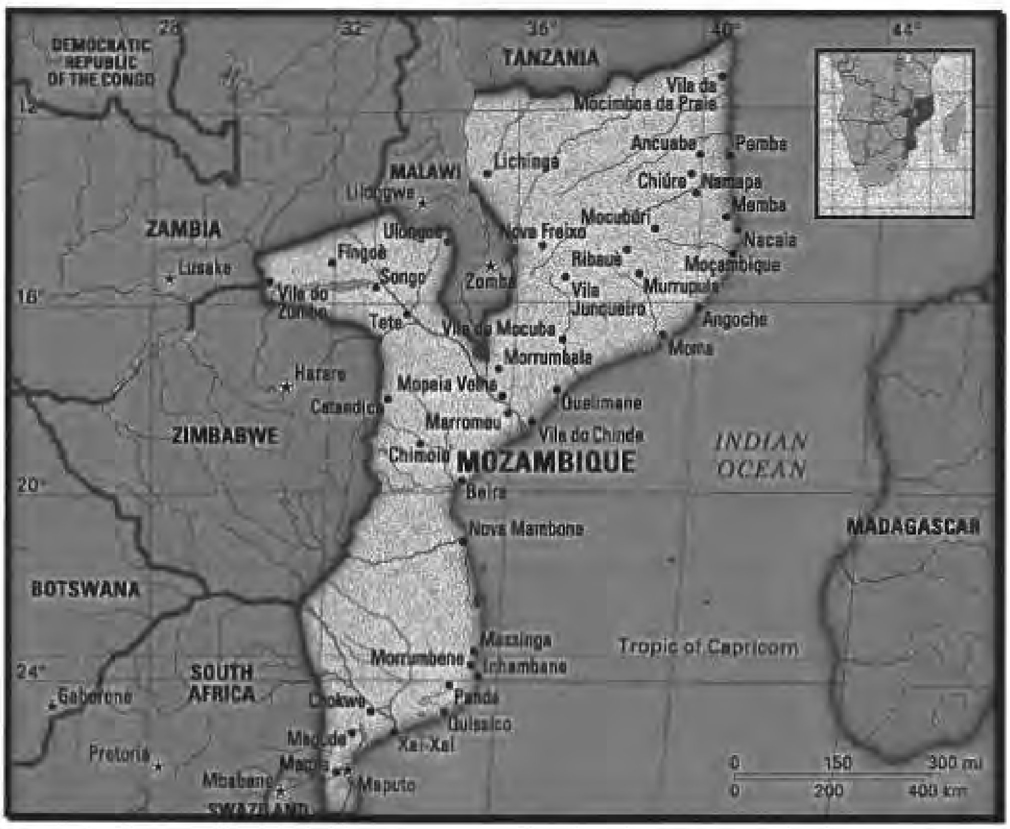


Figure 9: Country of Mozambique

The official language is Portuguese with English spoken in the cities and the local African languages, such as Shangaan, Ronga and Muchope spoken in the rural areas.

The July 1998 population estimate was approximately 18.6 million, with an estimated growth rate of 2.6% per annum.

1.4.2 Mozambique Recent History

The Republic of Mozambique gained independence from Portugal on the 25th June, 1975. Almost immediately the Country was plunged into civil war lasting until 1992, when a peace treaty was signed. Significant portions of the Country's infrastructure were damaged and economic growth was stalled during this conflict.

In 1994 the first multi-party elections were held after which the Country has basically remained stable.

Mozambique's economic development has proceeded under good control for the last several years. Successful fiscal management under World Bank guidelines has led to Mozambique's qualification for foreign debt relief, the first phase of which was implemented in 1999.

A political settlement has been consolidated in Mozambique in the past six years with Frelimo as the ruling party and Renamo the parliamentary opposition. The current peace is effectively guaranteed by the new regional geo-political realities and a donor determined policy environment anchored on multiparty democracy.

1.4.3 Project Development in Mozambique

While Mozambique is still classed as one of Africa's poorest, the government has adhered to guidelines proposed by the international investment community and in doing so has created a strong climate for economic revival. World Bank senior financial economist Simon Bell said in an interview published on 10 February, 1999, that Mozambique's macroeconomic story was "like a dream" at present. Sound economic policy has provided opportunities for rapid growth in some sectors and there is remarkable investor interest for the 98/99 year. This is however still a very poor country with a seriously run down economy.

The economy grew progressively and inflation declined progressively from 1995 to 1997 and continued to improve into 1998.

Mozambique possesses enormous resources for the production of energy. Large hydro, coal and natural gas resources exist and the high level of solar radiation is a further potential energy source. The net hydropower potential for electrical production, mainly on the Zambezi River, is estimated at 14,000 mW of which only about 2,250 mW is exploited today. Mineral coal is available in large quantities. The estimated reserves are 104 million tons. The natural gas fields are still being explored.

The government has instituted legislation to boost economic recovery and make Mozambique an attractive country in which to invest. In particular, the restoration and further development of the Beira corridor is important for this project. The government has given a preliminary indication that the project will qualify for Industrial Free Zone ("IFZ") status and enjoy tax incentives and other concessions.

In the current economic recovery of Mozambique, the largest investment to-date has been the $1.3 billion Mozal Aluminium Smelting Project, located near Maputo, led by Billiton and including South Africa's Industrial Development Corporation (IDC), Mitsubishi and the Mozambican government. Several other large-scale projects (including this one) are currently under consideration.

1.4.4 Project Implementation and Operations Issues

Successful implementation of the project must take into account upgrading all the following utilities, services and local infrastructure:

- Port facilities
- Water supply

- Roads and their maintenance
- Hospitals and clinics
- Training facilities for skilled and semi-skilled workers
- Communications systems.

All of these challenges are typical for a project of this kind and are not specific to Beira alone. As an example, the Mozal Project has been successful in managing similar challenges and it is anticipated that the Beira Aluminium Smelter Project will be similarly successful.

1.5 Comparative Evaluation of the Project

At this stage of the development and excluding any discount for overall Country risk, the proposed project compares favorably with similar recent projects. The project's efficiencies are realized through a business-driven design process using life cycle analysis of assets to determine the correct design decisions. This process is applied to potrooms, carbon, material handling and ancillary systems in cooperation with Kaiser, ABB and key equipment suppliers. In particular, innovations and improvements have been realized in the reduction cells and the alumina handling, potroom gas treatment and metal casting systems, hence the overall capital efficiency of the project.

As seen in the following figure, the expected capitalization of the plant (including the required infrastructure) is very attractive in comparison with other recent projects. The range of expected capital efficiency ($3,240-$3,920) follows from the expected range of annual production between 300,000 and 360,000 tonnes.

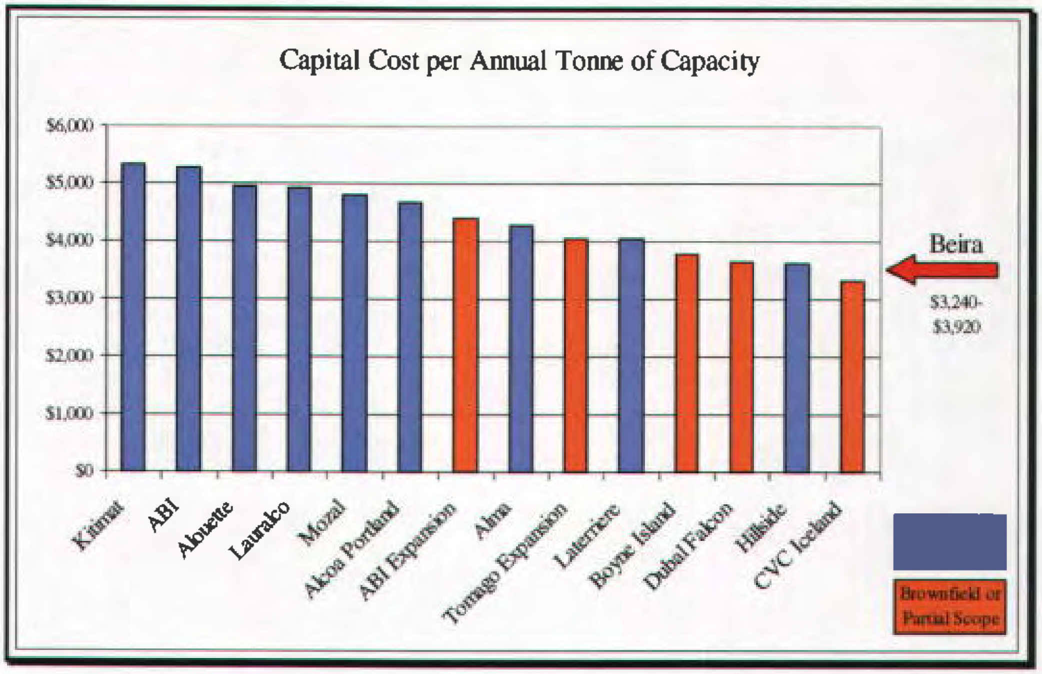


Figure 10: Comparative Capital Efficiency

Under the assumptions deemed appropriate for this project, the plant's projected operating cost is equally favorable, especially with respect to those cost elements typically differentiating one smelter from the other. The following figure shows the expected operating cost under Base Case conditions.

Cost Element per tonne of Al	$/tonne	M$/year
Alumina	$408	$123.1
Energy	$186	$56.0
Carbon	$108	$32.4
Spares and Consumables	$44	$13.2
Electrolyte Chemicals	$8	$2.4
Cell Relining	$15	$4.4
Labor	$52	$15.6
Total Base Case Operating Cost	**$820**	**$247.2**

Table 1: Summary of Operating Costs

The projected cost of energy and labor contribute significantly to the overall expected conversion cost of $820 per tonne, which as seen in the industry cost curve below, is one of the best in the world.

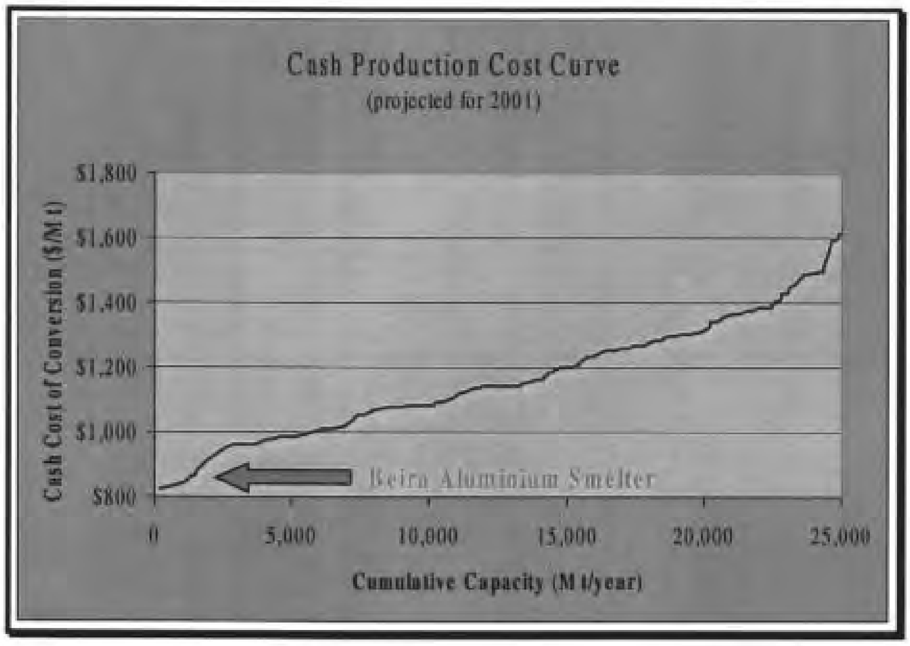


Figure 11: World Production Cost Curve

1.6 Indicated Financial Returns

With low capital cost and low operating cost, the financial analysis of the project is expected to be very favorable. However, country risk and project financing issues in Mozambique offset to some degree the advantages realized from labor and power. Interest rates for project financing are higher than many other places in the world and the equity contribution of the owners will be larger, as shown in the following two tables defining the Base Case assumptions for the analysis.

Base Case for Operating Costs	
LME Price	$1,565
Alumina Cost (% of LME)	12.5%
Power Cost ($/kwh)	$0.013
Labor Productivity (mh/t)	9.1
Aggregate Labor Rate ($/hr)	$5.70

Figure 12: Base Case Operating Cost Assumptions

Nominal Financing Plan	
Total Debt (millions, w/constr interest)	$737
Total Owner's Contribution (millions)	$603
Equity Contribution Rate	45%
Interest Rate	10.3%
Loan Repayment Period (years)	7

Figure 13: Base Case Nominal Financing Plan

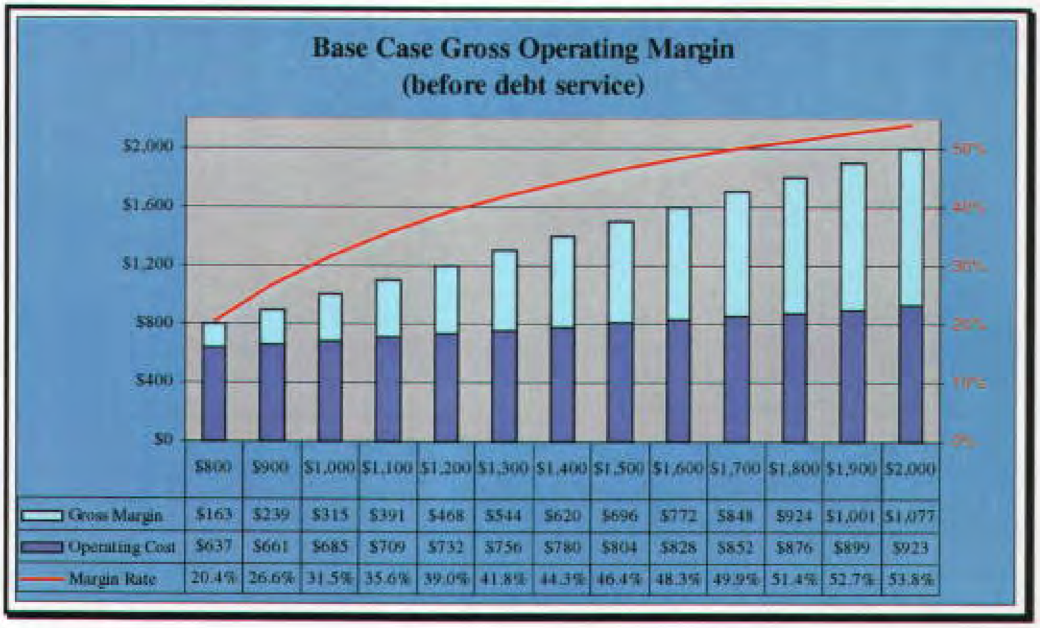
Using these Base Case conditions together with the resulting 20-year proforma Balance Sheets and Income Statements, several financial indicators are calculated and presented below. Annualized results are differentiated between the first 5 years, the second 15 years and the full 20-year period of analysis to demonstrate the different characteristics of the venture during the early period with heavy debt service and the later years where net cash flow is stronger. The analysis is not an absolute indication of planned project performance, but provides a reference point for sensitivity analysis and a baseline for evaluation of the impact of capital improvement programs.

Financial Statement Analysis			
Indicator	**Years 1-5**	**Years 6-20**	**Years 1-20**
Annual Revenues (millions)	$499.0	$610.3	$582.5
Gross Profit Margin	50.3%	50.9%	50.7%
Fixed Charge Coverage Ratio	1.64	15.24	5.53
Annual Profit after Taxes (millions)	$37.6	$282.8	$221.5
Average Profit per tonne	$125	$937	$734
Return on Assets	4.8%	559.5%	94.9%
Unleveraged Internal Rate of Return	10.1%		20.3%
Leveraged Internal Rate of Return	8.8%		25.6%
Net Present Value (millions)	-$16.4		$918.8
Invested Capital (millions)	$602.7	$0.0	$602.7

Figure 14: Base Case Financial Statement Analysis

The result of the large equity contribution percentage and the relatively high interest rate can be seen in the smaller than usual differential between the unleveraged and leveraged Internal Rates of Return.

This analysis is a "snapshot" of conditions considered representative of the project over its long term operation and will change significantly if the Base Case conditions are changed, especially with respect to assumed market price and calculated operating cost (mainly the cost of electricity). These variations are illustrated below in figures showing the projection of Gross Margin for different ingot prices and the sensitivity of Leveraged IRR to operating cost variation over a range of ingot prices.



	$800	$900	$1,000	$1,100	$1,200	$1,300	$1,400	$1,500	$1,600	$1,700	$1,800	$1,900	$2,000
Gross Margin	$163	$239	$315	$391	$468	$544	$620	$696	$772	$848	$924	$1,001	$1,077
Operating Cost	$637	$661	$685	$709	$732	$756	$780	$804	$828	$852	$876	$899	$923
Margin Rate	20.4%	26.6%	31.5%	35.6%	39.0%	41.8%	44.3%	46.4%	48.3%	49.9%	51.4%	52.7%	53.8%

Figure 15: Base Case Gross Operating Margin

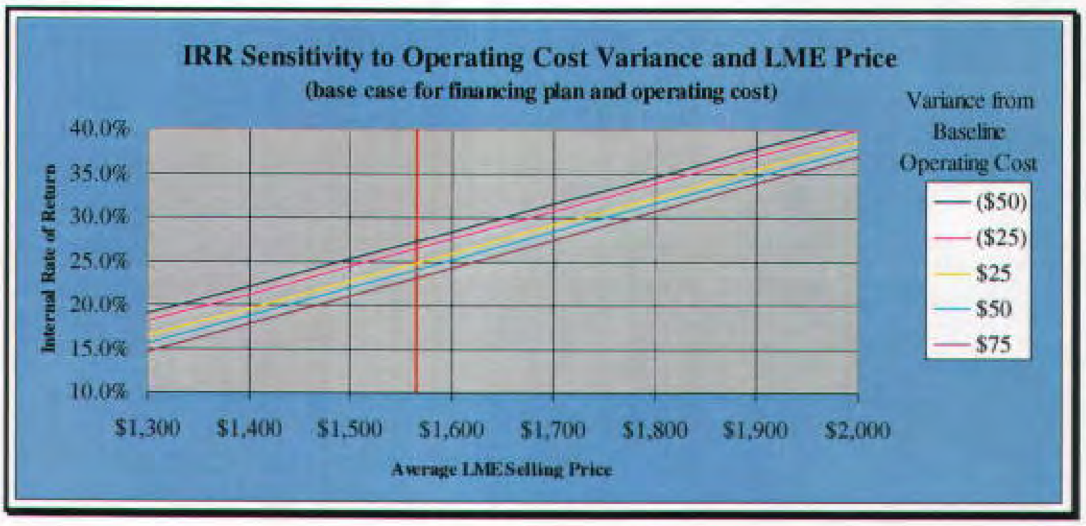


Figure 16: Base Case IRR Sensitivity to Operating Cost Variance and LME Price

From these charts, we see that an increase in average selling price of aluminum of $100 per tonne increases IRR by about 4% (e.g., from 25.6% to 29.6%). An increase in power tariff of about $0.002 per kwh results in an approximate drop in IRR of 1% (e.g., from 25.6% to 24.6%. The assessment of projected financial performance of the project must be done with an awareness of these two very important factors.

In light of the above information as qualified by our current limited verification of local costs (such as power tariffs), the project is certainly viable, and potentially one of the most competitive in recent history.

1.7 Critical Criteria and Major Risks

1.7.1 Key Success Factors

The assessment of the viability of this project identifies two primary criteria forming the basis of financial success. At the summary level, the vision of the project is to attain a competitive power supply contract and operate an efficient technology at the predicted production levels. Thus, successful power contracting and successful technical operations should receive strong focus when evaluating risks and benefits.

Power supply to Beira is critical to the success of this project. While a 6,000 megawatt power surplus exists, the transmission system in Mozambique is not adequate to easily place the power where needed in Beira. After considering various alternatives, the truly realistic source of power is Cahora Bassa, which will require expansion of the transmission capacity between the dam and Beira.

After successfully building and operating a plant for 30 years in Ghana, Kaiser Aluminum, building upon this experience, will manage the start-up, training and progressive take-over of plant operations by local Mozambicans. The strong sponsorship and participation of Kaiser resources builds high confidence that plant operations will be as predicted.

1.7.2 Significant Risks

As an evolving political and economic entity, the risks associated with the Country of Mozambique are difficult to assess. However, based upon all of the information collected throughout the course of the study and the current controlled expansion of Mozambique's economic base, Country risks are not considered critical, but will bear careful monitoring.

Due to the current shortage of skilled artisans in Beira, great emphasis will be placed on training personnel to the requisite level of skills to construct the facility and ultimately operate the plant.

Throughout Southern Africa, there has been a resurgence of many killer diseases, amongst them, malaria, tuberculosis, cholera, AIDS, to mention but a few. There is a chronic need for the upliftment of health facilities in the Beira area and the initiation of awareness, treatment and preventative programs. Core to the success of the project is the health and welfare of construction and plant operations personnel. From project initiation throughout the anticipated long life cycle of the plant, there must be great emphasis on health and safety programs.

A more immediate risk to the viability of the project is the lack of skilled craftsmen and industrial workers in the Beira region. If a skilled labor shortage slows the construction schedule, project returns will be seriously eroded. Based upon the projected interest rates and time value of money, each month's extension of the schedule would cost the project approximately $20 million. The proposed project execution plan addresses this important risk, and any construction campaign must recognize and protect against the schedule impact of skilled labor shortage.

1.8 Requirements for Further Development of the Project

The Feasibility Study Report provides a current assessment of the viability and estimated financial performance of the project and serves as a baseline for indicating the merit of further commitment of funds to develop the project.

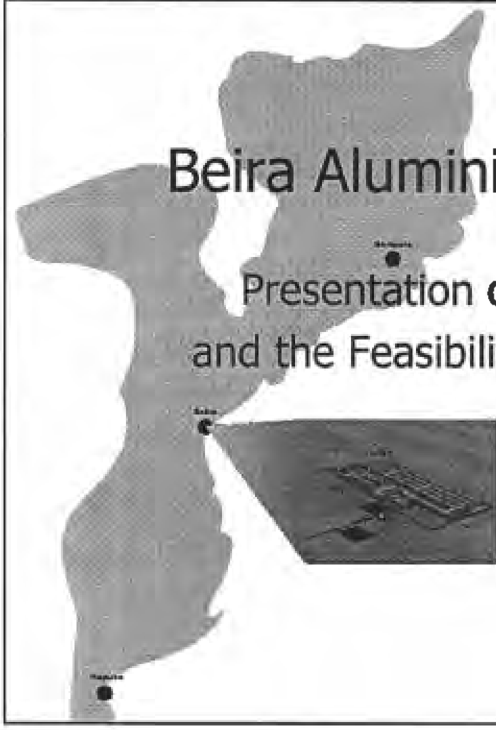
Upon favorable evaluation of the project's potential, project sponsors must invest additional time and energy to further define the project to an indicative (precise) stage as required for financing. The next steps in project development (in rough order of priority) should be:

- Secure a long term, competitive power contract. This contract is the keystone of project profitability.
- Determine the specific site for plant construction so that geotechnical, environmental and logistical diligence can be completed and the basis for the capital estimate can be finalized.
- Secure Industrial Free Zone status from the Government of Mozambique, providing a specific basis for Foreign Invested Capital incentives.
- Secure the contingent commitment of lending institutions so that the financing plan can be confirmed.

- If necessary, market the project to other investor/partners to satisfy the project's equity requirements.

These activities should be undertaken in close cooperation with the Government of Mozambique, specifically the Government Liaison Committee and the municipality of Beira, without whose support it is unlikely that the project will proceed.

Beira Aluminium Smelter



Presentation of the Project
and the Feasibility Study Report

Topics of this Presentation

- Project Development in Mozambique
- Project Location and Sites
- Description of the Facilities
- Project Implementation
- Comparative Evaluation of the Project
- Indicated Financial Returns
- Further Development of the Project

Beira Aluminium Smelter

Project Development in Mozambique

The Country of Mozambique

- 18 million people
- Democratic and stable
- Recent successful economic growth
- Energy rich
- Incentives for foreign investors

The Beira Region

- Regionally 1.3 million people
- 300,000 in Beira
- Important political center
- Good port facilities
- Lagging Maputo area in economic rebirth

Availability of Electrical Power

- Regionally, 6,000 megawatts of excess power
- Low cost hydroelectric power in Mozambique (Cahora Bassa Dam)
- Insufficient power transmission infrastructure
- Competitive power contract recently granted to Mozal

The Feasibility Study

- Conducted by Fluor Daniel, ABB and Kaiser Aluminum
- Sponsored by the United States Trade and Development Agency
- Completed in December, 1999
- Includes project definition, techno-economic analysis, socioeconomic assessment and implementation plan

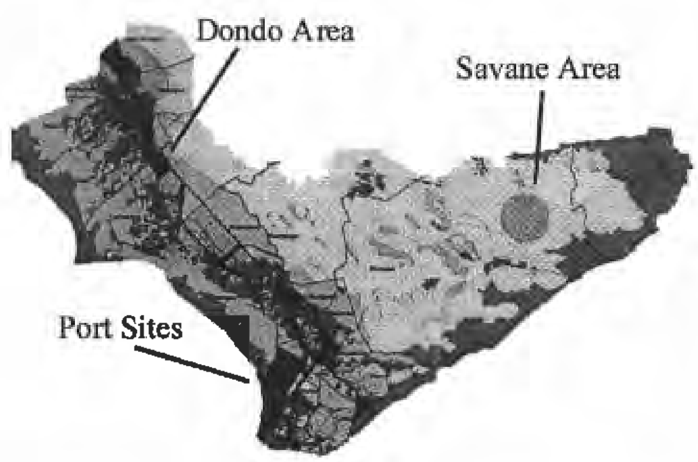
Beira Aluminium Smelter

Project Location and Sites

General Requirements for Location

- Proximity to ocean port for shipping and receiving
- Proximity to low cost, reliable supply of electrical power
- Supportive of economic recovery of Central Mozambique, especially the Beira Corridor.

Beira Regional Sites Considered



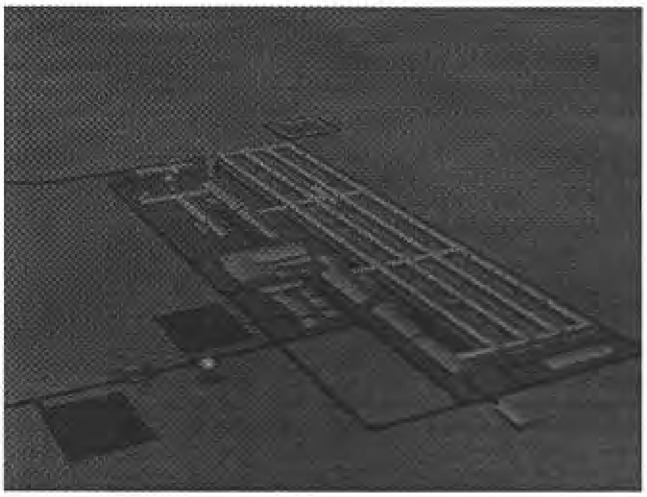
Preferred Site

- Outskirts of Beira City
- Near the Port of Beira
- Nearby trainable workforce
- Needs considerable site improvement before construction begins

Beira Aluminium Smelter

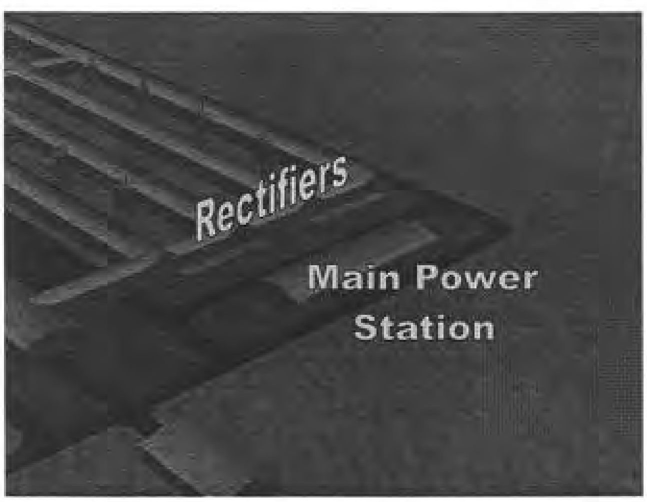
Description of the Facilities

The Proposed Facilities



- 300,000-360,000 tonnes per year
- Capital Cost of $1.2 billion
- Kaiser K220 technology
- 650 megawatts of power

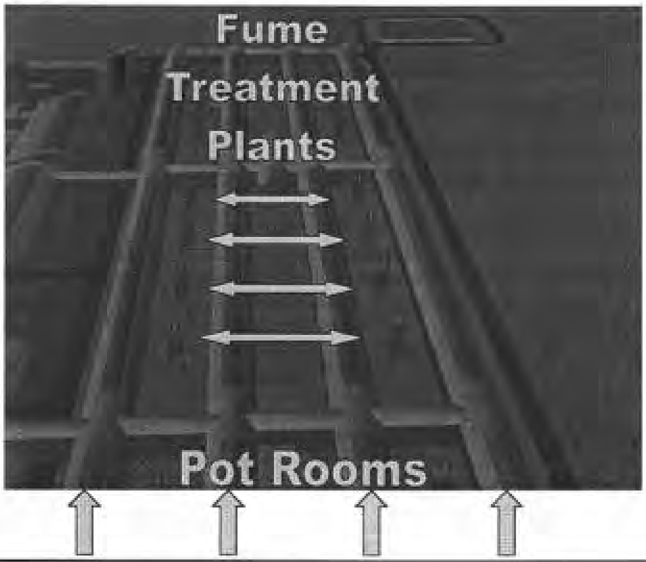
Description of the Facilities



180-220 kA operating range

Up to 650 megawatts of power

Description of the Facilities



Exceeds US and EU Environmental Standards

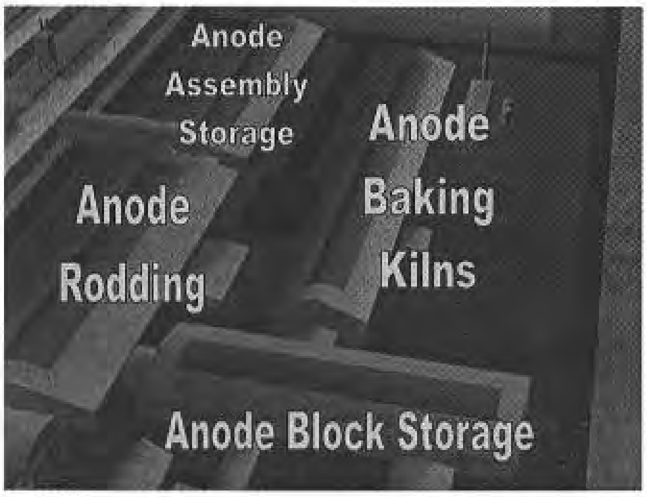
Two potlines of 300 cells each

Description of the Facilities

State of the Art mixing and forming systems

MACT-compliant emission control

Description of the Facilities



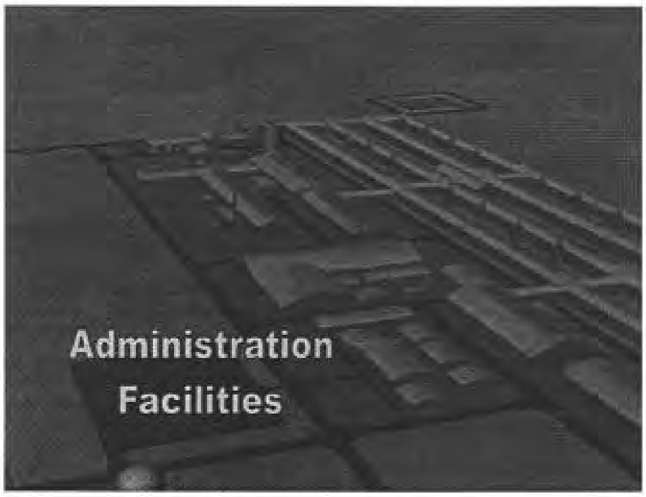
High efficiency baking kilns with best emissions control technology

Highly automated anode cleaning and rodding operations

Description of the Facilities

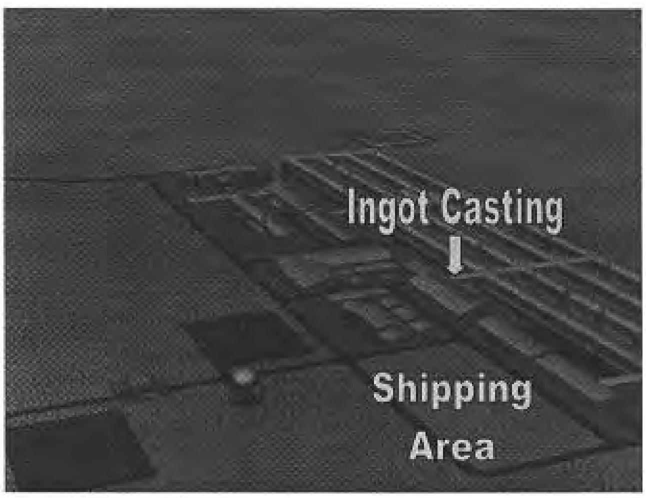
Comprehensive maintenance and engineering facilities for self-sufficiency

Description of the Facilities



Offices
Medical clinic
Safety/security
Food services
Shower house
Training center

Description of the Facilities



P1020 or A7 grade aluminium in 650kg ingots

Up to 360,000 tonnes/year

Associated Infrastructure Included in the Project

- Port improvements
- Water supply
- Health facilities
- Education and training
- Site development and channel dredging
- Housing
- Roads and rail

Power Transmission System Improvements

Reinforce existing system and add two new lines

Most cost-effective option for the smelter

May be changed to provide additional benefits to the grid

Capital cost of $170 million included as a power wheeling fee

Beira Aluminium Smelter

Project Implementation

Capital Cost Breakdown

BASS Aluminum Reduction Facility
Capital Cost Estimate
Revision 2.3 (12 November, 1999)

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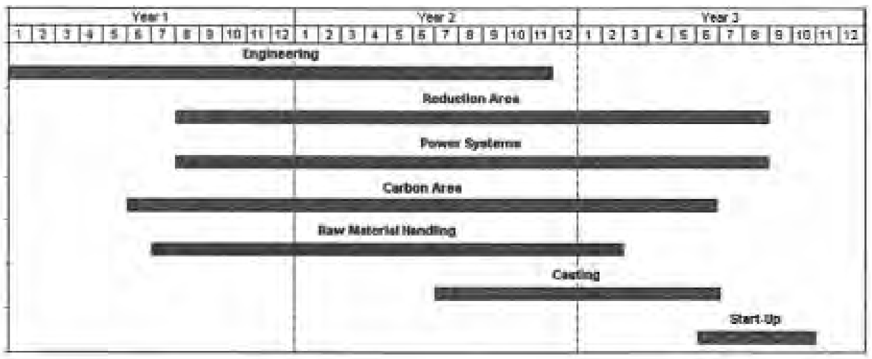
900000	INDIRECT COSTS	$265,956
990000	CONTINGENCY	$95,000
	TOTAL FACILITIES	**$1,183,814**

Implementation Schedule



Issues for Implementation

- Training construction and production workers
- Health and well being of the workforce
- Site preparation
- Material management and logistics

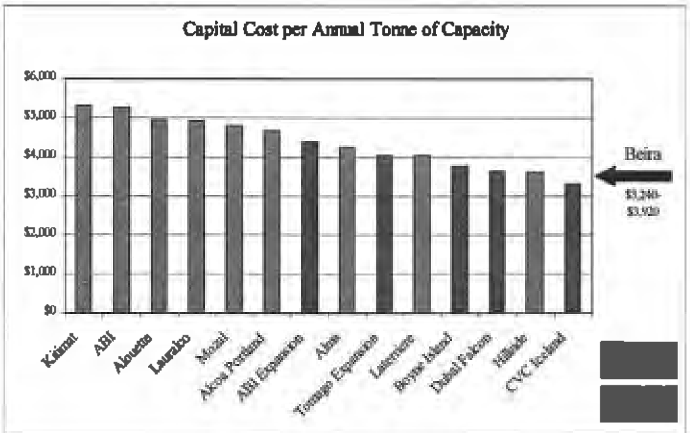
Beira Aluminium Smelter

Comparative Evaluation of the Project

Design Philosophy

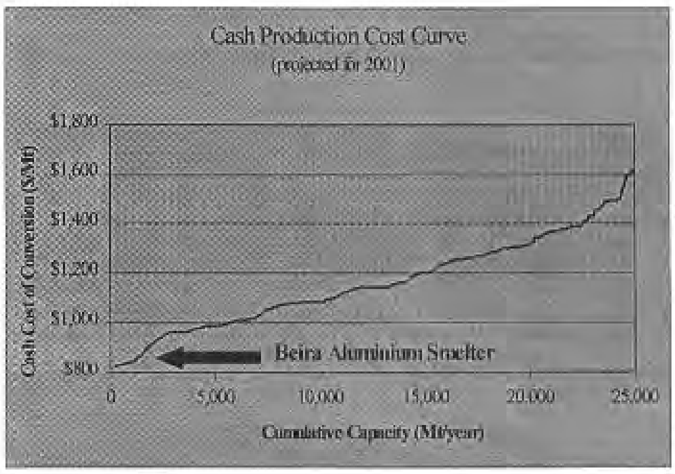
- A business-driven process
- Life cycle (20 year) view of the enterprise
- Decisions made in light of their overall financial impact
- All decisions made within a manageable risk profile

Capital Cost of Capacity



One of the most capital efficient in the last 15 years

Operating Cost Comparison



One of the lowest cost producers in the world

Summary Comparison
(vs. typical recent projects)

- Lower capital cost per tonne of capacity
- Lower operating cost per tonne of production
- Better taxation structure
- Better financial returns
- More complex (and difficult) debt package
- Higher equity requirements

Beira Aluminium Smelter

Indicated Financial Returns

Basis for Financial Analysis

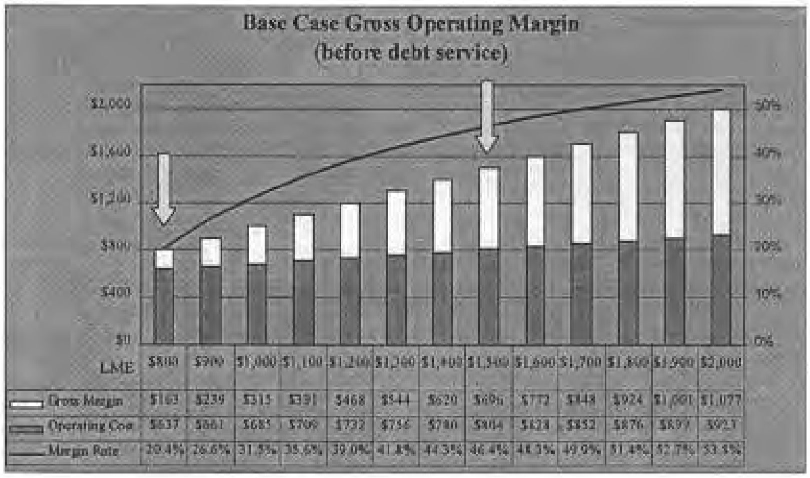
- Capital Cost Estimate of $1.2 billion
- Power cost of $0.013 per kwh
- Average ingot price of $1,565 per tonne
- Normal cost and revenue escalation
- 20-year pro forma accounting reports

Financial Indicators

Financial Statement Analysis			
Indicator	Years 1-5	Years 6-20	Years 1-20
Annual Revenues (millions)	$499.0	$610.3	$582.5
Gross Profit Margin	50.3%	50.9%	50.7%
Fixed Charge Coverage Ratio	1.64	15.24	5.53
Annual Profit after Taxes (millions)	$37.6	$282.8	$221.5
Average Profit per tonne	$125	$937	$734
Return on Assets	4.8%	559.5%	94.9%
Unleveraged Internal Rate of Return	10.1%		20.3%
Leveraged Internal Rate of Return	8.8%		25.6%
Net Present Value (millions)	-$16.4		$918.8
Invested Capital (millions)	$602.7	$0.0	$602.7

The indicated IRR is very strong for a project of this type

Expected Gross Margin

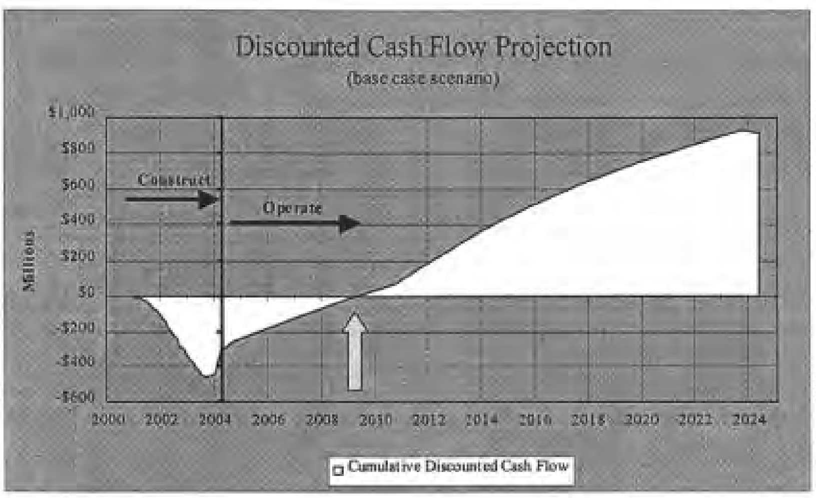


LME	$800	$900	$1,000	$1,100	$1,200	$1,300	$1,400	$1,500	$1,600	$1,700	$1,800	$1,900	$2,000
Gross Margin	$163	$239	$315	$391	$468	$544	$620	$696	$772	$848	$924	$1,001	$1,077
Operating Cost	$637	$661	$685	$709	$732	$756	$780	$804	$828	$852	$876	$899	$923
Margin Rate	20.4%	26.6%	31.5%	35.6%	39.0%	41.8%	44.3%	46.4%	48.3%	49.9%	51.4%	52.7%	53.8%

The project remains profitable at very low LME levels

At normal LME levels, gross margin exceeds 45%

Discounted Cash Flow



The project becomes discounted cash positive after 5 years operation

Breakeven Analysis

For the Base Case scenario, the project covers all costs and debt service when LME is as low as $1,180/tonne

If full production levels are realized, the project can withstand LME prices as low as $1,070 and still break even

Major Sensitivities

- Price of Electrical Power: An increase in power tariff of $0.002 per kwh decreases IRR by 1% (e.g., 25.6%→24.6%)
- Selling Price of Aluminium: An increase in the LME selling price of $100 per tonne raises IRR by 4% (e.g., 25.6%→29.6%)

Beira Aluminium Smelter

Critical Criteria and
Most Significant Risks

Key Success Factors

- A Competitive Power Contract is required for viability. This factor is not yet resolved.

- Successful Plant Operations are required for viability. Kaiser Aluminum will provide management, technical assistance and training, but long term, this must be "localized".

Major Risks

- Mozambique Country risks are acceptable, but should be closely monitored.
- Lack of skilled craftsmen and industrial workers could cause schedule overruns.
- In the long term, the workforce wellness must be maintained for self-sufficiency.

Beira Aluminium Smelter

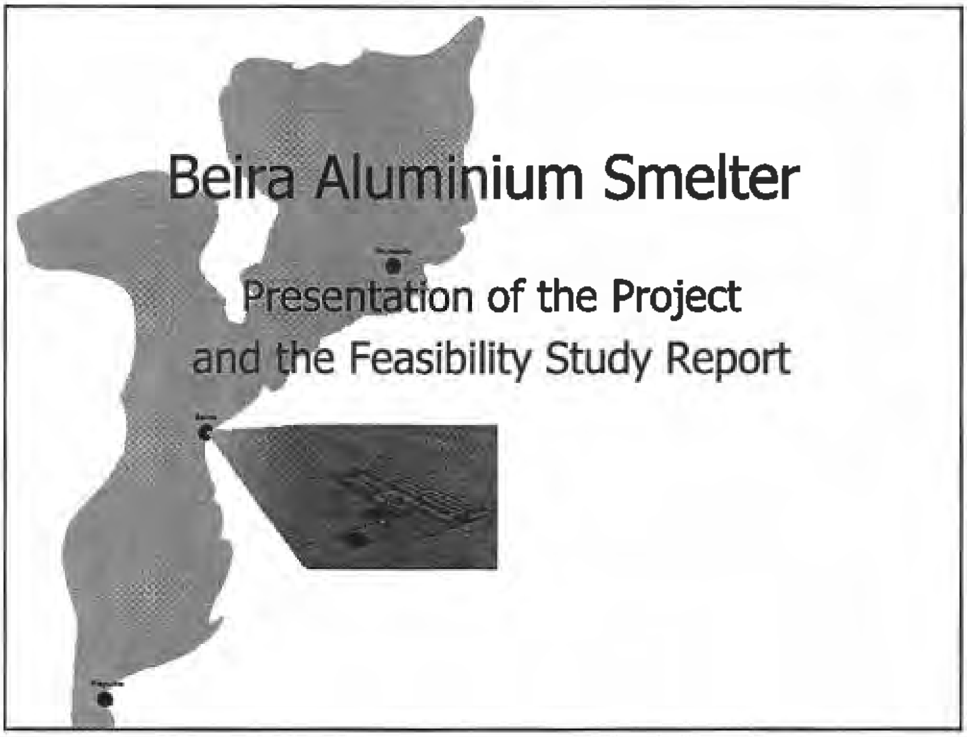
Further Development
of the Project

Maintain the Momentum

- Advertise the project and its attractive financial returns
- Solicit a sponsor to fund and lead the next stages
- Continue the strong involvement of the Government of Mozambique, especially the Government Liaison Committee and the Beira Regional leadership.

Next Steps for Development

- Secure a good power contract
- Commit to a specific plant site
- Confirm IFZ status
- Contingent support of lending institutes
- Expand the development consortium (if necessary)


Beira Aluminium Smelter
Presentation of the Project
and the Feasibility Study Report

BEIRA ALUMINIUM SMELTER STUDY

prepared for
The Government of Mozambique
December 1999

Volume 1
Feasibility Study Report

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The team of Kaiser Aluminum, Asea Brown Bovari and Fluor Daniel thank the people of Beira and the Government of Mozambique for their willing assistance in providing data upon which this report is based. In particular, we extend our appreciation and acknowledgement to the following organizations:

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Arquitudo

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Austral Consultoria e Projectos, Lda

Cemtos De Mozambique

Centro De Promcao De Investmentos ("CPI")

Cornelder De Mozambique

Electricidade De Mozambique ("EDM")

Emodraga

Eskom

Government Liaison Committee ("GLC")

Hidroelectrica De Cahora Bassa

JCI Projects (Pty) Ltd

Ministry of Industry, Trade and Tourism

Ministry of Mineral Resources and Energy

Municipality of Beira

Portos E Caminhos De Ferro De Mozambique ("CFM")

Projecta

Universidade Catolica De Mozambique

United States Embassy

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Attachments to the Report

1.1 Project Description

The proposed project consists of a primary aluminium reduction facility complete with major infrastructure required to support the construction and ongoing operation of the facility.

Reduction Facility

The reduction facility is based upon K220 technology supplied by Kaiser Aluminum, consisting of two potlines of 300 reduction pots each, anode production facilities, an ingot casting plant, and support facilities, as shown in the following figure.

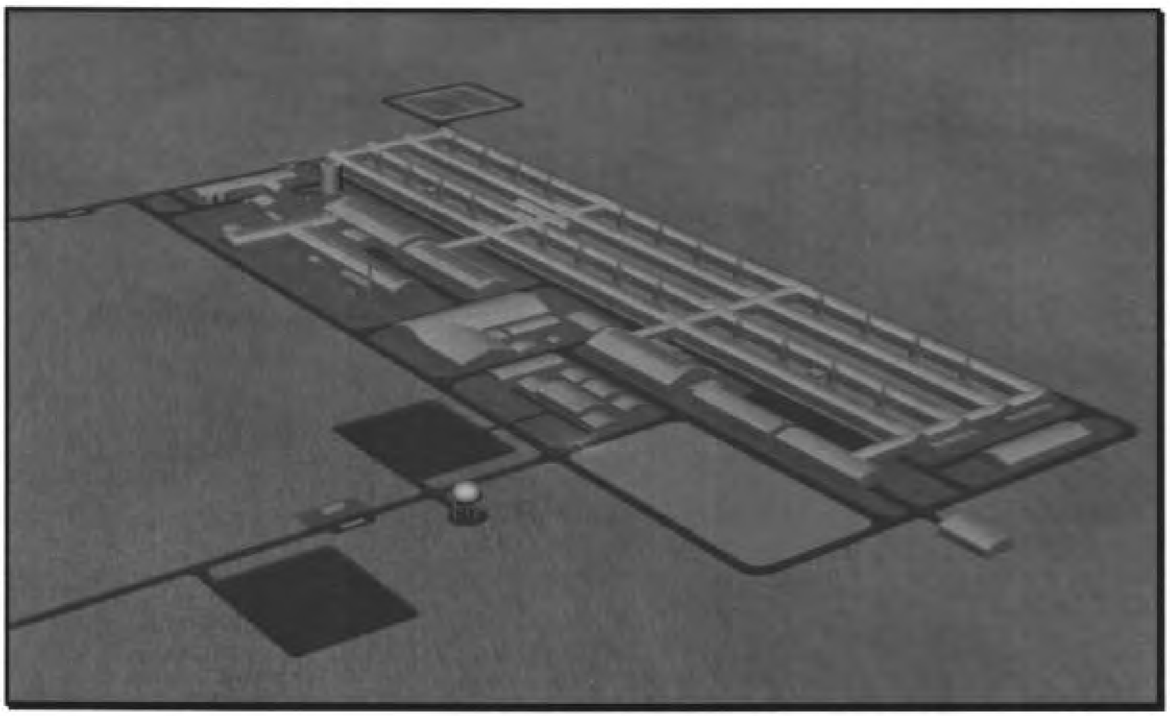

Figure 1: Beira Aluminium Reduction Facility

Port Facilities

Off-site infrastructure consists primarily of port facilities for importing petroleum coke and alumina, the two main raw materials. Existing commercial port operations will be used to receive pitch, carbon and other plant supplies and raw materials. The plant's ingot production will be exported through the existing container terminal. The existing port facility is shown in the following figure.

Figure 2: Port of Beira

Bulk raw materials unloading systems and main alumina and coke silos will be constructed in the port area to support the plant operations. The conceptual layout of these facilities is shown in the following sketch.

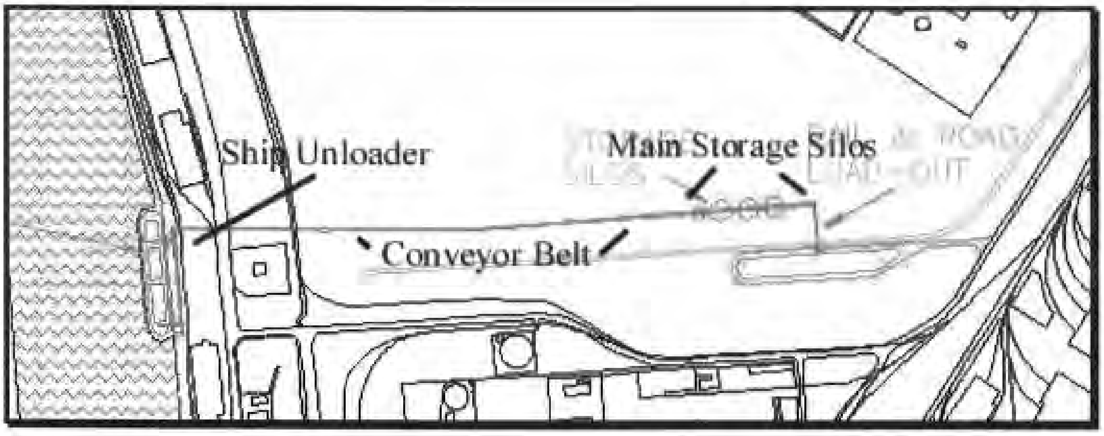

Figure 3: Port Layout

Electrical Transmission Systems

Existing overland electrical transmission systems will be upgraded, supplemented and replaced in order to provide the electrical power required for operation. The Central Region of Mozambique's power transmission system will be modified to increase reliability and capacity of transmission.

The general areas for improvement are indicated on the following figure. Ultimately, this solution may be supplemented to better serve the development of Central Mozambique's power distribution grid, but for the purposes of this study, it is the most capital effective and feasible configuration satisfying the smelter's requirements.

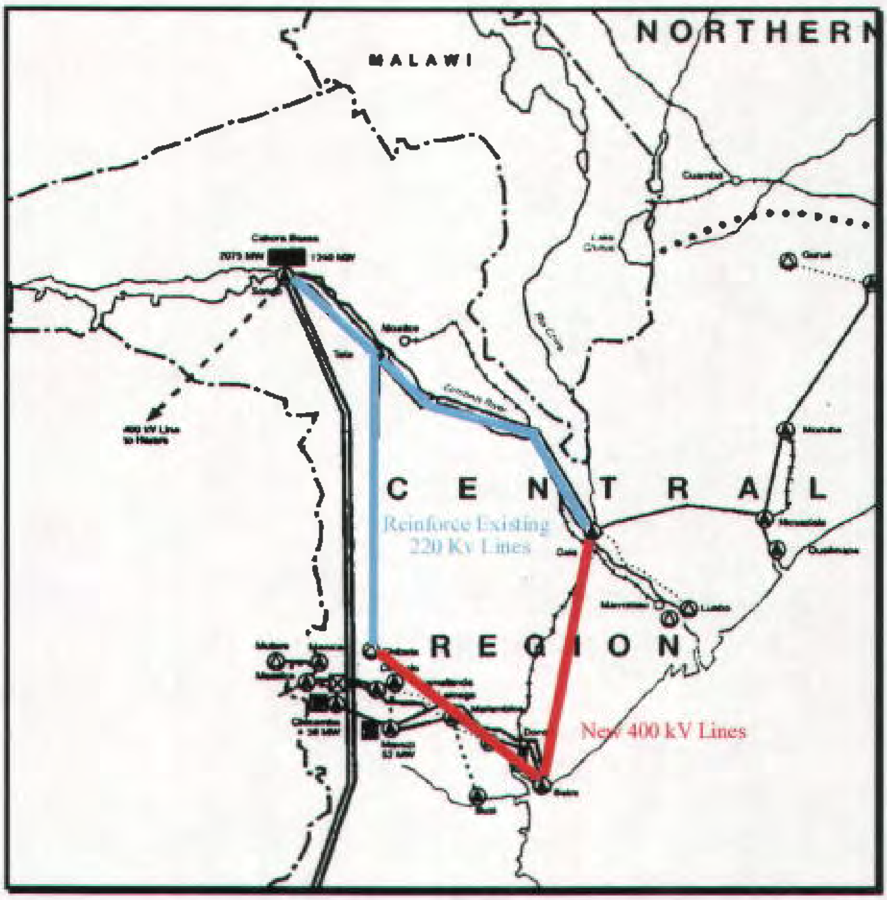

Figure 4: Planned Power Transmission Upgrades

Expatriate Facilities

Facilities for up to one hundred construction and two hundred operations expatriates will be required. Though most of the construction and plant operations workforce will be from the citizenry of the Beira area, expatriate project management and technical personnel will be required to a varying degree during the course of the enterprise. Housing, recreation, foreign-language schooling and supplementary medical care are planned to support these personnel.

Planned Production Capacity

The baseline production capacity of the facility is approximately 300,000 metric tonnes per year of unalloyed and unwrought primary aluminium ingot. To sustain this level of production, the plant requires approximately 700,000 tonnes per year of raw materials and almost 500 megawatts of power.

Kaiser K220 technology is designed to operate at production levels higher than baseline after start-up is completed and operating staff fully trained. This report uses baseline performance to determine project viability, but under optimal conditions, the plant could produce as much as 360,000 tonnes per year, or about 20% greater than baseline.

Baseline and optimal technical performance are summarized in the following table:

	Kaiser K220 Technology Performance Level	
	Baseline	Optimal
Number of Reduction Cells	600	600
Nominal Operating Amperage (kA)	180	220
Annual Production (tonnes)	301,689	364,852
Power Requirements (mW)	485	651
Raw Material Requirements (tonnes)	717,544	867,407

Table 1: Kaiser K220 Technical Performance

The project incorporates comprehensive safety, technical and managerial training programs to assist in providing human resources for both construction and operations. The ongoing programs assist in the migration of management and technical expertise from expatriate personnel to local personnel. Socioeconomic impact and ongoing community relations are monitored by a special focus group, also incorporated into the project's scope.

1.2. Country Background

The Republic of Mozambique is located on the eastern coast of Southern Africa. Maputo is the capital city and the Country is divided into 10 administrative provinces, each with it's own capital city. Beira is the capital of Sofala province and is the Country's second largest city and the gateway to the land-locked countries of Zimbabwe, Zambia, Malawi, Botswana and southern Democratic Republic of the Congo. The Country shares borders with six countries including South Africa and Zimbabwe. The land boundaries are 4,571 km long and the coastline is 2,470 km long.

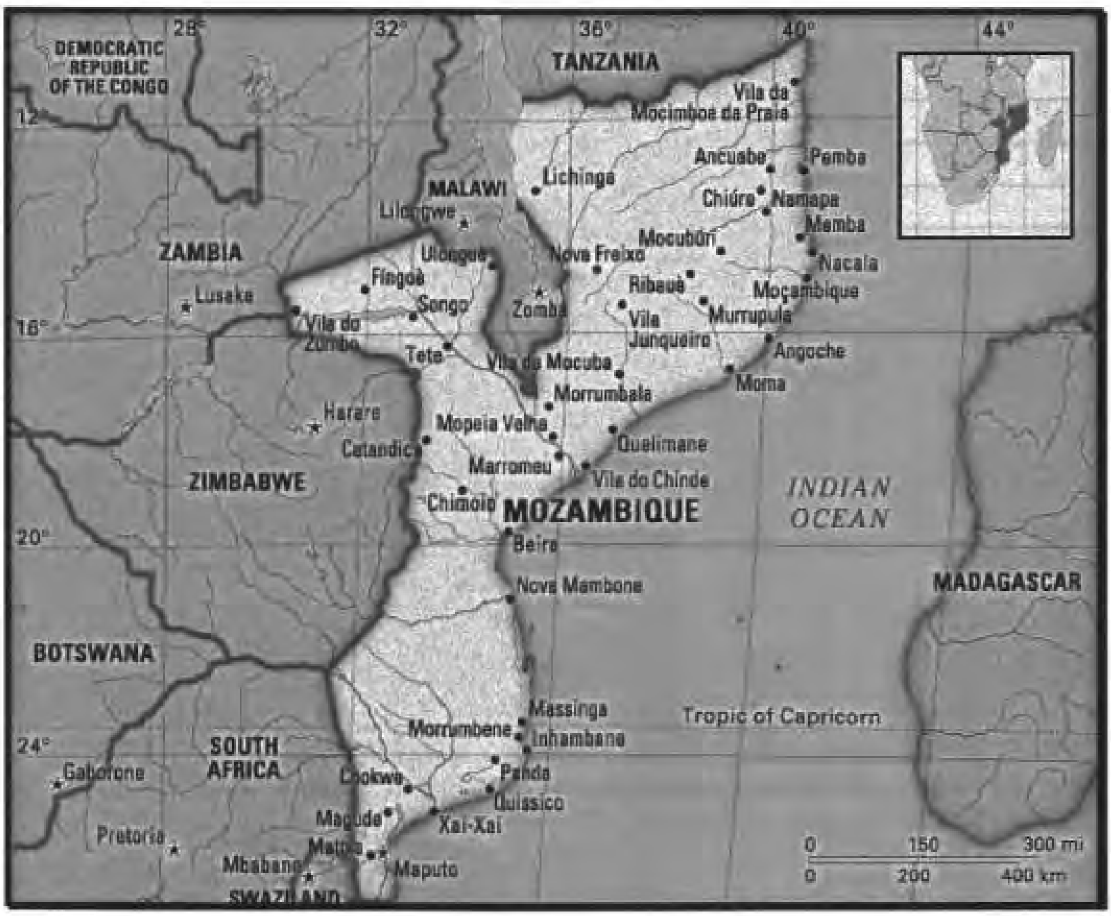

Figure 5: Country of Mozambique

Terrain varies from coastal lowlands to uplands in the center, high plateaus in the northwest and mountains in the West. The highest point is Monte Binga at 2,436 meters.

The province of Sofala lies between the Zambezi River in the north and the Save in the south. To the west is the province of Manica and to the east the Indian Ocean. Many rivers flowing into the India Ocean cross the province. The coast south of Beira has extensive mangrove swamps and the interior north and west of Beira is covered in deciduous forests. Acacia savannas occur along the border with Manica Province.

The climate varies from tropical to subtropical with a cool season from May to September. The rainy season lasts from November to April and monsoons cause extensive flooding along the coastal planes. The average annual rainfall in the Beira area is 1500 mm and the average maximum and minimum temperatures in summer and winter are approximately 29 and 21 degrees centigrade respectively.

The people originate from a variety of Bantu ethnic groups, each with their own language and culture. There are minorities of Asian and European descent. The official language is Portuguese with English spoken in the cities and the local African languages, such as Shangaan, Ronga and Muchope spoken in the rural areas.

The legal system is based on the Portuguese civil law system and customary law.

1.2.1. Mozambique Recent History

The Republic of Mozambique gained independence from Portugal after a long struggle on the 25th June 1975. Almost immediately the country was plunged into civil war lasting until 1992 when a peace treaty was signed between the warring parties. Significant portions of the country's infrastructure were damaged during this conflict.

In 1994 the first multi-party elections were held after which the country has basically remained stable.

Mozambique's economic development has proceeded under good control for the last several years. Successful fiscal management under World Bank guidelines has led to Mozambique's qualification for foreign debt relief, the first phase of which was implemented in 1999.

1.2.2 Current Socioeconomic Status

Population

The July 1998 population estimate is 18,641,469.

Age structure:	0-14 years:	45%	(male: 4,129,779	female: 4,232,091)
	15-64 years:	53%	(male: 4,807,742	female: 5,043,299)
	65 years +:	2%	(male: 177,895	female: 250,663)

Estimated population growth rate:	2.6%
Life expectancy at birth (1997):	45 years
GNP per capita (1997):	$90

Economic Climate

One of Africa's poorest nations may not seem an obvious place to begin looking for business opportunities but a closer look at the economic fundamentals will provide some surprise. Events of the past few years have established a base for economic revival. World bank senior financial economist Simon Bell said in an interview published on 10 February, 1999, that Mozambique's macroeconomic story was "like a dream" at present. Sound economic policy has provided opportunities for rapid growth in some sectors and there is remarkable investor interest for the 98/99 year. This is however still a very poor country with a seriously challenged economy.

Mozambique has virtually untapped agricultural, mineral, tourism and energy resources. Due to the wars the Country was not able to attract foreign investment. This started to change with the peace accord and once the move was made to a market based economy. The 1990's have started to show the benefits of the changes.

The economy grew by 4.1% in 1995, 6% in 1996 and reportedly 6.1% in 1997. An International Monetary Fund mission revised these statistics upward for 1997, indicating GDP growth at 12.5%. Inflation showed a corresponding sharp decline from 54% in 1995, 16.6% in 1996, 4.1% in 1997 and dropped to minus 4.2% between May and September 1998. The Bank of Mozambique stressed that these figures only accurately reflect economic conditions in Maputo, as it did not take into account variations experienced in other provinces.

Gross domestic product figures for 1995 show the following breakdown: Tourism and services 52%, Agriculture 23%, Industry and Fisheries 12%, and Others 13%.

VAT was introduced on the 1st April 1999, at a rate of 17%, as required by the government's programs with the World Bank and IMF.

Customs income hit a record high in 1998 collected by Crown Agents. Tax evasion and corruption are being reduced by the introduction of private agents at border posts.

Ownership of land and natural resources is vested in the State. Tenure to the land takes the form of a land use benefit license issued by the government for renewable periods of up to fifty years.

Mozambique possesses enormous resources for the production of energy. Large hydro, coal and natural gas resources exist and high level of solar radiation is a potential energy source. The net hydropower potential for electrical production, mainly on the Zambezi River, is estimated at 14,000 mW of which only about 2,250 mW is exploited today. Mineral coal is available in large quantities. The estimated reserves are 104 million tons. The natural gas fields are still being explored.

Mozambique has large trade deficits and external debt. Donors have agreed to reduce the Country's external debt to $1.1 billion in June 1999. The write-off will involve $2.9 billion under the terms of the Paris Club debt relief program and $1.4 billion in terms of the highly indebted poor countries initiative, led by such agencies as the World Bank and the IMF.

In March, Germany formally agreed to reschedule more than $50.6 million in foreign debt with repayment now over 23 years. In April, South Africa scrapped R40 million of Mozambique's debt to SA and finance minister Trevor Manuel is crusading for the IMF and the World Bank towards a more ambitious debt relief plan for the poorest countries, of which Mozambique is one.

Mozambique enjoys membership in the following international organizations:

1. African Development Bank.
2. Customs Co-operation Council.
3. International Bank for Reconstruction and Development.
4. International Finance Corporation.
5. International Monetary Fund.
6. Lome Convention.

7. Mozambique has Observer Status at the Preferential Trade Area for Eastern and Southern African States.
8. Organization for African Unity.
9. Southern African Development Community.
10. United Nations.
11. United Nations Conference on Trade and Development.
12. World Customs Organization.
13. World Trade Organization.
14. Commonwealth of Nations

Export processing zones and development corridors are the mix of tools chosen to boost the economic recovery. The Beira development corridor is important for the region we are interested in as it is hoped that it will attract many other investments. Once the transport corridor was rehabilitated the Zimbabweans invested in citrus exporting and took a 25-year lease on the cold storage facility in the port. Timber exports have also increased including logs, sawn timber and it is hoped wood chips. Now that the Zimbabweans have shown that the corridor is working the Mozambicans are trying to attract further investment. They want to create formal employment in agriculture, mining, energy and manufacturing.

Dutch shipping consortium, Cornelder, have signed a management agreement with CFM to operate the container facility at the port of Beira. Traffic is expected to top 100,000 containers this year, helped in part by Zimbabwe tobacco exporters moving their export operations from Durban in South Africa to Beira.

The largest investment to-date has been the $1.3 billion Mozal project led by Billiton and including South Africa's Industrial Development Corporation ("IDC"), Mitsubishi and the Mozambican government. Mozal has an agreement with CFM to develop and operate a dedicated terminal and other port terminal facilities at Matola. $14 million for the berth's construction is included in the project cost. The project is maintaining its 31-month program and the first aluminium is due in the year 2000.

The IDC is considering investments in several multimillion-Rand industrial development projects in Southern Africa. In Mozambique the projects under consideration include a R100 million fertilizer plant and a possible R200 million cotton plantation. Enron and the Mozambique government have signed an agreement for a gas-fired iron and steel project worth $2.5 billion to be built in Maputo. The one blot on the horizon is the failure of Spoornet and CFM to reach agreement on the rail link to Maputo. Discussions have been going on for more than a year and there has been no progress made. This could have serious ramifications for the Maputo corridor.

On the other hand good progress is being made with the building of the Witbank - Maputo toll road. The road is an integral part of the Maputo development corridor and is being built at a cost of $240 million. Trans Africa Concessions won the $480 million 30-year concession to build, finance, operate and maintain the road.

There are now eight commercial banks in Mozambique, five of which were set up in the last five years. The entire banking sector is now in private hands. Other companies that have been privatized include the Country's largest cement, milling, soap, cooking oil, citrus, tea, cashew nut, sugar and clothing manufacturing companies.

Mozambique faces an enormous task in rehabilitating and extending the electrical distribution network. Large parts were damaged in the war, which also made extending it very difficult. Electricidade de Mozambique ("EDM") was transformed from a state enterprise into a public company in July of 1995, with the aim of creating more autonomy in EDM's operations. Electrical consumption still remains very small with only about 6% of the population having access to power. The maximum peak demand in 1996 was 175 mW and the forecast for 1999 was 197 mW, excluding the development of large consumers. If finance can be obtained there are potential projects for EDM. These include 1,240 mW Cahora Bassa II, 1,700 mW Mepanda Uncua hydro station downstream of Cahora Bassa, the interconnection of lines to Mozambique's neighbors and distribution in all the main cities.

Hidroelectrica de Cahora Bassa ("HCB"), the Portuguese operator of the hydroelectric dam is seeking international arbitration over its tariff dispute with Eskom. HCB wants to increase it's tariff but Eskom does not want to pay the difference between HCB's new tariff and the cost of generating it's own power, unless the contract is long enough to allow Eskom to recover it's initial losses.

1.2.3. Current Political Climate

As in South Africa, a remarkable political settlement has been consolidated in Mozambique in the past six years. Frelimo is the ruling party and Renamo the parliamentary opposition. The parties have a stable relationship with opposing political philosophies. The current peace is effectively guaranteed by the new regional geo-political realities and a donor determined policy environment anchored on multiparty democracy. As common stakeholders in Mozambique's political stability and economic recovery, few substantive ideological or other differences now separate Frelimo and Renamo other than history and their perceptions of relative regional benefits.

The political system is a constitutional multi-party one, with the latest modifications to the constitution approved on the 30th November 1990. The national assembly has 250 seats. Frelimo has 129, Renamo 112 and the Uniao Democratica has two seats. The present head of state is President Joaquim Alberto Chissano. General elections are due in December 1999.

The Supreme Court validated the Country's June 1998 local elections in which Frelimo won all the 33 council seats in the Country. Opposition parties boycotted the elections arguing that the registration process was flawed.

Mozambicans have taken to their democratic institutions with some vigor but there is a daunting political task in the building of a culture of democratic governance, accountability, human rights and the rule of law. Despite a slow legislative process the consensus seems to be that the system is working reasonably well. Priorities are the strengthening of the judicial system and equipping and building a competent, incorruptible police force to handle crime and security concerns.

The political administration of the Country is sub-divided into six major levels namely:

1. Central (1).
2. Provincial (10 + Maputo City).
3. District (128)
4. Municipal (33, including Sofala, Beira and Dondo which became autonomous municipalities)
5. Administrative Posts (usually 2 to 4 in each district).
6. Localities (2 to 5 in each Administrative Post).

Below the locality level there are the villages and family/individual structures.

The Party that wins the majority in the Parliamentary Elections, which are held every 5 years, appoints the members of the Council of Ministers at the central level. The first and last multiparty and democratic elections took place in 1994 and the second are expected to take place in December this year. General elections at this level also select the President of the nation for a period of 5 years.

Apart from the Municipalities that are governed by legislative and executive elected bodies, the authorities at the other levels are appointed by the ruling Party. In 1998, thirty-three cities and villages throughout the country became autonomous municipalities. In Sofala province the process covered the cities of Beira, Dondo and Marromeu. The number of these municipalities is expected to grow as time goes on and the conditions for them improve.

In spite of the fact that the existing National Constitution does not recognize traditional authorities formally, they have a considerable influence at levels below the District and Municipalities. In many cases, these tend to be mixed up with the predominant political parties at the local level. In Sofala province the two major political parties are Frelimo and Renamo.

The three Municipalities created in Sofala are under the leadership of the Frelimo party, which won the majority in the thirty-three municipalities created at that time. In Beira the Municipal Assembly has, in addition to the Frelimo Party, a meaningful representation of a local and independent group, the "Grupo de Reflexão e Mudança."

Besides the political organizations, the last 10 to 12 years have witnessed a considerable proliferation of national and foreign development organizations which are very active in areas such as education, community development, health, assistance to small scale agriculture, water supply, and so forth.

1.2.4. Country Items Specific to this Project

Government programs facilitating business development are important to foreign capital investors when assessing the viability of projects such as the proposed Beira Aluminium Smelter. The Government of Mozambique provides this type of support through several specific programs as discribed below.

The Investment Promotion Center ("CPI") promotes direct foreign and national investment through a range of services including the facilitation of fiscal concessions and customs incentives. It helps to identify potential partners for joint ventures and provides institutional assistance to investors for the implementation of investment projects. The

BAS Study activities enjoyed access to information and guidance from CPI and further project development activities should similarly avail themselves of this fine resource.

Through development of the Mozal project in Maputo, the Government Liaison Committee ("GLC") was established. This committee facilitates relations with key government agencies, monitors the project to coordinate common infrastructure issues and sponsors the integration of the new enterprise into the economic and regulatory community. The GLC has been extremely helpful during the first study phase of this project and their continued support will be necessary for successful implementation.

The Government of Mozambique has established an Industrial Free Zone ("IFZ") initiative which encourages foreign investment through tax and duty concessions. The proposed Beira Aluminium Smelter is a candidate for such a program and the tax benefits indicated by the IFZ program are incorporated into the financial assessment of the project.

1.3 Industry Background

The proposed Beira Aluminium Smelter will join approximately 120 other active aluminium reduction facilities comprising the current world capacity of 20 million tonnes per year. These smelters vary in age and size from over 50 years old and under 60,000 tonnes capacity to modern smelters such as this project producing over 300,000 tonnes per year.

Aluminium production is a global industry with production centers located throughout the world. Capacity tends to concentrate in regions with available and competitively priced electricity, with the result that 75% of the world's capacity is centered in ten countries as shown in the following figure. With Beira and Mozal operating, Mozambique would just equal India's production capacity. The Mozambique/South Africa region would exceed Norway in production.

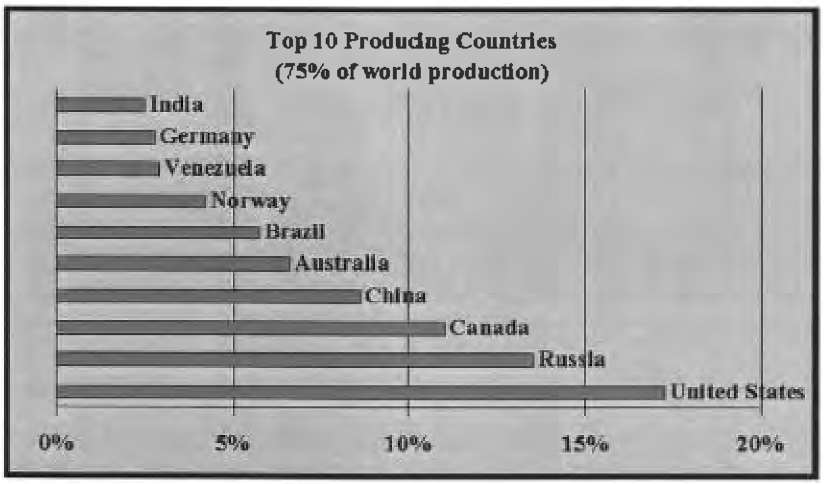

Figure 6: Centers of Aluminium Production

Aluminium production is also concentrated by capacity ownership. As of July 1999, the ten top aluminium companies controlled about 60% of the world's production as shown in the following figure. Further consolidation of ownership was announced in August, with the planned mergers of Alcoa and Reynolds and of Alcan, Pechiney and Alusuisse.

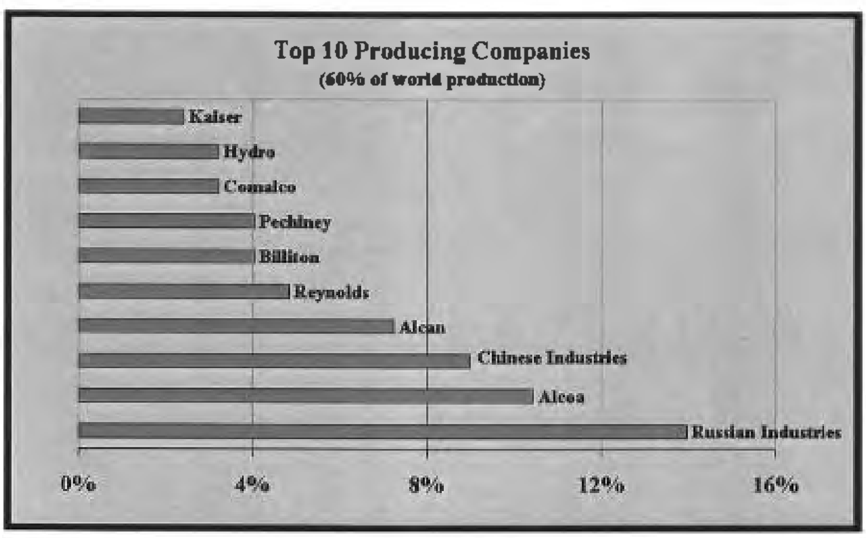

Figure 7: Aluminium Producing Companies

Just as the age and size of smelters vary, so does their individual cost of production. The major variable components of cost are labor and power, which often increase as a plant matures. Smelters typically enter the market with production costs near the world's best, then over time, drift upward in comparison with newer capacity, until no longer competitive. This effect is illustrated in the following figure.

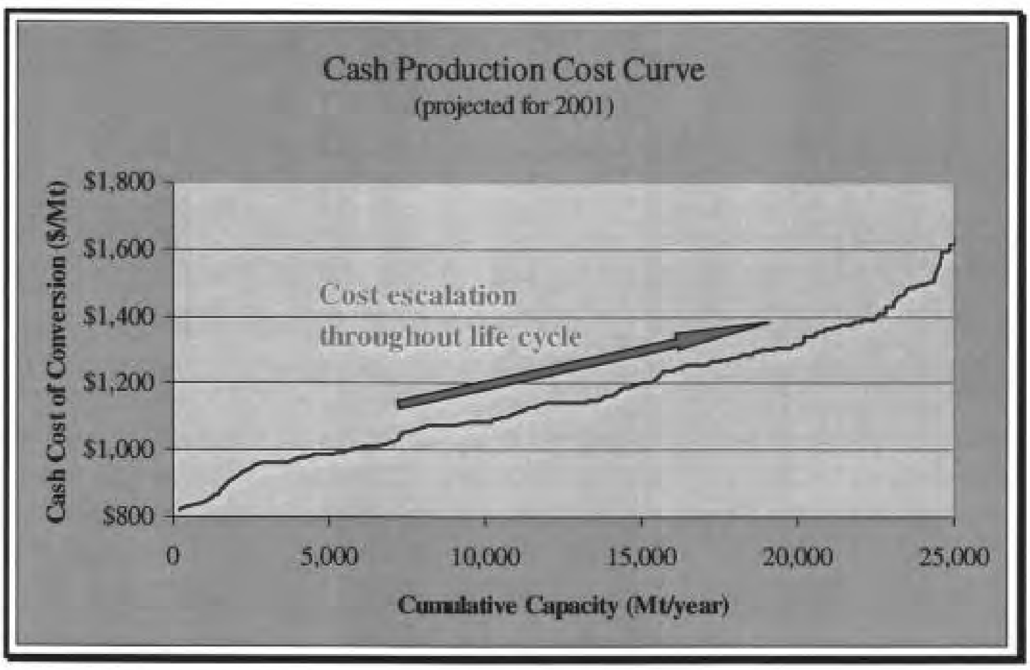

Figure 8: World Production Cost Curve

Though competitive with respect to conversion cost, new capacity has recently become very capital intensive. With some difficulty, the primary aluminium industry continues to service it's capital, but as illustrated in the following figure, the capitalization cost of some projects is too high for the project to proceed despite their planned very low operating costs.

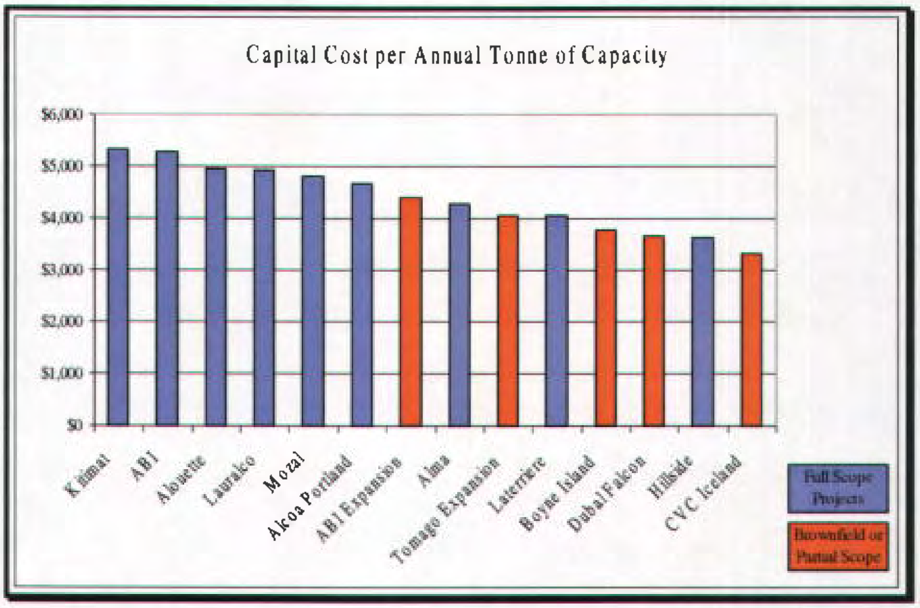

Figure 9: Capacity Cost of Recent Projects

The operating and capital cost trends have progressively squeezed aluminium producers, in part driving the recent consolidations described above. The following figure shows the trends of real margins, which is the foremost and immediate challenge of the industry.

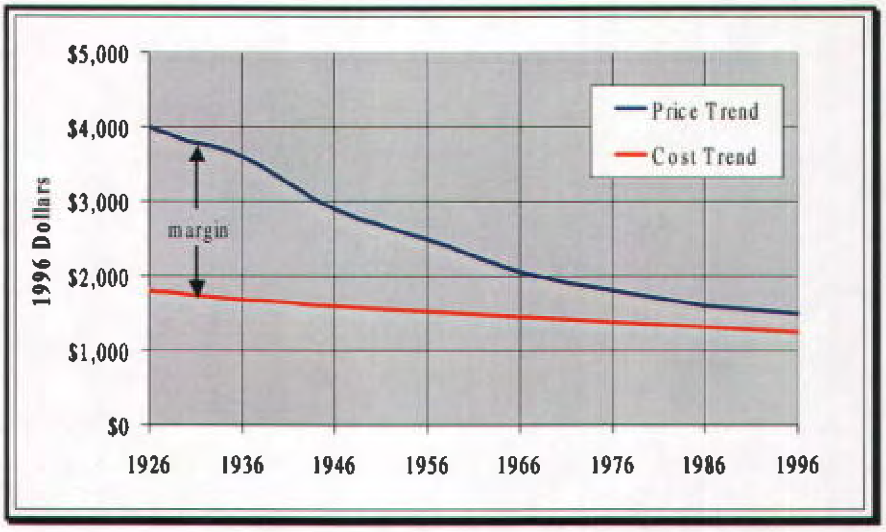

Figure 10: Aluminium Producers' Margin Trends

The proposed Beira Aluminium Smelter is subject to all of the economic pressures described above. But, as described in subsequent sections of this report, is well positioned with respect to both capital and operating costs and should hold a relative advantage over both older assets and new projects in the region.

1.4 Project History

1993-1995

Several aluminium producers, including Kaiser and Reynolds, considered the preliminary feasibility of a regional aluminium smelter using power from Cahora Bassa dam.

1994

Assisted by Reynolds Aluminum, the Government of Mozambique sought support from the United States Trade and Development Agency ("USTDA") to fund a feasibility study for the project.

1995

The USTDA completed a project definitional study that concluded that, on the basis of available inexpensive electrical power, Mozambique was an attractive country to build a facility. Whilst Beira was identified as the coastal town that offered the biggest opportunity and would benefit most, other towns could be considered.

1996-1997

A feasibility study based upon Reynolds technology was sponsored by the USTDA, but commercial agreement with the selected contractor was never reached and the work was not begun.

Late 1997

The previous award was cancelled and interest was solicited from other parties, including the consortium of Fluor Daniel, Kaiser Aluminum and Asea Brown Boveri.

April 1998

The consortium of FD, KAI and ABB submitted a proposal, which after reaching agreement on terms, was accepted in principle by the Government of Mozambique in October, 1998, and by Memorandum of Understanding in December, 1998.

January 1999

Work begun on the feasibility study.

December 1999

This feasibility study report was completed.

2.1 Overview of Key Project Requirements

The basic concept of this project is the use of Mozambique's electrical power to produce aluminium ingot for export. Though many details underlie this simple concept, a few key factors are pivotal in determining the project's overall viability.

Some variance from estimates and assumptions is expected at this stage of project development, with consequent minor variance in projected financial returns. However, if a key assumption or criteria is not met, or the assumed cost of a key operating component is incorrect, the overall viability of the project is threatened. The purpose of this Section is to discuss the criteria assessed as critical to project success and present the rationale for any assumptions regarding these key criteria.

For the Beira Aluminium Smelter, the findings of the USTDA "Definitional Mission Report" ("DMR") indicated several key elements making the business proposition attractive in comparison with other proposed aluminium projects around the world. The BASS team's initial investigations were directed at verifying the information in the DMR and further defining the key elements upon which the overall viability of the project is based. At the summary level, the critical criteria are somewhat simplistic: attain a competitive power supply contract and operate an efficient technology at the predicted production levels. These two criteria are discussed below under the topics "Supply of Electrical Power" and "Principle Process Technology."

2.2 Supply of Electrical Power

2.2.1 Overview and General Requirements

With abundant coal, natural gas and hydroelectric potential, the Southern African region is rich in energy resources. Currently, the on-line power generation capacity in Southern Africa is approximately 30,000 megawatts, which is about 6,000 megawatts in excess of current demand. This imbalance is expected to continue for the next 10 to 15 years.

In spite of the above, the regional generation and transmission of electrical power in Mozambique is not a simple situation. A war damaged power transmission grid and limited existing base load restrict the practical location of power intensive industries. In the case of the Beira Aluminium Smelter, supply from a regional power producer must be understood in terms of both the tariff for the power and the capital expense required to reconstruct and upgrade the transmission lines to the Beira area. Depending upon the source of power and the transmission requirements, the overall cost might vary significantly.

The proposed Beira Aluminium Smelter requires up to 650 megawatts of power with a load factor exceeding 98%. The power is required from start-up for a period of 30 years or more. The system generating and transmitting power to the smelter should be configured to sustain normal operation if one of the major elements of the system fails (N-1 configuration).

Based upon discussions with regional power suppliers, government power agencies and private companies engaged in the independent production of power, the three possible sources for power are the existing Cahora Bassa hydro power station, the Eskom grid or a new gas-fired generation station in Beira. The relative merit of each of these options is discussed below.

Our discussions also confirmed that several alternate sources of power might become available in the future. Most noteworthy of these are new coal-fired generation at Moatize, a new hydroelectric station at Mepande Uncua, and a future expansion of Cahora Bassa. Unfortunately, none of these sources will be available in time for a plant start-up of 2003.

2.2.2 Power from Eskom Grid

Eskom's South African grid currently has excess generation capacity exceeding 5,000 megawatts, some of which is available for export to Mozambique. Eskom has indicated the base power tariff for exported power will be $0.015 to $0.020 per kilowatt-hour. Transmission fees (wheeling charges) will be added to this tariff. These charges are based upon the capital cost of new transmission lines to Beira.

Transmission of the required power from South Africa to Beira will require a tie between Maputo and Beira, using the existing Matola Corridor lines to bring the power from South Africa to Maputo. Either HVAC or HVDC transmission technologies could be used, each costing around $350 million. The estimated wheeling charge for a capital expenditure of this size is $0.006 to $0.008 per kwh.

On this basis (assuming that Eskom's initial power tariff estimates are approximately correct), the estimated total cost of power supplied from Eskom's grid is $0.021 to $0.028 per kwh.

2.2.3 Power from Cahora Bassa

The firm output of the Cahora Bassa Hydroelectric Station is 1,600 megawatts, about half of which is being used at this writing. A further 400 megawatts of spare capacity is available as backup. Eskom holds a long term contract for this power, but the contract is currently under discussion between the governments of Portugal, South Africa and Mozambique. The outcome of these discussions is unknown at this time, but for the purposes of this assessment, it is assumed that Cahora Bassa power will be purchased at market rates from Hydro Cahora Bassa, the operator of the dam.

The tariff for HCB power has not been offered pending resolution of the above-mentioned discussions, though HCB and others have indicated that a "competitive" power rate is possible for the Beira smelter. In the absence of a definitive indication by

HCB, the current tariff for supply of power to Zimbabwe ($0.010 per kwh) will be used with the understanding that no firm commitment has been made for this rate.

The transmission of power from Cahora Bassa to Beira is more straightforward than from Maputo to Beira. Existing AC transmission lines can be improved and adapted to handle increased load, which will bring the power as far as Caia to the North and Chibata to the West. Two new lines from Caia and one new line from Chibata complete the required circuit as shown below.

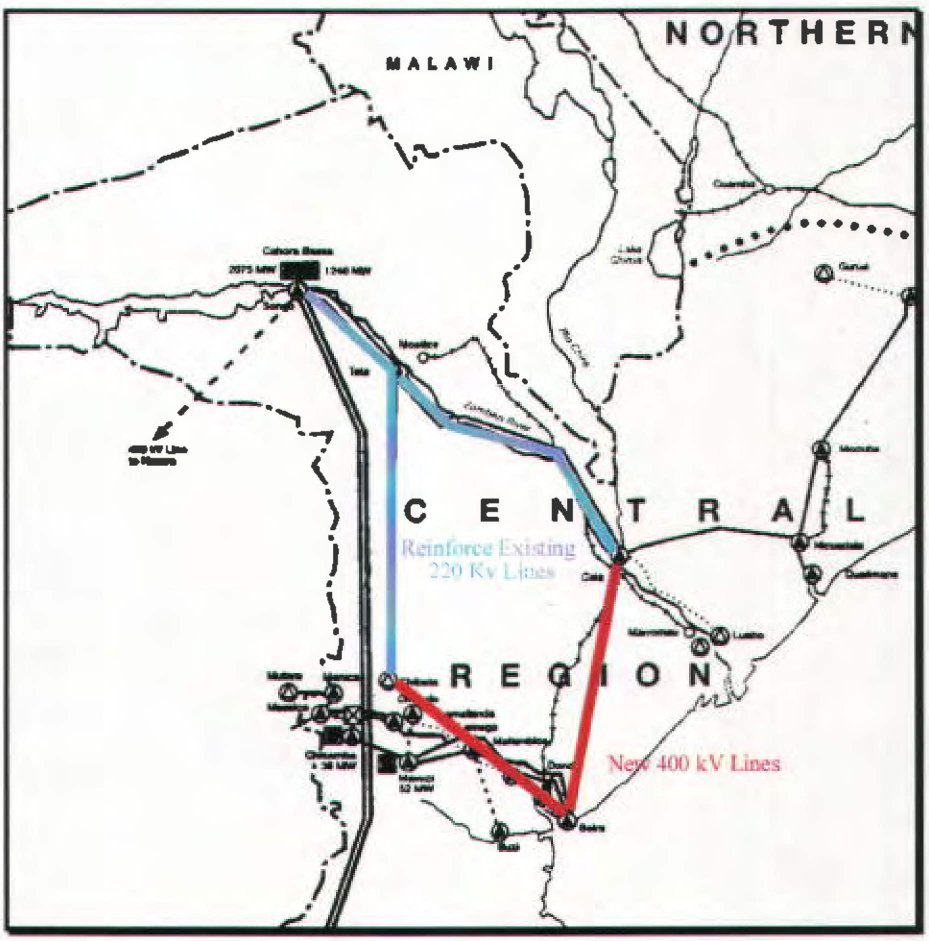

Figure 11: Planned Power Transmission Upgrades

The total estimated capital cost of these improvements is $170 million, or $0.003 to $0.004 per kwh in wheeling charges. Ultimately, this solution may be supplemented to better serve the development of Central Mozambique's power distribution grid, but for the purposes of this study, it is the most capital effective and feasible configuration satisfying the smelter's requirements. On this basis, the estimated total cost of power supplied from Cahora Bassa is $0.013 to $0.014 per kwh. It may be possible to improve upon the base tariff, but any improvement on capital cost of transmission lines (hence wheeling charges) is unlikely.

2.2.4 Power from Natural Gas

Natural gas is readily available in south-central Mozambique and possibly available in very large quantities immediately offshore of Beira from the unproven Sofala field. Though indications from the Government of Mozambique suggest their preference to use natural gas in high-efficiency chemical processes rather than to generate electricity, for the purposes of this study, we have considered the use of gas to generate electricity for the smelter.

Natural gas concessionaires in the Central Mozambique Region have indicated a cost (including well-head cost and pipeline transmission to Beira) of $1.00 per gigajoule. This price, however, is unsubstantiated by a formal offering or reference to an existing commercial practice. This price may vary by as much as 100%.

The capital cost of gas-fired generation is dependent upon the size of the station, which in turn is dependent upon the plant's requirements for continuously supplied power. In this case the assured supply of 650 megawatts requires a total station capacity of 900 megawatts. The cost of a station of this size, including electrical substation, is approximately $280 million.

All-up power cost can be grossly estimated based upon the capital cost of the facility, the assumed conversion efficiency (35%) and the cost of natural gas. Our best estimate for power generated from a gas-fired station is $0.017 per kwh, though this estimate could change upward significantly depending upon actual gas cost and required return on investment from the power station.

2.2.5 Basis for Power Supply and Power Tariffs

Each of the options for supply of power is based upon assumptions and indications currently unsubstantiated beyond indications of the possibility of favorable or competitive rates. However, in order to assess the viability of this project and estimate the financial returns of the venture, we are required to nominate a total power tariff as a key component of cash operating cost.

Though ultimately another structure may emerge, we feel the most reasonable scenario for supply of power to the smelter is the Cahora Bassa option. The facility is existing, fully functional, currently underutilized and from our preliminary assessment is the most cost effective source of power for the smelter.

The specific option for power transmission from Cahora Bassa is not as easy to nominate. Many other regional issues are important in deciding the overall capacity, routing and technical features of the power distribution system. However, for the purposes of this study, we have focused on the minimum effective system for satisfying the smelter's needs and have decided the cost basis for the analysis as discussed above. Though clearly of regional importance in the long term, any additional features or capacity beyond the smelter's requirements should be evaluated in a separate forum.

On this basis, we have nominated $0.013 per kwh as the baseline power cost, originating at Cahora Bassa for $0.010 per kwh and wheeled to the smelter for an additional $0.003 per kwh. The elements of this scenario and more detailed discussions of the other options are provided in the ABB report as Attachment D.

2.3 Principle Process Technology

2.3.1 General Requirements and Considerations

For the purposes of this Feasibility Study Report, "technology" and technology options refer to the basic choices in implementing the systems and industrial infrastructure required to support the Hall-Heroult Smelting Process. Typically, these choices are exhibited in the design approach of an equipment supplier and/or the configuration of a sub-system processing unit. Technology options apply to the overall process in the reduction area, casting, green mill, baking, and rodding as well as much of the individual equipment servicing these processes.

The determinants in selecting plant technology are strongly influenced by the basic potroom design and operating practices as defined by the principle reduction technology partner. The other technology choices (especially carbon manufacturing) must be compatible with the potrooms' requirements; hence it is typical that the selected potroom technology partner specifies supporting technologies compatible with the main reduction process.

Ultimately, the predicted performance of a successful reduction technology must be linked to the assessment of the overall financial success of the proposed project, which in this case is the return on invested capital. In terms of the contribution to financial success, the technology is evaluated against the following criteria:

- The ability of the technology to comply with all environmental, industrial hygiene, and other regulatory requirements of the Government of Mozambique and any potential lending institutions.

- The capital cost of capacity (expressed in capital dollars per annual tonne of production).

- The unit operating cost to convert alumina to aluminium (expressed in dollars per tonne produced), factored in terms of specific labor and electricity costs for this project.

- The profile for attaining (or exceeding) the planned production and the risks associated with this attainment, including such items as:
  - Risk that the technology will not meet the claimed level of production.
  - Ability to transfer the technology into routine operations, including training of operators and process managers.
  - Ability to maintain the technology in good working order, hence protecting the output of the plant.
  - Potential for future increased production

- Access to ongoing support and improvements to help the plant sustain good operations over long periods of time.

2.3.2 Evaluation of Kaiser K220 Technology

The nominated principle technology for the Beira Aluminium Smelter is the Kaiser K220 reduction cell. This technology is based upon evolution the Kaiser P-86 reduction cell that has operated successfully in Sweden for over a decade. The K220 operates in a range from 180 kA up to as high as 220 kA. Since the higher amperage levels are not proven in long term industrial operation, the basis of this discussion and the projections of this report is the K220 cell operating at 180 kA. Each of the criteria in Section 2.3.1 is discussed below in terms of this basis.

Compliance with Regulatory Requirements and Environmental Standards

The Kaiser K220 technology provides a modern state-of-the-art reduction cell which equipped with ABB Flakt dry scrubbing technology, provides environmental performance compliant with both the USA and European standards for environmental and industrial hygiene performance. No compromises in the high standards for environmental performance are suggested for the Beira Aluminium Smelter.

Capital Cost of Capacity

As described elsewhere in this report, the Kaiser K220 technology is among the lowest unit capital cost in recent history. It compares favorably with the initial projections for the Mozal smelter based upon other technology. Based upon our work in Southern Africa and research in Beira, we estimate that the project will cost approximately $3,920 per annual tonne of capacity for 180 kA operations and considerably less per tonne for higher amperage operations. This compares favorably with the approximate average of other recent projects of $4,600 per tonne.

Unit Operating Cost

The Kaiser K220 technology is based upon higher current density, but lower operating amperage, design principles. As a consequence, unit energy consumption (kwh per tonne) and labor requirement (man-hours per tonne) are not as low as higher amperage cells such as the Pechiney AP-30. However, when factored using local Mozambique costs for electricity and labor, the dollar cost impact is about $5 per tonne for additional power and $15 per tonne for additional labor. These variances are not significant when compared with the projected all-up cash cost of production, hence K220 technology operated in Mozambique is not considered disadvantaged with respect to operating cost.

Attaining (and Exceeding) Planned Production

Production forecasts in this assessment are based upon operation of the proposed technology at 180 kA, which is the same current density as the proven P-86 design for which Kaiser has supplied technical performance data from years of operation. Though the Kaiser technology has not operated in as many plants as some of the other technology choices, the statistical significance of the existing performance data is not significantly less than that of other technologies. At 180 kA (where the historical data is applicable), Kaiser's technical performance claims (including production rates and cell life) are conservative and do not represent a large risk.

In and of themselves, technical performance parameters are not sufficient to predict total plant production. These parameters assume steady-state production of a mature plant, fully started, with a fully trained workforce. Another significant issue in determining the validity of the production plan, is the ability of the technology partner to transfer their knowledge, of bringing the plant to a full and sustainable production level at the earliest possible moment and to maintain the plant in good working condition with high production levels for long periods of time, to the plant operator.

Kaiser has a long history of successful technology transfer, both in green field applications and in retrofit environments (which are typically much more difficult than the green fields). Kaiser's Valco Plant in Ghana is a good example of their ability to train a world-class workforce and exceed predicted technical performance through good process management know-how and practices. With Kaiser's Ghana experience as a model, the risks of production shortfalls from slow start-up, under-trained workforce or a deterioration in plant condition are no worse than any of the alternate technologies, and considerably better than most.

Ongoing Support and Improvements

Like most other technology suppliers, Kaiser maintains ongoing engagement with their client-base. In fact, through their retrofit business base, Kaiser has specialized in providing ongoing technical assistance and support for the primary aluminium industry for the last decade and is well equipped to continue in the future.

Overall Assessment

The capital efficiency of the Kaiser cell and their long term successful engagement in Ghana support the choice of the Kaiser K220 cell for the proposed Beira Aluminium Smelter.

3.1 Overview of Site Evaluation

The identification of potential sites for the aluminium smelter is based on the request of the USTDA, that the site be in the Beira area and that the "project execution plan be coordinated with the planned upgrades of the port facilities and regional electric power supply system." Secondary to using Mozambique's cheap electrical power to generate foreign currency by making aluminium, it is the desire to use this project to improve the socioeconomic conditions through employment and improved infrastructure in the Beira area.

Considering the development potential and the need to "kick start" the Beira area economy and infrastructure rehabilitation, sites close to the city of Beira were given significant consideration. The criteria therefore considered not only the best site from an investor's view but also takes into account the benefits to the city of Beira.

In searching the Beira area for suitable sites there appeared to be three areas of interest zoned for industrial development in the proposed Beira Development Plan. These areas are the city of Beira, the proposed free trade zone at Savane (near Nhangau) and inland at Dondo, as indicated on the following map (which also shows the four sites currently under consideration).

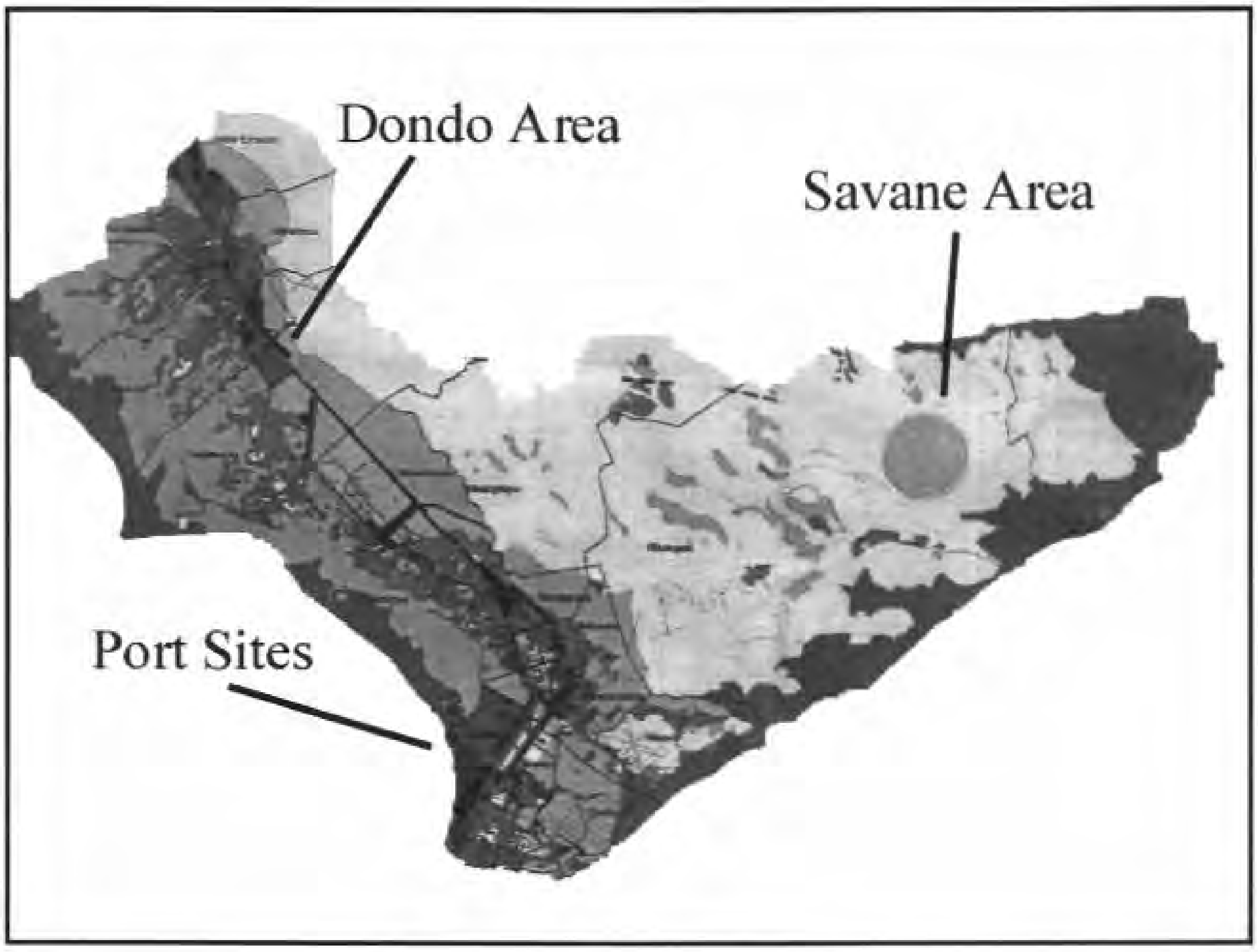

Figure 12: Beira Area Map

3.2 Evaluation Criteria

Many of the traditional site selection criteria were irrelevant for this study due to the lack of modern infrastructure and high capacity electrical power grid anywhere in the search area.

Consequently, the criteria for selecting the site for the smelter was determined to be as follows:

1. Located in the Beira area.
2. Accessible to existing port facilities for outgoing product.
3. Accessible to suitable offloading facilities for incoming alumina and coke shipments.
4. Minimum 100 hectares of land available with preferably 250 hectares including buffer.
5. Area that would benefit from improved infrastructure.
6. Area that is not environmentally sensitive.
7. Accessible to incoming power transmission lines.
8. Suitable geological and seismic conditions.
9. Suitable hydrological conditions.
10. Close to trainable workforce for construction and operations.
11. Available construction power and access.

12. Available gas supply for anode baking furnaces.
13. Potentially good security.
14. Reasonable environment for expatriate living conditions.
15. Access to airport with international air connections.
16. Good local and national government support.
17. Available tax and duty incentives.
18. Acceptability as a "free trade zone."
19. Lowest site construction costs.
20. Other socioeconomic considerations.

3.3 Sites Considered

Four sites were identified as potential smelter sites in the Beira area. Two of these sites are located near the port, one near Dondo and one near Savane as described below.

Site A

As shown in the figure below, this site is on CFM property at the port between the new oil terminal and Quay 10. The area is triangular in shape and approximately 100 hectares in size. The area is currently undeveloped, low-lying and has about 1,200 meters of waterfront along the southwest side. There is a small area reserved for a sugar and grain facility in the southwest corner. The area is bounded on the northeast side by the oil pipelines from the unloading terminal to the tank farm and on the south side by the future marshalling yard.

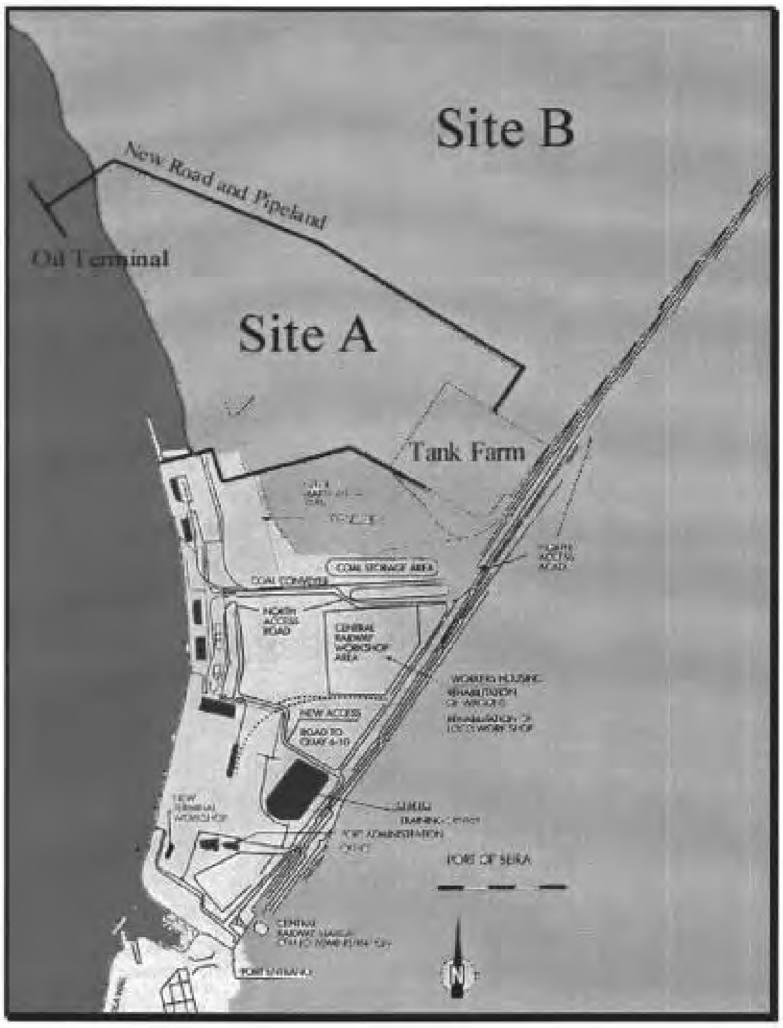

Figure 13: Locations of Sites A and B

Site B

As shown above, this site is approximately 500 meters northeast of site A on land controlled by the municipality of Beira. An area of approximately 250 hectares has been identified in a 600 hectares area zoned for industrial development. The total industrial zoned area is approximately 2 kilometers by 3 kilometers. The area is low-lying and mostly undeveloped. Some wetland type cultivation exists along with a considerable number of huts, mainly along the southwest boundary. There is considerable flexibility at this time regarding the size and shape of the land available for the smelter at this site.

Site C

This site is located near Dondo approximately 25 kilometers northwest of Beira. The area is zoned for industrial and residential development and is adjacent to a large Portland cement factory only partially operating at this time. As shown below, the area available for development is approximately 250 hectares of flat low-lying agricultural land. The site has about 2.4 kilometers fronting on the Beira to Harare road and is about 1.1 kilometers deep. The main Beira to Harare railway line is about 150 meters northeast of the site.

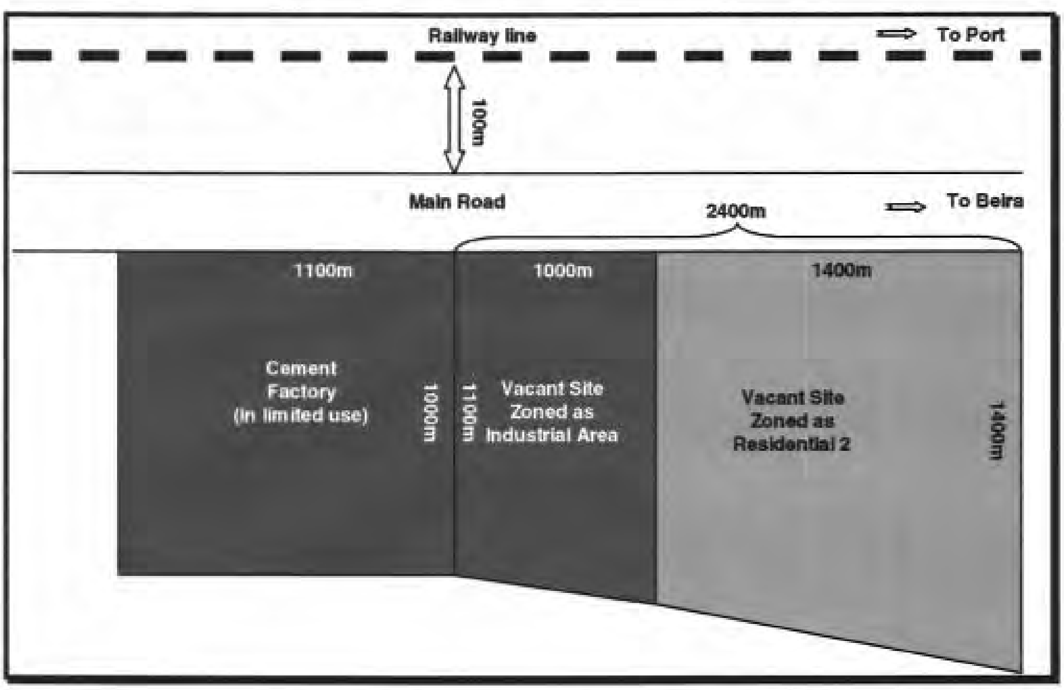

Figure 14: Location of Site C

Site D

This site is located approximately 25 kilometers northeast of Beira near Savane. The site is being planned for development by JCI as a Free Export Zone. This is also a low-lying agricultural area prone to flooding during the wet season. The area planned for development is about 8,000 hectares with no current restriction on the amount that could be allocated to a smelter site. The only access at this time is a dry weather sand road connecting to the Beira - Harare main road.

There may be other potential sites along the Beira to Harare road that would be of interest but none are zoned for industrial use at this time in the proposed Beira development plan.

3.4 Nomination of Most Suitable Site

The objective of this study is to identify suitable sites and select one of these sites for the basis of the capital and operating estimates, using existing data and observations. A detailed site selection study must be performed based on detailed engineering and environmental investigations in the next phase of project development. Key issues requiring thorough engineering analysis are hydrological, geotechnical and environmental investigations. It is possible, but unlikely, that a fatal flaw in the sites identified may show up during these investigations. It is more likely that conditions may be discovered that will change the evaluation rankings by increasing the cost of mitigating such discoveries.

Based on current data and observations, a Kepner-Tregoe analysis was performed on the four sites to determine a ranking of the sites. The analysis can be found in Attachment C.

All four sites met the "must" criteria of 100 hectares, being in the Beira area, having access to a port, being near a trainable workforce and qualifying for free trade zone status.

Site A is the least desirable although it is located strategically to the incoming raw materials and outgoing finished product. However, being located within the port property severely limits the expansion of the port facilities and places limitations on the smelter layout. For these reasons this site is not recommended for further investigation.

Site B is the most desirable of the sites due to its proximity to the port and city of Beira. However, there are substantial challenges in developing this site for a smelter. Particularly the time and cost that will be incurred raising this site above potential flood level. This would need to be coordinated with the much needed dredging of the port entrance channel. Although no flood data exists, observations indicate that the site would have to be raised about 3 to 4 meters. This would require 2 to 3 million cubic meters of fill and take 12 months to accomplish.

Site C adjacent to the cement factory at Dondo is an acceptable site. Normally, cement factories would not be desirable neighbors due to the cement dust emissions. However, the kilns are not operational and there are no plans to reactivate them due to a lack of limestone. The factory produces cement every few weeks when clinker is shipped from Maputo. This site is at a higher elevation than the other sites and will cost less to develop. However, being 25 kilometers from Beira, more supporting infrastructure will be needed at site with less impact on Beira. Given the quantities of raw materials and finished goods to be moved between the port and the site, the railway and road from Beira to Dondo would need to be upgraded.

Site D in the Savane development area would be acceptable once the area is developed and infrastructure is in place. At this time however nothing exists and the site is inaccessible during rains. This site would also require considerable filling and would have the biggest environmental impact of the four sites. Considerable engineering investigation has been performed for this site and is available through JCI. This site will incur considerable development costs due to its remoteness, lack of infrastructure and transportation costs.

There could be other acceptable sites but they are not shown on the proposed Beira area development plan as zoned for industrial use. A project of this magnitude would warrant reevaluation of the plan if other desirable land were found.

In summary the recommended sites in order of preference are the site adjacent to the port of Beira and the Dondo site adjacent to the cement factory (sites B and C).

4.1 Approach for Design, Construction and Procurement

The general approach for scope definition and project implementation includes the special requirements for construction in Beira, the process requirements for long term stable operations and the necessity to train local technicians and managers to operate the plant in a self-sufficient manner. This approach was very successful for Kaiser in their construction and start-up of the Valco facility in Ghana. In this spirit, the philosophy for defining the facilities is comprised of the following:

- The plant should be equipped and staffed to operate as a self-sufficient facility without routine programmed assistance from outside of the region.

- The principle technology should be easy to operate and forgiving of minor process and raw materials variability.

- Adequate spare parts, redundant systems and predictive maintenance procedures are included with machine design and facility layout criteria in determining the extent of the equipment and facilities.

- A high priority will be placed on training local Mozambicans to the required skill level to replace expatriate dependence in as short a period of time as is realistically achievable.

- The use of local materials and services will be maximized during the construction and ultimate operation of the facility.

4.2 Power Transmission System

The recommended scope of the power transmission system is based upon the joint system study between ABB Power Systems Group and Electricidade de Mozambique ("EDM"). This scope cannot be finalized until the specific source of electrical power is identified and the associated infrastructure benefits for EDM's existing transmission system are determined and agreed. The issues bearing upon this determination and their impact upon transmission system scope are discussed in the ABB report included as Attachment D.

In the absence of a specified source of electrical power, the most cost-effective solution has been nominated for the basis of the assessment. The rationale for selection is discussed in Section 2 of this report and summarized below.

The proposed power transmission system will carry up to 650 megawatts of power from the Cahora Bassa hydroelectric power station to the plant main substation in Beira. Currently, there are two 220 kV lines from Matambo to Caia and one 220 kV line, currently operated at 110 kV, from Matambo to Chibata. These lines can be extended with three lines to Beira (two of these are from Caia and the third is from Chibata).

In order to get 650 mW firm, each of the 220 kV lines must be reinforced to provide a transfer capacity of around 350 mW. It is thought that this could be done with about 65%

series compensation and SVCs at Caia, Chibata and Beira. To mitigate overvoltages, it is estimated that three 30 Mvar line reactors will also be needed at Beira.

The above solution requires very high degrees of reactive power compensation and requires further investigation and modeling. Should these studies demonstrate that it is not possible to accomplish the above reinforcement with 220 kV lines, then 400 kV lines must be used. In such event, the price of the lines would increase, and 220/400 kV substations would have to be built. At 400 kV, the size of the line reactors needed to control overvoltage effects also increases. The implications of increasing or reducing the power transfer levels, or downgrading the reliability of this system are the same as for the 220 kV alternative.

Based upon the possible instability of the 220 kV solution and our inability to verify this design at this time, the assessment of this project is based upon the 400 kV alternative and an anticipated technical scope content as follows:

Item	Size
Series capacitor k=65%	2 x 260 Mvar
Caia substation	2 x 315 MVA
400 kV line Caia-Beira	2 x 200 km
SVC Caia	250 Mvar
Series capacitor k=65%	1 x 260 Mvar
Chibata substation	1 x 315 MVA
400 kV line Chibata-Beira	1 x 200 km
SVC Chibata	250 Mvar
Beira substation	3 x 315 MVA
SVC Beira	250 Mvar
Line reactors	3 x 100 Mvar

4.3 Smelter Complex

The smelting facility is based upon Kaiser technology and operating practices as defined in their series of Design Control Specifications MZ-1 through MZ-32 appended to this report. The following description of the smelting complex is based upon the information in those documents.

The Kaiser K220 reduction cell technology is designed to operate from 180,000 amperes up to 220,000 amperes. In general, this assessment conservatively assumes 180 kA production levels, but the facilities are sized to manage the product streams of 220 kA operations.

The technical parameters of the smelting facility and a detailed material flow diagram are provided as Attachment A. Both the 180 kA base case and the 220 kA design basis are provided.

4.3.1 The General Facility

The proposed facility consists of the reduction plant, the carbon manufacturing plant, the metal casting area, maintenance shops, laboratories, administration facilities and other plant amenities.

The area of the plant site is approximately 1,200 meters by 500 meters and is organized as shown in the following figure and in the drawings of Attachment N. The potrooms area is marked in green, carbon manufacturing in orange, casting in blue and support services in violet.

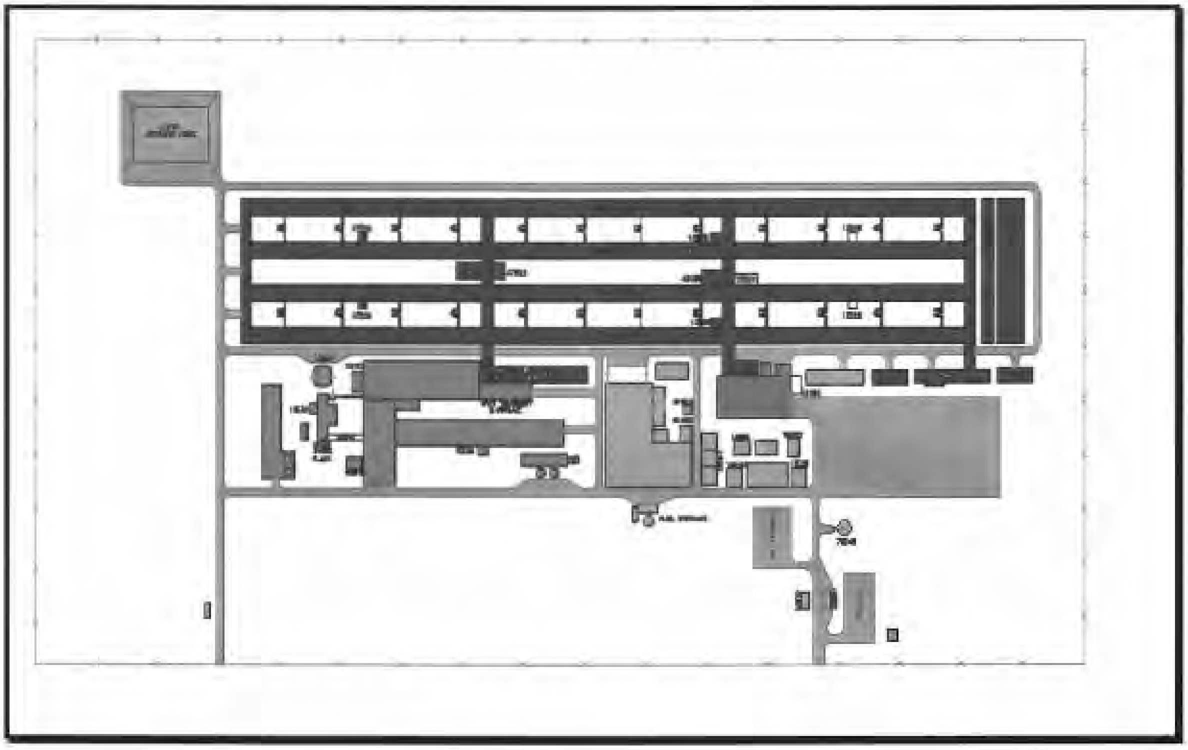

Figure 15: Plant Site Layout

The plant structures consist mainly of industrial mill buildings of relatively low profile (typically less than 15 meters in height) as shown in the following perspective rendering.

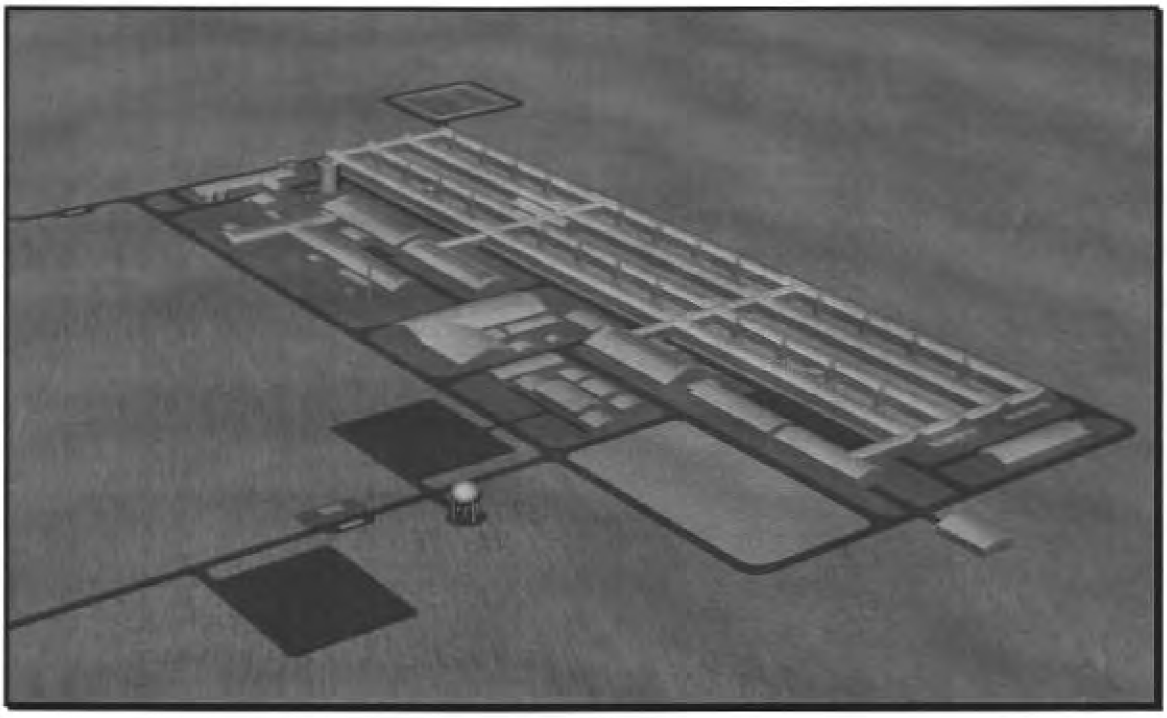

Figure 16: Smelting Plant Conceptual Rendering

The proposed facilities are designed to produce primary aluminium in 650 kg ingots. Initial production will be 303,000 tpy of aluminium metal with expansion capability to produce 366,000 tpy by a planned increase in amperage from the base case of 180 kA to 220 kA. The plant will consume approximately 725,000 tonnes of raw material annually and require 485 megawatts of continuous power for operation. The planned material flow of the facility is shown in the following diagram.

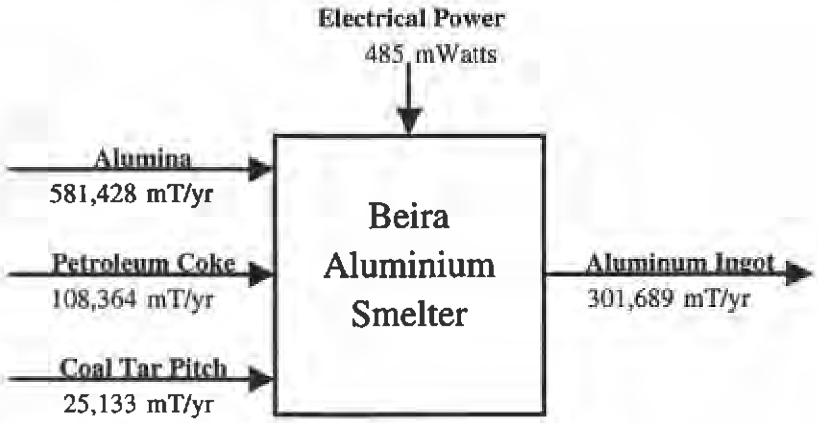

Figure 17: Simplified Material Flow Diagram (180 kA Operation)

As mentioned above, the plant is sized to operate at up to 220,000 amperes of process current, with a corresponding increase in material flow, as shown in the following diagram.

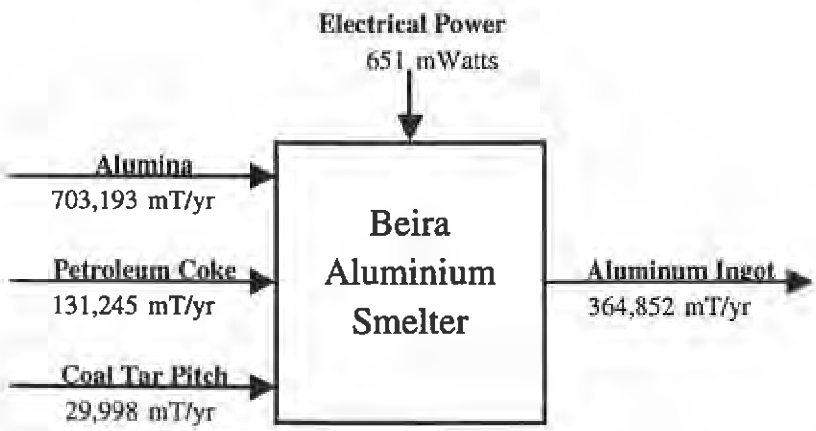

Figure 18: Simplified Material Flow Diagram (220 kA Operation)

Details of material flow and technical performance are provided in Attachment A.

4.3.2 The Reduction Facility

The function of the reduction plant will be the reduction of aluminium oxide into primary molten aluminium. The initial plant will produce 303,000 t of aluminium metal per year with the following parameters:

- Two pot lines of 300 pots each
- Operate at a nominal rating of 180,000 amps current at a nominal 1,400 volts DC
- Initial pot lining will be done in situ
- Anode movement will be by pallet trucks
- Molten metal in crucibles will be handled by crane to the center passageway and then delivered to the metal service area by tractor-trailer
- Alumina will be delivered to each pot by air slide conveyor
- Pots will be relined in pot repair prior to resetting in the potrooms
- Three pot tending cranes will be provided for each potroom

Aluminium will be produced by reduction cells with prebaked carbon anodes using the Hall - Heroult electrolytic process. The initial facilities will include two, two-room pot lines with a total of 600 reduction cells as shown in the following perspective rendering:

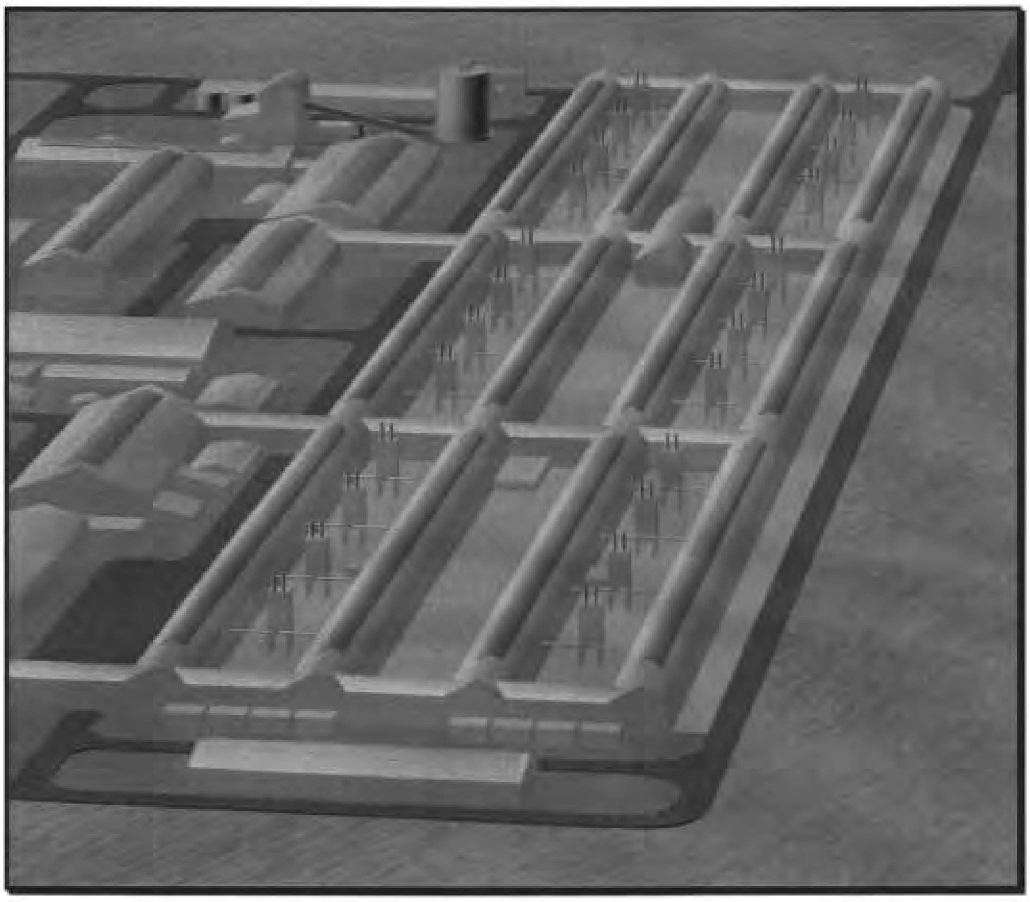

Figure 19: Pot Rooms Conceptual Rendering

Support facilities for the reduction plant will include pot reconstruction shops, pot tending crane maintenance bays, molten metal crucible cleaning facility and an anode cooling and marshalling area.

The design throughput for the potrooms is shown in the following figure.

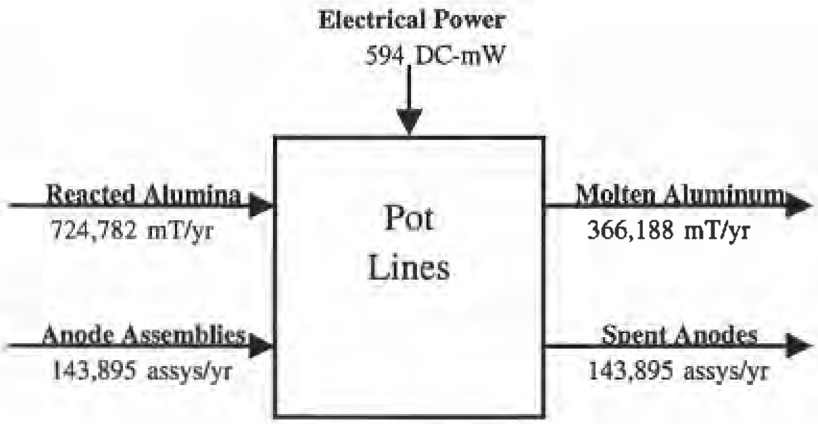

Figure 20: Pot Lines Design Throughput

4.3.3 Substation and Rectifiers

The main power station provides the primary process power for the reduction plant and the central plant power distribution station. It includes all facilities required to receive power, meter, control, convert to direct current at the correct voltage, and to deliver the direct current power to the pot lines. It also includes the transformation and control equipment necessary to distribute electrical power for auxiliary and general usage. The station will carry up to 650 mW of incoming power at peak plant design capacity.

In general, these facilities will consist of:

- Incoming power lines supplied by the transmission grid.
- Step-down transformers as required.

- Circuit breakers and switching equipment for two pot lines and standby.
- Regulating transformers for two pot lines and standby.
- For each pot line, four rectifier units supplied by others, and rated to supply 220 kA at a nominal 1,400 V dc with one unit out of service. MMI and remote readouts in selected smelter locations are also to be provided.
- Aluminium collector bus
- Central control room
- Halmar type equipment for accurate and precise measurement of amperage to pot lines.
- Precise and accurate watt-hour meters for billing purposes to each major operating department.

4.3.4 Potlines Environmental Control Systems

The function of the air control systems is to minimize pollution of the atmosphere due to the escape of particulate and gaseous contaminants from the electrolytic cells. The proposed system is based upon ABB Flakt's proprietary Pot Integrated Dry Scrubber ("PIDS") system consisting of 24 treatment centers distributed throughout the potrooms area as shown in the following rendering.

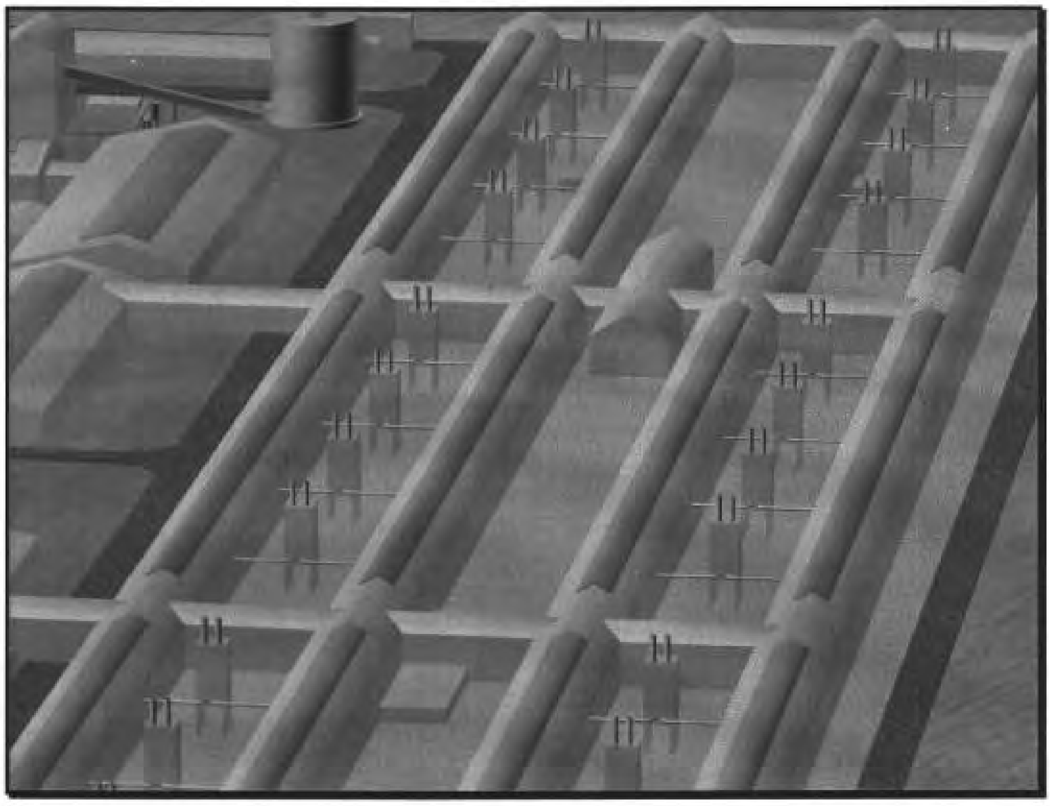

Figure 21: Gas Treatment Systems Conceptual Rendering

The potrooms gas treatment system will include the following features.

- Each pot will be hooded and connected to an air duct system capable of providing a minimum evacuation rate of 5,000 Nm3/hr per pot.
- A dry scrubbing system using reduction grade alumina will be used to capture the fluorine ions and particulate.
- The cleansed air from the potrooms will be discharged to the atmosphere through a stack.
- Dust control will be provided at all required locations throughout the system.

- The system will provide the localized storage of alumina for the potrooms
- The system will deliver reacted alumina to the pots.

A more detailed description of this system including technical specifications is provided in Attachment E of this report.

4.3.5 Green Carbon Plant

The green carbon plant will consist of facilities for the production of green anode blocks, cooling of these anode blocks, and their transfer to the carbon baking plant. The facilities consist of a multi-story structure, storage tanks and auxiliary buildings interconnected to raw materials supplies and downstream processing areas through various conveying systems as shown in the following rendering.

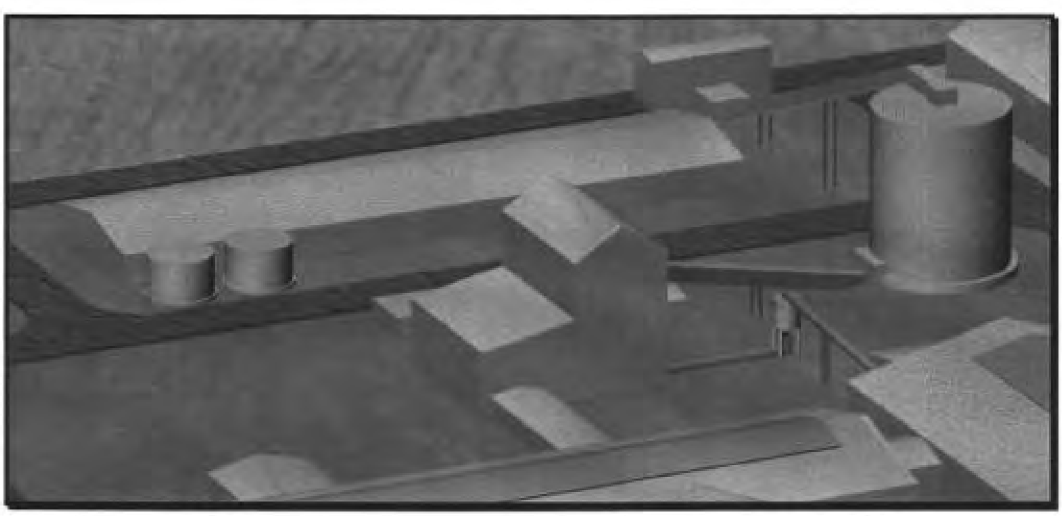

Figure 22: Green Mill Conceptual Rendering

The green carbon plant will be designed for the specific purpose of producing prebaked anode blocks for use in the reduction cells. This process includes preparing, storing, transporting, batching and mixing calcined petroleum coke, butts and coal tar pitch to form green anodes at an elevated temperature.

An additional function of the plant will be the delivery of sized calcined petroleum coke for use as packing material in the baking furnaces. The plant will reuse undersized baked packing material from the baking furnace and spent anodes generated from all sources.

After mixing, the anode former will receive the carbon paste from the paste coolers and mold it into green anodes, transferring them to a cooling conveyor for delivery to the furnace building.

The design capacity of the green mill is shown in the following figure.

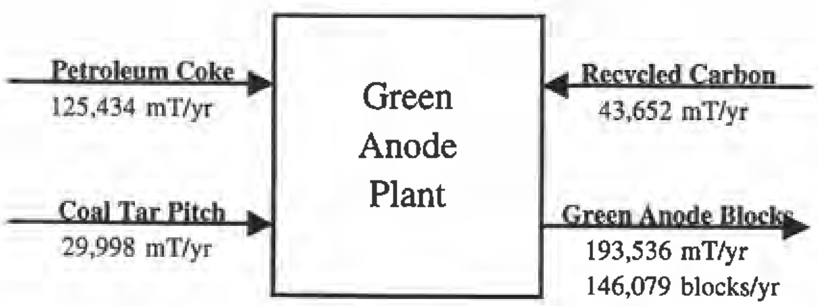

Figure 23: Green Mill Design Throughput

In addition to the process requirements of the green mill, there will be adequate offices for the carbon plant supervisory, technical, and clerical staff. A sample preparation room will be provided. Adequate amenities for supervisory and hourly employees will be provided.

4.3.6 Anode Baking Furnace

The carbon baking facility receives the green carbon anodes from the green carbon plant, bakes them into finished baked anodes having acceptable strength and electrical characteristics for use in the prebake reduction cell, cleans, stores and delivers them to the rodding room for further processing. The anode baking furnace is equipped with a dedicated exhaust gas scrubber. A conceptual rendering of this facility is shown in the following figure.

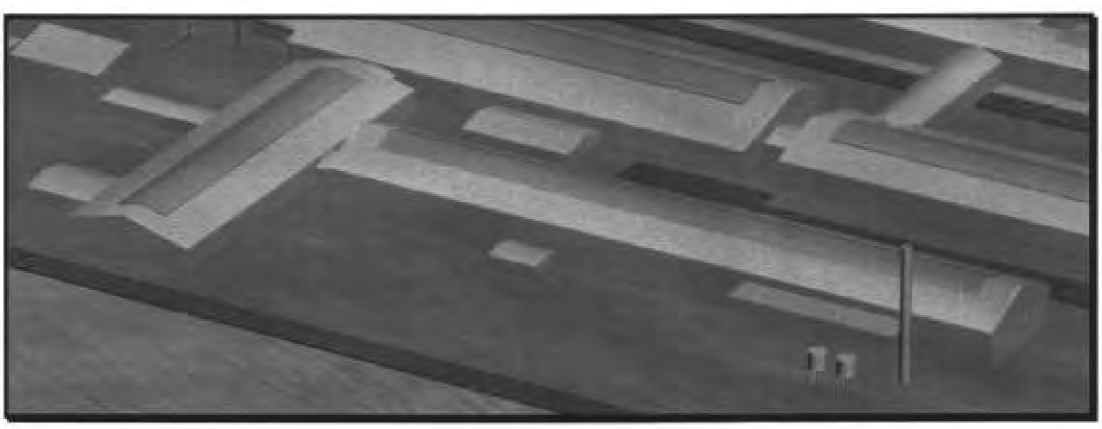

Figure 24: Anode Baking Area Conceptual Rendering

The anode baking facility will consist of the following:

- Multi-section baking furnace with burners, exhaust manifolds and control equipment.
- Multipurpose anode handling cranes.
- Green and baked anode storage and handling equipment.
- Exhaust gas treatment center.
- Area maintenance facilities.
- Offices and amenities to support the carbon baking operations.

The design capacity of the anode baking facility is shown in the following diagram.

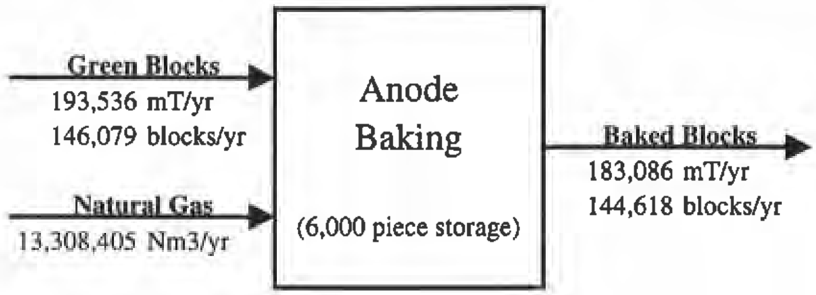

Figure 25: Carbon Baking Design Throughput

4.3.7 Rodding Room

The function of the rodding room is to maintain a continuous supply of rodded carbon anode assemblies for use in the reduction cells. In accomplishing this, the rodding room accepts baked anode blocks from carbon baking and used anode assemblies from the potrooms, replacing the used anodes with new blocks and returning the new assemblies to the potrooms. Cover bath is also removed from the spent anodes and returned to the potrooms for reuse. The orientation of the rodding area with respect to the other plant process areas is shown in the following conceptual rendering.

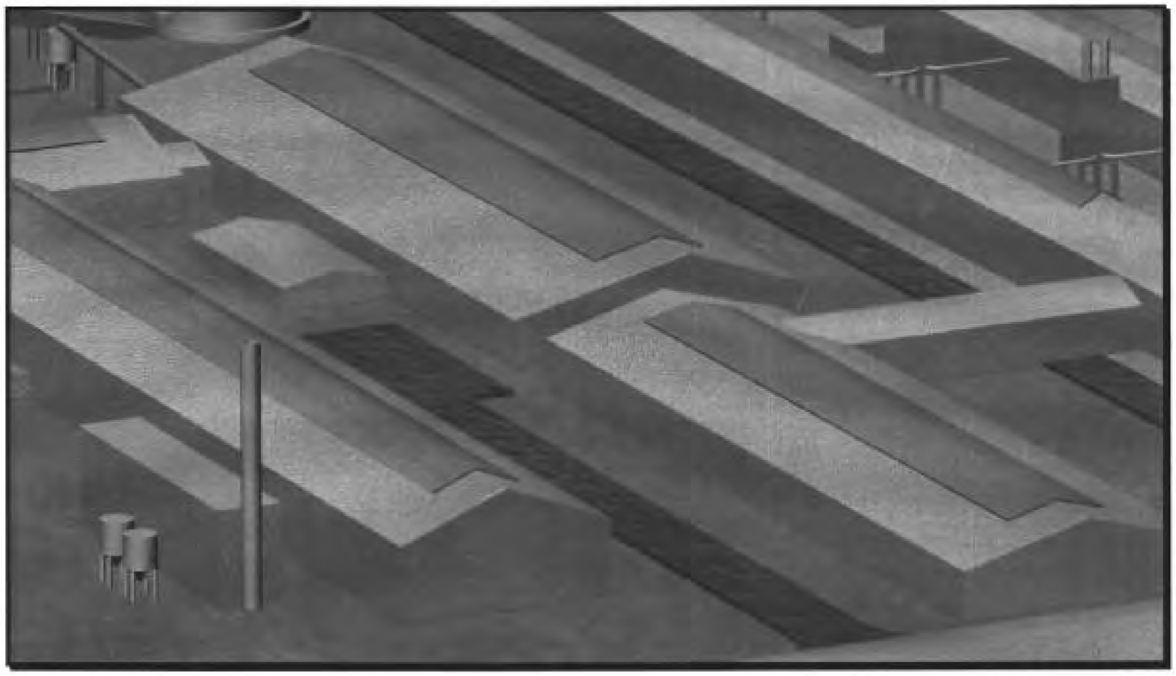

Figure 26: Rodding Room Conceptual Rendering

The carbon rodding room is designed to produce rodded assemblies. Rod assemblies are reconditioned, cast into baked anodes, and transported to the potrooms. Baked anode scrap, green anode scrap, and spent anodes are crushed and conveyed to the green carbon plant. Bath material covering the spent anodes is removed, crushed to size, metal scrap removed, and stored for reuse in the reduction cells. The facilities are designed to produce the required number of anode assemblies on a one-shift, seven days-a-week operation to satisfy requirements. The design throughput of the rodding area is shown in the following figure.

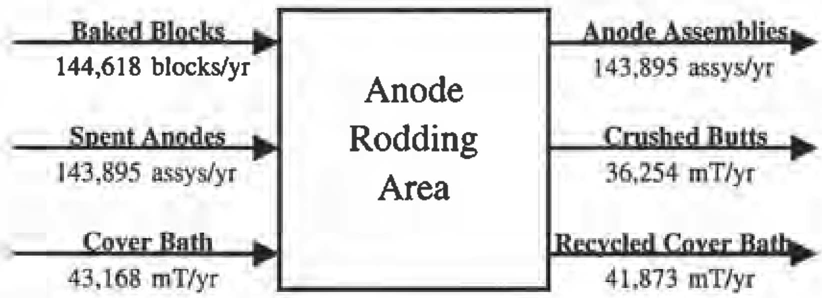

Figure 27: Rodding Room Design Throughput

Facilities will be provided to perform the following functions:

- Receive spent anode assemblies by pallet trucks from the potrooms' spent anode cooling area.
- Remove, clean and crush the spent anodes and deliver the crushed material to the green carbon plant.
- Remove and reclaim the cast iron thimbles.
- Straighten, clean, and recondition the rod assemblies, including stub replacement by automatic welding equipment.
- Reassemble the rod assemblies with new carbon anodes received from the carbon baking plant.

- Deliver the final assemblies to the potrooms by pallet trucks.

- Crush and store the cover material that is removed from the anodes.

- Suitable inside spaced facilities for storage of process supplies and spares.

4.3.8 Cast House

The function of the Cast House, or Metal Service Area, is the further processing of metallic aluminium received from the potrooms for shipment to customers. The Cast House is located close to the potrooms to facilitate the transfer of molten aluminium. A storage yard is provided nearby for marshalling of ingot for packaging and shipment.

The following conceptual rendering shows the location of the Cast House.

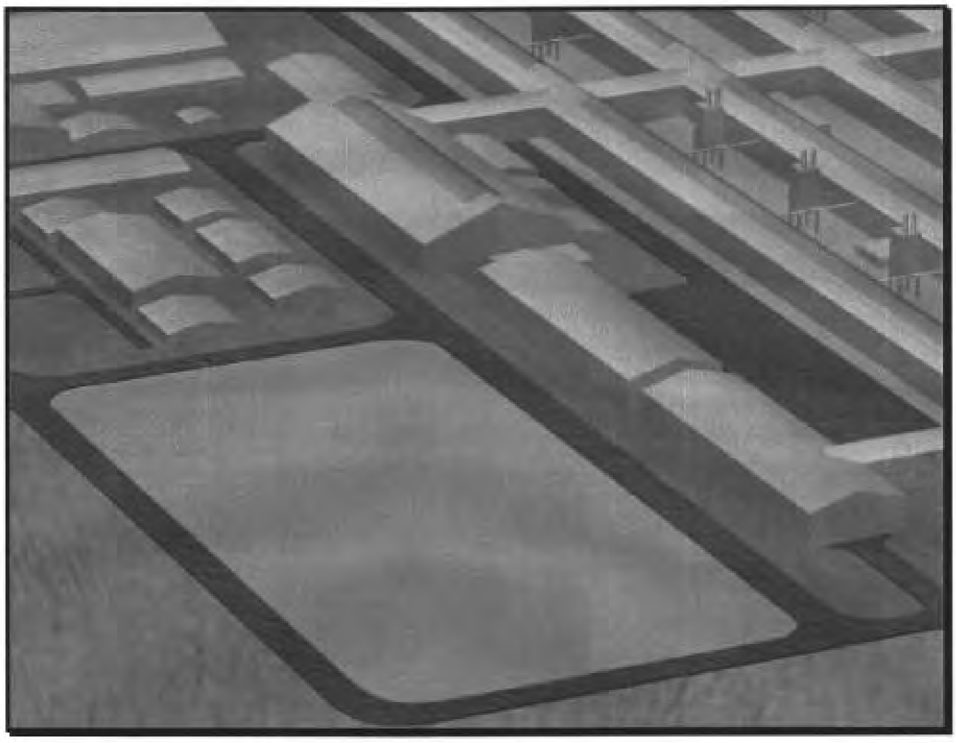

Figure 28: Cast House Conceptual Rendering

Facilities in the Metal Service Area will receive primary molten aluminium from the potrooms and convert the molten metal into a saleable product. Conversion of the primary molten metal will consist of processing, casting, packaging, inventorying, and marshalling for shipment of the product. For the purposes of this study, the cast metal products are limited to 650 kg ingots. Provisions will be made for inspection, identification stamping, and weighing of the 650 kg ingots in preparation for shipment. Support facilities, tooling and in-process product storage will be included.

The design throughput of the Cast House is shown in the following figure:

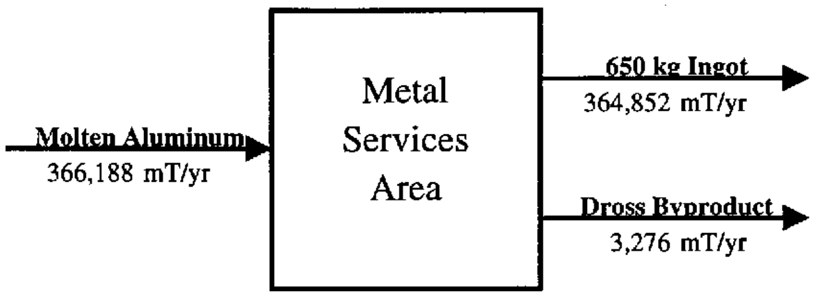

Figure 29: Cast House Design Throughput

4.3.9 Plant Shops and Other Required Infrastructure

Throughout the plant the operational equipment uptime requirement is 90% with 8% downtime for scheduled maintenance (preferably on down shifts) and a maximum of 2% downtime for breakdown maintenance.

Facilities for the complete maintenance of the assets of this plant will be provided. These facilities will accommodate routine and major maintenance for fixed and mobile equipment and facilities, including storage for supplies, parts and spares. These facilities will also provide amenities to serve the maintenance function.

Ancillary facilities will be provided as follows:

- Laboratory to support the quality control and process control requirements of the plant.
- Change and shower house and industrial hygiene facilities for industrial workers.
- Human resources facilities, kitchen, canteen and lunchrooms.
- Training center.
- Plant security, safety, first aid and emergency response facilities.
- Administration building.
- Operations and engineering buildings.

Site development will comprise roads, paving, stormwater drainage, fencing, landscaping and sanitary sewage. A detailed description (used as the basis of the estimate) can be found in Section 7.2

The following utilities will be provided and a detailed description used as the basis of the estimate can be found in Section 7.2:

- Domestic and industrial water.
- Compressed air.
- Plant power.
- Natural Gas.
- LPG.
- Electrical power.
- Firewater.

4.4 Port Facilities

4.4.1 General Description of the Port

The port of Beira is located on the mouth of the Pungue river estuary at latitude 19° 51' south and longitude 34° 50' east. Centrally situated in Mozambique's Sofala province the port serves Mozambique's central interior region as well as the republics of Malawi, Zimbabwe, Zambia, Botswana and can be used for cargo from the south of the Republic of the Congo. The port and railways are owned by Portos E Caminhos De Ferro De Mozambique ("CFM") and have contracted with Cornelder of Holland to operate the container terminal, general cargo quays and associated warehouses. British Crown Agents have the concession for customs operations at the port.

Access from the Indian Ocean is via the 17 nautical mile Macuti channel. The port is tidal with a spring range of 6.2 to 7.4 m above chart datum, the lowest ever tide recorded. Tidal variation can be more than 7 m. Vessels anchor at the bar while waiting for a CFM pilot. The approach to the river is obstructed by many banks and shoals which are constantly changing. The channel has not been dredged since 1991 and currently restricts port entry to vessels of less than 35,000 tons. Channel width varies from 200 m to 100 m and maneuvering area alongside the quays is less than 800 m.

Vessels with a draught of less than 4.88m may enter the port irrespective of the tide. Those drawing more than 4.88m must wait for a suitable tidal height. The port is open 24 hours per day, however night navigation is restricted due to a bottleneck at the Macuti Curve and narrowing of the channel in certain areas. Night navigation is therefore restricted to vessels drawing less than 7 m and a LOA up to 140 m in acceptable weather conditions. Maximum permissible draft is 11 meters and LOA 210 meters on a spring tide.

An emergency maintenance dredging program was completed in August 1998. The water depth alongside the quays varies from 7 to 12 meters and is maintained by the local CFM dredger. A major dredging program is required to deepen and maintain the entrance channel and this is being negotiated with the European Community for funding. A new 1,000 m^3 hopper dredger is due at the end of 1999 from Japan but will only be capable of maintenance dredging.

The existing port facilities and parts of the city are founded on sand dredged from the channel during the development of the port and city.

The port has four container berths, four general cargo terminals, one coal terminal, one old oil terminal and one new oil terminal. The container terminal is fairly new and well run with modern 40-ton gantry cranes and forklifts as seen in the following figure.

Figure 30: Beira Container Terminal

Rail mounted cranes with capacities from 3 to 20 tons and 90 to 200 tons per hour bulk unloaders are available along the general cargo quays. There are 85,000 square meters of sheds and warehouses including cold storage facilities.

A layout of the port is shown in the following figure.

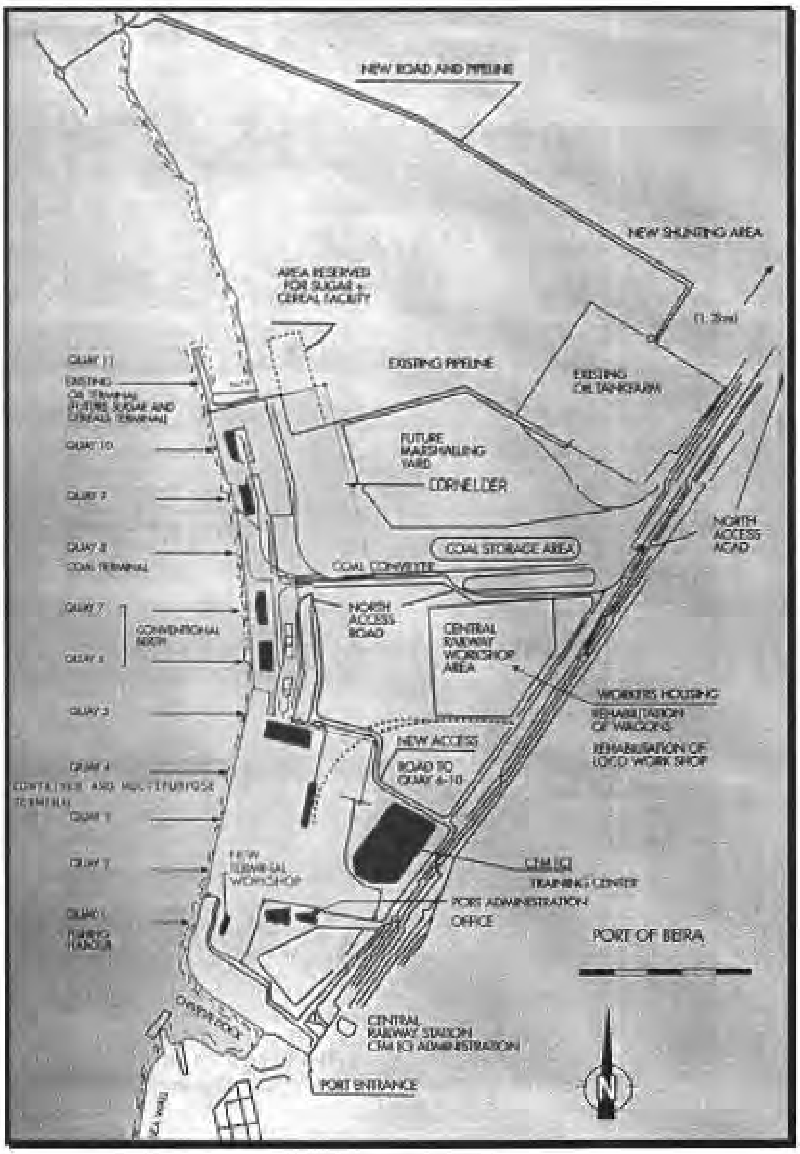

Figure 31: Port of Beira

4.4.2 Port Operations

The port employs about 3,000 people of which 1,500 are casual employees. CFM trains their own artisans and provides schooling for employee children.

CFM operates it's own pilot vessels and tugboats and has a joint venture with Cornelder of Holland to operate the Multipurpose Container Terminal and General Cargo Terminal. British Crown Agents operate the customs facilities and are currently training local CFM employees to perform this function.

Several freight forwarders and shipping agents operate in the port including:

AMI	Beira Cargo Handling
Caravel	Gundelfinger
International Shipping	King &Sons
Mac Overseas Service	Maersk
Manica Freight Services	Mocargo
Mediterranean Shipping Company	Multimpex
Sotrabel	Transmore
Union Transport	

The following figures show the volumes of various cargoes handled by the port in recent years.

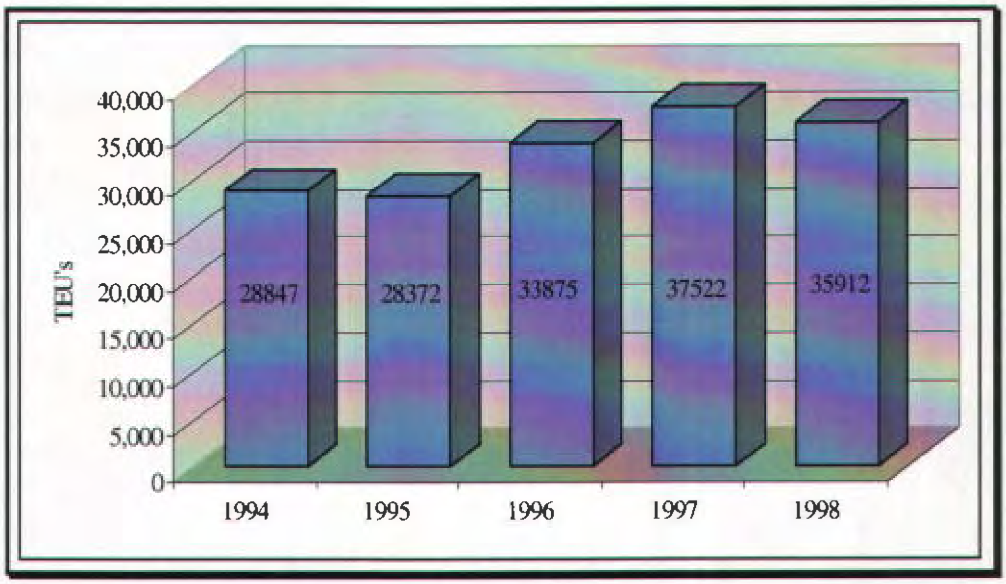

Figure 32: Port of Beira Container Volume

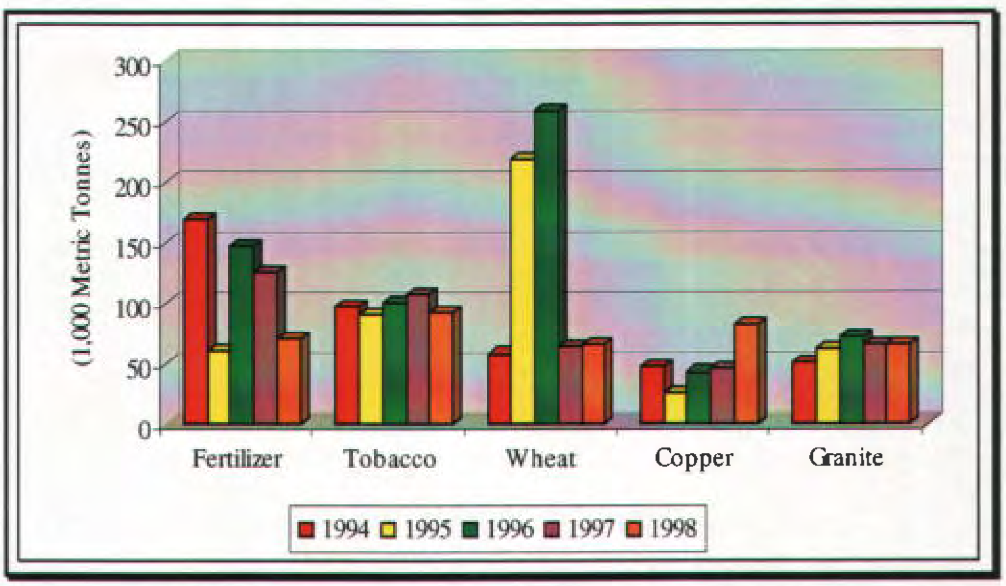

Figure 33: Port of Beira Main Commodities Volume

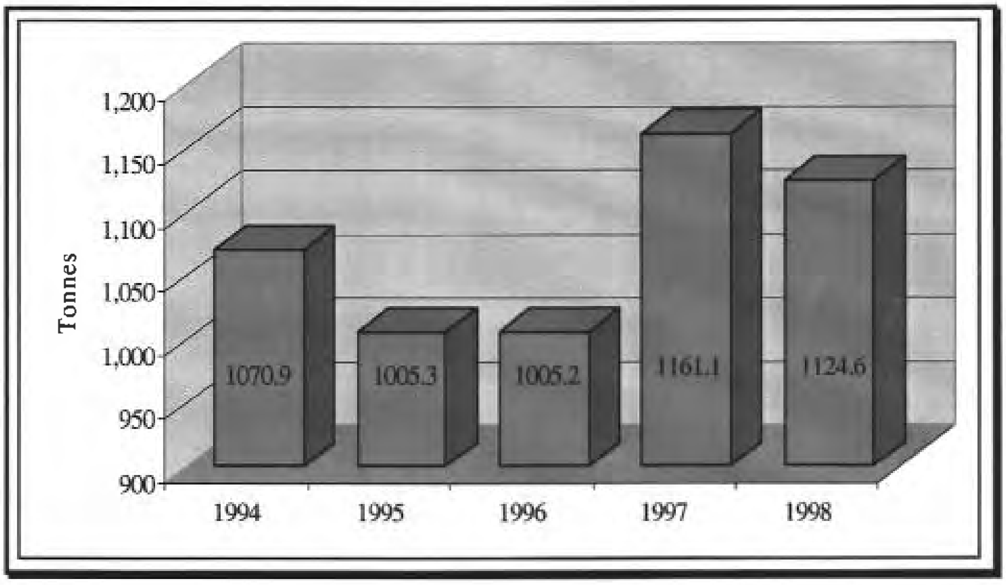

Figure 34: Port of Beira Oil Products Volume

Mobile Oil, BP and Petromoc import, transport, store and market refined oil products such as petrol, diesel, kerosene, aviation fuels, oils and lubricants through the port of Beira. A large tank farm is located at the north end of the port and connected to a new oil terminal by a modern piping system.

4.4.3 Smelter Requirements and Upgrades

The major raw materials to be imported through the port for the smelter at 180 kA are 580,000 tonnes/yr of alumina, 111,000 tonnes/yr of petroleum coke and 24,000 tonnes/yr of coal tar pitch. Finished product to be exported through the port is 300,000 tonnes/yr of aluminium ingots. Ideally, alumina would be delivered in 50,000 tonne shipment in "Panamax" type ships. However, should the dredging program not accommodate this size ship, "Handimax" ships with lower capacity and shallower draft are acceptable.

Most major construction materials will be imported through the port. These would include building materials, cement, steel, piping, equipment and electrical switchgear. Construction equipment could also be imported through the port. The current general cargo terminals are sufficient for this purpose although special lifting equipment would be required for lifts greater than 40 tons.

Quay number 8, shown in the figure below, has been identified as available for unloading bulk alumina and petroleum coke. This will require renovations to the fender structure, paving and trackage. CFM have surveyed the quay and estimated the renovations to cost approximately $3.5 million.

Figure 35: Port of Beira, Quay 8

The existing coal loading equipment would need to be replaced with a vacuum unloading system for the alumina and coke. It is possible that the existing coal conveyor structure could be modified to carry the wider covered conveyor belt for transporting the alumina to the storage silos.

Storage silos for alumina and coke will be required in the port for rapid unloading of ships. Alumina will require three 37,500 tonne silos and coke will require one 15,000 tonne silo. These silos will be fed by an enclosed conveyor from the unloader. An area approximately 3 hectares in size has been identified in the port for locating these silos. A layout of the smelter port facilities is shown in Attachment N and summarized in the following figure repeated from Section 1.

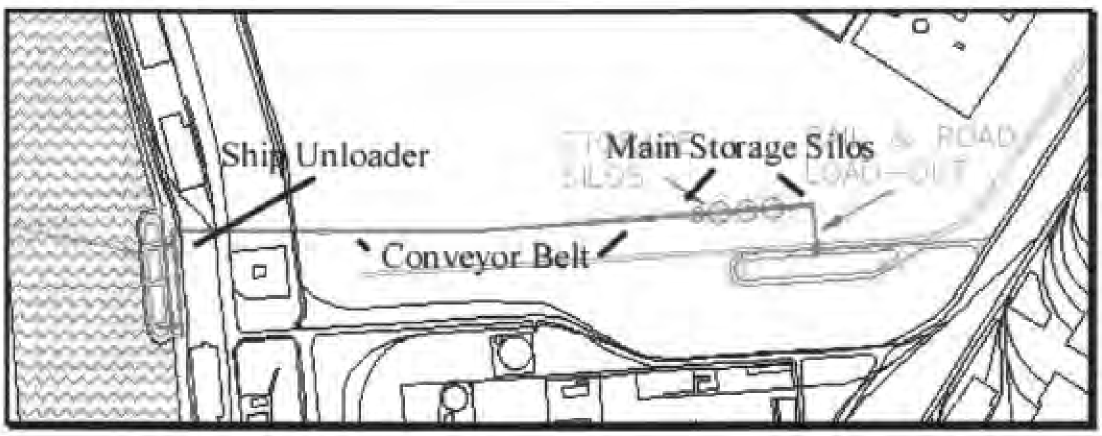

Figure 36: Sketch of Port Layout

Other raw materials will be delivered bagged and can be unloaded at any of the general cargo terminals.

Aluminium ingots will be containerized and shipped out through the container terminal. No special upgrades will be required providing normal maintenance is continued at the terminal.

The most urgent port improvement is the dredging of the entrance channel to accommodate ships up to 50,000 DWT. The entrance channel has silted up to the point where ships are now restricted to 35,000 DWT during normal tides. Future dredging programs need to be coordinated with the Beira development plan to utilize the dredged material for filling the areas designated for industrial development.

5.1 Environmental Regulations

Environmental protection and conservation are high focus priorities of the Government of Mozambique. In this light, the Government of Mozambique has embraced the concept of "Sustainable Development," meaning that the present generation of Mozambicans should endeavor to use natural resources in such a way that it does not prevent future generations from having access to those resources.

In 1994, Mozambique established the Ministry for the Co-ordination of Environmental Affairs ("MICOA"), which is responsible for the development and co-ordination of the necessary measures aimed at managing the resources in sustainable manner.

5.1.1 Environmental Impact Assessment Procedures In Mozambique

In December 1998, the Council of Ministers passed Decree No. 76/98 that approves the Regulation for Environmental Impact Assessment.

Under this decree the Ministry for the Coordination of Environmental Affairs is required to:

1. Approve the specific terms of reference, tendered by the sponsor of an activity that will guide the environmental impact assessment.

2. To convene a public meeting when asked to do so by a public or private entity interested in the proposal.
3. To review the environmental impact statement, within 60 working days, in co-ordination with interested public entities, civil society and the communities affected by the proposal.
4. To issue an environmental license for approved projects, or provide a statement of rejection, within 10 working days of the end of the review.

The Project sponsor is required to:

1. Submit terms of reference for the EIA to MICOA.
2. Submit the EIA report, mitigation and management measures to MICOA, in Portuguese.
3. Comply with guidelines from MICOA on public consultation.

The decree does not specify the time allowed for MICOA to approve the terms of reference for the EIA, nor who bears the cost of the consultation process. In practice, approval may take some time, and the developer is responsible for meeting the cost of the consultation process.

Adequate financial resources should be allocated to cover the cost of meetings and for the preparation and dissemination of EIA reports in both Portuguese and English.

5.1.2 Industry Specific Regulations

At this writing, no specific regulatory limits have been set for primary aluminium smelting, though it is anticipated that Western world standards should and will apply. Both the Kaiser technology described in this report and the Pechiney AP-30 technology being implemented in Maputo are compliant with both European and United States regulatory environmental standards.

5.2 Safety and Industrial Hygiene Regulations

Safety and Industrial Hygiene is regulated by decrees passed in 1966 and 1973 (Legal Decree No. 48/73). Decree No. 48/73 indicates the responsibilities of both, the employers and employees in relation to safety and hygiene in the working place. Under that decree employers are required to take the necessary physical and educational measures to protect their employees against accidents and illness.

All workers have the right to work in hygienic and safe conditions. Employers must ensure the workers physical and mental well being. Work related risks must be explained and education given on the adequate compliance of hygiene and safety rules. Workers are in turn responsible for their own safety and of those around them. They must collaborate with the employer in hygiene and safety issues. All work areas must be secure and risk free and where necessary the appropriate protective equipment must be supplied.

Safety committees are required and must integrate worker and employer representatives. A medical facility will be required on site providing first aid in the case of accidents, sudden illness, intoxication or indisposition. Workers will have to be examined regularly in order to verify that the work can be carried out, if there are any infectious or contagious diseases that could endanger co-workers, or if there is any mental illness present.

5.3 Tax Structure

Under normal circumstances, foreign companies are subject to the same taxes as Mozambican companies on profits made in Mozambican territory. From January 1994, the main corporate tax rates differ according to the company's business activity: 35% for agriculture, 40% for industry and 45 % for commerce and services. Earned income is not subject to double taxation. Personal income tax is progressive and reaches its maximum of 30% on incomes above the equivalent of about $105 per month. Normally the employer retains and pays the tax on behalf of the employee.

5.3.1 Personal Income Taxes

All residents of Mozambique must pay tax on their personal income. The rates are as follows:

Salary (in meticais)	Tax	Deduction
Up to 600,000 Mt	Free of tax	
Between 600,000 Mt and 2,400,000 Mt	10%	60,000 Mt
Between 2,400,001 Mt and 9,600,000 Mt	15%	180,000 Mt
Over 9,600,000 Mt	20%	660,000 Mt

Personal income tax of employees is retained and paid monthly by the employer to the Government

Other fiscal obligations on income tax covered by the recent Labor Law are as follows:

- Social Security contribution is 7% of the gross income, of which 3% is paid by the employee and 4% is paid by the employer, who retains this tax and pays monthly to the Government.
- Insurance against working accidents averaging 1.25% of the gross income, paid by the employer to the Government.
- Non-residents earning income in Mozambique are required to pay a 15% withholding tax on that income.

5.3.2 Investment Income Taxes (Consumption Tax)

Investment income is taxed at higher rates than wage income as follows:

- 10% on the first 10,000,000 Meticais (approx. $900).
- 15% on the next 30,000,000 Meticais ($2,700).
- 27% on the next 40,000,000 Meticais ($3,600).
- 40% on investment income over 80,000,000 Meticais (i.e. over $7,200).

5.3.3 Corporate Tax

Companies are required to pay the following rates of tax on their gross profits:

- 35% for enterprises in Agriculture.
- 40% for enterprises in Industry.
- 45% for enterprises in Trades and Services

Corporate balance sheets must be provided to the Ministry of Planning and Finance before the 31st of May of the year following the year for which the balance sheets apply. Using those documents, the Ministry then calculates forecasted Gross Profits for the coming year and requires payment of 1/12th of expected taxes in the coming year to be remitted to the Government of Mozambique each month. A reconciliation of forecasted and actual taxes is made at the end of the fiscal year.

5.3.4 Sales Tax – VAT

A flat tax of 17% value added tax ("VAT") was implemented on 1 June 1999. Decree 52/98 of 29/09/98 regulates the areas covered and the procedures for implementing VAT. It also defines those areas exempt from this tax.

However, even in the cases of legal exemption, VAT must always be included in the invoice as "0%" rate and reasons for exempting have to be explained. Moreover, outgoing invoices and incoming invoices must always include a VAT number (NUIT- Número Único de Identificação Tributária).

5.3.5 Customs Duties

For imported products, the following duties apply to their CIF value:

- 5% on essential, basic consumer goods.
- 5% on raw materials.
- 10% on capital goods (equipment and machinery).
- 25% on ready-made goods for assembly.
- 35% on non-essential and luxury consumer goods.

All goods worth more than $2,500 must receive advance certification by Customs to permit an accurate determination of their real value.

5.3.6 Customs Handling Fee

There is a Customs handling fee for all cross-border trade, imports and exports. The fee on imported goods is 1% of the value of the goods.

5.3.7 Real Property Transfer Tax.

The sale of real property is subject to taxation as follows:

- 5% on the first sale of the real property.
- 10% on all subsequent sales of that property.

5.4 Banking and Foreign Exchange Regulations

Foreign investors are allowed to operate both local and foreign currency accounts and such accounts are freely transactional. Foreign currency accounts for investors can be denominated as retention accounts meaning that the availability of the foreign currency is guaranteed.

The right to repatriate capital, dividends, and other distributions of profit is guaranteed by law. Firms are obliged to register all imports of goods or money with the Central Bank's Department of Exchange Control. Non-registered money faces the difficulty of future repatriation.

5.5 Foreign Investment Regulations

The Government of Mozambique has assumed a proactive posture for attracting Foreign Invested Capital to Mozambique. Coupled with their national fiscal policy for controlled growth, the GoM through sovereign decree provides material assurances to foreign investors as follows:

- Security and legal protection of property and goods rights in connection with the investments made.
- Freedom to import equity capital or arrange loans to carry out investments.
- Remittance of funds abroad in connection with exporting the foreign investor's profit, payment of royalties and other charges abroad, loan repayments and interest charges due abroad and any amounts paid as just and equitable compensation.
- Repatriation of capital invested upon liquidation or sale, total or partial, of goods or rights of an investment undertaking.

The Government of Mozambique implements these principles and commitments through a series of specific investment, trade and taxation regulations as discussed below.

5.5.1 Objectives of the Investment Regulations

The current investment regulations are administered according to Investment Law No. 3/93 and Decrees Nos. 12/93 and 14/93. In addition, a few changes have been implemented through Decree 37/95. Its main objectives are:

1. To develop, rehabilitate, modernize and expand productive projects and services.
2. To expand and improve national productive capacity and the delivery of services.
3. To contribute to the creation, expansion and development of local entrepreneurs and Mozambican business partners.
4. To create jobs for nationals and raise the professional skills of the Mozambican labor force through adequate training programs.
5. To promote technological development, entrepreneurial activity and efficiency.
6. To increase and diversify exports.
7. To intensify productive activities with a view to generating foreign currency.
8. To reduce and substitute imports, through creation of import substitution industries.
9. To contribute to the improvement of local market supply and to meet the Mozambican peoples' basic needs.
10. To contribute to the improvement of the Country's Balance of Payments and Government of Mozambique revenues.

5.5.2 Restrictions Imposed by the Regulations

Though the principles of Mozambique's emerging economy are based in the free market, foreign capital investments are currently restricted in certain economic sectors. These restrictions manifest themselves as requirements for Government or other Mozambique national participation in enterprises focused in certain areas as specifically defined by the regulations.

The following economic sectors are specifically nominated for investment by Private Enterprise (foreign or otherwise):

- Agriculture, livestock and agro-industry.
- Forestry plantation and industrial wood processing.
- Mineral resources exploitation and related industrial processing.
- Tourism including casinos.
- Aquaculture and fish processing.
- Chemical, textile, clothing and footwear and related manufacturing.
- **Metallurgical** and metalworking **manufacturing industries.**
- **Energy** and electronic **industries.**
- Development and operation of transport and communications services.
- Construction materials, civil construction and real property development.

- Insurance, banking, money changing, leasing and financial intermediation.
- Participation in the privatization of parastatal companies.

Metallurgical and energy generation industries, such as aluminium smelters and independent power producers, are reserved for Private Enterprise.

Other areas are reserved for direct ownership and control by the Government of Mozambique, either by itself or in joint venture with Private Enterprise (foreign or national). Though the GoM has stated its intentions to further privatize some of the sectors in this category, the current regulations nominate the following for government control or participation:

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- Production and transmission of power for public consumption in accordance with relevant legislation.
- Supply of water for domestic and industrial purposes in urban centers.
- Operation of postal service and public telecommunications.
- Development and administration of national parks, both marine and terrestrial and other areas protected by law.
- Production, distribution and trade of weapons and ammunition.

Of particular interest to this project is the requirement for Government participation in power transmission enterprises, which for the purposes of this study is assumed to be operated by a foreign investor supported in joint venture with Electricidade de Mozambique ("EDM").

5.5.3 Incentives Available under the New Investment Regime

For most projects supported by foreign invested capital, the Government of Mozambique offers customs and fiscal incentives to investors. These include the full exemption from Custom Duties and Consumption and Circulation Tax on equipment for carrying out project feasibility studies and investment project implementation. This exemption also extends to items such as building materials and equipment necessary to carry out an approved investment project. Passenger cars for company representation are also included in this category, provided that the value does not exceed 1% of the value of the total project investment. Raw materials, intermediate products and packaging materials used for production are exempted only for the first production cycle. Lastly, foreign investors' and expatriate technical staff's personal belongings are exempt from customs duties.

As a further incentive for qualified projects, the 1993 investment law enables the establishment of Industrial Free Zones ("IFZ") in Mozambique. The regulations regarding the development and operation of IFZs came into effect on the 1st January 1994 with the vision that IFZs in Mozambique will be developed by the private sector for the promotion of export processing activities. Investors can choose to develop and/or administer IFZ areas or operate within them as certificate holders (industrialists).

The production of an IFZ industry must be mainly for export. A maximum of 15% of the production is allowed for sale to the domestic market. Development licenses for those who wish to develop and/or administer IFZ areas require a minimum investment of $5 million. Land concession must be requested via normal government channels. Developers must pay a royalty fee of 1% of their gross turnover from the 6th year of operation and are exempt from the payment of any taxes and customs duties. Companies operating in the IFZs are issued an operations certificate. A minimum investment of $50,000 is required. The companies pay the same royalty fee of 1% from the second year of operation and enjoy a total exemption of taxes and customs duties.

Of particular interest for this project, is the Government of Mozambique's recognition of the special challenges of large foreign investments and extends additional incentives for "megaprojects" exceeding $500 million in value. These additional incentives are nominated and confirmed for each qualifying project.

5.5.4 Overview of the Regulations

In its effort to regulate, standardize and attract foreign investment to Mozambique, in 1984 the Government of Mozambique approved an Investment Law defining the requirements and nature of foreign investment in the Country. Since the promulgation of that core document, rules, regulations and requirements regarding foreign investment in

Mozambique have been modified significantly in various supplemental laws, codes and decrees. The details of the various changes since 1984 are not recorded here, instead, keynote rules and regulations of the existing foreign investment environment, as embodied in current legislation, are summarized to inform the reader. Specific interpretation of Mozambique foreign investment legislation is beyond the scope of this study.

The Government of Mozambique offers a package of fiscal and customs duties incentives to encourage investment. It has recently simplified the approval process for investment projects and the registration of firms. To assist in this process the Government established the Investment Promotion Centre ("CPI") to support the processing of proposals and business plans by the responsible government agencies according to pre-set schedules. All proposed investment projects must go through the CPI. The CPI charges 0.1% of the proposed investment as a service charge.

Under existing regulations, there are two ways to set up a business in Mozambique in order to obtain fiscal and customs benefits: (a) establishing a local investment and (b) establishing a foreign investment. In both situations companies obtain incentives from the Government of Mozambique, but with certain differences.

For the cases of companies formed as (a) and (b) above, and which **invest between $5,000 and $50,000**, the following incentives apply:

1. Reduction of Corporate and Dividend tax by:
   a. 80% if the project is in the remote provinces of Cabo Delgado, Niassa or Tete.
   b. 65% for projects in all other provinces outside the respective provincial capitals.
   c. 50% for projects located in provinces identified in 1b, but within provincial capitals.

2. Reduction of Corporate Income Tax and Investment Income by 50% in the case of 1a above from the 10th to 16th year of the project.

3. Reduction of corporate and dividend tax by 25% in the case of 1c above from the 10th to the 13th year of the project.

4. Exemption of customs duties, circulation and consumption taxes on goods imported for the implementation of the project.

5. Exemption of customs duties, circulation and consumption taxes on goods imported that belong to expatriate technical staff of the project.

6. A reduction of 50% in Customs handling fees from an official level of 5% of the value of imported goods to 2.5% of the value of the goods.

7. Up to a 5% reduction of corporate taxes on net profits, for costs incurred to train local employees.

For the case of foreign companies investing **over $50,000** the following additional incentives apply (as in the case of this proposed project):

1. Repatriation of up to 100% of dividends upon the establishment of a legal reserve for reinvestment.

2. Repatriation of capital in the event that the Project comes to an end. The Government grants the repatriation in the original currency over a period of not more than 5 years.

3. Grants of hard currency to repay credits and loans incurred abroad.

4. Tax holidays on interest earned.

On certain specific projects, the Government of Mozambique also offers the following additional incentives:

1. Corporate and dividend tax is not payable for five years, or until the full value of the investment has been recovered, whichever comes first.

2. Costs related to the construction or rehabilitation of public infrastructure such as roads, schools, hospitals, sewerage, electricity, and water can be written off against income at the rate of 120% of their actual cost.

3. The purchase of works of art or other expenditures that contribute to the development of Mozambique's culture may be deducted from income.

In the case of construction and operation within an approved IFZ, the following incentives also apply:

1. Full exemption on customs duties, consumption and sales taxes and customs handling fees for:
   a. Construction equipment and materials.
   b. Machinery and industrial and transport equipment and related parts and subsidiary material.
   c. Telecommunications equipment and related parts and subsidiary material.
   d. Raw materials and components to be used for the production of articles for export.
   e. Up to 20 light passenger cars for the project, provided their value does not exceed 1% of the value of the investment project.

2. Full exemption of any taxes on exports and profits. In lieu of such taxes, companies will pay a royalty equal to 1 to 2% of gross revenue or another similar charge based on space used.

5.5.5 Analysis and Approval of Investment Projects

The Government of Mozambique has simplified the approval process for investment projects and the registration of firms. CPI is responsible for providing the necessary assistance for project development. The CPI has recently committed itself to rendering decisions about project approval within 20 days of the submission of a proposal for a project.

The schedule for project proposal assessment is as follows:

1. Within 7 days of submission, the CPI will have circulated and gathered approvals or comments relating to the proposal from all relevant Government Departments.

2. After 7 days, the proposal will be sent to the competent decision maker who will be:

   a. The Governor of the Province for projects less than $100,000.

b. The Minister of Planning and Finance for projects between $100,000 and $100,000,000.

c. In either case, the competent decision maker must decide to approve or not approve the proposal within 3 working days.

3. Projects over $100,000,000 or meeting other conditions will require the approval of the Council of Ministers, which must make its decision within 10 working days.

Important in the regulations is that if a decision is not made within the prescribed time limits the project will be deemed to have been approved, and any decisions regarding the proposal taken after the prescribed time limit has passed cannot reverse the approval.

If a proposed project is approved, but the investor delays implementation of the project, the investor must request an extension of the start-up of the project. At this point, the investor must post a bond with the Central Bank equal to 5% of the project's value. Failure to invest within the new time limit means the 5% reverts to the Government. If the investor does proceed within the new time limit the 5% reverts to the investor.

5.6 Special Government Concessions for this Project

The CPI has recognized the Beira Aluminium Smelter as a candidate mega-project for IFZ status and maximum investment incentives. At this writing, the project meets all of the stated criteria by written confirmation by the Director of CPI.

Cost estimates, revenues and income for this project are forecast on the basis of maximum investment incentives. No import taxes or duties are accounted in the capital and operating cost estimates. No corporate income tax is included in the proforma Income Statements.

5.7 Protection Against Nationalization of Property

Diligence with respect to political risk is beyond the scope of this study. However, it is noted that Mozambique is a member in good standing of the following international insurance organisations:

- The Multilateral Guarantee Agency.
- The Overseas Private Investment Corporation ("OPIC") protocol.

Mozambique also provides recourse to arbitration through the International Convention and Center for Settlement of Investment Disputes and the Paris-based International Chamber of Commerce.

The professional posture of the Government of Mozambique, their participation in recognized insurance agencies and their close engagement with World Bank programs for economic recovery provide a level of assurance against political risk. Further protection can be bound through organizations such as OPIC. The cost of which, for the construction and start-up period of this project is included in the estimate of capital costs.

6.1 Environmental Overview

The Hall-Heroult process for production of primary aluminium is an electrolytic reaction of carbon anodes in the presence of aluminium oxide to produce aluminium metal and carbon dioxide. There are no principle products of this reaction producing an inherent waste stream.

Secondary waste streams arise from the carbon anode production process and from the incomplete capture of dusts and gases evolving from the electrolytic melt. Technical control of these pollutants, which typically appear as air emissions, is excellent as further described in this section of the report.

Any significant wastewater streams from the smelter are not related to the smelting process (which is dry), but rather to the general needs of an industrial facility and its employees.

Solid wastes from the production of aluminium are primarily residual bricking and carbon materials from the relining of the reduction furnaces (Spent Cathode Lining or "SPL"). In addition to their inert refractory content, these materials contain soluble fluorides and traces of cyanides. SPL must be contained and treated prior to landfill.

Environmental Impact

It is noted that if this project proceeds, an Environmental Impact Assessment ("EIA") will be required in conformance with the terms of reference to be agreed with the Ministry for the Co-ordination of Environmental Affairs ("MICOA"). Subsequent plant environmental management and control will then follow the agreements of the EIA. At this stage of the project's assessment there are no known difficulties with meeting the anticipated requirements.

6.2 Transient Effects of Construction

The main effects of construction will be the actual disturbance of the land being built upon and it's change in land use. For this reason we have considered sites in areas designated for industrial use. The following discusses the various areas of the project and the associated environmental issues.

6.2.1 Smelter Complex

Construction of the smelter at either site B in Beira or at Site D at Savane would mean using at least 50 hectares of wetlands. However, the Beira site is classified for industrial use and therefore the smelter at this site will not reduce the planned wetland preservation.

Filling of the site will require careful siltation and erosion control to avoid impact on the Pungue River and its mangroves from storm runoff. Normal silt fencing, berms and ditching can provide adequate protection.

During dry periods normal dust control by water trucks can provide adequate countermeasures.

Fuel storage for construction equipment will need to be diked to contain potential spills. The entire site will in all likelihood be surrounded with a berm to protect against flooding. This berm will provide secondary containment of runoff containing silt or construction contaminants. Other than dust there is unlikely to be airborne pollution from this type of construction.

A sewage treatment plant will be provided at the start of construction to treat sanitary waste generated by the construction labor force during construction of the smelter.

6.2.2 Port Facilities

By utilizing the existing port facilities, significant disturbance of the mangroves is avoided.

Reconstruction of the dock facilities should not pose a risk to the environment, particularly if loss of materials into the harbor is avoided. Storage of fuel for construction equipment should follow normal good house keeping practices with refueling areas contained to prevent contamination from spills.

Construction of the storage silos and material handling equipment will necessitate the disturbance of a 5 to 10 hectare area. The same runoff and dust control implemented for the smelter construction will prevent pollution problems at the port.

6.2.3 Power Transmission System

The environmental impact of the power transmission system will depend on the route and type of equipment required. A detailed environmental study of the route will be required during preliminary engineering to balance the cost with the minimum environmental impact. If existing transmission corridors are used then there is unlikely to be any significant change in the environment.

Construction traffic in the transmission corridors will need to be controlled in sensitive areas.

6.2.4 Transportation System

Transportation of construction materials to the site will generally be through the port or by rail or road from Zimbabwe. An exception to this may be the hauling of crushed rock and sand from inland quarries. At this time such quarries have not been identified and therefore no comment can be made on their environmental relevance.

Significant smelter construction truck or rail traffic along the established Beira corridor should have very little additional impact. Similarly, movement of construction materials through the port using existing facilities and practices will have no additional impact.

6.3 Generation of Pollutants from Smelter Operations

Aluminium smelting uses the raw materials alumina, pitch and petroleum coke. The chemical properties of alumina are closely associated with those of the normal mineralogy of soil. A spillage of alumina in either water or on soil will have virtually no effect. Petroleum coke, although combustible, is difficult to ignite and burns slowly reducing the risk of fire in the event of a spill. Pitch solidifies at room temperature so spills will only require localized cleaning.

In the carbon manufacturing process, calcined petroleum coke is mixed with coal tar pitch and formed into "green" carbon blocks. This process releases coal tar pitch volatiles, which are captured and treated by a special system. Some of the lighter hydrocarbon fractions are released to the atmosphere. This is the primary source of any Volatile Organic Compounds ("VOC") emitted by the smelter.

Green anode blocks are transformed into anodic carbon through a baking process which combusts the volatile fractions of the coal tar pitch content and cokes the remaining carbon into a more homogeneous block of carbon. This process releases fine carbonaceous particles, products of combustion and some fluoride gases and dust, all of which are treated in a dry sump cooling tower, dry scrubber and bag filtration system (off-gas scrubber). Uncaptured dusts from this process are the source of some of the particulate air emissions of the plant.

The baking and melting furnaces will be fired with heavy furnace oil ("HFO"), liquefied petroleum gas ("LPG") or natural gas ("NG"). HFO would be stored in aboveground tanks in bunded areas so that any spills will be contained. LPG would be contained in conventional above ground pressure vessels. The NG would be piped to the site.

Baked anode carbon and alumina are reacted in an electrolytic process to form carbon dioxide and aluminium metal. Carbon dioxide is by far the largest single waste product of the smelter. The electrolytic process requires a "bath" of molten fluoride salts, which emit particulate and gaseous fluorides as part of the process. These fluorides are captured by high efficiency gas treatment systems and returned to the process for reuse. Some of the fluorides and other particulate matter are not captured, which is the principle source for gaseous and particulate air emissions of the smelter.

Periodically, reduction cells are refurbished to maintain "as new" condition. The used refractory and carbon lining of the pot is removed and replaced as part of the refurbishment process. The used material, known as Spent Pot Lining, or SPL, contains soluble fluoride salts and traces of cyanides. SPL has been declared hazardous by the United States Environmental Protection Agency and must be treated to reduce the cyanide content. SPL must be contained prior to treatment and facilities for this purpose are provided.

Other common industrial pollutants such as transformer oil, paints and greases are present on the plant site. Containment rooms, safe storage facilities and secure installation pads are provided in the scope. All points to the storm water reticulation system where oil can enter will contain oil traps.

Attachment B provides expected values for air emissions from the smelting process. These pollutant sources and the sources associated with general industrial operations are described in the following table.

Source	Pollution Type	Environmental Medium
Anode manufacture	Dust	Air
Paste plant	PAH	Air
Anode baking	Sulphur dioxide	Air
Anode rodding	Carbon dust	Water
Aluminium reduction	Gaseous fluoride Particulate fluoride Sulphur dioxide Carbonyl sulphide Carbon disulphide	Air Air Air Air Air
Spillage	Fluorinated products	Water
Casthouse	Sulphur dioxide Salts	Air Water
Spent pot linings	Cyanide Fluoride	Solid waste Solid waste

Table 2: Potential Sources of Pollution

6.4 Treatment and Containment of Pollutants

Modern aluminium smelters such as the one proposed for Beira are sophisticated in their use of recycling technologies for the containment and treatment of waste products and process emissions. Integral systems for capturing and recycling process chemicals are included in all stages of the manufacturing process. These systems "scrub" the off-gases of potentially polluting materials.

For potroom and carbon baking air emissions, the scrubbing media is the incoming alumina to the plant. Chemicals removed from the gas streams are bonded to the alumina, which is then added to the reduction calls, recycling the chemicals.

For green mill air emissions, the scrubbing media is calcined petroleum coke. Gaseous hydrocarbons are absorbed by the coke, which is then returned to the production stream to make green anodes, recycling the hydrocarbon volatiles.

The following paragraphs describe the pollution containment systems in greater detail.

6.4.1 Scrubbing of Gases

The potential gaseous pollutants (listed in the table above) are trapped by hoods that enclose the pots and then ducted to dry scrubbing units called Gas Treatment Centers ("GTCs"). In the GTCs, the gases react with incoming alumina that absorbs the fluoride, removing it before the gas stream enters the atmosphere. The enriched (or fluoride-laden) alumina is fed to the pots. In this way the fluorides are recycled so that only small amounts of aluminium fluoride need to be added to the pots. The fluoride emissions to the atmosphere are greatly reduced.

As a consequence of sulfur content of petroleum coke, the smelting process generates some sulfur dioxide gas. Sulfur dioxide is not readily absorbed by alumina and as a result it is released to the atmosphere from the stacks of the GTCs. The sulfur entering the atmosphere is converted, in the approximate ratios, to sulfur dioxide 82.1%, carbonyl sulfide 16.8% and carbon sulfide 1.1%.

The bake furnaces could be fired by heavy fuel oil whose combustion will also emit sulfur dioxide. These fumes will be treated in a fume treatment center ("FTC") similar to the GTCs, in which the tars and fluorides emitted from the anode baking operation are collected. (If the furnaces can be fired with natural gas or propane, the sulfur gases from heavy fuel oil combustion will be emitted.)

Technical performance of these scrubbing systems is included in Attachment E.

6.4.2 Particulate Containment.

The Gas Treatment Centers for the green mill, carbon baking kilns and potrooms also filter fine particulate matter from the off-gas streams. The expected remaining particulate air emissions are shown in Attachment B.

Dust generated by other process operations such as bath grinding, anode cleaning, spent anode crushing, and so forth, are contained by dust collection systems provided with the systems.

Dusting from raw material handling is controlled through closed pneumatic ship unloading systems, covered conveyors, closed pneumatic truck loading and unloading systems and transfer point dust hoods and filters.

6.4.3 Waste Water Treatment

The key aspect pertaining to the surface and ground water quality is the control of any fluoride and salts in the storm water runoff from the site. The on-site capture, possible treatment and subsequent controlled discharge of storm water are essential to ensure adequate dispersion and dilution is achieved in the receiving water. A containment pond for storm runoff is provided in the scope of the project.

6.4.4 Spent Pot Lining Treatment and Containment

The spent cathode lining must be safely stored in a facility pending the specification of an approved treatment or disposal method that is technically and economically feasible. SPL can be treated through a variety of ways, depending upon the local facilities and the areas needs. One successful method of disposing of SPL is incineration in a cement kiln. If the Dondo cement factory is reactivated, this would probably be the preferred method of SPL disposal, but if not, there are a number of other ways to neutralize SPL in routine use around the world.

In any case, the plant makes provision for on-site storage and containment of any SPL prior to treatment.

6.4.5 Containment of Slurries and Solids

Other than for SPL, no special provisions are made for containment of slurries or solids. No significant generation of wastes of this type is expected.

6.5 Environmental Consequences of the Project

The entire region under consideration is classified as a wetland ecosystem, (riverine swamps and flood plains). These ecosystems have been recognised as an important environment for livestock, fisheries, wildlife, agriculture and biodiversity. Therefore, they are very important to a rural economy. These ecosystems are very sensitive and need an effective planning, management and conservation strategy.

Wetlands in general are very sensitive ecosystems to pollution because of the quick dissemination / transport of the pollutants throughout the water bodies. The polluted surface water can quickly contaminate the groundwater and will be quickly spread over a large area. Pollution of groundwater is a major problem because of the difficulties in cleanup and recovering from an accident. It should be noted that there is no known significant groundwater aquifer in the smelter area and few, if any, people rely on wells for their water needs.

It is foreseen that the installation of an aluminium plant in the area will affect the environment negatively to a limited extent. However, the indirect positive impacts of improving the infrastructure and living standards should far outweigh any negative impact.

The potential impacts associated with the materials handling during smelter operation are itemized in the following table. Generally the environmental consequences of material handling in an efficiently run smelter are not high and the only significant material requiring special handling is spent pot lining.

	Handling of alumina, pitch, coke and other raw materials	**Handling, storage and use of fuels**	**Laboratory waste**	**Disposal of spent pot linings**
Extent	Localised	Localised	Localised	Localised to regional.
Duration	Short-term	Short and long term	Short-term	Long-term
Intensity	Low	Low	Low	Low
Probability of occurrence	Low	Low	Low	Low
Legal requirements				Basel convention
Criteria: Destruction of flora, groundwater contamination, Direct harm to humans	Low	Low to medium	Low	Medium
Status of impact	Neutral	Negative	Negative	Negative
Degree of confidence in predictions	High	Medium	High	High

Table 3: Potential Environmental Impact

However, despite these anticipated very low pollution levels, the nature of the surrounding environment indicates that the approved Environmental Management Plan for the smelter should monitor the local ecosystem, flora and fauna, for build up of any pollutants. All water runoffs should be monitored for total suspended solids, fluorides and hydrocarbons. Ambient air should be tested for pollutants of local concern.

6.5.1 Air Quality

Mozambique does not currently have suitable guidelines for atmospheric pollution. Other companies have used the South African non-binding guidelines for common pollutants. These are similar to legally binding standards elsewhere in the world based on human and animal considerations as well as floral damage.

At the expected concentrations, gaseous fluoride poses minimal public health risk, but it can injure susceptible plants and is one of the most phytotoxic air pollutants. An average ambient concentration of 0.4μg/m³ of gaseous fluoride is regarded worldwide as a standard that will protect even sensitive plant species. An industrial exposure limit of 2500 μg/m³ in air has protected workers from osteosclerosis (abnormal hardening of bones). Public exposures are typically 1/1000th of the work place limit. Guideline annual average values of 1μg/m³ for industrial areas and 0.4 μg/m³ for residential areas are recommended for evaluating this project. This compares to the following standards applied elsewhere:

- Germany, 1 μg/m³, yearly average.
- Netherlands, 0.8 μg/m³, monthly average.
- Washington State, USA, 0.5 μg/m³, growing season.

Sulfur dioxide as emitted by this smelter is a common air pollutant arising from many processes. In this case, the sources of sulfur are the anodic petroleum coke and any burning of heavy fuel oil. Average values should be well below the twenty-four hour US EPA guideline value of 260 $\mu g/m^3$ or 80 $\mu g/m^3$ for an annual average.

Polycyclicaromatic hydrocarbons ("PAHs") are a large family of organic compounds. The main sources of PAHs are the green mill and anode baking kilns. Most of the PAHs are burnt in the furnaces or caught in the fume treatment center.

Carbon dioxide is emitted from the electrolytic process. In extremely high concentrations (>5,000 ppm) it can lead to asphyxiation. Such high concentrations are usually found in confined spaces and not in an aluminium smelter. Carbon dioxide is the most common greenhouse gas and is therefore likely to contribute to the global-scale impact of global warming, rather than the immediate surrounds of the smelter.

6.5.2 Water Quality

Small amounts of fluoride are beneficial to the strength of bones and teeth. For example, the South African water quality criteria set maximum of 1.5 ppm in fresh water streams and rivers, and 5 ppm in the estuarine and marine environments. The smelter must control any fluoride laden storm water within these limits to maintain environmental compliance.

The major sources of fluorides in storm water are fluoride fallout due to atmospheric emissions and on-site spills of products containing fluoride. It is possible after a long dry spell that the concentrations of fluoride in uncontrolled storm water might exceed these limits. The first flush of storm water will therefore be caught in a holding dam and be discharged in a controlled manner so that the 1.5 ppm and 5 ppm limits are not exceeded.

6.5.3 Ground Water Quality

Ground water quality can be impacted in the following three ways. Recharging the aquifer with storm water effluent possibly including fluorides and other salts, direct recharge of the aquifer from rainfall, and from possible waste disposal operations on the site.

Appropriate storm water control measures are required to minimize the effect of contaminated rainfall reaching the groundwater.

Airborne emissions must be controlled to minimize the impact of contaminated rainfall directly recharging the aquifer.

Landfill and waste disposal practices are required to mediate the possibility of ground water leaching from industrial dumps.

6.6 Compliance with Mozambique Regulations

Mozambique does not have pollution standards specified for the aluminium industry, but it does have environmental regulations as described in Section 5 of this report.

Although Mozambique has no industry specific regulations, the proposed technology will comply with US and EU standards and will specifically be in compliance with United States Environmental Protection Agency Maximum Achievable Control Technology ("MACT") regulations for airborne emissions from aluminium smelters.

The construction and operation of the smelter will be subject to these regulations and there is no reason to believe there will be any difficulty complying.

7.1 Summary of the Estimate

Based upon the stated scope of the project and exclusive of any capital costs associated with high voltage power transmission systems (which are included as part of the power tariff), the estimated total capital cost of the Beira Aluminium Smelter is $1.184 billion, including $95 million of contingency protection.

This estimate excludes interest accrued during construction, first fill costs and any other components of working capital. These costs will vary depending upon financing and operating plans, and though incorporated in the financial model for the enterprise, are excluded from this indication of capital cost.

At nominal production levels, the capital utilization of the project is approximately $3,920 per annual tonne of capacity, which is among the best in recent history. At enhanced production levels, the capitalization cost could be as low as $3,243 per tonne.

These cost are achievable using the Kaiser technology and Fluor Daniel project execution systems. Capital costs are minimized by simplifying facilities and outsourcing non-production services.

The summarized breakdown of the estimate (in thousands of 1999 US dollars) is shown in the following table. Additional detail is provided later in this Section and in the Attachment G of this report.

	BASS Aluminum Reduction Facility Capital Cost Estimate Revision 2.3 (12 November, 1999)	
100000	REDUCTION PLANT	$437,945
200000	ANODE MANUFACTURING	$152,082
300000	METAL PRODUCTS	$6,400
400000	MATERIAL HANDLING AND RECEIVING	$38,992
500000	PLANT POWER AND UTILITIES	$84,858
600000	NON-PROCESS FACILITIES	$20,457
700000	SITE DEVELOPMENT AND FACILITIES	$78,124
800000	OFF-SITE FACILITIES	$4,000
900000	INDIRECT COSTS	$265,956
990000	CONTINGENCY AND ESCALATION	$95,000
	TOTAL FACILITIES	$1,183,814

Figure 37: Summary Capital Estimate

Note that item 990000 does not include escalation.

7.2 Estimate Methodology

7.2.1 Basis of the Estimate

General Basis

This estimate is based upon the facilities descriptions and functional requirements set forth in Kaiser's package of Design Control Specifications ("DCSs") issued for the purpose of defining the implementation of Kaiser K220 technology at a location near Beira. Off-plant infrastructure items, such as wharf facilities, are also included.

The capital costs associated with power transmission systems are not included in this estimate. The estimate for these facilities has been developed in cooperation with EDM and presented in a separate document. Because the ownership and financing plans for power transmission systems are substantially different from the smelting complex, the impact of the capital cost for power transmission is included in the operating cost estimate as a "wheeling" charge added to the power tariff.

Basis for Site Development Estimate

The estimate is based on developing the site adjacent to the Port of Beira and coordinating the development with the harbor dredging program.

Mine Clearing: It is assumed that a level 1 survey for the entire site and surrounding buffer of 250 hectares will be necessary followed by a level 2 survey for 10% of the site.

Relocations: Current observation is that approximately 1,000 occupants will have to be relocated from the property in accordance with World Bank guidelines.

Site Investigation: Full scale environmental, geotechnical and hydrological surveys are required during the next phase of engineering. The cost of these investigations is included in the estimate.

Earthwork and Drainage: Although the land is designated "Industrial," it is only 4 meters above sea level datum and potentially vulnerable to flooding. The land will therefore be raised to 8 meters above datum, which is considered above foreseeable flood level.

The land will be drained by surface ditching and subsurface drainage techniques prior to raising the elevation.

It is anticipated that fill material will be dredged from the harbor channel and placed on site to form the building pad for the smelter. The surrounding buffer area will remain at the current elevation until needed for further development. Subsurface soil improvement and drainage is considered necessary to facilitate settlement.

A combination of open ditches and underground pipe will be required to facilitate storm drainage.

Site Paving: Site paving will be a combination of asphalt and concrete paving blocks. Heavy traffic areas will be heavy duty asphalt paving and lightly loaded areas, such as courtyards and parking, will be concrete paving blocks.

Basis for Buildings

The potroom buildings will be a combination of structural concrete and steel. Concrete foundations and structure up to the crane rail height will support a steelwork canopy and overhead cranes.

All other major buildings will be structural steel with metal cladding. Minor buildings will be blockwork with metal roofing.

All major buildings including the potrooms will be founded on piles. Piles are assumed to be precast concrete, 20 to 30 meters long and driven to refusal.

Buildings will have the services described in the Smelter DCSs.

Basis for Utilities

Compressed Air: A compressed air system including building, compressors, dryers and distribution pipework will be provided to service the potrooms and other buildings requiring compressed air.

Natural Gas: Natural gas will be provided by the gas supplier to the property line. The estimate includes the pressure reduction station and distribution system to the anode bake furnace and other buildings requiring gas.

Industrial Water: A one million gallon elevated tank will be provided to store industrial water and an underground distribution system will supply the cast house and other user points. A water well will be provided as backup to the municipal supply.

Potable Water: A water purification and filtration system will be provided for potable water use. A distribution system will be installed to all buildings.

Fire Water: Pumps and a fire water loop around the plant will be provided for fire protection purposes. Sprinklers will be provided in the main administration building and as required in the smelter DCSs.

LPG: The LPG storage tank(s) will be supplied by an LPG supplier such as Afrox. The estimate includes the distribution system to user points.

Plant Electrical Services: The electrical services requirements are based upon supplier load information and the normal auxiliary power consumption of similar facilities. Cost information for electrical service equipment, from the main switchyard through the low voltage disconnects (400 V, 3 phase) at each of eight planned substations, was provided by equipment suppliers. Allowances and factored takeoffs were used to complete the costs associated with delivery of electrical services to each building.

Basis for Waste Stream Management

Sanitary: A package sanitary treatment plant will be provided to handle the construction labor load and remain to service the operational needs of the plant. The plant will be sized for 90,000 gpd. A combination of pressure and gravity mains will be required to collect waste throughout the smelter.

Solid Waste: A storage building will be provided for the containment of spent cathode lining.

Industrial Wastewater: A lagoon and collection system will be provided for storm water runoff that may contain pollutants from paved areas. There is no industrial wastewater from the process operations.

Basis for Material Handling and Storage

One rail mounted 700 tph vacuum unloader will be required at the quay for unloading coke and aluminium. A 1,000 tph conveyor system will deliver the alumina and coke to silos at the port. There will be one 15,000 tonne concrete coke silo and three 37,500 tonne concrete alumina silos at the port. A fleet of trucks will transfer coke and alumina to the smelter, where one 15,000 tonne concrete silo will store coke and each of 24 GTC day tanks will store alumina. All silos will be founded on large diameter bored piles. Truck and rail loading and unloading stations will be provided at the port facility and the plant.

Basis for Port Renovation

Quay number 8 has been designated for unloading smelter raw materials and will need significant renovation as described by CFM. The bulk of the repairs will entail replacing the piling and concrete decking including support beams.

Basis for Transportation Requirements

Road and rail access from the port to the plant must be provided. Approximately 1200 meters of heavy duty truck road will be required to extend the port tank farm road to the plant.

The railroad must be extended from the adjacent line into the plant to service the Green Mill area and ingot shipping areas.

A one hundred tonne rail scale and a fifty tonne truck scale will be provided for weighing shipped product.

The estimate includes the mobile equipment listed in the smelter DCS.

Basis for Offsite Facilities

Housing: A housing facility will be provided for 200 expatriate employees and families complete with living, medical, educational and recreational facilities. This element of project scope is an excellent opportunity for linkage with local Beira enterprises, hence the capital cost of this complex is excluded from the estimate and an allowance for lease payments for housing is added to construction labor costs and operating expense.

Medical: An allowance is included for upgrading the local medical facility. This is primarily for providing laboratory facilities and equipment.

Training: An allowance is included for upgrading existing training facilities, providing equipment, implementing construction training systems and providing instructors.

7.2.2 Sources of Information

This estimate is based upon information gathered during the discovery and engineering phases of the study, generally from one of the following sources:

- Supplier Quotations: Proposals and indicated costs from equipment and bulk materials suppliers responding to the functional requirements of the technology and facility.
- Recent Buys: Procurement data from recent purchases of similar or identical goods and equipment.
- Historical Data: Regional historical construction costs and procurement data, trended to estimate current costs in Mozambique.

- Detailed Estimation: Calculated costs based upon engineered definition of site and facilities, built up from the detailed level and summarized for specific facilities.

- Factored Takeoffs: Transfer of trend information based upon detailed estimates of other facilities for this specific project.

- Allowances and Other: Recognized scope substantiated with reasonable and typical costs as generally experienced in the industry.

The specific percentage breakdown of the estimate in terms of these information sources is shown in the following diagram.

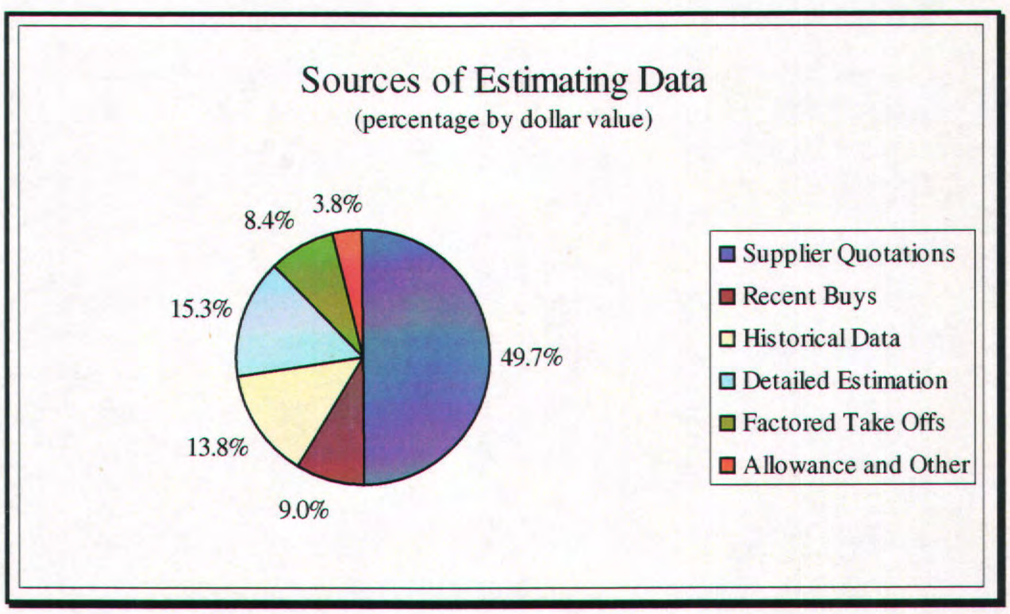


Figure 38: Sources of Estimating Data

7.2.3 Contingency Accounts

In order to provide a level of protection for the accuracy of the estimate from cost variances associated with scope and/or rate changes, each of the major categories of scope were analyzed with respect to cost risk. The analysis quantifies each element of risk and applies a "Monte Carlo" statistical technique to determine the range of probable outcomes for the entire project. This approach allows the quantification of appropriate contingency funds at a specified level of statistical confidence to protect the target estimate from overrun.

For the purposes of this study, contingency protection at 85% confidence level was selected, resulting in a total contingency account of $95 million, or 8% of Total Installed Cost. The forecasted distribution of risk (and contingency protection) by plant area is shown in the following diagram. The percentage allocation is applied to the total contingency dollar value. This percentage is determined by a combination of the overall dollar value of the line item and the specific uncertainty associated with the line item.

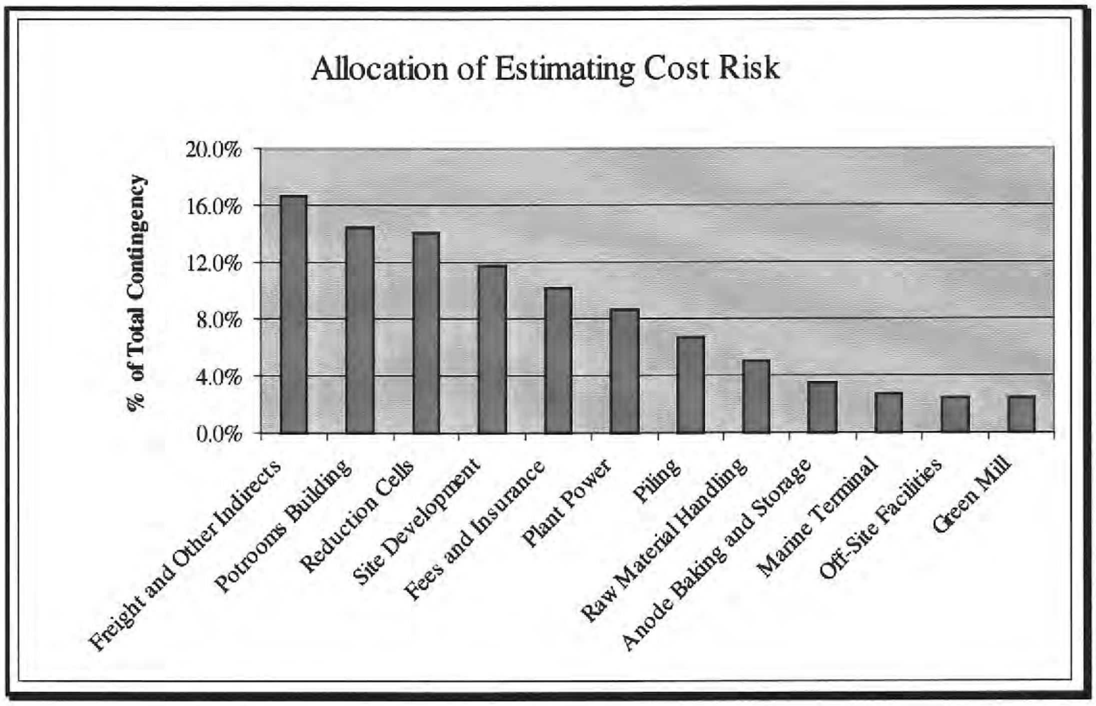


Figure 39: Allocation of Contingency

Based upon the results of the cost estimate risk analysis, the project is predicted not to exceed the target price of $1.089 billion by more than $95 million, with 85% level of confidence. If the confidence level is changed to a higher value, the required contingency will also increase. For example, the highest confidence levels indicate a required contingency of 18% of project value, or almost $200 million. The "Range Estimate" analysis in Attachment H provides additional information about contingency.

At this stage of the development of the project, the largest contributors to cost uncertainty are:

- Supply logistics, sources of origin and freight
- Site geotechnical status and required site improvements
- Skilled labor availability and workforce health maintenance
- Infrastructure support and available utilities.

These uncertainties are reflected in the cost estimate of scope as indicated in the percentage allocations shown in the graph. The next phase of project development should provide additional focus in these areas to improve the overall accuracy of the capital estimate, which at this stage of development is considered no better than plus or minus 15%.

7.3 Analysis and Comparisons

7.3.1 Estimation of Capital Cost

The methodology described in Section 7.2 of this report was applied to the scope of the project as defined in Kaiser's series of DCSs with the results shown in the following table.

BASS Aluminum Reduction Facility
Capital Cost Estimate
Revision 2.3 (12 November, 1999)

100000	**REDUCTION PLANT**		**$437,945,490**
110000	POTROOM BUILDINGS	$58,692,713	
120000	REDUCTION PROCESS SYSTEM		
121000	CATHODE SYSTEMS	$81,093,456	
122000	CONDUCTORS (POT TO POT)	$77,665,073	
123000	SUPERSTRUCTURE SYSTEMS	$104,041,620	
124000	POT CONTROL AND ELECTRICAL EQUIPMENT	$6,178,000	
130000	POTLINE PROCESS SUPPORT EQUIPMENT		
131000	OVERHEAD CRANE SYSTEMS	$38,966,117	
132000	ANODE TRANSPORTATION SYSTEMS	$2,411,000	
133000	MOLTEN MATERIALS TRANSPORTATION SYSTEMS	$3,800,000	
134000	SOLID MATERIALS DISTRIBUTION EQUIPMENT	$1,600,000	
135000	GENERAL UTILITY VEHICLES	$87,000	
136000	SPECIALTY EQUIPMENT	$1,760,067	
137000	POT EXCHANGE EQUIPMENT	$1,605,167	
138000	PROCESS MONITORING EQUIPMENT	$1,200,000	
139000	OTHER SUPPORT EQUIPMENT AND TOOLS	$300,000	
140000	POTLINE ALUMINA AND GAS TREATMENT	$50,000,000	
170000	POTLINE SUPPORT SYSTEMS		
171000	POT RELINING FACILITY	$4,241,641	
172000	CRUCIBLE CLEANING FACILITY	$4,048,238	
174000	POTROOM GENERAL SERVICES SHOP	$255,400	
200000	**ANODE MANUFACTURING**		**$152,081,696**
210000	GREEN MILL	$42,278,020	
220000	ANODE BLOCK HANDLING AND STORAGE	$4,653,088	
230000	ANODE BAKING OPERATIONS	$71,798,100	
240000	ANODE RODDING OPERATION	$32,599,401	
250000	ANODE ASSEMBLY STORAGE	$753,088	
300000	**METAL PRODUCTS**		**$6,399,719**
310000	METAL PRODUCTS BUILDING	$3,756,394	
340000	CASTING BAY SYSTEMS AND EQUIPMENT	$2,154,125	
370000	METAL PRODUCTS MOBILE EQUIPMENT	$489,200	

400000	**MATERIAL HANDLING AND RECEIVING**		**$38,992,486**
410000	MARINE TERMINAL FACILITIES	$15,856,638	
430000	RAW MATERIAL STORAGE AND HANDLING	$23,135,848	
500000	**PLANT POWER AND UTILITIES**		**$84,858,064**
510000	MAIN ELECTRICAL SUBSTATION AND SWITCHYARD	$21,000,000	
520000	PRIMARY PROCESS POWER STATION	$38,275,000	
530000	PLANT POWER DISTRIBUTION SYSTEM	$10,452,000	
540000	PLANT UTILITY SYSTEMS	$11,935,105	
550000	PLANT FIRE PROTECTION SYSTEM	$1,370,619	
560000	PLANT ENVIRONMENTAL SYSTEMS	$1,825,340	
600000	**NON-PROCESS FACILITIES**		**$20,457,297**
610000	MAINTENANCE AND ENGINEERING OPERATIONS	$10,608,310	
620000	ADMINISTRATION AND GENERAL SUPPORT FACILITIES	$9,050,176	
630000	ON-SITE EMPLOYEE FACILITIES	$798,811	
700000	**SITE DEVELOPMENT AND FACILITIES**		**$78,123,765**
710000	SITE DEVELOPMENT	$38,380,165	
720000	PILING AND SOIL IMPROVEMENT	$39,743,600	
800000	**OFF-SITE FACILITIES**		**$4,000,000**
810000	EXPATRIATE LIVING COMPLEX	$2,500,000	
820000	BEIRA MEDICAL FACILITY	$500,000	
830000	BEIRA EDUCATIONAL FACILITY	$500,000	
840000	CITY ROADS AND TRANSPORTATION INFRASTRUCTURE	$500,000	
900000	**INDIRECT COSTS**		**$265,955,840**
910000	EPCM SERVICES	$129,720,000	
930000	INSURANCE	$10,000,000	
940000	FREIGHT, DUTY, FEES	$74,000,000	
950000	OWNERS COSTS	$12,000,000	
970000	FINANCING COST	$15,000,000	
980000	CONSTRUCTION INDIRECTS	$25,235,840	
990000	**CONTINGENCY AND ESCALATION**		**$95,000,000**
992000	EVALUATED CONTINGENCY	$95,000,000	
	TOTAL FACILITIES		**$1,183,814,358**
	TOTAL DIRECT COSTS	$822,858,518	
	TOTAL INDIRECT COSTS	$265,955,840	
	TOTAL CONTINGENCY AND ESCALATION	$95,000,000	

Notes

Estimated in US Dollars as valued in September, 1999

This estimate is based upon the following sources of information:

- Budgetary proposals from equipment suppliers
- Costs of recent similar purchases
- Engineering calculations and quantity take offs
- Recent regional unit construction costs.

Table 4: Capital Cost Estimate

7.3.2 Potential Sources of Supply

The most likely geographical source of supply of each of the major line items of the estimate has been identified based upon the probable project execution approach and budgetary proposals received from the pool of possible suppliers.

The geographical categories of Mozambique, Southern Africa (mainly RSA), Europe/Asia and United States were chosen to differentiate the various sources of supply, to estimate the in-country benefit to Mozambique and to support financial planning with respect to Export Credit Agencies.

At this stage of development of the proposed project, the indications of this analysis should be considered preliminary. While the trends are reasonable with the data in hand, specific sources of supply will not be determined until much later in the project. On this basis, however, the following charts illustrate our best estimate of the geographical distribution of the sources of supply.

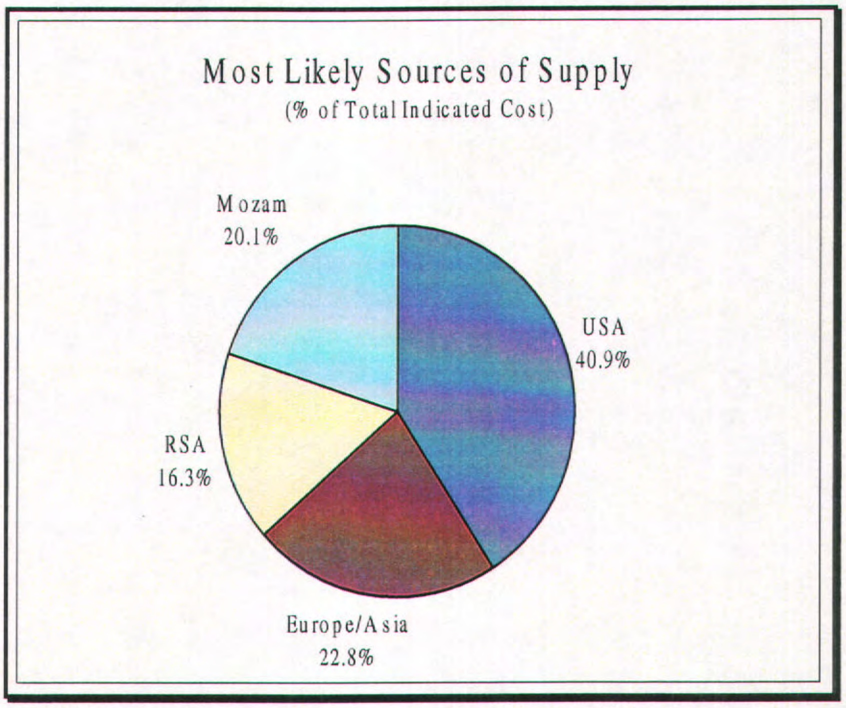


Figure 40: Potential Sources of Supply

7.3.2 Comparison with Other Recent Projects

Though there are many factors determining the overall viability of this project, its capital efficiency (i.e., dollars per annual tonne of capacity) is a good indicator of competitive position. Projects with high capital efficiency are better able to sustain operations during difficult markets and provide an overall higher rate of return throughout their life cycle.

The following graphic shows the relative position of the Beira Aluminium Smelter with other recent projects and studies. The data is based upon publicly available information and is expressed in 1999 US dollars.

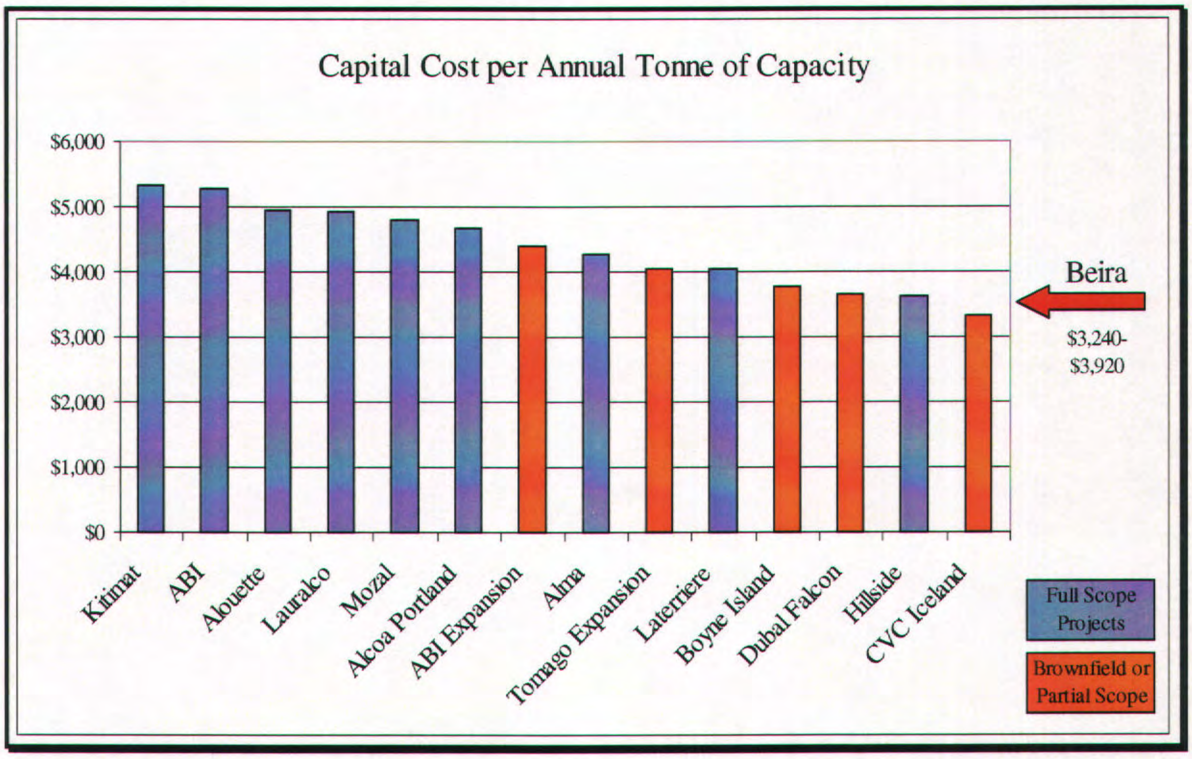


Figure 41: Comparative Capital Efficiency

In the case of the Beira Aluminium Smelter operating at nominal conditions, the capital efficiency is approximately $3,920 per tonne. Potentially, the capital efficiency could be as low as $3,243 per tonne if maximum production is realized. This compares favorably with the recent average cost of new capacity of approximately $4,600 per tonne. Under similar financing plans, the Beira project's minimum difference of $710 per tonne of annual capacity would result in a $26 million per year cash flow advantage during the first seven years of the project.

8.1 Basis of the Operating Cost Estimate

The estimate of operating cost is conservatively made on the basis of "Base Case" technical operation at 180 kA.

The estimate for operating cost is based upon the predicted raw material usage from the Material Flow Diagram in Attachment A, staffing levels in Attachment J and unit costs in Attachment I. This information is a composite of data provided by Kaiser, collected from Mozambique and correlated with current industry databases. The source of each element of the calculation is noted in the table titled "Unit Cost Basis" in Attachment I.

The cost of materials and supplies required for the maintenance of the plant is based upon best practices and industry benchmarks, then compared and adjusted using current Kaiser operating information from their Valco facility in Ghana.

The major elements of operating cost are alumina, power, carbon, and the cost of labor, described as follows:

- Alumina requirements are typically contracted at a price tied to the current price of aluminium ingot as traded on the London Metal Exchange ("LME"). This analysis assumes a specific LME price and a specific percentage factor for calculating the cost of alumina. For the purposes of this analysis, LME price is assumed to be $1,565 per tonne and the cost of alumina is 12.5% of LME, plus freight.

- Several possible suppliers of electrical power for the project have indicated their willingness to negotiate competitive power tariffs for this project; however, at this writing, no definitive agreement has been reached for power tariffs. For the purpose of this analysis, the current power tariff from HCB to Zimbabwe of $0.010 per kilowatt-hour will be used. A power transmission (or wheeling) charge of $0.003 per kilowatt-hour is added to this tariff in lieu of $180 million capital expense to upgrade existing power transmission lines (as discussed in Section 2 of this report). Hence, the all-up cost of electrical power delivered to the plant's main switchyard is assumed to be $0.013 per kilowatt-hour for the duration of the project life.

- Carbon cost is based upon predicted technical consumption of petroleum coke and coal tar pitch and current international contract pricing for these materials, plus transportation costs.

- The cost of labor is divided into the three categories of US expatriates, Ghanaian expatriates and local Mozambicans as described in the Staffing Plan in Attachment J. All expatriate labor costs include housing and subsistence costs. The mix of staff will progress from the high percentage of expatriates needed for start-up and training, to mainly Mozambique nationals as the plant and its operations organization matures. For the purposes of this analysis, no reduction in overall labor cost is anticipated from this migration to mostly Mozambican management and labor. It is assumed (as was experienced by Kaiser in Ghana) that the general increase in wages and standard of living will offset any reduction in expatriate subsistence costs. Hence, subject to escalation factors described elsewhere in this report, labor cost is constant for the life of the project.

8.2 Estimate of Operating Cost

The following table summarizes the estimated operating cost per metric tonne of aluminium for the Base Case scenario. The estimate is based upon the assumptions in Section 8.1 and Attachments I and J.

Cost Element per tonne of Al	$/tonne	M$/year
Alumina	$408	$123.1
Energy	$186	$56.0
Carbon	$108	$32.4
Spares and Consumables	$44	$13.2
Electrolyte Chemicals	$8	$2.4
Cell Relining	$15	$4.4
Labor	$52	$15.6
Total Base Case Operating Cost	**$820**	**$247.2**

Table 5: Summary of Operating Costs

Because of the variable pricing technique for alumina, unit operating costs change significantly, but predictably, with the LME price of aluminium ingot. Additional information on the changes in operating costs over a range of LME prices is shown in the Financial Analysis section of this report.

8.3 Possible Variations in Operating Cost

These Base Case operating costs are predicted under the reasonable assumption of a well-managed operation. It should be noted however, that variances in management or commercial practices can impact operating cost and hence the overall viability of the project. The sources and significance of possible variations from Base Case operating assumptions are described in the balance of this Section of the report.

The most significant components of operating costs are alumina, power, carbon materials and labor, in this order. The degree of contribution of each of the components is shown in the figure below.

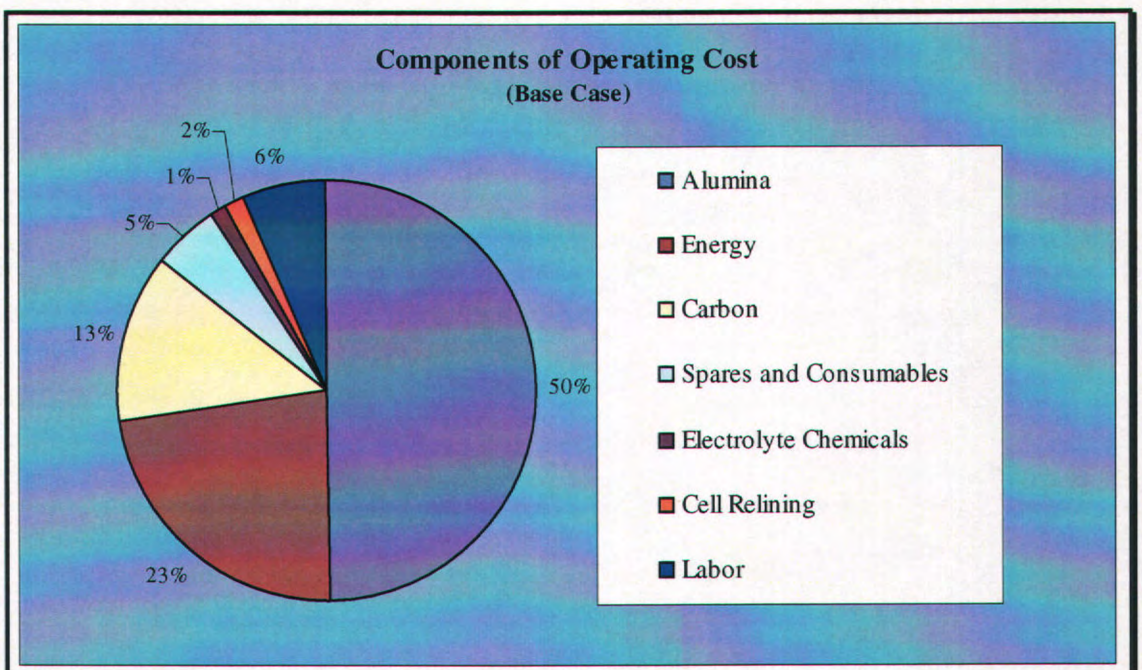


Figure 42: Base Case Components of Operating Cost

While carbon cost and consumption are relatively steady from project to project, the other major factors can vary across a range of values. As examples:

- Negotiated terms of alumina supply contracts are dependent on market conditions at the time. If world alumina supplies are tight, as is the case at this writing, a higher price (as a percentage of the LME) is generally realized. Conversely, if alumina is in oversupply, alumina is generally less expensive. For the Base Case, the price as supplied by Kaiser is equivalent to recent projects, but variance from this case should be anticipated and considered when evaluating this project.

- Power rates are subject to change from time to time, either as a result of supply and demand or through regulatory means. Sometimes, the cost of electricity is linked to the current price for aluminium ingot, though this is not the case for this analysis. The Base Case is built upon the assumption of a fixed long term power rate at the indicated level, but these terms are subject to negotiation and change.

- Labor productivity can vary between plants and over time. While wage structure is reasonably predictable, the total staffing requirements (headcount) can change from the planned levels of the Base Case. Initially, the level of productivity of local labor does not overly influence total production cost; however, as the plant organization becomes more seasoned and begins to operate as an independent world-class operation, labor productivity is an important cost factor.

8.4 Sensitivity of Operating Cost to Key Variables

The sensitivity of operating cost with respect to the three factors discussed in Section 8.3 is illustrated in the following three figures. Other than the factor under consideration, all other baseline assumptions are assumed to be constant at their Base Case value. Data tables for these charts are included in Attachment L.

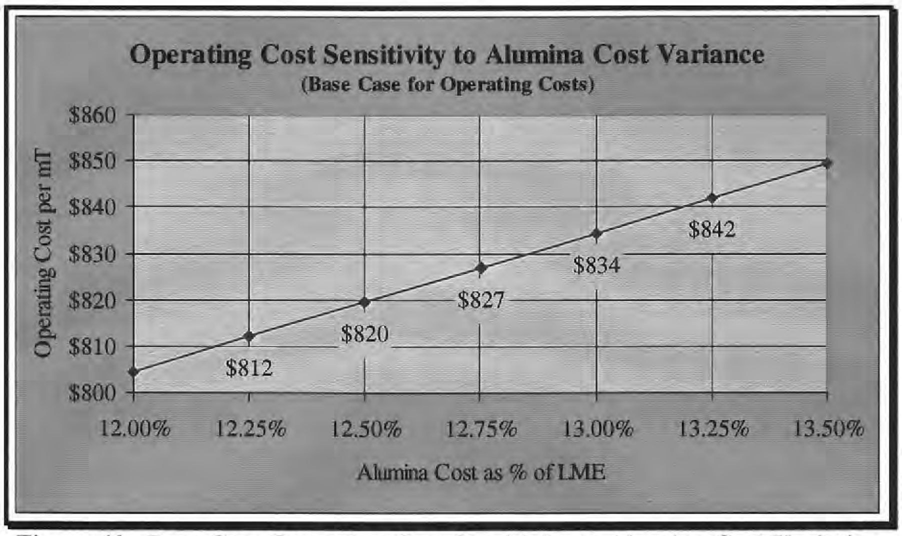


Figure 43: Base Case Operating Cost Sensitivity to Alumina Cost Variation

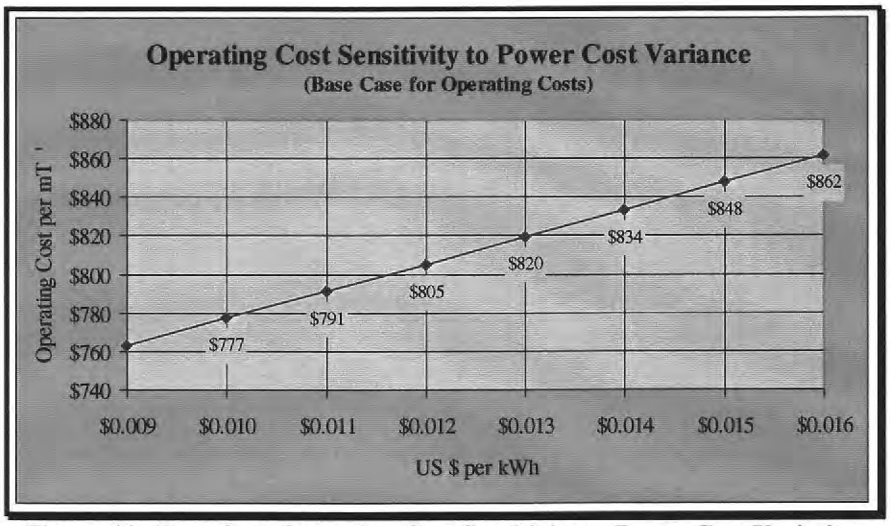


Figure 44: Base Case Operating Cost Sensitivity to Power Cost Variation

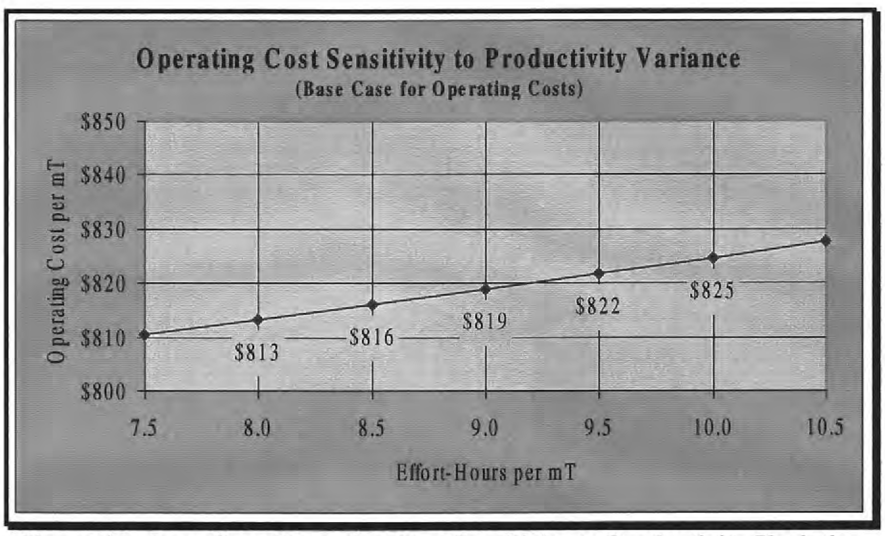


Figure 45: Base Case Operating Cost Sensitivity to Productivity Variation

The variability shown in these three figures should be considered when evaluating the overall impact of changes in assumptions for operating cost.

9.1 Mozambique Implementation Requirements and Constraints

The successful implementation of the project will require the recognition of the special conditions of constructing and operating the smelter in Mozambique and coordination with the development of the local infrastructure.

9.1.1 Coordination with Infrastructure Upgrades

Port Facilities

The port facilities are critical to the construction and operation of the smelter. The current situation at the port of Beira and the necessary upgrades required for the smelter, are described in Section 4.

Very little needs to be done to the port for importation of construction materials. Moderate reconstruction of quay number eight will need to be completed prior to startup of the smelter. This work could be achieved within a twelve months timeframe.

The most urgent upgrade is the dredging of the harbor entrance channel and this needs to be coordinated with the raising of land elevation in the designated industrial area north of the port. The most desirable smelter site is in this area and will require at least 2 million cubic meters of fill. The most logical source of fill is the material to be dredged from the harbor channel.

It is understood that the Dutch Government has committed to dredge the channel, but may be unaware of the value of the dredged material and may plan to dump this material at sea. Discussions should be initiated between the Dutch Government, CFM and the Municipality of Beira to ensure that constructive use of the dredged material is made by placing it on land to facilitate future industrial development. Any such raising of land will need to be performed well ahead of construction to allow for drainage and settlement.

General Infrastructure

The current status and impact of the smelter on the Beira area infrastructure is described in Section 12.1

Major concerns are the water supply and health facilities. It is understood that the Government of Mozambique is soliciting proposals to perform a study of the Pungue River Basin and intends to award a contract for the operation of the water supply by a qualified private sector operator.

Water supply for the smelter construction and the expatriate housing complex should be coordinated with the above mentioned study and considered in the calculations for future water demand. Potable water must be available for both the housing complex and smelter prior to start of construction.

Likewise, the healthcare facilities must be upgraded with the provision of a well-equipped laboratory prior to the start of construction. Staffed clinics at the smelter site and housing complex should be coordinated with the local medical authority but will likely operate independently.

Housing is considered to exist in Beira for local construction workers. However, should demand exceed supply local businesses have expressed interest in providing additional housing as a private enterprise. The expatriate housing complex should be coordinated with the local businesses that have investigated and expressed interest in financing, building and operating the complex.

Although a new Municipal sewage treatment plant is shown on the proposed Beira development plan it is unlikely that a sewage treatment plant will be constructed and operational in the next few years. Nonetheless, the smelter and housing complex requirements should be coordinated with the planning process for a Municipal sewage treatment plant. The capital cost estimate will be based on the smelter providing a package plant to handle it's own needs.

Roads connecting the smelter to the existing network will be constructed as part of the proposed project. General maintenance and upgrading of existing roads will also be required to facilitate acceptable traffic movement throughout the city.

Electrical Power and Communications Infrastructure

A major portion of the smelter investment will be the power supply required for production of aluminium. This must be coordinated with the Government of Mozambique, Hydro Cahora Bassa and Eskom. The parties involved will depend upon the source of power and wheeling rights within Mozambique. Transmission of power to the smelter should be coordinated with government planning for the upgrading of the central region grid currently operated by Electridade de Mozambique. EDM has stated that construction power can be made available to the site but detailed discussions on quantity and timing will be necessary prior to construction.

Telecommunication requirements must be coordinated with Telecomunicacoes De Mozambique and planned upgrades should be sufficient to service the smelter needs.

9.1.2 Special Concerns and Considerations

Of major concern for the execution of the smelter project is the high incidence of malaria and AIDS. AIDS awareness and prevention programs can be implemented to reduce future cases. The influx of people from highly infected areas may exacerbate the situation.

Malaria is a major problem in Mozambique and especially along the coast. The low lying wetlands will make it very difficult to control the malaria carrying mosquitoes. Personal protection and avoidance programs will need to be communicated to the workforce and coordinated with the health authority. Cooperation with the World Health Organization and participation in the Lumbombo Spacial Development Initiative will be required to improve the living and working conditions in the Beira area.

Medical evacuation plans must be in place for expatriates prior to the start of construction. This can be contracted to several firms operating out of Johannesburg, South Africa.

9.1.3 Use of Local Labor and Material Resources

The general philosophy should be to utilize local labor and materials to the maximum extent possible and consistent with meeting the project cost, schedule and quality goals.

At this time there is adequate trainable labor in the Beira area that can be trained to meet the construction and operations needs. As discussed in Section 12, the area has adequate training facilities if upgraded to meet the training demands of the smelter. Training should be coordinated with the existing institutes who will require specialized programs, instructors and additional equipment. Preliminary discussions have taken place with these institutions and all are keen to participate in the project.

A project labor agreement must be negotiated with the national labor unions and the Government Liaison Committee will facilitate this process. The Mozal agreement will probably used as the model.

Local materials suitable for construction are very limited in the Beira area. Crushed rock is available 80 to 120 kilometers inland and will have to trucked to the site as the railway is not operational. Cement from the factory in Dondo is of uncertain quality but probably suitable for nonstructural use. Sand is available from dredging operations and limited supplies are available on land. A geotechnical survey of the area is needed to identify potential subsurface deposits.

Other construction materials will have to be imported from Zimbabwe or South Africa.

9.1.4 Possible Coordination with Other National Development Projects

There are several significant projects planned for the Beira area and if they were under construction at the same time could exhaust the available labor pool in Beira. However, with the high unemployment in Mozambique and neighboring countries, availability of labor should not be a problem. Importing labor will present housing and cultural problems as well as cost and absenteeism associated with home leave and travel.

The Mozal project could provide experienced labor and an effort will need to be made not to transplant the majority of Mozal construction workers to Beira instead of training local workers. It would be beneficial to leverage off the Mozal experience by utilizing experienced supervisors from that project. There will be many lessons learned from the Mozal project, particularly in dealing with local communities and government interfaces, that will be applicable to the Beira smelter project. The Government Liaison Committee and "Linkage Program" are examples.

Reconstruction of the Sena railway line and other infrastructure projects under study at this time will have an impact on the smelter construction and effect the capital cost of the project.

The Sasol and HBI projects being proposed for Beira should be coordinated with the smelter, although differing requirements may make co-location and other facilities sharing impractical and cost prohibitive. Given the enormity of the construction forces and materials required for these mega projects it is advisable to ensure that local roads and other infrastructure do not become overloaded and choked. Labor availability should not be a problem but housing, water supply, sewage treatment, transportation and health facilities for the influx of construction workers will become a major concern if several of these projects were to be under construction at the same time.

9.2 Project Management Methodology

The following management and execution sections deal with the general requirements for executing the project and are not meant to describe any particular definitive methods for doing so.

The key to successful project execution is to integrate the engineering, procurement, construction and startup processes. The following principles must be driven through all phases of the project execution to achieve excellence in project execution.

Scope Definition and Control	Safety
Continuous Performance Improvement	Design Effectiveness
Constructability	Prime Contract Relationships
Subcontract Relationships	Effective Project Organization
Construction Technology	Project Controls
Quality Control	Materials Management
Craft Resources and Training	Cost Awareness

Project productivity is directly related to these principles, hence cost, schedule and overall project returns. The following discusses the plans for designing, procuring, constructing and commissioning the proposed facility as formulated in consideration of the above principles

9.2.1 Project Execution Philosophy

Engineering, Procurement and Construction Management activities should be structured by major work package as shown below. The specific approach for execution varies from package to package to establish the most effective commercial and technical structure.

Work Package	Engineering	Implementation
Civil works	Design	Construction by site civil contractor
Steel work & cladding		
Potrooms	Design	Fabricate & erect (potential pre-engineered building)
Simple buildings	Specify	Pre-engineered type
Administrative offices	Specify	Turnkey
Laboratory	Specify	Turnkey
Environmental	Specify	Turnkey
Potroom equipment	Design	Purchase individual components
Bus system		Assemble & install by Potroom mechanical contractor
Superstructures		Fabricate sub-assemblies off site & install by contractor
Pot shells		Fabricate on site & install by contractor
Compressed air		Fabricate piping on site & install by contractor
Pot lining		Buy refractories & install by contractor
Control rooms		Fabricate off site & erect by contractor
Pot controls	Performance spec.	Turnkey
Pot Tending Machines	Specify	Turnkey
Fume Treatment Plant	Specify	Turnkey
Rodding room		
Foundations	Design	Construction by site civil contractor
Building	Design	Fabricate & erect (potential pre-engineered building)
Equipment	Specify	Turnkey
Green mill		
Foundations	Design	Construction by site civil contractor
Building & equipment	Specify	Turnkey
Baking furnace		
Civil works	Design	Construction by site civil contractor
Building	Design	Fabricate & erect (potential pre-engineered building)
Refractories	Design	Several suppliers & installation contractor
Firing system	Performance spec.	Turnkey
Conveying system	Specify	Turnkey
FTA	Specify	Turnkey
Casting shop		
Foundations	Design	Construction by site civil contractor
Building	Design	Fabricate & erect (potential pre-engineered building)
Casting equipment	Specify	Turnkey
Utilities	Design	Supply key items & install by contractor
HV Electrical Systems	Specify	Turnkey – switchyard & rectifiers separately or combined
LV Electrical Systems	Design	Supply key items & install by contractor
Yard utilities & security	Design	Supply key items & install by contractor
Alumina handling	Specify	Turnkey – separate packages for unloading, silos and other
Coke silos	Design	Construction by specialized contractor

Table 6: EPCM Approacb for Major Work Packages

The basic execution philosophy must incorporate the principles of utilizing local labor and Mozambican contractors to the greatest extent possible. For this not to jeopardize schedule and quality a strong overall Engineering, Procurement and Construction Management contractor should be appointed to manage the entire project.

While it is recognized that very little construction materials are available in Beira maximum use of on-site fabrication should be considered consistent with the skills of local trained craftsmen.

The EPCM contractor should perform central purchasing and possibly bulk materials purchasing for Mozambican contractors as well. Goals should be established early for Mozambican participation in the construction and material supply. The government's "Linkage Program" established for the Mozal project could be used as the model.

Procurement of equipment and materials should be on a worldwide basis with US suppliers given an equal opportunity to participate in the project.

Due to the capital intensity of the project the construction schedule will be critical to the financial viability. Therefore the EPCM contractor will need to provide "hands on" supervision and direction of the construction contractors. This will include recruitment and training of the construction workforce.

9.2.2 Project Management Structure

The basic management structure recommended is shown below. The project shareholders would create a Board of Directors with a Managing Director reporting directly to the board on all aspects of the project.

An important aspect of the management structure will be setting up of a Government Liaison Committee to work with the project on all government interfaces. The GLC will facilitate the expeditious response of government agencies to project requirements such as permitting, customs clearance and labor relations.

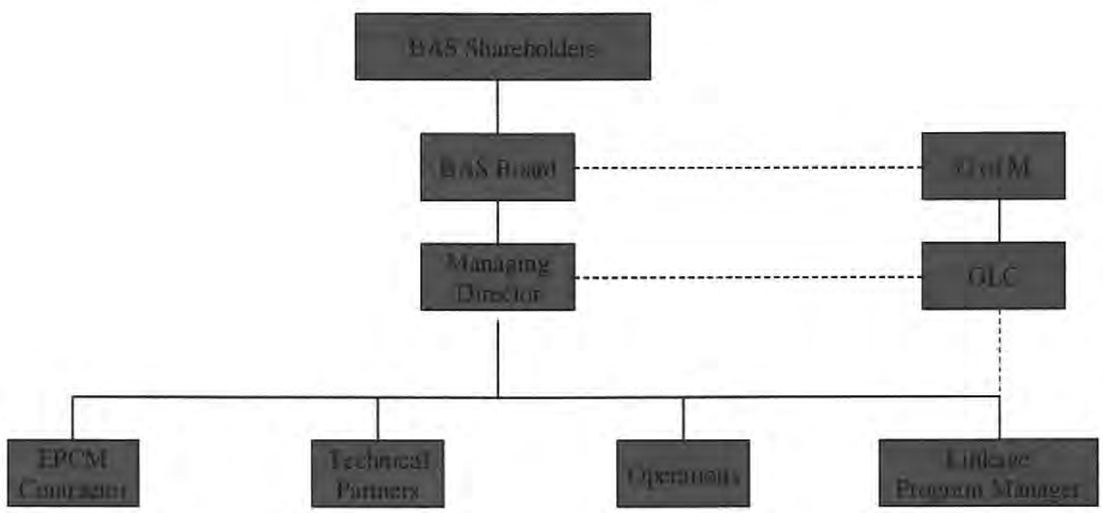


Figure 46: Project Management Structure

Project participation by Mozambican contractors and suppliers will need to be nurtured and monitored through the "Linkage Program" established by the government for other large projects in Mozambique. A Linkage Program Manager will be an important role in the project management structure, supporting the EPCM in meeting participation goals.

The EPCM contractor will be responsible for all engineering, procurement and construction matters and should be organized on the site by area. Each area should have it's own dedicated management and supervision covering all disciplines. Functional management will also be required to ensure continuity and efficient use of labor, materials and equipment.

Technology Partners reporting directly to the Managing Director will be required to supply the smelter technology to the EPCM contractor during the design phase, to assist in startup and participate in the operation of the smelter.

Smelter operations personnel under the direction of the plant manager will work closely with the EPCM contractor for startup of the plant. It is anticipated that the plant manager will be responsible to the Managing Director.

9.2.3 Project Safety Considerations

Safety is a major concern on any construction project and will require basic training and "round the clock" enforcement on this project to overcome the lack of experience and cultural differences. A strong safety program starting with the safe use of basic hand tools to operation of heavy equipment will be required.

The site management will need to include extensive safety training and enforcement and a safety awareness program in English, Portuguese and the local language. A Safety Director reporting directly to the overall Project Director should be appointed to provide the level of importance that safety must have on this project.

We do not recommend any compromise of the highest standards for worker safety. Western standards such as OSHA must be applied with the same regard to human life as in any developed country. To meet this, safety equipment and appropriate work clothes will have to be supplied to the local workforce. This will probably include shoes and overalls as well as the normal safety equipment of hard hats, glasses and harnesses.

The safety performance of all contractors must be examined and taken into consideration when qualifying potential bidders for work on the site. The safety record in developing countries and construction safety programs should be a major consideration in selecting the EPCM contractor for the smelter.

9.2.4 Project Controls

Systems must be set up to control documentation, costs, schedule, quality and safety. These systems must support reporting to the project owners and government agencies as well as support the management of the project. As with all well managed projects, change control will be essential and must facilitate change from any participant that impacts either cost or schedule. This will require the integration of change control culture with modern computer tracking and reporting systems.

Due to the size and complexity of the project these systems must integrate all aspects of design, procurement and construction. This must be accomplished at the macro level down to day-to-day execution. Small local contractors will need assistance in setting up control systems and will have to be integrated into the overall project, particularly to maintain schedule.

Due to the size of capital expenditure and anticipated complexity of investment arrangements, schedule and cash flow control will be critical. The cost and accounting systems will also have to address the taxation agreements and other government incentives.

All control systems must be computerized and capable of feeding the owner's SAP program and complying with World Bank standards.

9.3 Training and Orientation Programs

There are limited skills available in Mozambique and the industrial base is low. In the region of 5,500 people will require training in basic skills and a safety induction program. Of these about 60% will be in civil/structural skills and 40% will be in mechanical/electrical skills. This will take between 5 and 20 days per person and cost between $6 and $7 million.

The first step will be to identify all the skills required for both the construction and the operation of the plant. The objective then will be to train the local instructors in Beira, so that the local institutions are able to provide the smelter with the skills it needs. This will not only be technical skills but also supervisory and management.

9.3.1 Expatriate Orientation

The relatively large number of expatriate personnel during construction, startup and operations will have a significant impact on the local community and it will be essential to ensure that this impact is positive. Similarly, the success of the construction and operations will depend to a large extent on the working relationship between expatriates and the local workforce. Orientation programs with continuing reinforcement will enhance these relationships.

Expatriates will need orientation in the following areas:

- Mozambique culture and customs
- Community relations
- Working conditions
- Living conditions
- Health
- Safety and security
- Language
- National and local government
- Mozambique law and import regulations
- Project execution and operating philosophies
- Industrial relations

All management personnel should undergo basic orientation prior to assignment to the site. More “hands on” and detailed programs designed to suit the Beira environment should be set up in Beira and mandatory for all expatriate personnel.

9.3.2 Local Construction Labor

The local labor force will require extensive skills and safety training and the EPCM contractor is expected to establish and implement this training.

Skills training should be provided in cooperation with the local training institutes as described in Section 12.

Specific training for each craft such as the US Labor Department's "Wheels of Learning" should be introduced into the local training schools. Instructors with actual construction experience will be needed to augment the existing trainers available. "On the job" training will be necessary to transition from the classroom to the work environment.

Training Needs

The following steps should be followed in determining the training requirements:

- Identify training needs taking manpower requirements, starting dates and skill sets into consideration.
- Set minimum entry requirements such as educational levels, psychometric testing, evaluation and selection.
- Establish skill requirements according to the categories and levels identified.

- Through a skill assessment, establish the level of available skills and balance this against the plant's requirements to determine the number of people requiring training.
- Establish employment opportunities.
- Set a career path for each trainee so that he or she can identify with the training and eventually reach artisan or supervisory status.
- Confirm the project start-up dates and required category and level figures.

The training program must have a bona fide certification system capable of tracking certified craftsmen throughout the construction industry in Mozambique.

It is anticipated that the operations and maintenance personnel will graduate from the ranks of the construction force and therefore progressive training programs will be required to achieve this goal.

Extensive safety training and orientation of all construction workers will be provided prior to entering the work site. The skills training must incorporate the safe use of tools and equipment. Safety orientation can be achieved through video tapes and pre work assignment briefings. However, due to the anticipated "step change" in safety practice for most of the workforce, on the job continual reinforcement will be required. A "buddy system" whereby every worker looks out for his buddy's safety should be implemented to enhance the safety program.

Safety training manuals and handbooks will need to be in the local language as well as the official project language of English or Portuguese. Simple cartoon-like graphics will be effective in communicating safety training.

Skills Required During Construction

The list below gives an idea of the variation in training that will be required. Along with most of these skilled people will be the necessary compliment of semi-skilled and laborer categories.

Civil:	Scaffold Erectors	Batch plant operators
	Bricklayers	Excavator operators
	Plasterers	Crane operators
	Painters	Grader operators
	Carpenters	Roller operators
	Insulation erectors	Truck drivers
	Fencing erectors	Concrete finishers
	Steel erectors	Formwork erectors
	Reinforcing fixers	Pavers
Mechanical:	Welders	Fitters
	Boiler makers	Millwrights
	Riggers	Pipe fitters
	Machinists	Steel bender
Electrical:	Electricians	Instrument fitters
	Cable pullers	Cable tray erectors
	Programmers	Equipment erectors

9.3.3 Local Production Labor

As stated above it is expected that the operations and maintenance personnel will come from the construction workforce. Potential workers needed for operating and maintaining the smelter will require initial training and orientation in a similar operating facility.

Experienced expatriate personnel will be required to startup the plant and to train local workers to run the smelter. A transition from expatriates to local workers for smelter operations will be systematic and gradual over several years with “on the job” training provided by the expatriate staff.

9.4 Engineering

Engineering for the smelter will likely be a multinational effort with the emphasis on simplicity. Basic engineering will likely be performed in several locations outside Mozambique. Turnkey systems are likely to be designed at the successful bidder's home location by engineers experienced with that particular system. There will be some opportunity for local Mozambique firms to participate in the front-end studies, particularly in-country data gathering.

9.4.1 Pre-engineering Activities

Prior to engineering, a detailed site selection study must be performed based on extensive field investigation not covered in this report. These studies will include a detailed environmental survey, a geotechnical profile based on actual borings and a hydrological survey of the proposed sites. Other sites may also become available as the Beira area development plan proceeds.

An Environmental Impact Assessment must be performed in accordance with the terms of reference to be approved by the Ministry for the Co-ordination of Environmental Affairs ("MICOA") of the Mozambique government. The Terms of Reference guidelines are currently under development by MICOA, who is the review authority for the EIA and subsequent issuer of the environmental license.

A detailed geotechnical investigation of the selected site based on the approved site layout and anticipated equipment and building loads will be required. This investigation must address foundation types, settlement, design parameters, sources of fill and bedding materials and site preparation recommendations.

9.4.2 Design Philosophy

The design philosophy must be to simplify construction, installation and operations as much as possible. Design of the facilities will need to be in greater detail than for similar work in developed countries to enable local participation and ensure quality.

Instead of the usual "supply and install" philosophy for process equipment, "supply and installation design" will be more appropriate as few, if any, suppliers will have installation experience in Mozambique. Where the integrity of the system dictates a "design, supply and install" approach local participation through subcontracting and supplier installation supervision should be encouraged.

9.4.3 Process Design

The Process Technology Supplier will provide Design Control Specifications for all systems that will form the basis for detail design of the facility. Design of all process related systems and equipment bid specifications should be reviewed by the Process Technology Supplier prior to issuing for construction or purchasing.

The Process Technology Supplier must be integrated into the design, construction and startup of the smelter.

9.4.4 Design Procedures

US or European design standards should be used for all design. It is anticipated that basic engineering will be executed by an experienced Engineering firm with a strong background in aluminium smelting plants.

Site-wide design guidelines and specifications must be produced to create visual and functional continuity across the site. These site-wide guidelines must ensure sufficient continuity for volume discount purchasing and minimum installation training. An additional benefit will be common spare parts and maintenance procedures.

Pre-engineered buildings will be considered where cost effective compared to custom design steel or concrete structures.

All major design work will be performed using computer-aided systems. Construction drawings must be capable of being electronically transmitted to the construction site. A common CAD system will be specified for the project with English as the common language and metrics as the common measurement system.

9.4.5 Engineering Schedule

The smelter will need to be a "fast track" project with the engineering supporting an aggressive construction schedule. The engineering schedule will be integrated into the overall project schedule such that the impact of any changes in the engineering schedule on other aspects of the project, or visa versa, can be assessed along with the impact on final project completion.

The project definition or "basic engineering" phase could be completed in approximately four months and should result in a definitive estimate. The bulk of the following "detail design" phase should take approximately sixteen months. A detailed design schedule should be developed as part of the basic engineering phase as the scope of the facility is finally defined.

9.5 Procurement

Purchasing and contracting will be key activities in maintaining schedule and controlling costs. A very experienced procurement staff familiar with international procurement will be essential. The core procurement team will likely be located in the corporate offices of the EPCM contractor with minor purchasing performed at the smelter site.

9.5.1 Procurement Strategy

All construction contracts and equipment supply will be competitively bid complying with World Bank standards. A bidder qualification process will be implemented which accounts for the special conditions of working in Mozambique and the need to involve local enterprises where feasible.

Established US suppliers are to be given opportunity to bid major equipment for the smelter in accordance with the project procurement procedures. These procedures are to be set up early to enable international response to an aggressive project schedule.

Although turnkey contracts are anticipated for a number of major systems, consideration of using local labor for installation will be mandatory.

9.5.2 Transportation and Logistics

A strong trafficking effort will be required to ensure the timely delivery of construction materials and process equipment. Most materials and equipment will arrive via the Port of Beira or by road or rail through Zimbabwe. Both the port and rail options are controlled by CFM and their cooperation will be critical.

A traffic organization and procedures will need to be implemented by the EPCM contractor to handle shipping, customs clearance, receiving and storage. Several shipping lines and freight forwarders service Beira at this time (see listing in Section 4).

Temporary warehouses and construction lay down areas will be required at the port and at the site. Non-critical buildings completed early can be used as temporary warehouses and assembly shops until required for their design use.

9.5.3 Inspection and Expediting

An experienced team of inspectors will be required to inspect equipment and materials in fabrication shops around the world prior to shipment to the site. In many instances equipment trials will be conducted prior to equipment being dismantled and shipped to the site. Modularization of systems should be maximized which will require inspection to ensure problem free installation and operation.

Worldwide expediting capability with automated progress tracking will be required to meet the aggressive schedule. Vendor payment terms will need to support early delivery and discourage tardy performance.

9.6 Construction

The project's biggest challenge will be the actual construction of the smelter including associated logistics.

A mega project such as this must be broken down into manageable areas of physical work with overall systems and procedures to meet cost, schedule, quality and safety goals. Physical well being of the construction labor force will be critical to project success. Up time of construction equipment through proper maintenance and operation will be very important due to lack of supporting services in the Beira area.

9.6.1 Construction Philosophy

The recommended construction philosophy is for the EPCM contractor to subcontract all construction through competitive lump sum contracts.

Modern construction technology must be applied to maintain schedule and quality. Labor intensive methods can be used for low skill activities such as paving block laying where such methods maintain quality and schedule and are cost effective.

9.6.2 Construction Methodology

The EPCM contractor will employ an experienced management and supervisory staff on site to coordinate contractors and identify potential problems.

All construction work should be planned and discussed with the responsible EPCM manager prior to commencement of site activities. Particular attention must be given to planning safe work and coordination with other contractors.

Given the large volume of concrete it is anticipated that concrete batch plants will be set up on site for the production of all site concrete. These may be run by the EPCM contractor or sublet to an experienced concrete batch plant operator.

Steel fabrication shops will likely be set up at the site to handle fabrication of building steel, support structures and the pot shells. Some minor fabrication of minor steelwork may be performed off site by local fabricators. Critical and exotic welding will be performed at suitable facilities outside Mozambique for quality reasons.

Should the Port or Savane site be selected, special site preparation methods will be required to prepare the low flood prone land for smelter construction. These methods will include drainage, organic soil removal, foundation improvement and pre-construction settlement.

A large-scale piling program will be required which will be tendered to international contractors capable of providing the numerous piling rigs and experienced in this type of foundation condition. Common piling systems will be used for all structures other than the storage silos, which may require a different system to handle the higher loads.

9.6.3 Construction Schedule

The construction schedule needs to be aggressive and integrated with the engineering and procurement. Site preparation should commence as soon as permitting is complete and can be supported by engineering. "Fast track" methods will be used whereby each construction discipline is closely overlapped by the next as soon as each discipline has progressed enough for the subsequent operations to commence.

Construction sequences and scheduling will be highly weather dependant until the structures are "out of the ground" and buildings can be "weathered in." Heavy rains are experienced from December to April and flooding will need to be controlled as soon as possible.

Once the site is ready for construction it is anticipated that the smelter can be built in about twenty-four months. This is aggressive considering the weather, location and site conditions and will require very detailed planning and expeditious government approvals.

9.7 Commissioning and Start-up

Start-up activities and overall system integration must be carefully planned at the earliest possible point to insure overall coordination and maintain project schedule.

The required smelter commissioning sequence is shown in the following diagram.

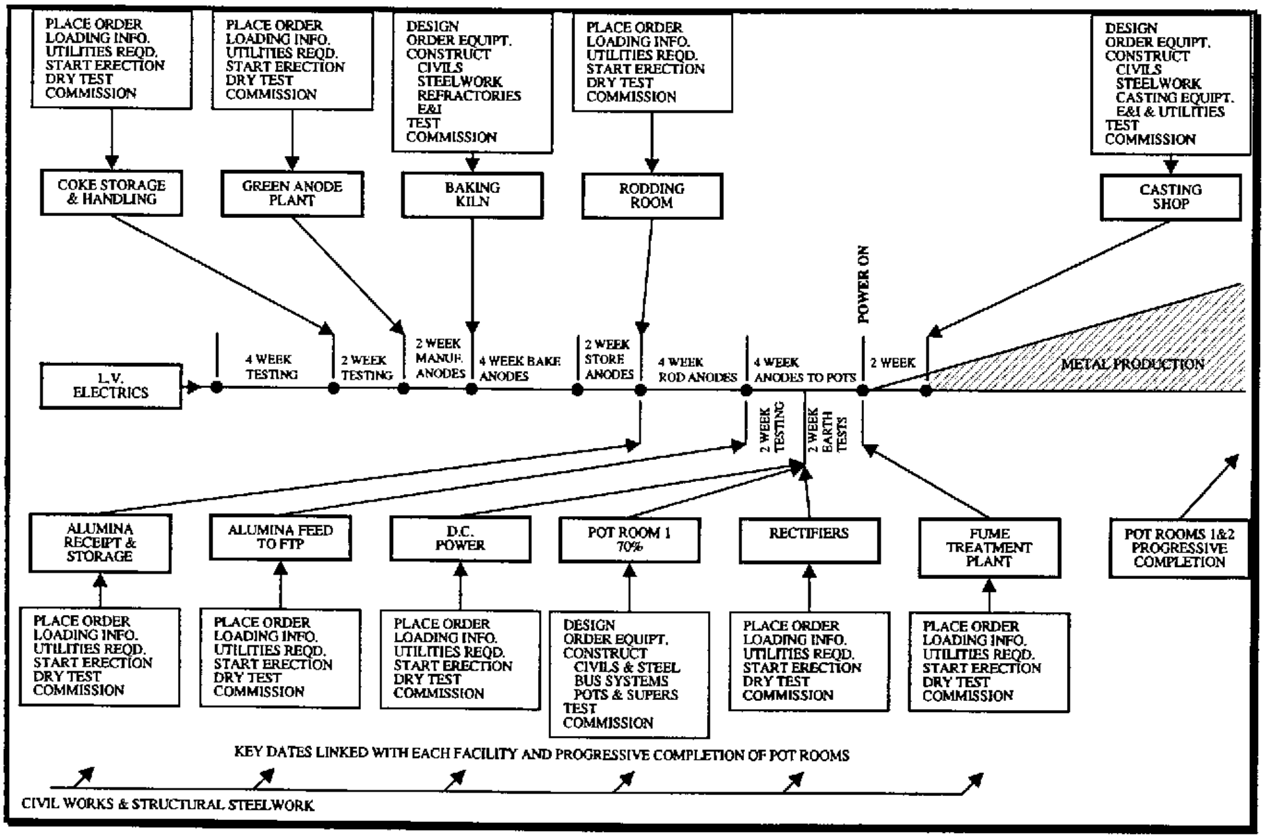


Figure 47: Smelter Commissioning and Start-Up Sequence

All of the project activities that feed this sequence must be coordinated to provide a smooth start-up. Controlled commissioning of individual systems and seamless interaction between suppliers must be programmed in from the start. The successful implementation of this program requires broad-based participation and support from operators, technologists, engineers, procurement agents, equipment suppliers and constructors.

Start-up and cut-in of the reduction cells will begin with a small group of cells in Line 1. These cells will provide an area for training and orientation. After training, the work crews will rotate to other plant areas as the start-up expands. Once a core work force is established, the start-up will proceed in parallel in both lines as shown in the table below. Nominally, the entire start-up will take less than six months.

Start Up Month	End of Month Cell Count		
	Line 1	Line 2	Total Plant
0	0	0	0
1	60	0	60
2	176	12	188
3	291	72	363
4	300	199	499
5	300	300	600
6	300	300	600
7	300	300	600
8	300	300	600
9	300	300	600
10	300	300	600
11	300	300	600
12	300	300	600

Table 7: Cell Start-up Schedule

The sponsorship of commissioning and start-up activities will be established during the initial phases of basic engineering by appointing a Start-Up Manager. This manager and his team of specialists provide start-up focus during all phases of engineering, procurement and construction throughout the life of the project

Commissioning and start-up responsibilities include:

- Coordination of the sequence of events necessary to bring the potlines online smoothly.
- Field compliance testing of systems for warrantee verification.
- Specification, procurement and organization of spare parts complement.
- System orientation of plant maintenance personnel and initiation of plant planned maintenance practices and systems.
- System orientation of plant operations personnel for all plant ancillary equipment. (Orientation and training for carbon, potrooms and casting process systems is a responsibility the plant manager and the technology supplier).

- Consultation and coordination between operations and technology supplier personnel with respect to system functionality.

- Start-up coordination with equipment suppliers.

- Review of engineering, procurement and construction activities throughout the project cycle as they pertain to commissioning and start-up responsibilities.

Successful management of plant start-up activities results in lower project costs, earlier production and a smoother transition to routine plant operations. The project execution plan recognizes that plant start-up is a top priority from the very beginning of the project.

9.8 Project Schedule

The overall timeframe for designing and constructing the project will be approximately 33 months. However preparation of the site for construction may well take 12 to 18 months depending on the results of a detailed geotechnical investigation and the rate at which fill material can be acquired.

First metal is expected 30 months into the schedule and full production at month 36.

The following chart shows the overall project schedule assuming that the site preparation will proceed simultaneously with the funding arrangements and pre-engineering work.

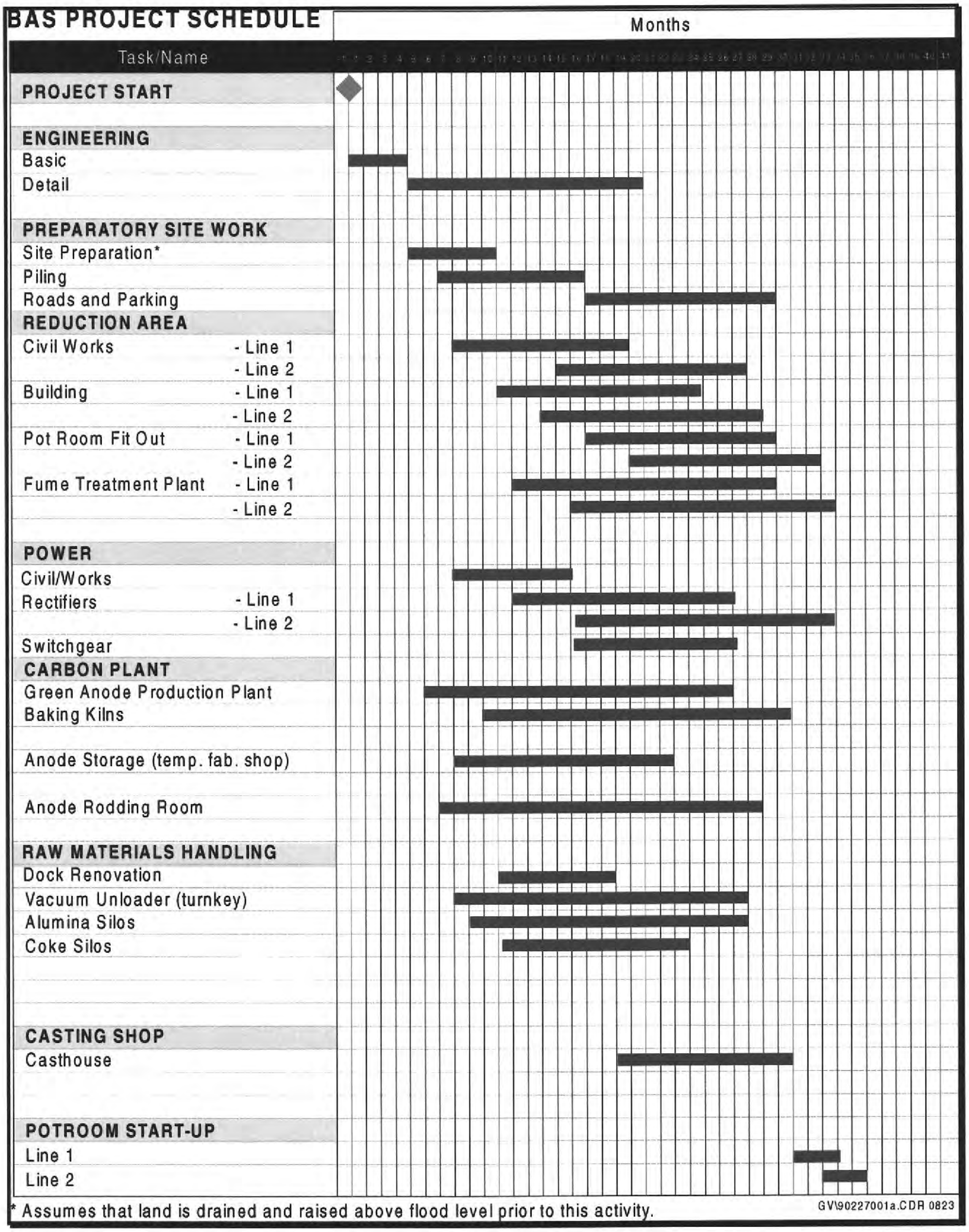


Figure 48: Project Schedule

The anticipated rate of spending over the course of constructing the project (based upon an assumed start date of 1/1/2001) is shown in the following figure. This spending curve is based upon the anticipated contracting structure and delivery schedules for the work packages and equipment supply contracts of the job.

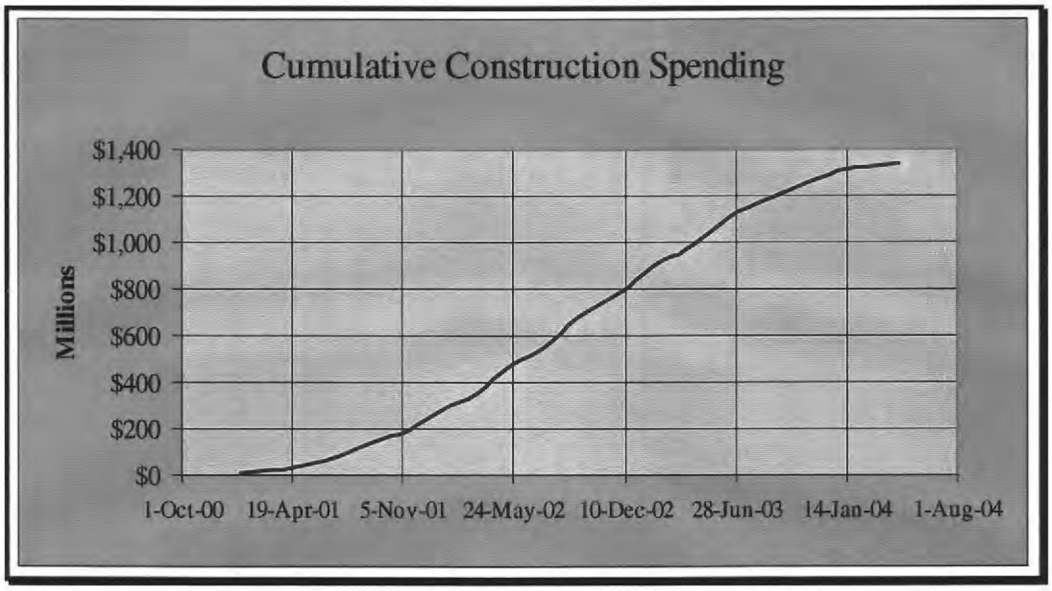


Figure 49: Cumulative Construction Spending

The overall financial performance of the project can be improved by shortening the time to first metal, the time to full capacity and the time to completion of construction. Each day before production comes on-line is an investment-day without an offsetting revenue stream, hence special efforts which shorten or otherwise protect the schedule are often very cost-effective.

The most significant potential benefits of schedule acceleration are listed below:

- Each one-month improvement in schedule results in an additional month of production, or about 25,000 tonnes of potroom metal for the Base Case.
- The incremental value of this extra metal is **over $15 million per month**.
- Construction interest is avoided when the schedule is accelerated. Toward the end of this project interest accrues at the rate of **about $5 million per month,** which is avoided with an earlier completion date.

The total potential benefit for each month of schedule reduction is approximately $20 million, which should be considered in evaluating any programs to protect the proposed schedule, or to accelerate it for early completion.

Until the actual site is selected and the basic engineering plan is formulated, the feasibility of schedule acceleration cannot be considered with any degree of certainty. However, under the current understanding of the project feasibility issues, the following can be stated:

- Government support and their familiarity with facilitating the Mozal smelter will be helpful to schedule compression.

- Early commitment to a fast-track approach is needed.

- The site must be ready for smelter construction to start shortly after engineering commences. This means, if the port site is chosen, that the land is drained and raised above flood level in coordination with the dredging program.

- Critical path items, such as the following, are given high priority and expedited without delay.

  - Site selection
  - Site development
  - Environmental permitting
  - Piling program
  - Site layout approval
  - Pot room foundations
  - Training program
  - Long lead equipment
  - Power supply lines

It must be recognized that constructing a major project in the Beira area will have the same challenges as the Mozal smelter with the addition of being considerably more remote and will be challenged to a greater degree with respect to health and weather conditions. These must be planned for and managed to achieve the schedule shown above and will make it difficult to compress the schedule further.

10.1 World Primary Aluminium Supply and Demand

10.1.1 World Primary Aluminium Supply

At this writing, world production capacity for primary aluminium is approximately 21 million tonnes per year. Excluding many very small producers in China, there are about 120 active aluminium smelters in the world.

Primary aluminium smelters are typically located in areas with abundant electrical power, especially in areas where either a large steady base load is needed for stabilization, or in areas where direct export of electricity via transmission lines is difficult. The following figure shows the locations of the world's primary aluminium smelters.

Figure 50: Locations of Primary Aluminium Smelters

Other than the many very small facilities in China, the traditional centers for aluminium production have been French Canada, the US Pacific Northwest, the US Ohio River Valley, and Northern Continental Europe. More recently, South America and Australia have increased their primary aluminium capacity, and most recently, Southern Africa is becoming a regional center of aluminium production. The following figure (repeated from Section 1) shows the current aluminium smelting capacity of the major producing countries.

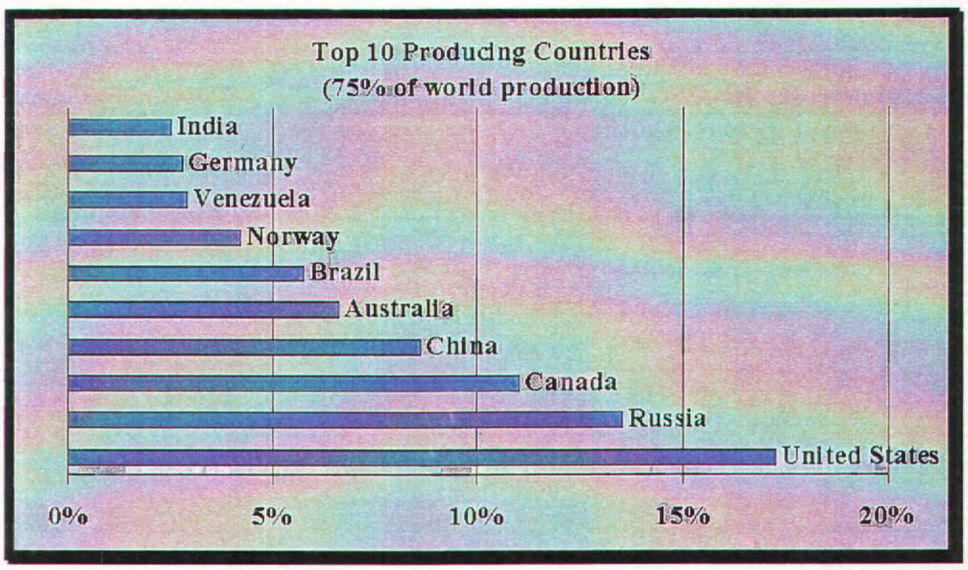


Figure 51: Aluminium Producing Centers

The completion of the first phase of the Mozal smelter and the realization of the proposed smelter in Beira would place Mozambique as the ninth largest producer of primary aluminium.

10.1.2 End Use Markets for Aluminium

Aluminium is a strong, durable, lightweight, versatile metal. It is also highly recyclable. Though the production process was invented in 1886, the common use of aluminium as a material for consumer products and other applications did not begin until the middle of the 20th century. Its excellent strength-to-weight ratio and durability contributed to its early growth as a material for aerospace and military applications. Packaging applications, initially consumer foil products, expanded to include beverage cans in the mid-1960's, becoming an important end use of primary aluminium and a cornerstone of the aluminium recycling industry. Most recently, the use of aluminium for automotive applications has grown to a point that transportation uses are currently the largest single use of aluminium. This trend is expected to continue. The following figure shows the approximate distribution of the end use applications of primary aluminium.

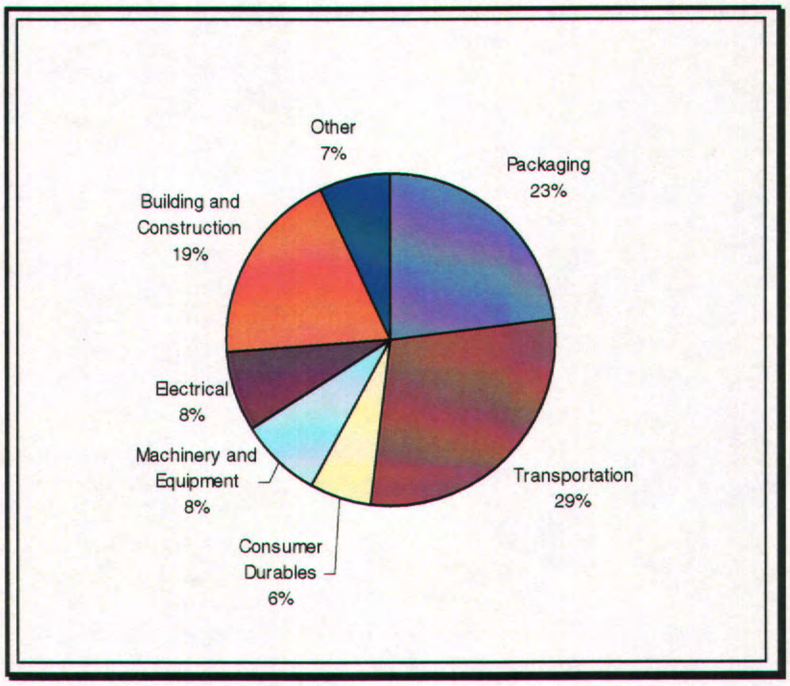
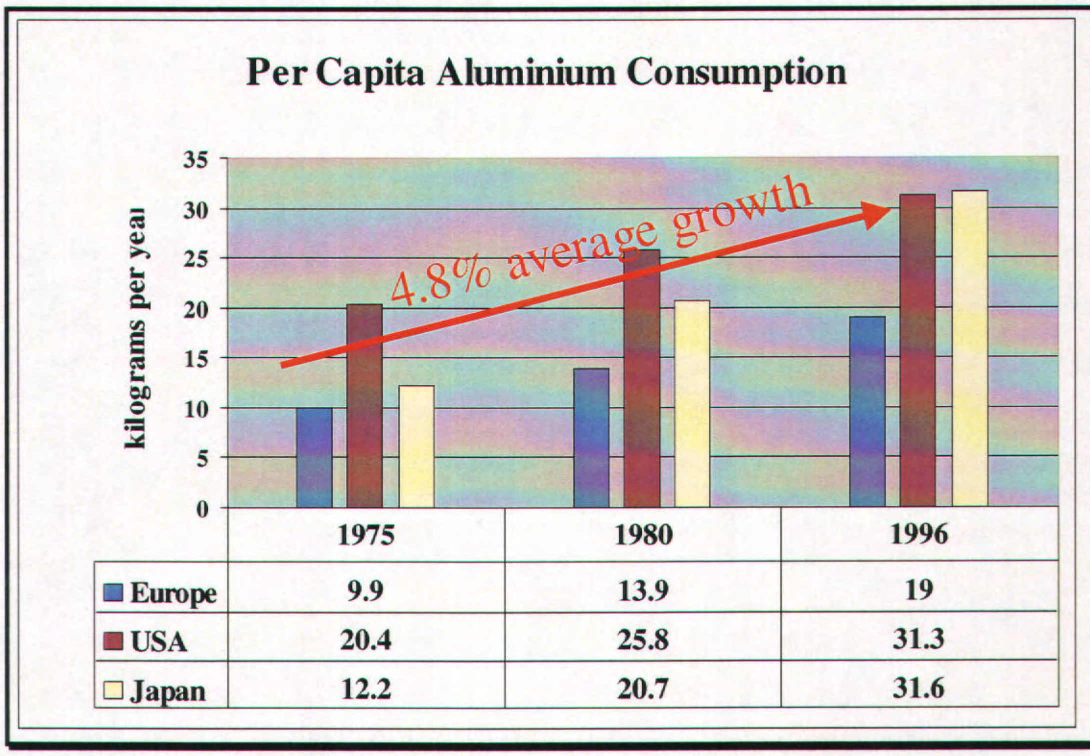


Figure 52: End Uses of Aluminium

10.1.3 Historical Growth in Demand

Historically, as consumer economies mature, the per capita consumption of aluminium increases. Durable goods, packaging materials and fuel-efficient automobiles underpin this growth, which has averaged about 5% per year for the last several decades. The following chart shows the growth in aluminium consumption (as kilograms per person per year) for Japan, USA and Western Europe.



	1975	1980	1996
Europe	9.9	13.9	19
USA	20.4	25.8	31.3
Japan	12.2	20.7	31.6

Figure 53: Per Capita Aluminium Consumption Trends

This growth in demand is satisfied by increases in primary aluminium capacity and through increases in recycled (or secondary) aluminium production. Historically, the split between primary and secondary demand growth has been about equal, with primary aluminium production growth to satisfy demand averaging 2.4% for the last decade as shown in the following figure.

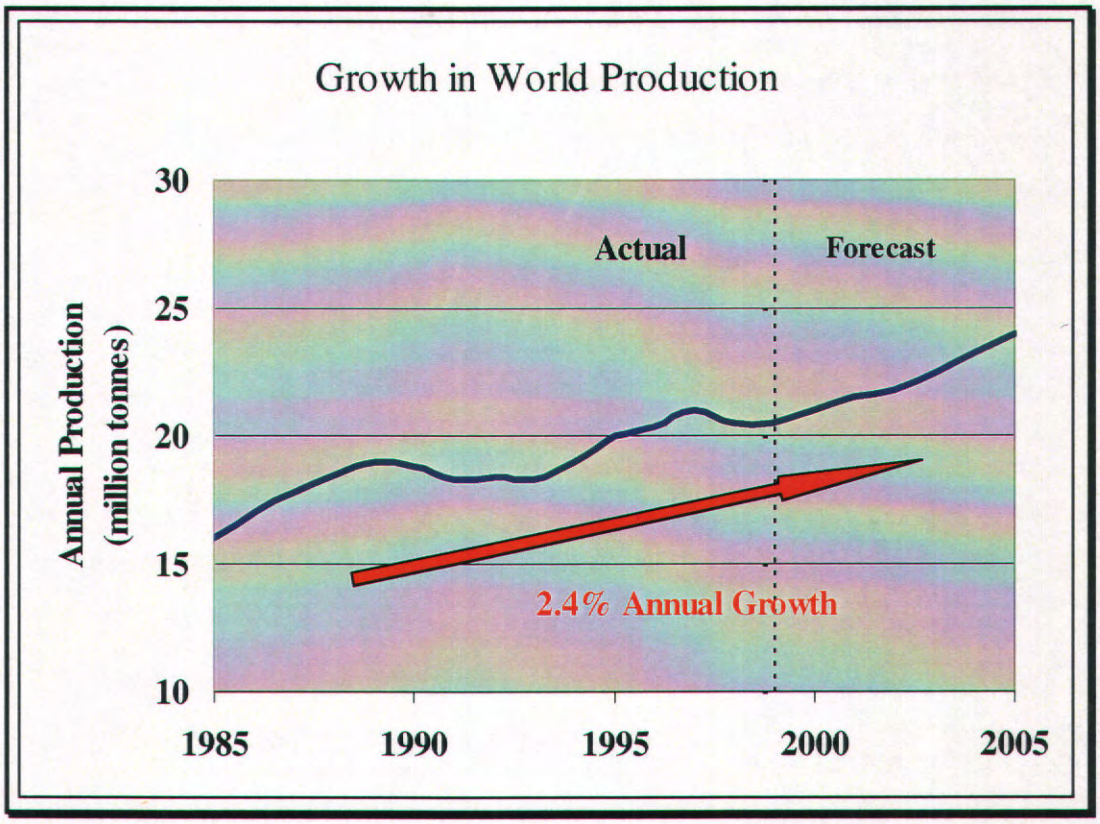


Figure 54: Growth in World Aluminium Production

The forecast of future growth is beyond the scope of this market discussion. However, a consensus of aluminium market consultants, commodities traders and major aluminium producers indicates a growth in demand for new primary aluminium production from 1.9% to 2.7% per year for the several decades. The consensus of the demand growth forecasts is shown in the following figure.

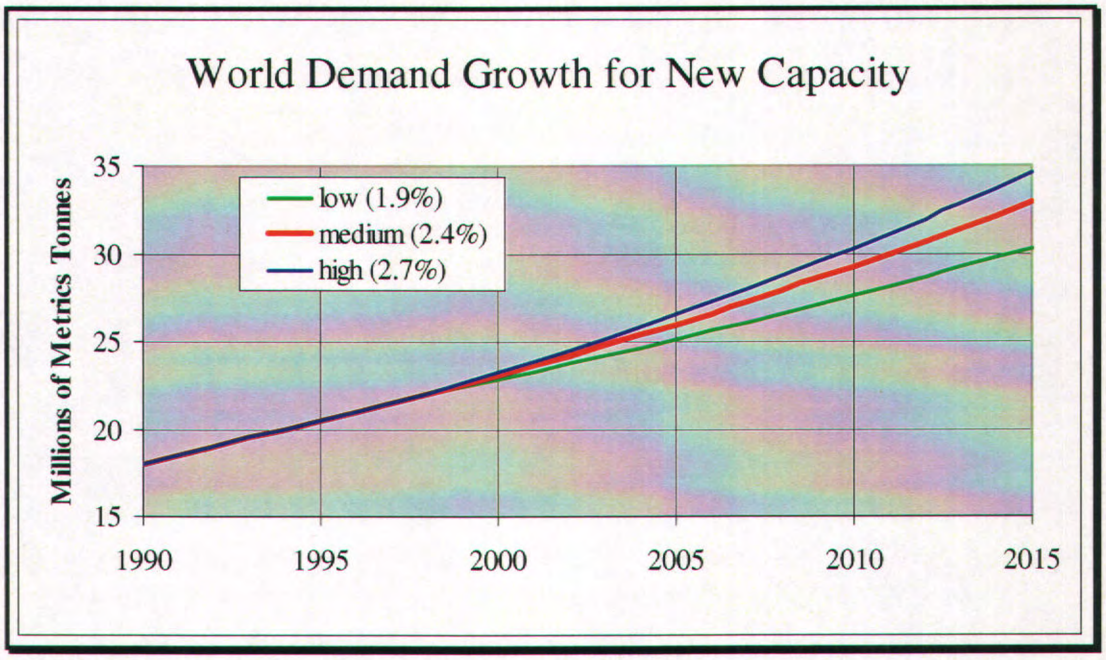


Figure 55: Capacity Growth Forecast

These growth rates are equivalent to an increase in annual demand of 400,000 to 570,000 tonnes per year. On this basis, each year one new large smelter such as this proposed project is required to satisfy the demand and maintain commodity price stability.

10.2 Mozambique Projected Demand for Primary Aluminium

Mozambique's current economy will provide no significant demand for primary aluminium, hence all of the initial production of the Beira Aluminium Smelter will be exported for sale on world commodities markets.

If Mozambique's economic maturity follows normal trends, the domestic consumption of aluminium will increase as the economy improves. Developed economies such as the US or EU consume between 20 and 30 kilograms per person per year, growing at about a 5% rate. On this basis, Mozambique will eventually require as much as 480,000 tonnes per year for domestic consumption. However, with many other national priorities for development of infrastructure and standard of living, it is not anticipated that Mozambique will reach this level of internal aluminium consumption for at least a decade.

In any case, because of the commodity pricing nature of primary aluminium, any domestic aluminium consumption will compete with export markets, thus providing the smelter with a domestic market equivalent to the London Metal Exchange throughout the life of the project. Revenue projections will be made on this basis.

10.3 World Cost of Production

The comparison of this project's projected unit conversion cost (or cost of production for one tonne of aluminium) provides a relative measure of the project's strength to compete in a world commodity market. It should be noted that because some electricity supply contracts and most alumina supply contracts are indexed in some form to the current aluminium commodity price, unit conversion costs will change in absolute value. They will also change relative to other producers, depending upon the nature of the key supply contracts.

For the purpose of comparing the Beira Aluminium Smelter to the world smelters, the following figure shows the cumulative production in terms of unit conversion cost. The chart plots the amount of aluminium produced at or below the indexed cost. As is readily seen, the Beira Smelter's projected conversion cost (based upon the assumptions described in Section 8 above) is one of the very best in the world.

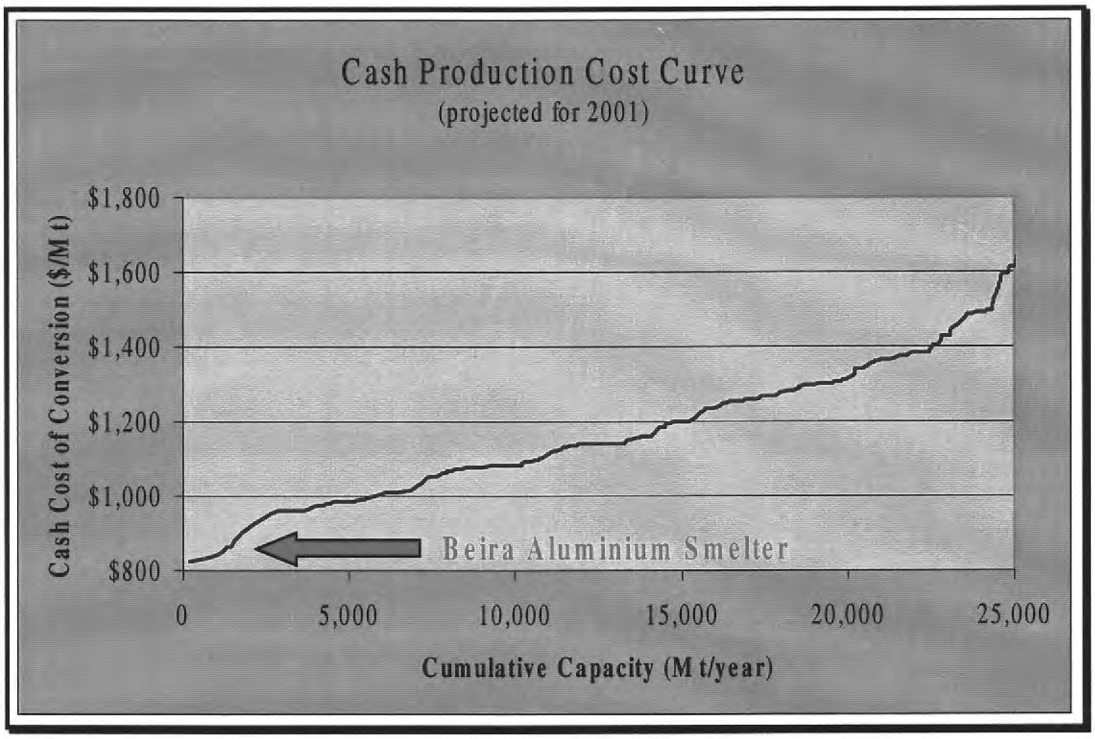


Figure 56: World Production Cost Curve

10.4 Primary Aluminium Commodity Price Outlook

For simplicity's sake and to better represent the baseline viability of the proposed project, the Beira Aluminium Smelter will produce unalloyed aluminium ingot of Grade A7, which is a commodity priced and traded on the London Metal Exchange ("LME"). A7 ingot (or equivalently P1020 grade) is at least 99.7% pure, with maximum iron content of 0.2% and maximum content of other non-aluminium constituents (mainly silicon) of 0.1%. The LME specification for this product is included as Attachment M for reference.

The LME trades in warrants for spot or various future delivery of A7 ingot. Of these, the 90-day contract is the most prevalent and is a common index for off-LME agreements as well. The 90-day contract price as shown in the following figure is the basis of the information presented in this section of the report.

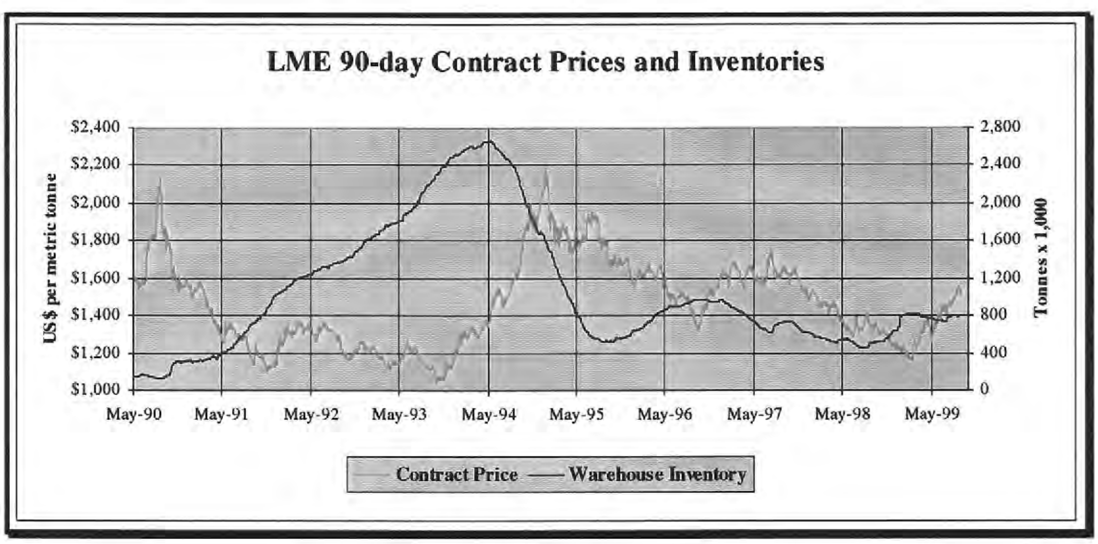


Figure 57: LME 90-Day Contract Prices

As is seen from the graph, aluminium commodity pricing is cyclical in nature and precise forecasting is complicated and difficult to achieve. Aluminium pricing has ranged from about $1,100/tonne to more than $2,000/tonne over the last 10 years. The 10-year average contract price is just over $1,500/tonne and the 5-year average is about $1,565/tonne.

Fortunately, the 20-year analysis of project cash flow helps to smooth the cyclical variations somewhat, supporting a simpler definition of the future market for aluminium in terms of (a) the average expected price over time, and (b) the expected sustained minimum price at the bottom of cycles.

The first index (Average LME price) is nominated as **$1,565/tonne** to provide a basis for revenue projections. This value is representative of the last five years of the market, and if escalated normally over the life of the project, agrees reasonably with predictions from Natural Resources Canada and several major aluminium producers of $1,700 per tonne.

The second (Minimum Sustained LME Price) tests the project's cash flow strength during bad markets. Based upon historical data, a value of **$1,150/tonne** is considered as the sustained market bottom.

It must be noted, however, that this study is not intended to provide an independent professional assessment of the future market for commodity aluminium, but rather to present historical data to support the base case assumptions for the purposes of calculating pro forma financial results. Because the confirmation of future market expectations is beyond the scope of this writing, the authors of this report make no claims as to the accuracy of these assumptions. To better inform the readers and to provide a more universal analysis of this project's viability, all financial indicators are calculated across a broad range of values of LME pricing, then presented in graphical format to show the sensitivity of the analysis with respect to LME price variations.

10.5 Alternative Marketing Arrangements

The market assumptions and revenue projections of this study are based upon the free trade of aluminium ingot (both warrants and physical deliveries) through a trading board such as the London Metals Exchange. Alternate market off-take arrangements are possible and perhaps likely, depending upon the final equity structure of the venture. In the case of such alternate agreements, the assumptions made in the preceding section are considered equivalent for the purposes of evaluating cash flow. Any additional project benefit such as future revenue guarantees provided by metal off-take agreements will be discussed in the Financing Plan Section below.

11.1 General Requirements for Project Financing

At this stage of the project, the financing plan that would be most attractive is highly subjective and impossible to preempt. However, current trends indicate that some form of limited recourse off-balance sheet financing may be the most attractive. The equity partners will have to provide creditworthy completion guarantees, but after a production standard has been met, the debt financing will become non-recourse. While this option is likely to be more expensive, its attraction lies in the allocation of risk being more acceptable to the equity partners.

Current trends in project financing in Africa (as demonstrated by Billiton for the Mozal project) favor a high level of equity, or "pseudo-equity" through subordinated debt. For this project, up to 50% of the total project value must be covered in this manner. Limiting the senior debt of this project to 50% affects the lenders' risks in funding a large project in a relatively underdeveloped area.

In project financing structures, all major risks must be apportioned to appropriate creditworthy entities. We anticipate the following requirements must be met by this project for financing to be possible:

- The future offtake of production must be secured through a long term market agreement with a creditworthy entity.

- Supply of all major materials (especially electricity and alumina) must be supported by long term contracts with credit worthy entities.

- The performance of the plant's technology must be assured by credit worthy entities.

- The timely completion and total cost of construction must be guaranteed.

- The ongoing operations and management of the plant must be supported by a capable and experienced entity.

- Political risks specific to Mozambique must be insured or otherwise covered.

11.2 Possible Equity Partners

While a number of potential stakeholders have expressed interest in investing in this project, a major equity partner has not yet committed to participate and no commitments have been made to any parties to provide equity to the project.

Nevertheless, the project is attractive as a source of low cost aluminium ingot and based upon a number of preliminary inquiries, we anticipate that the major sources of project equity, in their order of significance to be as follows:

- Aluminium commodity trading companies seeking capacity to convert alumina to aluminium at low cost.
- Major consumers of aluminium metal, especially the Asian manufacturing sector, seeking to secure their future requirements for primary aluminium products.
- Regional aluminium companies bolstering supply chains and production base.
- Companies with a broad interest in the reconstruction of Central Mozambique.

11.3 Possible Sources and Terms of Funding

Project financing for the Beira Aluminium Smelter (as exemplified by Mozal) will require the support of Foreign National Export Credit Agencies ("ECAs"), Multilateral Agencies ("MLAs") and possibly politically sponsored "pseudo-equity" subordinated debt. After researching Mozal's financing structure, the United States Export-Import Bank's view on Mozambique, the posture of European ECAs and discussing the project with various international commercial banks, the following types of financing are anticipated for this project:

- Funding from Foreign National Export Credit Agencies, tied to the export of goods and services from the funding nation. The amount of ECA support is dependent upon the amount of equipment and services purchased from the funding nations and the specific exposure limit any particular country might have for Mozambique. For Mozambique, this funding will probably be 7-year term (after construction) at 7% interest rate and requiring an origination/exposure fee of 10%, which is approximately equivalent to a 7-year term loan at an all-in 10% interest rate.

- Funding from Multilateral Agencies, which provide funding to development projects in the region. Terms for MLA lending in Mozambique might be 10%

interest over a 10-year term (after construction) with a 3% origination fee, or equivalently, approximately 11% interest over a 10-year term.

- Various forms of subordinated debt or special equity participation aimed at providing additional leverage for the equity partners. The terms of this type of financing can vary considerably, but for the purposes of this study, a 15-year loan tenor at 13% interest rate and 3% origination fee is assumed.

Based upon similar projects successfully funded in the past, approximately $15 million in legal and advisory services will be required to structure and package the debt for this project. These costs are in addition to any loan-specific administration, management and origination fees.

11.4 Pro Forma Financing Structure and Interest Rate Estimates

Part of the basis for analysis of the project's financial performance is the nominal financing plan described in this section. This plan has been greatly simplified from actual practice to facilitate the preliminary analysis of the project. As such, conservative assumptions have been used, with the expectation that the Owner's team will complete the financing plan and rationalize terms to the project's benefit.

The elements and assumptions of the nominal financial plan and the pro forma calculation of debt service and interest expense are listed below:

- Funding is proposed from an unencumbered equity contribution of 45% of the estimated cost of property, plant and equipment, plus interest during construction plus working capital.
- A single fixed-interest debt package funds the balance of project costs, including interest accrued during construction. The debt package consists of 67% ECA funding and 33% MLA funding.
- Owner's investment is committed on a pro rata basis throughout the construction period, with 45% of costs met from the owner's fund and 55% from the lender's fund.

- For the purpose of this analysis, no subordinate debt is considered. Further, any specific foreign national or Mozambique government sponsorship of either debt or equity is excluded from the analysis, even though participation may be possible.

- The assumed simple interest rate of 10.3% per annum is based upon the estimated rates for ECA and MLA financing, including prorated origination fees.

- Terms are consistent with conventional project financing packages, with debt service beginning after project completion. Principle and interest are serviced in equal annual payments for the first seven years of operation, after which the original debt is completely retired. These terms are a rough approximation of the anticipated actual package.

- Interest during construction is accrued, capitalized and rolled into the debt package at plant start-up.

- Requirements for working capital and additional cash are met by selling forward aluminium production as cells are started using 90-day instruments on the LME. This obligation is treated as a current liability offsetting inventory and cash assets and is rolled over throughout the life of the project. The obligation is satisfied as part of the liquidation at the end of 20 years.

12.1 Beira Infrastructure

Based upon background research, site visits, interviews with local personnel and information provided by the Government of Mozambique, the following is the current assessment, smelter requirements and community impact anticipated by this project on the Beira infrastructure. Where indicated, provisions are made in the project scope for infrastructure improvements.

A detailed study of the Beira infrastructure with identified improvements and costs can be found in the proposed Beira Development Plan recently completed for the Municipality of Beira by the joint venture of Palmer Associates, Projecta and Scott Wilson.

12.1.1 Housing

__Current Situation__

Expatriate housing is scarce in Beira and non- existent at Savane and Dondo. Most expatriates in Beira live in the Macuti housing complex built by the Nordic countries to house their expatriates during the Beira corridor study. Other aid agency expatriates live in the United Nations housing compound. A few have found private housing to lease in the community. The most suitable housing is the Macuti complex run by Hifab

International. The complex covers a secured area of about 4 hectares and contains 36 one-bedroom flats and 36 three-bedroom houses. There is a clinic with doctor, recreation room, library, laundry, tennis courts, satellite television, and restaurant. The complex has it's own standby electric generator and sewage holding tank. Each individual housing unit has it's own water treatment system.

Adequate housing appears to be available for the local workforce although the supporting infrastructure is in need of upgrading. There are many high rise apartment buildings as well as single family dwellings.

Smelter Requirements

During construction it is anticipated that housing will be required for approximately one hundred expatriates on a single status assignment. For operations, housing will be required for approximately one hundred expatriates on single status and one hundred on family status. This will necessitate the building of about one hundred two and three bedroom houses and one hundred single bedroom flats in a secure compound with supporting facilities similar to the Macuti complex. It is feasible that local businesses build, own and operate such a complex and lease the housing to the smelter or it's employees. The complex would need to start by providing housing for construction expatriates and expanding to accommodate operations expatriates.

It is anticipated that as many as six to eight thousand construction workers and one thousand production and maintenance workers will be required for the smelter construction and operations respectively. As there appears to be enough trainable people for construction already living in Beira it is not anticipated that additional housing will be required. The current trend is for semi-skilled workers to continue to become available from CFM due to the reduction in cargo being shipped into and out of Zimbabwe. Should this trend be reversed or other substantial construction projects commence in parallel with the smelter, then housing for construction workers could become an issue and consideration will have to be given to building more housing within the city or close to the smelter.

Impact on the Beira Area

The smelter expatriate housing will significantly increase the amount of modern housing in Beira. Eventually, local residents will occupy this housing as they take over the operation and maintenance of the smelter. The housing complex will expand the city and provide further employment in the construction, maintenance and operation of the complex. Leasing will bring additional revenue to the local business owning and operating the complex for many years.

It is anticipated that the steady wages of local workers on this project will be applied in part to improve the conditions of their existing housing. Some new housing may also be required to meet demand and will probably be supplied by enterprising local businessmen.

12.1.2 Sewage Treatment

Current Situation

There is no operational sewage treatment plant in Beira and untreated sewage is currently discharged into Sofala bay. The sewage drainage system connecting to the Sofala bay discharge line is in poor condition and may very well be contaminating the ground and the water distribution system. Housing complexes such as Macuti have their own holding tanks that are periodically emptied by the city.

Smelter Requirements

The smelter will comply with World Bank standards and will therefore treat all sewage generated at the smelter site. Unless the Municipality of Beira obtains funding for it's planned sewage treatment plant prior to commencing construction of the smelter a package treatment plant will be installed at the smelter site to treat sewage generated on site.

A package treatment plant is also recommended at the smelter housing complex to treat sewage generated at the complex.

Impact on Beira

If the smelter takes care of it's own needs, no additional burden will be placed on the city. Should the city install a municipal treatment plant and it services the smelter and associated housing, revenues from the smelter and housing fees would contribute to the operations and maintenance of the treatment system. Forecasted revenues from paying customers could possible be used to justify the financial viability of building the needed municipal treatment plant.

12.1.3 Water Supply

Current Situation

The Beira water treatment and supply system is in very poor condition. There is a shortage of water due to pumping restrictions and most users have an elevated storage tank for use during the periods during the day when water is not pumped from the treatment plants. A more serious problem with the supply is that the water intake is located on a canal that depends on a private sugar plantation to charge from the Pungue River. At times of low river flow the river intake becomes saline and no water is pumped into the canal.

The treatment system comprises of a 20,000 cubic meters per day plant built in 1953, a 10,000 cubic meters per day plant built in 1974 and a new 30,000 cubic meters per day plant built in 1997. The two older plants were rehabilitated in 1989 and the new plant is not yet fully operational due to electrical supply constraints. A new supply line to the Beira storage reservoirs was also constructed in 1997.

The water quality is not good enough to drink due to the condition of the older plants and the new plant not being fully operational. Residents in the Macuti housing complex boil and treat the water for domestic use and bottled water is used extensively for drinking.

The distribution pipework is also in very poor condition with forty to sixty percent of water lost through leaks. Broken pipes are also a major contributor to contamination of the water supply. Although most households are metered, either the meters do not work or the reading and billing system is not effective resulting in lack of revenues required to maintain and repair the water system.

The Government through the Department of Urban Water Supply and Sanitation intends to call for and award a contract for the operation of the Beira water supply system by a qualified private operator. The National Directorate of Water is negotiating financial assistance from the Swedish Government to undertake a study of the Pungue River Basin to improve the raw water supply to the treatment plants. The Government recognizes the importance solving the raw water shortage during the dry season and is looking for an emergency solution for the next five years as well as the long term permanent solution to meet demands to the year 2017.

There is no data showing significant aquifers in the Beira area that could be used for water wells. It is understood that there are some domestic wells yielding small quantities of "sweet" water.

Smelter Requirements

Although water is not used in the making of aluminium, water is used in auxiliary cooling systems and general maintenance. Water is also required for drinking, food preparation, showers, toilets and laundry. The total smelter requirement will be approximately 2,300,000 liters per day.

Expatriate housing will also require potable water for domestic use. Peak usage would be approximately 40,000 liters per day.

Impact on Beira Area

Unless the smelter produces it's own water from desalination, upgrades will be needed to the Beira water supply system. These may need to include a weir across the Pungue River to prevent the migration of salt water upstream, a new intake further upstream, new treatment facilities, and new supply lines, all of which would be of great benefit to the Beira area. The smelter would be expected to bear a portion of these upgrade costs but could not be expected to finance the entire upgrade for the city.

The requirements for the smelter and associated industries may provide the impetus to upgrade the Beira water supply system through foreign government donations. Upgrading the water supply system is basic to attracting new industry and fundamental to the regeneration of Beira. Without such basic infrastructure it is difficult to envisage attracting people and industries to the area.

12.1.4 Roads

Current Situation

Beira is a well laid out city with a well planned road network. However, the lack of maintenance has caused serious deterioration of the roads within the city. Minimal maintenance is keeping traffic flowing and local traffic is adept at detouring around severely potholed road sections. The main road to Harare via Dondo is under reconstruction and most is in excellent condition. The road to Savane is a sand road washed out in several places for many months especially during the rainy season. One of the problems with this road is that the culverts are either silted up or dammed up to form small ponds for local fishing. Several roads in and around the port have been rebuilt using locally manufactured concrete blocks. These roads appear to be standing up well and can be maintained with little resources other than labor.

Smelter Requirements

The road requirements for the smelter will depend on its location. The suggested location adjacent to the port will require a short extension to the Port North Access Road currently terminating at the oil storage tank farm. The Dondo site will require a short access road off of the main Beira to Dondo road. The Savane site would require a new road from Beira across low-lying flood prone land.

Impact on the Beira Area

During construction there will be considerable personnel traffic from Beira to the construction site. This should not cause any problem with the Beira site, however a site at Dondo or Savane would place heavy personnel and commercial traffic on the busy Beira to Dondo road. It is conceivable that the Dondo site would require the Beira to Dondo road be widened to a dual carriageway. Programs such as the Valco Fund in Ghana could be set up whereby the smelter would fund infrastructure improvements such as roads in cooperation with the local community. This would greatly benefit the city of Beira by improving the road system for all users.

12.1.5 Electrical Supply

Current Situation

Electricidade De Mozambique provides electrical power to the Beira area. The power lines to Beira have been rehabilitated and 6.6 megawatts of power is currently being consumed in Beira. There is sufficient power (up to 20 megawatts) available for additional light industry from low head hydroelectric dams on the Pungue River.

Smelter Requirements

At its maximum production level, the operational requirements for the smelter are approximately 650 megawatts at a load factor of 98%. The construction load will be much less at 10 to 20 megawatts.

Impact on Beira Area

The large electrical load required for the smelter will necessitate new high capacity transmission lines to Beira from a source such as the Cahora Bassa dam or the Eskom grid. This will bring stability and much needed additional power to Beira. Other industries should be attracted to the area by this reliable power supply.

12.1.6 Telecommunications

Current Situation

Telephonos De Mozambique provides telephone service in the Beira area. Long distance and international service is provided through a satellite link and works reasonably well. Cellular service should be available by the end of 1999. There is also an internet provider in Beira and effective use of the internet is common.

Smelter Requirements

The smelter will require reliable international telecommunication links, especially to South Africa. Connection to the local network will also be required. It is anticipated that the internet will be used extensively during construction and for operation of the plant.

Impact on Beira Area

The smelter requirements will provide a substantial base load for overall improvements to the Beira area communications systems. Satellite uplink systems provided in the smelter's capital estimate may be best owned and operated by a community business or agency.

12.1.7 Medical Facilities

Current Situation

There is a government hospital in Beira and several government and private clinics. There are American and European doctors but a lack of equipment and laboratory facilities. Most expatriates who become sick are airlifted out to Harare or Johannesburg for diagnosis and treatment. While there are a few cases of cholera and typhoid, the major problems are malaria and AIDS.

Smelter Requirements

Emergency facilities will be required for the expatriate and local workforce during both construction and operations. The smelter will have a staffed on-site first aid station and ambulance. A cooperation program with the local hospital is recommended. All smelter employees and designated family members would be covered by a customized health plan. Laboratory facilities for complete diagnostics will be required to support the health program.

Air evacuation will be required for expatriates during construction and operations. This would likely be a contracted service.

Impact on Beira Area

The smelter program would bring much needed upgrades to the Beira hospital facilities and add additional medical staff. A laboratory could be set up and equipped at the Catholic University, which is eager to cooperate with such a program. A smelter health care program would improve the health care for a significant portion of the population.

12.1.8 Technical Training

Current Situation

There are several training institutions in Beira, including the Catholic University, Technical Institutes, Trade Schools and CFM Training School. Three technical institutes have been targeted for Swedish development aid. These are Instututo Industrial E Comercial da Beira, Escola Industrial de Beira and Escola de Artes E Oficios.

The trade schools have good classroom facilities and are well equipped. There is a shortage of qualified instructors resulting in high student/instructor ratios.

The Catholic University will be a good source of administrative and accounting personnel.

The CFM training school trains primarily for port and railway type work skills.

There appears to be no shortage of high school students available for training for either construction or operations. There is a high student demand for electronics and computer training but a reluctance by students to train for construction type work.

Smelter Requirements

Training facilities, equipment, instructors and programs will be required for all construction trades, maintenance and administrative work. Smelter construction requirements will be high initially for civil trades, followed by mechanical and electrical trades. Some 6,000 to 8,000 workers will be required for construction, most of which will require some degree of training. Production, technical and managerial training are an integral part of the ongoing operation of the smelter and its personnel development program.

Impact on Beira Area

It is envisaged that the smelter training requirements will be integrated into the existing facilities rather than in separate facilities built solely for the smelter. The introduction of equipment, instructors and construction training programs into the existing facilities will vastly improve these facilities and enable Beira to become a center for technical training.

12.2 Beira Socioeconomic Factors

Based upon background research, site visits, interviews with local personnel and information provided by the Government of Mozambique, the following describes our current assessment of socioeconomic factors with material impact upon the proposed project. The Execution and Operations plans for this project incorporate this socioeconomic information into the planning process.

Most of the information is based upon existing documents provided by local and national government officials, specifically:

- Structural Plan of Beira and Dondo Project, 1998
- II Population Census and Housing Enumeration, 1997 – Preliminary Report
- II Population Census and Housing Enumeration, 1997 – Final Report
- National Institute of Statistics, 1996
- Sofala Conference "Towards the 21st Century," 1996
- National Institute of Employment and Professional Training, Sofala Delegation, 3/04/99
- Research on Human Resources in Beira, Sociedade Austral de Desenvolvimento, SARL, 1998 – Final Report

The data collected covers Sofala Province in general and the cities of Beira and Dondo, including the three Administrative Posts that are part of Beira, namely:

- Nhangau (in Savane area)
- Inhamízua, comprising of the quarters of Alto da Manga, Nhaconjo, Vila Massane, Chingussura, Inhamizua and Matadouro.
- Munhava, comprising of only two (2) of its quarters, Munhava Central and Vaz (North of Beira Port).

12.2.1 Standards of Living and Occupancy

By Western standards, the standard of living in Mozambique is very low. Many people still live in reed and mud houses or other temporary dwellings and a large percentage of the population live below the poverty level.

Land Use and Land Tenure Systems

The following figure shows how land is occupied at present. In the areas under consideration land use and land tenure systems are described below. This takes into account land occupation, population density and land uses for urban soil.

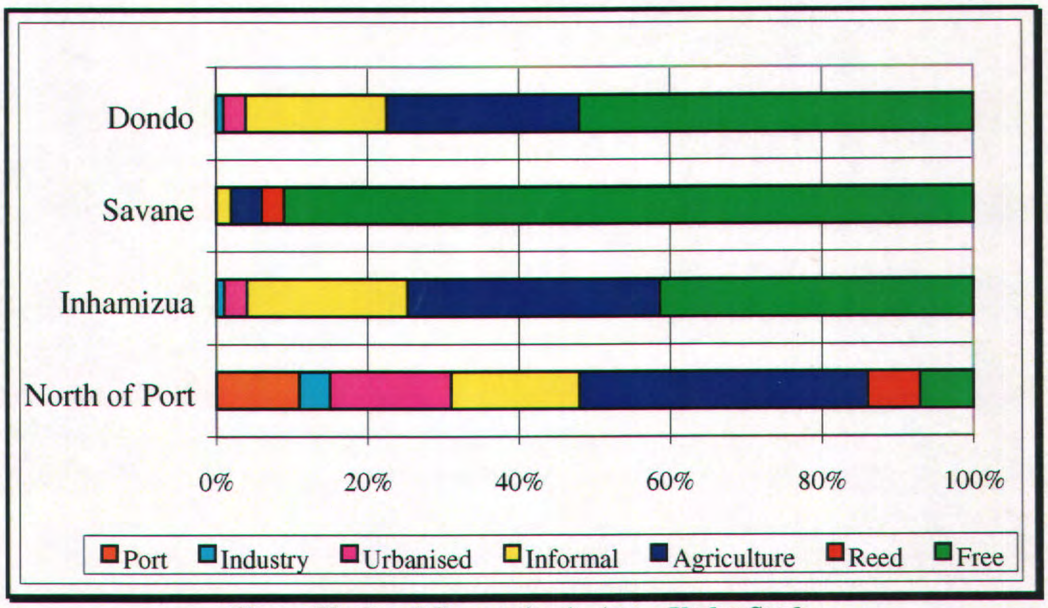


Figure 58: Land Occupation in Areas Under Study

North of Beira Port (Munhava Central and Vaz Quarters)

In these two quarters (Munhava Central and Vaz), the area consists of houses and small agricultural plots in lowland areas. The houses are aligned alongside the main roads and scattered informally in some pockets. In Munhava Central, the population density is very high and it is of medium density in Vaz.

On agricultural land, there is a predominance of subsistence small-scale family agriculture. The land is divided into very small plots following an informal tenure system. The owners and workers of these plots come mainly from the two quarters and some from other quarters.

Administrative Post of Inhamizua.

The quarters of this Administrative Post are characterized by mixed occupation comprising of areas for housing, industry, commerce and agriculture. On one hand, housing forms urban areas located mainly in the Manga Quarter and alongside the Beira Corridor up to the Inhamizua Quarter. On the other hand, housing is characterized by informal settlements of medium density (Manga Quarter) or low density (Inhamizua). Most of the people of Beira live in these areas. Inhamizua was defined by the City Council as one of the areas for housing expansion, within the framework of the future development of the City.

In the areas described above, small scale agricultural plots are abundant. The ownership of some of these plots is based on informal land tenure systems. Other plots are formally owned through the City Council. In some areas, there is a proliferation of private gardens being developed on land that is accessed through formal channels and procedures. These are under the control of the Beira City Council. Private gardens are also abundant in Manga, Nhaconjo and Inhamizua.

Industry, commerce and other tertiary activities are located alongside the Beira Corridor, including manufacturing and processing factories, shops, schools and health centers.

Administrative Post of Nhangau (Savane)

Nhangau is divided into four major urban areas and several informal settlements. Among the urban areas are the Headquarters of the Post and the Savane Tourist Center. Informal settlements with high population densities can be found alongside the main roads. In these areas the main economic activities comprise of informal trade, small family scale subsistence agriculture and fisheries. The latter is concentrated in Njalane Village.

The remaining settlements are concentrated on higher land where woodland exploitation and subsistence farming are the basic economic activities. Smaller quantities of private gardens dedicated to agriculture and animal farming (cattle, goats and pigs) can also be found.

Dondo City

Industrial projects are concentrated along the main railway line in Consito, Mafarinha and Nhamaiabaiwe Quarters. Some of these factories are of considerable size (Cement, Asbeto (Lusalite), Cement Crossbars and a few Sawmills).

The urbanized areas of Dondo City are concentrated in the Central Quarter and are now expanding to Consito. In the later, occupation follows a mostly informal pattern. In Centro Emissor, Samora Machel and Chandula Quarters, settlements are predominantly informal while Mandruzi and Macharote Quarters are mainly reserved for small family scale agriculture and scattered informal housing.

Land acquisition and ownership in these areas tends to follow informal channels. Only a few plots are acquired under a system controlled by the City Council and the District Administration (before the establishment of the municipal body in Dondo, in 1998). Mafarinha and Nhamaiabaiwe Quarters also show a limited occupation and have more free plots of land. There are also a few private gardens formally distributed and controlled by the Municipal Council.

Population and Dwelling Statistics in Each Area

The table below shows the number of people (by sex), families and dwellings in the areas under consideration.

	People			Families	Dwellings
	Male	Female	Total		
Dondo City	35,843	35,801	71,644	12,489	12,755
Beira (Total)	205,734	191,634	397,368	83,124	74,981
Adm. Post of Nhangau	3,806	3,501	7,307	2,052	2,038
Adm. Post of Inhamízua	57,416	56,394	113,810	23,219	20,287
Munhava Central Quarter	16,308	14,764	31,072	n/a	n/a
Vaz Quarter	3,057	3,071	6,128	n/a	n/a
Sofala Province	**628,747**	**660,643**	**1,289,390**	n/a	n/a

Table 8: Population Distribution in Area Under Study

The following table shows a summary of the population in Beira, Dondo and Sofala Province by sex and age group.

Age Group	Sex	Beira	Dondo	Sofala
0-14	M	81,391	15,417	281,740
	F	82,307	15,259	281,578
	Total	163,698	30,676	563,318
15-59	M	118,843	19,206	321,089
	F	104,032	19,098	351,891
	Total	222,875	38,304	672,980
60 or more	M	5,500	1,220	25,918
	F	5,295	1,444	27,174
	Total	10,795	2,664	53,092
Total	M	205,734	35,843	628,747
	F	191,634	35,801	660,643
	Total	397,368	71,644	1,289,390

Table 9: Population Distribution by Age and Sex

The largest percentage of the population is in the age group 15-59, which is of working age or soon to be economically active. This means that very few people will need to be brought into the area for the construction work as the local population can be trained for the skills required. The few that are brought in will have a minor impact on the population.

One risk for consideration is that large numbers of people will flood into the area hoping for work at the smelter or associated industries. The other problem may be the spontaneous development of informal settlements around the complex. This will need to be addressed early by the local government to prevent unnecessary relocations and occupation of land designated for future associated development.

Lifestyle and Quality of Life

In urban areas, social life is diverse and stratified along social class and age lines. Certain activities such as religion, sports and culture tend to bring the different groups closer. National and regional sports tournaments can assemble huge numbers of people of different economic and social background.

On weekends people have social gatherings in places like clubs, bars, restaurants and nightclubs. These are widespread in Dondo and Beira and attended according to class divisions. In the case of Beira City, the local beach also attracts many people.

Impact upon the Standard of Living

The proposed smelter could require the relocation of people, the number depending on the site chosen. This will occur during the early stages of construction and will be permanent. It will affect both the community being resettled and the host community in the area where resettlement will occur. The impact will be long-term with the intensity determined in part by the relocation distance. This is considered the most serious of all social impacts.

Most people at the possible sites are living in poor quality housing in a state of disrepair. New and improved housing is likely to form part of relocation plans, if required. This can be regarded as a significant positive impact of the proposed development. Depending on the needs and objectives of the community other benefits that could be derived include improved sporting facilities, community halls, health-care services, shopping and other commercial interests.

The permanent loss of agricultural land could occur at some of the sites. As subsistence agriculture is the main use of the land, the impact will occur and is expected to be negative, long-term and of high intensity. Food security is very important to these people with few employment opportunities so the magnitude of the impact will depend on resources and opportunities at resettlement sites.

At any site the smelter will restrict the through way of residents. The impact will be limited to the site, be long-term and of medium intensity.

12.2.2 Cultural Factors

Factors such as cultural heritage and archaeological sites have not been studied at this stage but will be part of a full environmental impact report once the project proceeds. The information collected from the most recent census is given here.

Religious, Spiritual and Other Sensitive Issues

Community religious beliefs need to be taken into serious consideration. One particular aspect that tends to interfere with the development of projects is graveyards. Urban areas have community graveyards. In certain cases, it is acceptable to remove these graveyards, but in all cases, it requires that certain traditional ceremonies conducted by traditional and spiritual leaders be observed. However, there are graveyards that cannot be removed under any circumstance.

Before starting construction of a project of a certain magnitude , it is often required that a religious ceremony headed by the local traditional chief be performed. It is believed that this is a way of inviting the ancestors to bless the project and that it enhances the chances of project success.

Religions

Most Mozambicans practice traditional religions, believing in the beneficial power of their ancestors. Even those who have embraced more formal religion tend to continue to associate with this form of traditional religion. The table below shows the breakdown of the population by religion.

Denomination	Urban	Rural	Total
Zionist	62,987	166,949	229,936
Catholic	139,991	69,541	209,532
Evangelical Protestant	72,612	45,888	118,500
Indeterminant Christian	5,998	1,314	7,312
Jehovah's Witnesses	2,286	2,451	4,737
Muslim	22,685	2,341	25,026
Other	12,139	29,229	41,368
None	193,939	401,750	595,689
Unknown	19,154	38,136	57,290
Total	531,791	757,599	1,289,390

Table 10: Main Religions of the Area

In urban areas the Catholic Church is the most common, followed by different Protestant Churches. In rural areas the Zionist church is the most prevalent.

Languages Spoken in Sofala Province

The following table provides a summary of home languages spoken in the Province of Sofala by residential area (urban/rural). The two dominant languages in both areas are

Cisena and Cindau. Portuguese is widely used in urban areas where 20.7% of the people speak it as their mother tongue.

Home Language	Urban Population		Rural Population	
	Number	%	Number	%
Portuguese	92,954	20.7%	9,528	1.6%
Cisena	169,478	37.7%	326,531	53.7%
Cindau	108,633	24.1%	245,999	40.5%
Echuabo	26,133	5.8%	2,941	0.5%
Xitswa	19,910	4.4%	2,676	0.4%
Emakhuwa	4,571	1.0%	1,072	0.2%
Other Mozambican Languages	19,787	4.4%	9,722	1.6%
Foreign Languages	1,921	0.4%	273	0.0%
None	905	0.2%	878	0.1%
Unknown	5,748	1.3%	8,480	1.4%
Total	450,040		608,100	

Table 11: Home Languages

Project Impact on Cultural Environment

The proposed development will not have an influence on the religions practiced either by its employees or its neighbors. The impact is considered to be neutral. There will however be a big impact on language as the technical and operational language of the plant will probably be English. This will occur to a small extent during construction but will affect all the operational staff. Training will have to be given in all aspects of English to ensure the safe operation of the plant. Although this is a big change its impact is considered to be positive, as it will open up other opportunities to those who learn English as it is widely spoken in the countries bordering Mozambique.

As Portuguese is the language of Beira, the expatriate staff will have to receive training in this language. The number of expatriate staff will be small in relation to the local workforce so the impact is small and positive.

12.2.3 The Local Economy

The economy is generally in a very poor state after many years of war. Most of the population is subsistence farmers as there are very few opportunities for other forms of employment. Projects financed by foreign donors, such as the rehabilitation of the Beira Corridor road, are providing some jobs but fall well short of that required. The recent Zimbabwe recession has had a negative effect on the local economy as employers, such as the Port, have had to lay off people.

Under present legislation, 450,000 meticais per month is the minimum salary set by the government. At this writing, approximately 13,000 meticais equals one US dollar. Public employees have a salary scale according to their education and years of experience. This salary scale is not necessarily observed by the private sector. In the private sector salaries are established after direct negotiation with individual employees or their groups or with the labor unions.

A sample of 30 companies, with more than 100 employees each, established in Sofala Province, taken in 1996 shows the following average incomes by common trade groups.

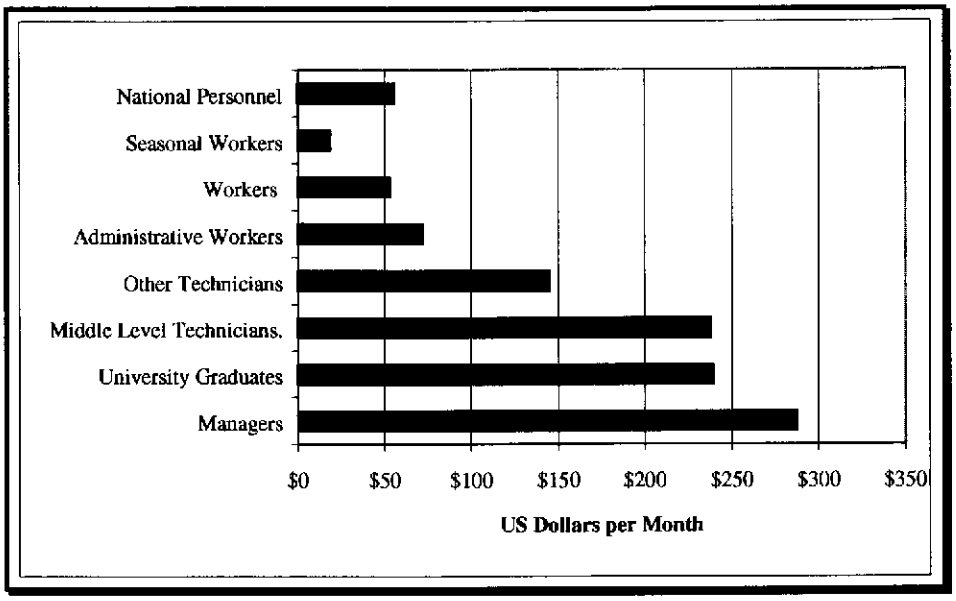


Figure 59: Average Income from Sample of Local Companies

Project Impact on Local Economy

In light of the current relatively small economy in the Beira Region, the proposed development of the smelter carries very tangible economic impacts for the region. This will be the value added to the national income through direct employment generation and through contributions to national tax revenue. Annual remuneration received by the

Mozambican workforce will certainly have a positive effect on the local and regional economy through employee compensation and tax revenue.

The smelter will be built in an Export Processing Zone where no taxes are payable during construction. Therefore only employment issues will make a contribution to the economy during this stage of the development. Assuming that most of the construction workforce will be local and will likely spend most of their income locally the impact on the local economy will be large and positive.

There will also be positive impacts on the Mozambican construction and building industry and mechanical and electrical service providers. The overall impact of the smelter development during construction will be positive and generally short to medium term. The provision of entertainment and other facilities, such as health care, must be in place and accessible to employees and surrounding communities.

The impact during smelter operation will be positive and long term especially for the local labor pool and regional infrastructure. However aluminium smelters tend to be highly capital intensive rather than labor intensive. Only a few forward or backward linkages into the Mozambican economy are expected as a result of smelter operations. All raw materials will be sourced from outside Mozambique and all processed aluminium exported. Only the purchase of electricity may be local although this may come from South Africa's Eskom. The more significant contributions are expected to be as a result of outsourcing non-core businesses and services to the smelter.

As the smelter will be in an IFZ, it will enjoy considerable tax incentives and other benefits. Alternative options could be considered to increase the economic share of Mozambique in this development. This could be in the form of encouraging aluminium fabrication plants to set up nearby to foster links into the Mozambican economy.

The proposed smelter and housing requirements will make significant demands on all aspects of the infrastructure. In view of the current weakness in infrastructure, significant improvements will be needed. The project will aid in this process, as property taxes from the housing complex, amongst others, will contribute to the financial strengthening of the municipality. Services that are paid for will lead to better service delivery.

The multiplier effect of the salaries paid to local people must also be taken into account. The economy normally benefits between six and ten times for every dollar paid in salary.

12.2.4 Employment and Human Resources Availability

The small skills base and high illiteracy rates make unemployment a serious issue in Mozambique. Activities generating employment are therefore needed to begin to adsorb a large unskilled labor force and to provide employment opportunities that are skill and education enhancing.

Legal and labor relations between the employer and the employee are established by a written work contract that can be either individual or collective. The work contract can be signed for a specific length of time or for an unlimited length of time. The agreement has to be communicated by the employer to the Ministry of Labor, except in the case of seasonal or temporary work.

The normal working period shall not exceed 48 hours per week, i.e. 8 hours per day. This period can be extended to 9 hours per day in which case the employee shall be given a complementary half a day off per week besides the normal resting days

Main Occupational Categories by Residential Areas

The number of people employed in the main occupational categories is shown in the table below, spilt between urban and rural areas.

Category	Urban	%	Rural	%	Total
High Level Managers/Owners	2,173	1.4%	498	0.2%	2,671
University Level	2,621	1.7%	410	0.1%	3,031
Non-University Level	5,456	3.4%	1,560	0.5%	7,016
Administrative Personnel	7,947	5.0%	948	0.3%	8,895
Industrial Workers	27,061	17.1%	11,201	3.9%	38,262
Independent Artisans	407	0.3%	1,006	0.4%	1,413
Retailers	26,090	16.5%	7,820	2.8%	33,910
Tertiary Sector Personnel	21,626	13.6%	10,016	3.5%	31,642
Domestic Employees	2,579	1.6%	232	0.1%	2,811
Small Scale Farmers	57,487	36.2%	245,191	86.3%	302,678
Agricultural Workers	772	0.5%	1,894	0.7%	2,666
Other Occupations	52	0.0%	10	0.0%	62
Unknown	4,326	2.7%	3,455	1.2%	7,781
Total	158,597	100.0%	284,241	100.0%	442,838

Table 12: Employment by Sector

Manpower Availability in Beira City

The following table shows the summary of unemployed workers registered with the Beira Employment Department. It should be noted that not all unemployed people seek employment through this department. A considerable number approach potential employers directly.

Trade	Male	Female	Total
Clerk Workers	1,363	558	1,921
Computer Operators	26	34	60
Telephone Operators	30	1	31
Drivers	306	-	306
Construction Managers	46	6	52
Brick Layers	407	-	407
Assistant Brick Layers	594	-	594
Carpenters	528	-	528
Mechanic	171	-	171
Civil Construction	132	-	132
Welders	63	1	64
Civil Electricians	175	4	179
Industrial Electricians	51	-	51
Auto Electricians	31	-	31
Mechanics	279	-	279
Panel Beaters	12	-	12
Plumbers	132	-	132
Painters	496	-	496
Watchmen	392		392
Unskilled Labor	3,181	421	3,602

Table 13: Registered Unemployed Workers

At this writing, the total number of unemployed people registered in the Employment Department was 14,979, of which 2,367 are women.

The figures given in the table above are probably a large understatement of the actual conditions in the Beira Region. Based upon other observations, they seem very low and may not be a true reflection of how many people could be available to work on the project.

Project Impact on Employment

During the construction phase about 6,000 to 8,000 people will be directly employed. This will be for construction work in the areas of civil, structural, mechanical, electrical and instrumentation engineering. Although it is not expected that all the skills required for the construction phase will be available, it is believed that enough trainable people will be available who could be trained for construction. At least 80% of the construction force could be from the Beira and Dondo areas, which could represent as much as 2% of the economic active population of the area.

With the current levels of unemployment in Mozambique a project of this nature will attract unemployed people from across Mozambique, and possibly also neighboring countries. If this process is not be controlled it could result in an influx of people into the area with the establishment of informal settlements near the site. This could worsen the unemployment situation, as these people will compete with local people for jobs at the site and from other industries in the area.

With the construction of the smelter, various indirect employment opportunities will be established. Increased volumes through the Beira port will increase the activity levels for CFM, which could result in increased employment. Supporting industries will also develop which will create further employment opportunities. It is believed that for a project of this nature, a multiplier factor of between 4 and 6 could be applied which will mean that during construction 6,000 direct jobs could result in more than 24,000 indirect employment opportunities. It is difficult to estimate the sustainability of these businesses upon completion of construction of the smelter, as this will depend on what other industries become established in the area.

Once in operation, the smelter will employ about 1,300 people and most of these should come from the Beira - Dondo area. It is expected that many of the operational personnel will come from the construction work force, where they are trained in the necessary skills for operations and maintenance. Again a similar multiplier factor will apply which could result on the establishment of more that 5,000 permanent jobs as a result of the 1,300 people directly employed.

Although a positive impact, the negative consequences of sudden and large economic growth in a poor area cannot be ignored. The influx of people from other areas of Mozambique, and neighboring countries, seeking employment could worsen the unemployment situation and the socioeconomic climate of the area. It is essential that an uncontrolled influx of people be prevented to ensure that the local communities benefit from this project.

12.2.5 Educational Standards and Capabilities

The following table shows a summary of educational levels attained by the population in Sofala Province by residential areas (urban/rural).

Level of Education Attained	Urban	Rural	Total
Post Literacy	1,474	1,009	2,483
Primary Education	135,496	46,080	181,576
Secondary Education	17,414	2,273	19,687
Initial Technical Education	241	36	277
Basic Technical Education	1,829	99	1,928
Middle Technical Education	1,821	168	1,989
Teacher Training	611	264	875
University Education	950	41	991
No Level Attained	285,108	557,492	842,600
Unknown	5,096	638	5,734

Table 14: Education Levels of Local Population

Educational Institutions

The table below shows a summary of the main training institutions in Beira.

Institution	Mgmt	Courses Taught	Duration	Level Accorded
Educational (Pedagogic) University	Public	Geography Mathematics and Physics Chemistry	5 years	Licentiate (MSc)
Catholic University	Private	Human Resources Mgmt Management Public Administration	12 months 5 years 5 years	Professional Licentiate Licentiate
Beira Commercial and Industrial Institute	Public	Electronics Electric Systems Building Roads General Mechanics Accountancy	3,5 years	Mid-Level Technician
Beira Industrial and Commercial School	Public	Electricity Civil Locksmith Plumbers Mechanic Mechanic Design Construction Supervisor	3 years 3 years 3 years 3 years 4 years 3 years	Basic Level Technician
Beira Professional Training Center	Public	Various	Diverse	Professional/Vocational

Table 15: Educational Institutions in Beira

The Catholic University expects to be able to graduate 15 people by the year 2001. Of these 6 will be in Economy and 9 in Management. Apart from these formal university courses, this institution also offers professional training courses in various administrative areas. The attendance plan for this institution up to the year 2003 is summarized below:

Year	Bachelors Degree		Licentiate Degree	
	Economy	Management	Economy	Management
1999	8	12	-	-
2000	12	17	-	-
2001	25	35	6	9
2002	50	75	10	15
2003	95	140	20	30

Figure 60: Attendance Plan for Catholic University

The Beira Industrial and Commercial Institute is now benefiting from ASDI support and has been active in trying to adjust its educational curricula to the needs of the productive sector. The ultimate goal is to build partnerships with local productive companies and run tailor made courses in its educational programs.

Beira Industrial and Commercial School is attended by 802 students. The average number of annual graduates from this school ranges from 15 to 25. Most of these have difficulty finding jobs in the local job market.

The National Institute of Employment and Professional Training manages Beira Professional Training Center, which provides vocational education in areas such as: Automobile Mechanic, Panel Beating, Electricity, Accountancy, Computers and Secretarial Work.

All the training and educational institutions were found to be compatible with the planned training campaign associated with the construction and operation of the proposed aluminium smelter.

12.2.6 Local Supporting Industries

This project will result in the development of various supporting industries, both during construction and throughout operations. The following is believed to be the most important:

Port and Railways

Most of the construction materials for this proposed development will be handled by the Port of Beira, and by the railway system if the site is established inland. This will provide CFM with much needed work especially since import volumes for Zimbabwe are deteriorating along with its economy. The result could be additional employment opportunities at CFM, and upgrading of port facilities, dredging programs, railway infrastructure, and so forth.

Once the plant is operational the Port of Beira will handle in excess of 1 million tonnes of raw materials and final product for the smelter. This will represent more that 35% of the port's current volume, and over a long period will bring more stability to CFM's business in Beira.

Transportation

The public and private transportation systems in Beira are in a poor condition, as a result of the high level of poverty and people not being able to afford to pay for transport. With the introduction of this project, people will have to be transported to and from work. This will result in the establishment of transportation services to and from the plant and will also stimulate informal transportation services, as more people will be able to afford paying for transport.

Supply of Construction Materials

During construction of the smelter, various construction materials will be sourced from the Beira area, which will have a significant impact on the local suppliers. The following are believed to be the most important:

- Cement: The Dondo cement factory could supply a share of the estimated 80 000 tons of cement required by the smelter. Although the factory does not operate its kiln because the railway access to its raw materials has been destroyed, clinker is imported from a plant in Maputo to produce cement suitable for non-structural work. The rest of the cement could be imported from Maputo, which will further benefit the Mozambican economy.

- Stone: Stone quarries exist some 50 kilometers from Dondo. This project will require an estimated 100 000 m^3 of stone for concrete alone, and probably another 20,000 m^3 for infrastructure development. This will offer opportunities for the development of further quarries and local transportation companies to develop transportation capabilities.

- Sand: Sand will be required for fill material and concrete. The volume of sand required for the project is not available from local sources and it is believed that the most cost-effective way of providing sand is from dredging sea sand. The port of Beira is in desperate need of a dredging program to increase the channel draft so as to maintain current operations, and to increase ship capacities that can enter the port. If this program could be conducted and dredged sand could be pumped to shore, a source of affordable sand will be available and the capacity of the port will be improved.

- Timber: Various saw mills exist in the area which can produce building materials such as scaffolding and shuttering.

- Office Supplies: Suppliers of office consumables exist in Beira. They could expand their businesses by supporting the plant and the industries that grow up around it.

- Maintenance: Certain maintenance activities could be outsourced to local businesses. Examples of this are vehicle maintenance, plumbing and office maintenance. In addition to this will be the supply of spares for those activities mentioned above and those that the plant could carry out itself, such as electrical maintenance.

- Security: Security will be very important for both safety and financial reasons. All movement in and out of the plant will have to be carefully controlled. The long boundary fence will also require regular patrolling. This service will provide long term business to a local security company. In addition to smelter security is the safety of the personnel, their families and homes. The housing compounds will have similar security needs and access control.

- Catering: There are two distinct phases to the delivery of catering services. The first being during construction when large numbers of workers will have to be fed in a construction environment. During this phase the services of a company experienced in dealing with large numbers of construction workers will be required. The second phase being once the plant is established and facilities are permanent. There will then be the opportunity to provide the smelter with restaurant service.

- Personal Consumables: With the employment of 6,000 to 8,000 construction workers and 1,300 permanent workers the demand for household goods, foodstuffs, clothing, and other personal consumables will increase, stimulating the development of the industries supplying these commodities.

12.3 Mozambique National Socioeconomic Factors

The implementation of the Beira Aluminium Smelter as proposed will provide a cornerstone for economic growth in the central Mozambique region. This growth (partly from the smelter and partly from other enterprises) should contribute to the further socioeconomic development of the Country of Mozambique, especially in the following areas:

- The proposed IFZ area will generate foreign exchange to possibly cover currency exchange requirements for purchase of foreign capital goods and equipment for future growth.

- Increased import/export activities can underpin the existing port operations and support the regional and national plans for further development of transportation corridors. North/south land transport options (if competitive) will have a long term market.

- The regional and national power transmission systems will greatly benefit from a long term, steady base load in Beira. This load can underpin the linkage of power generation from the North to the South.

12.4 General Socioeconomic Impact of this Project

From the viewpoint of limited scope of socioeconomic investigation associated with this study, the overall impact of the Beira Aluminium Smelter will be very positive, providing a cash stream of foreign exchange, several thousand new long term jobs, reinforcement of local community infrastructure (especially the power grid), higher utilization of the existing port and international exposure of the Beira area as an emerging economic trade zone.

Life quality should also improve as permanent employment leads to a higher standard of living, access to improved medical care, re-engagement with the cultures of visiting expatriates and a meaningful emphasis on education and technical training.

Socioeconomic difficulties consequent to this project are difficult to predict, but it is anticipated that careful planning will be required to integrate the new jobs (especially the construction jobs) into the local economy without creating a localized hyperinflation environment. Fortunately, since Beira's development will follow somewhat that of the Maputo region, lessons learned during the integration of new enterprises such as Mozal can be applied to the Beira sub-economy.

13.1 Basis for Financial Accounting

The pro forma financial accounting for the project is based upon a simplified model of project revenues and costs, integrated with the obligations of the simplified financing plan and extended through 20 years of operation via annual Income Statements and year-end Balance Sheets. Calculations are based upon the following information and assumptions:

- Capital and operating costs are based upon the estimates in Sections 7 and 8 of this report.
- The indicated cost of cell reconstruction is not incurred until after the fifth year of operation.
- The cost of land is not included in anticipation of a long term land use concession.
- Year 0 Balance Sheet begins at the completion of construction when the plant is operating at full capacity.

- Operating costs and profits of the progressive start-up during the construction period are shown in the Construction Period Income Statement and incorporated into the Year 0 balance Sheet. These costs and revenues are based upon the early staffing of departments and the planned rate of cell start-up.

- Inventories and working capital requirements are based upon the technical calculations of the Material Flow Model (Attachment A) and priced using unit costs or earned value from the Operating Cost Model (Attachment I).

- Operating profits are assumed tax free under Mozambique IFZ regulations. Though this incentive program may be modified in the future, the best basis at this time is the existing IFZ legislation. Any Owner's tax liability or other off-set obligations are excluded from the analysis. These assumptions represent a rough estimate used for preliminary analysis and are not meant to express any expectations of the actual tax obligation of the venture. Determining the applicability of international tax regulations requires additional investigation.

- For analysis purposes, the economic life of the plant is 20 years. Scrap value at the end of 20 years is 10% of original capitalization. Though neither of these assumptions represents the expected term of plant viability and plant value, the progressive discounting of value over 20 years diminishes the significance of these differences beyond the expected accuracy of the analysis, hence the 20 year cut-off.

- Depreciation is calculated using the fixed declining balance based upon the useful plant life and residual value.

- The annual cash discount rate is 10% for purposes of calculating Net Present Value.

- Revenues as determined by LME selling price are escalated at the rate of 0.7% per year, beginning in Year 2 of the plant's operation.

- Cost are escalated as follows:
  - Alumina costs are tied to the selling price of aluminium ingot and are escalated at 0.7% per year.
  - Power will be supplied under long term contract whose tariffs are pre-defined for the span of this analysis.
  - All direct operating costs (except for power and alumina) are escalated at 1.5% per year beginning in Year 6 of operation.

- For the purpose of calculating Gross Margin, Cost of Goods Sold includes sustaining maintenance costs but does not include depreciation.

- For the purpose of calculating Owner's Return, all cash earnings are disbursed to Owner at each year's end.

- Revenues are calculated as described in the following section.

13.2 Basis for Projection of Revenues

The returns generated by aluminium reduction facilities can vary from marginal to extremely attractive, depending upon the selling price of aluminium ingot. For this project, strong cash flow is required to service debt during the project's first years of operation and sustained revenues are required throughout the project to provide acceptable returns.

Because of the importance of future ingot prices, we have nominated our most reasonable estimate for the 20-year average LME price in 1999 dollars for use in the base case scenario. In addition to this specified target price, the following basis has been used to project revenues over the life of the project:

- The LME target price for analysis is $1,565 per tonne as discussed in Section 10, Market Analysis. The price is FOB, plant site. An escalation factor of 2% per year is applied over the period of analysis. At this writing, the target price assumption is somewhat conservative compared with projections of aluminium market analysts.

- Though the plant will be technically capable of producing a family of value-added primary aluminium products (if the necessary cast house equipment is installed), this analysis assumes that all of the plant's production will be A7 grade (P1020) primary aluminium ingot packaged as sows.

- Aluminium ingot is a world-traded commodity. There is always a market for the product. Warrants can always be placed on the LME for any production not sold directly to customers, providing the seller will accept the current market value of the warrant. The warrant can be satisfied by delivery of the nominated quantity to an LME-designated warehouse, or alternately, to another point agreeable to a buying party.

- Like all commodities, aluminium ingot is subject to the cyclical pressures of supply and demand. In recent history, short-term aluminium ingot price has cycled through a range roughly between $1,200 and $2,000, as shown in the figure in Section 10. This analysis presents financial returns for project-average ingot prices ranging from $1,300 to $2,000.

13.3 Analytical Approach

The preliminary analysis of financial performance of a project is by necessity based upon assumptions and unverified information. Typically, some of the unknowns have been qualified or bounded by reasonable ranges, others are understood to a high degree of certainty and some are altogether unknown.

However, since the purpose of a feasibility analysis is the justification of additional project development activities and not the justification of the investment capital itself, uncertainty during the preliminary stages is acceptable. In addition to pro forma financial accounting, preliminary analysis should include information about the variability or sensitivity of the conclusions. This approach is supportive of the "decision" quality of the analysis and has been adopted in this report as follows:

- A target scenario for ingot price, costs and basic financing plan is nominated. This scenario is the pivot point for analysis of variations in the key data elements.

- Using the projected cost and market information, pro forma financial analysis for twenty years of operation is generated in the form of simplified annual Income Statements and end-of-year Balance Sheets. These documents are used for subsequent analysis of performance.

- The relative viability of the project is viewed in terms of the Leveraged Internal Rate of Return ("IRR") over the life of the project, expressed in 1999 US dollars. IRR is the calculated annual cash discount rate which, when applied to the forecast future earnings stream, would result in a net present project value ("NPV") of zero.

- The Unleveraged IRR for the project is also calculated. This calculation assumes 100% equity without debt and is a measure of the project's strength without the influence of financing programs.

- The relative viability of the project is also viewed in terms of its Breakeven Price or the minimum LME ingot price allowing the plant to cover operating costs and to service debt (both interest and principle) during the first years of the project.

- The sensitivity of these two factors is tested with respect to variations in the major components of financial analysis, especially LME ingot price, operating cost, capital cost and financing terms.

13.4 Financial Accounting Statements

Pro forma versions of Annual Income Statements and Year-end Balance Sheets are included in Attachment K of this report. The reports are organized by operating year, from Year 0 (immediately after the completion of construction and attainment of full capacity operation) to Year 20 (the end of the analysis period).

These reports represent the estimated financial performance of the Base Case configuration operating under the target set of assumptions described in Sections 7, 8 and 12 of this report and summarized in the following two tables.

Base Case for Operating Costs	
LME Price	$1,565
Alumina Cost (% of LME)	12.5%
Power Cost ($/kwh)	$0.013
Labor Productivity (mh/t)	9.1
Aggregate Labor Rate ($/hr)	$5.70

Table 16: Base Case Operating Cost Assumptions

Nominal Financing Plan	
Total Debt (millions, w/constr interest)	$737
Total Owner's Contribution (millions)	$603
Equity Contribution Rate	45%
Interest Rate	10.3%
Loan Repayment Period (years)	7

Table 17: Base Case Nominal Financing Plan

13.5 Estimated Cash Flow of the Project

The estimated cash flow of the project is shown in the following figure. The cumulate cash flow curve is discounted at the rate of 10% per year.

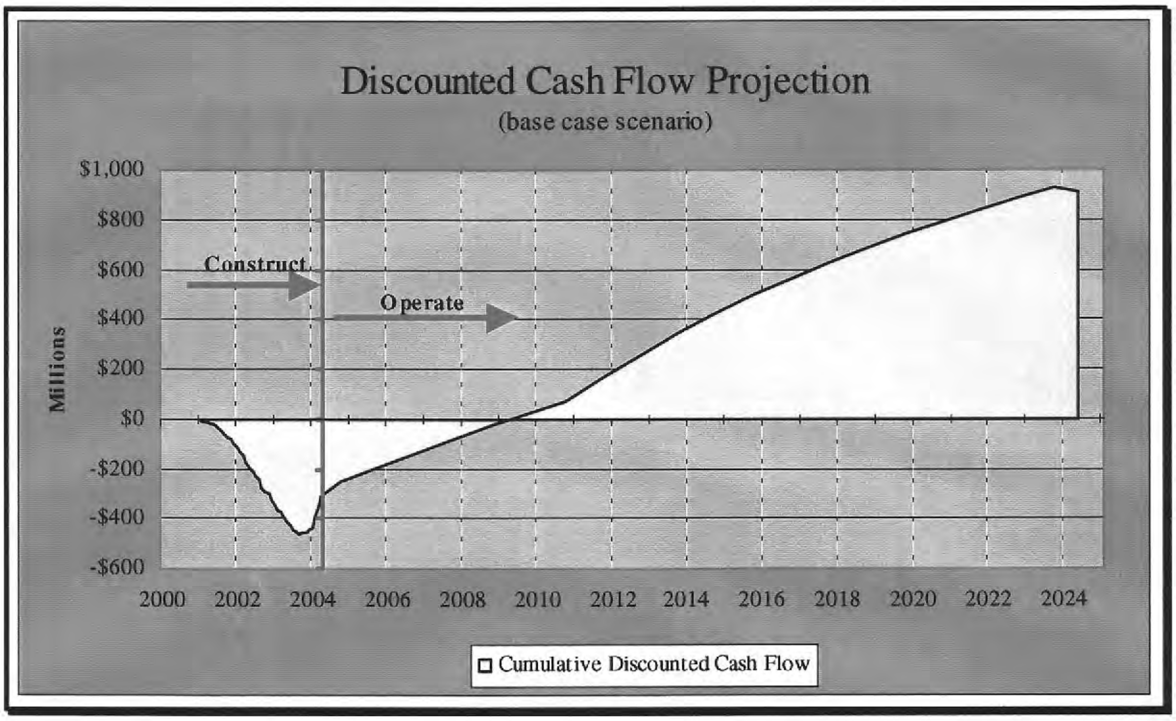


Figure 61: Base Case Discounted Cash Flow Projection

13.6 Nominal Financial Indicators

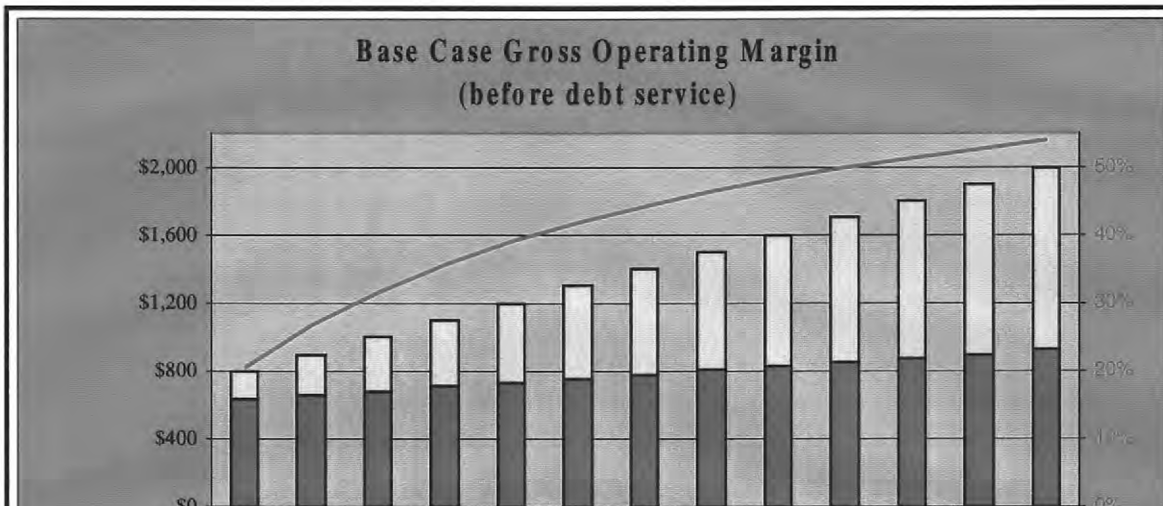
Several financial indicators are calculated using the information contained in the Balance Sheets and Incomes Statements in Attachment K with the results shown in the following table. Annualized results are differentiated between the first 5 years, the second 15 years and the full 20-year period of analysis.

The analysis is not an absolute indication of planned project performance, but provides a reference point for sensitivity analysis and a baseline for evaluation of the impact of capital improvement programs.

Financial Statement Analysis			
Indicator	**Years 1-5**	**Years 6-20**	**Years 1-20**
Annual Revenues (millions)	$499.0	$610.3	$582.5
Gross Profit Margin	50.3%	50.9%	50.7%
Fixed Charge Coverage Ratio	1.64	15.24	5.53
Annual Profit after Taxes (millions)	$37.6	$282.8	$221.5
Average Profit per tonne	$125	$937	$734
Return on Assets	4.8%	559.5%	94.9%
Unleveraged Internal Rate of Return	10.1%		20.3%
Leveraged Internal Rate of Return	8.8%		25.6%
Net Present Value (millions)	-$16.4		$918.8
Invested Capital (millions)	$602.7	$0.0	$602.7

Table 18: Base Case Financial Statement Analysis

This analysis is a "snapshot" of the project if all of the Base Case assumptions are accurate and constant. It describes one of a family of possible outcomes and is presented without interpretation. Even under normal circumstances, actual results may vary significantly. The figure below illustrates the impact of a single assumption, average ingot price, on Gross Margin as it varies over a reasonable range.



	$800	$900	$1,000	$1,100	$1,200	$1,300	$1,400	$1,500	$1,600	$1,700	$1,800	$1,900	$2,000
Gross Margin	$163	$239	$315	$391	$468	$544	$620	$696	$772	$848	$924	$1,001	$1,077
Operating Cost	$637	$661	$685	$709	$732	$756	$780	$804	$828	$852	$876	$899	$923
Margin Rate	20.4%	26.6%	31.5%	35.6%	39.0%	41.8%	44.3%	46.4%	48.3%	49.9%	51.4%	52.7%	53.8%

Figure 62: Base Case Gross Operating Margin

Because of the significance of assumed LME price in calculating cash flows and predicting financial performance, the sensitivity of each of the other significant variables discussed in the following sections will be represented graphically in terms of assumed LME price.

13.7 Sensitivity Analysis

13.7.1 General Assumptions for Sensitivity Analysis

The analysis in this section addresses the variability, or sensitivity, in financial performance introduced by changes in the assumed values of cost and/or technical factors. For the purpose of this study, a simplified approach to sensitivity analysis is adopted as follows:

- The sensitivities of Breakeven Price and Leveraged Internal Rate of Return are analyzed. Breakeven Price is a measure of the enterprise's ability to service its obligations during weak markets. IRR provides an indexed measure of the project's overall financial return.

- Breakeven Price is analyzed with respect to financing terms and capital cost, which are typically the two largest influences on this value.

- IRR is analyzed with respect to capital cost, operating cost and % Owners' Equity, which are typically significant factors.

- The IRR analysis is also performed over a range of average LME prices. Sales revenue, determined by LME price, is the most influential factor in determining internal return rates.

- The analyses assume that all other factors are constant at their Base Case values. This approach does not account for the cumulative effect of several factors varying from target assumptions.

13.7.2 Breakeven Price Sensitivity to Variance of Key Factors

The following two figures show the effect of Financing Term and Capital Cost on Breakeven Price. Data tables for these graphs are included in Attachment L.

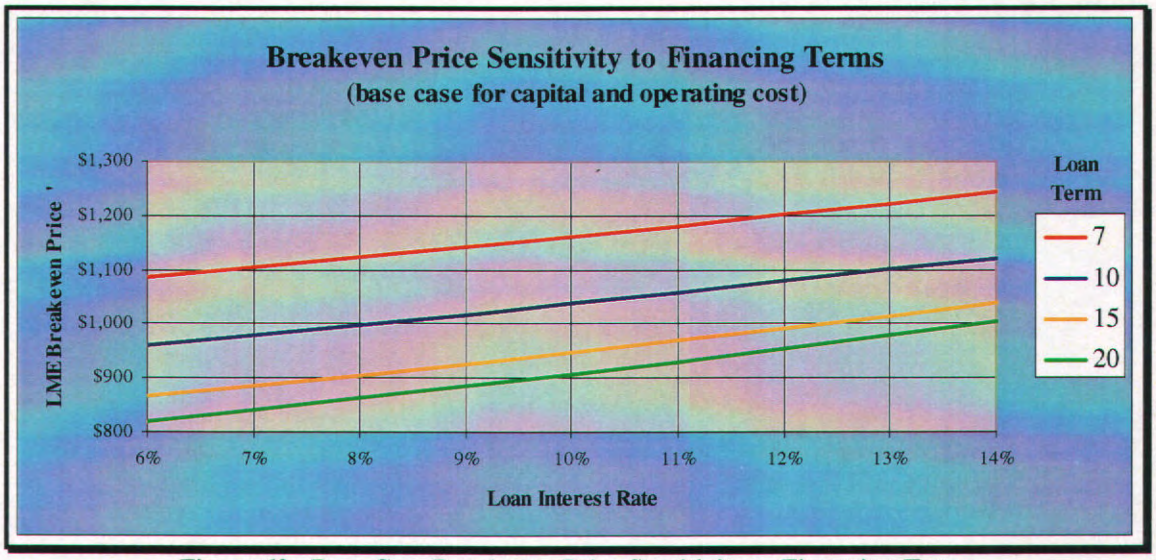


Figure 63: Base Case Breakeven Price Sensitivity to Financing Terms

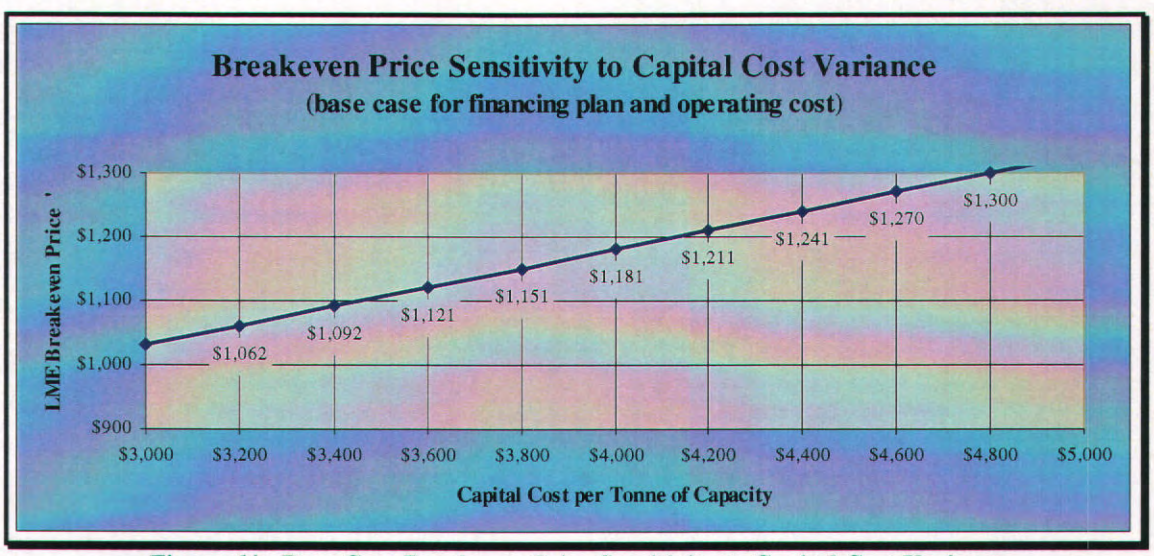


Figure 64: Base Case Breakeven Price Sensitivity to Capital Cost Variance

Even in consideration of conservative assumptions for financing and/or capital cost, the smelter remains cash flow positive at relatively low LME prices. If capital cost is held to less than $3,900 per tonne and aggregate interest rates are 9% or less, the project will be cash flow positive even at the historical low discussed in Section 10, Market Analysis.

13.7.3 Internal Rate of Return Sensitivity to Variance of Key Factors

The following three figures show the effect of capital cost, operating cost and Owner's Equity on IRR, all with respect to average project LME price. Data tables for these graphs are included in Attachment L.

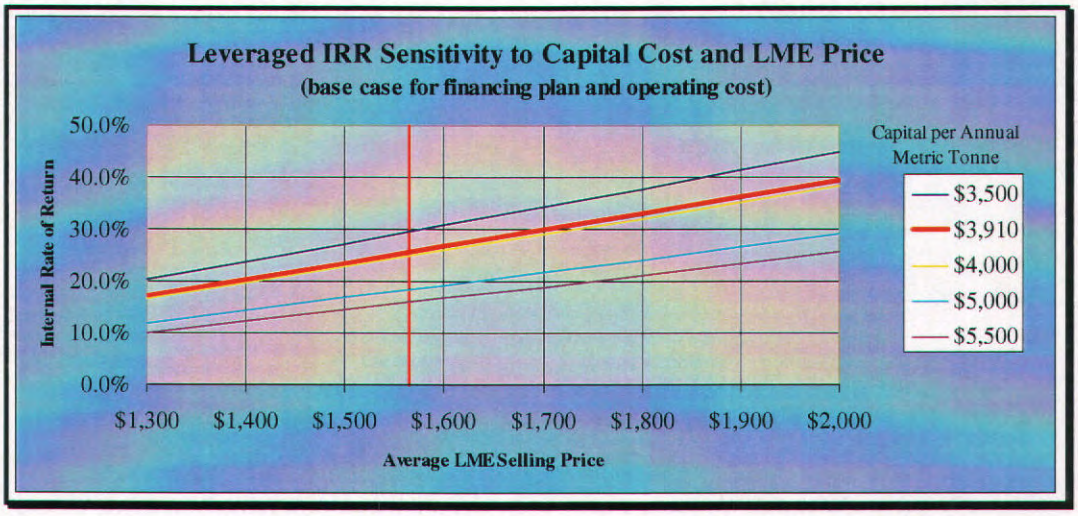


Figure 65: Base Case IRR Sensitivity to Capital Cost Variance and LME Price

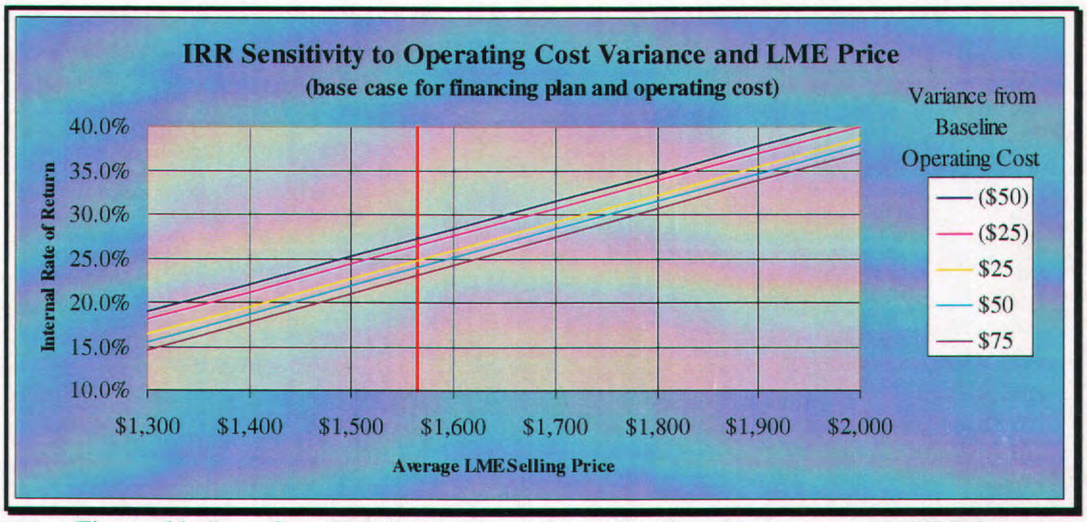


Figure 66: Base Case IRR Sensitivity to Operating Cost Variance and LME Price

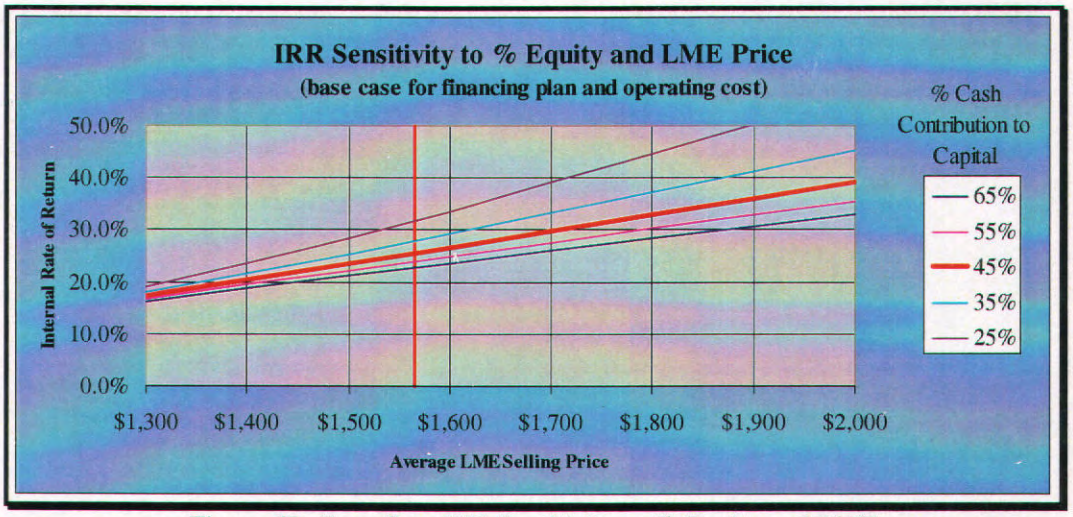


Figure 67: Base Case IRR Sensitivity to % Equity and LME

Based upon these figures, the project estimated returns remain greater than the assumed Cash Discount Rate even under extreme conditions.

Other than market price, operating cost is the most influential factor, which in the case of this project equates to the assumed price of electricity. An increase in power tariff of about $0.002 per kwh results in an approximate drop in leveraged return of 1%.

BEIRA ALUMINIUM SMELTER STUDY

prepared for
The Government of Mozambique
December 1999

Volume 2
Attachments to the Report

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Attachments to the Report

Kaiser K220 PreBake
Beira Reduction Facility

12 November, 1999
Base Case (Rev. 2.3)

Summary of Operating Parameters

Technical Performance	Performance Parameters		Annual Usage	
Potrooms				
Average Current	180	kAmps		
Average Cell Voltage	4.10	volts/cell		
Unit Energy Consumption	12,800	DC-kwh/mT		
Current Efficiency	95.50%	C.E.		
Potrooms Molten Metal Production	302,779	mT(hot)/year		
Number of Potlines	2	potlines		
Number of Cells per Potline	300	cells/line		
Number of Cells	600	cells		
Average Operating Cells	599.4	operating cells		
Nominal Production	1.384	mT/cell-day		
Alumina Consumption (Chemical)	1.892	mT/mT-Al(hot)		
Alumina Consumption (Physical)	1.920	mT/mT-Al(hot)	581,428	mT/yr
Nominal Bath Ratio	1.08	weight ratio		
Aluminium Fluoride Consumption	0.009	mT/mT-Al(hot)	2,618	mT/yr
Cryolite/Cold Bath Consumption	0.000	mT/mT-Al(hot)	149	mT/yr
Anodes/Cell	16	anodes/cell		
Anode Weight (Baked)	1.266	mT		
Anode Changes per Cell-Day	0.551	changes/cell-day		
Anode Exchange Rate	330	anodes/day		
Gross Carbon Factor	0.504	mT/mT-Al(hot)	152,627	mT/yr
Net Carbon Factor	0.400	mT/mT-Al(hot)	121,111	mT/yr
Potrooms Environmental				
Pot Hooding Efficiency	98.50%	% captured		
Gas Collection Draft	5,000	Nm^3/cell-hr		
Aggregate Gas Collection	2,997,000	Nm^3/hr		
Tail Gas Scrubber Water	0	liters/hour	0	m^3/year

Kaiser K220 PreBake
Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Summary of Operating Parameters

Carbon Production				
Baked Carbon Production	154,943	mT/yr		
Baked Carbon Production	332	blocks/day	121,164	blocks/year
Weight Loss on Baking	4.65%	Green to Baked		
Total Capacity	72	sections		
Operating Level	3.07	avg. fires		
Packing Coke Utilization	0.030	mT/mT-C(bk)	4,648	mT/yr
Refractory Consumption	0.006	mT/mT-C(bk)	898	mT/yr
Anode Baking Fuel Consumption	2.52	mBTU/mT-C(bk)	390,297	mBTU/year
Baking Natural Gas Consumption	71,962.3	N-liters/mT-C(bk)	11,150,069	Nm^3/year
Rodding Room Capacity	40	assys/hour		
Rodding Room Utilization	8	8-hr shft/wk		
Rodding Room Iron Consumption	0.33	kg/mT-Al(hot)	100	mT/yr
Green Mill Production Throughput	26	mT/hr		
Green Mill Utilization	16	shifts/wk		
Green Anode Butt Content	20.67%			
Green Anode Coke Content	63.83%			
Green Anode Pitch Content	15.50%			
Petroleum Coke	0.358	mT/mT-Al(hot)	108,364	mT/yr
Coal Tar Pitch	0.083	mT/mT-Al(hot)	25,133	mT/yr
Cell Reconstruction				
Average Cell Life	8.22	years cell life		
Cell Relining Rate	6.1	per month		
SPL Generation	0.017	mT/mT-Al(hot)	5,143	mT/yr
Bottom Blocks Usage	0.00343	mT/mT-Al(hot)	1,039	mT/yr
Side Blocks Usage	0.00055	mT/mT-Al(hot)	166	mT/yr
Ramming Paste Usage	0.00096	mT/mT-Al(hot)	292	mT/yr
Bars and Cast Iron Usage	0.00329	mT/mT-Al(hot)	995	mT/yr
Brick and Other Usage	0.00478	mT/mT-Al(hot)	1,448	mT/yr
Recycled Iron	0.003	mT/mT-Al(hot)	916	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

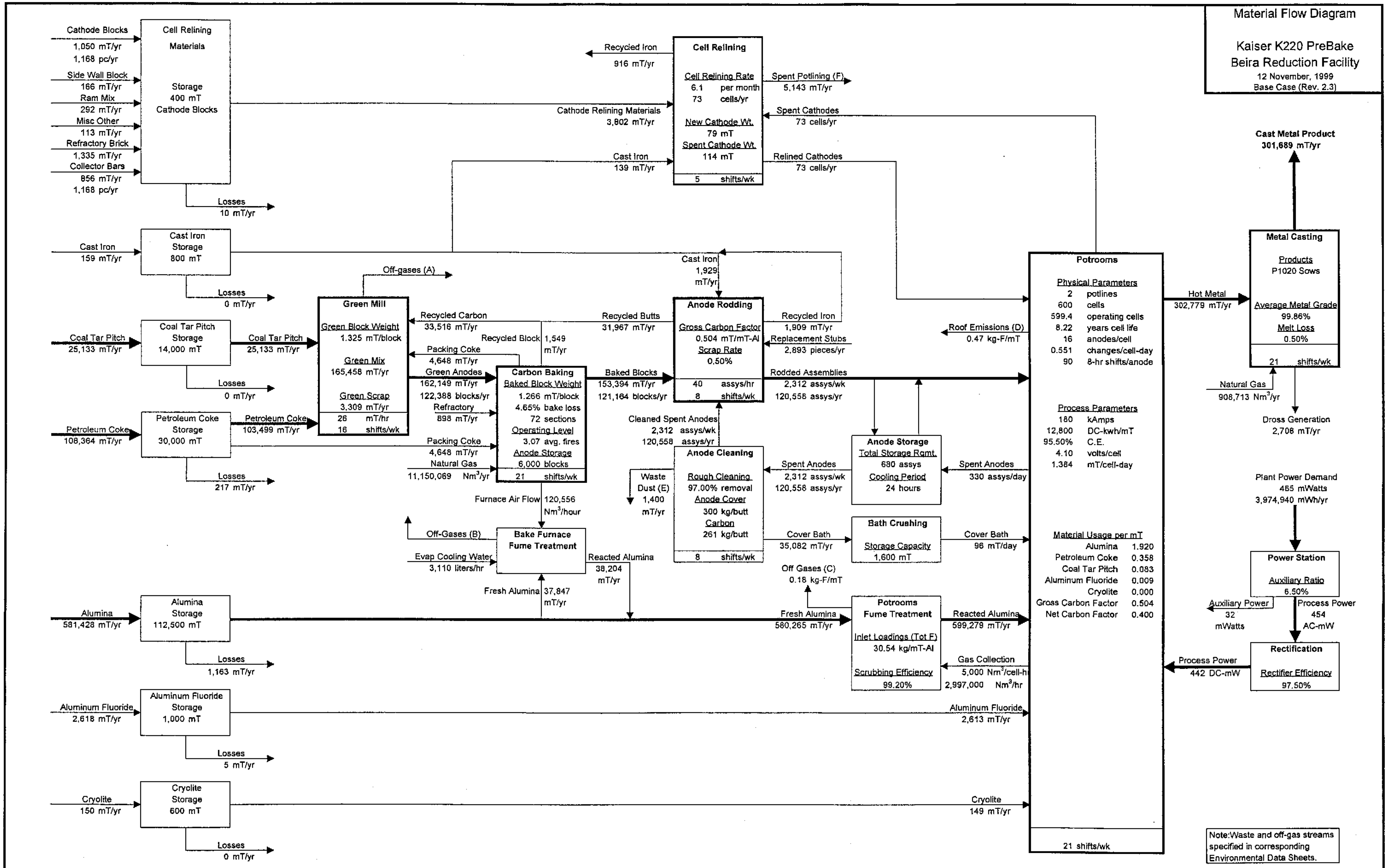
Summary of Operating Parameters

Metal Casting				
Cast Metal Production	301,689	mT(cast)/year		
Average Metal Grade	99.86%	purity		
Melt Loss	0.50%	% lost metal		
Dross Generation	0.89%	mT/mT-Al (hot)	2,708	mT-Al_2O_3/yr
Metal Casting Fuel Consumption	0.105	mBTU/mT-Al(cast)	31,809	mBTU/year
Casting Natural Gas Consumption	3012.1	N-liters/mT-Al(cast)	908,713	Nm^3/year
Electrical Power				
Plant Power Demand	485	mWatts		
Process Power	454	mWatts	3,974,940	mWh/yr
Auxiliary Power	32	mWatts	276,333	mWh/yr

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Summary of Operating Parameters

Inventories and Capacities	Capacity (mTs)	Average Stock (mTs)	Spec'd Capacity
Raw Materials			
Alumina	100,942	68,641	112,500
Petroleum Coke	19,673	13,223	30,000
Coal Tar Pitch	7,918	4,744	14,000
Cathode Blocks	350	262	400
Cast Iron	53	40	800
Aluminum Fluoride	600	382	1,000
Cryolite/Clean Bath	56	31	600
Green Blocks	2,973	2,973	6,000
Baked Blocks	2,940	2,940	(for both)
Cover Bath in Processing	603	603	1,600
WIP Materials			
Aluminum in Cells	3,596	3,596	
Cover Bath in Cells	2,877	2,877	
Carbon in Cells	7,324	7,324	
Molten Bath in Cells	3,596	3,596	
Alumina in Hoppers	2,398	2,398	
Blocks in Baking	9,844	9,844	
Packing Coke	3,600	3,600	
Rodded Carbon (Safety Stock)	138	138	
Rodded Carbon (WIP)	305	305	
Spent Anode Carbon	86	86	
Spent Anode Cover Bath	99	99	
Anode Rods (piece count)	10,360	10,360	
Finished Goods			
Aluminum Ingot	0	0	

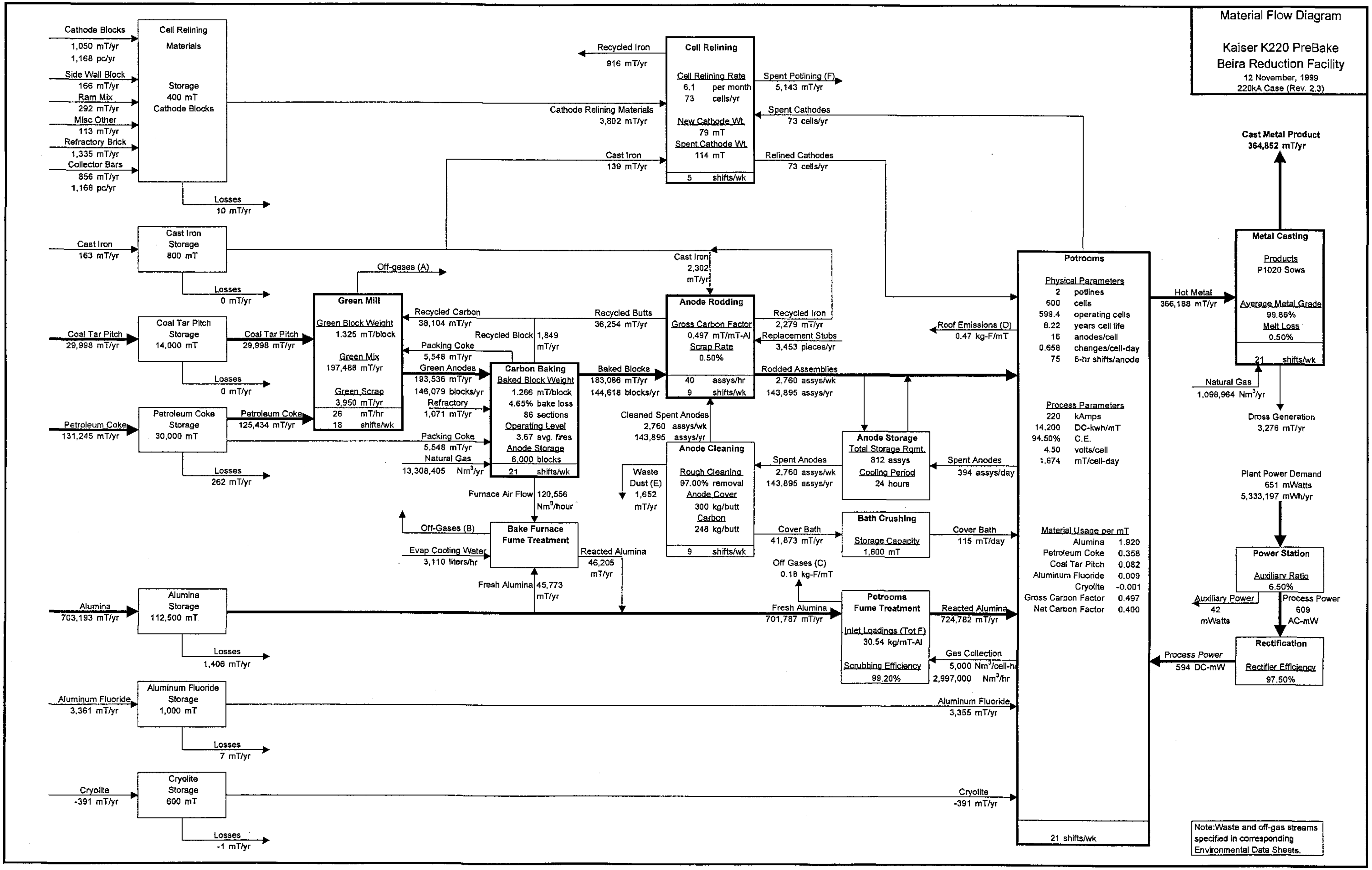


Material Flow Diagram
Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)
Cathode Blocks 1,050 mT/yr 1,168 pc/yr
Side Wall Block 166 mT/yr
Ram Mix 292 mT/yr
Misc Other 113 mT/yr
Refractory Brick 1,335 mT/yr
Collector Bars 856 mT/yr 1,168 pc/yr
Cell Relining Materials Storage 400 mT Cathode Blocks
Losses 10 mT/yr
Cast Iron 159 mT/yr
Cast Iron Storage 800 mT
Losses 0 mT/yr
Coal Tar Pitch 25,133 mT/yr
Coal Tar Pitch Storage 14,000 mT
Losses 0 mT/yr
Coal Tar Pitch 25,133 mT/yr
Petroleum Coke 108,364 mT/yr
Petroleum Coke Storage 30,000 mT
Losses 217 mT/yr
Petroleum Coke 103,499 mT/yr
Alumina 581,428 mT/yr
Alumina Storage 112,500 mT
Losses 1,163 mT/yr
Aluminum Fluoride 2,618 mT/yr
Aluminum Fluoride Storage 1,000 mT
Losses 5 mT/yr
Cryolite 150 mT/yr
Cryolite Storage 600 mT
Losses 0 mT/yr
Off-gases (A)
Green Mill
Green Block Weight 1.325 mT/block
Green Mix 165,458 mT/yr
Green Scrap 3,309 mT/yr
26 mT/hr
16 shifts/wk
Recycled Carbon 33,516 mT/yr
Packing Coke 4,648 mT/yr
Recycled Block 1,549 mT/yr
Green Anodes 162,149 mT/yr 122,388 blocks/yr
Refractory 898 mT/yr
Packing Coke 4,648 mT/yr
Natural Gas 11,150,069 Nm³/yr
Carbon Baking
Baked Block Weight 1.266 mT/block
4.65% bake loss
72 sections
Operating Level 3.07 avg. fires
Anode Storage 6,000 blocks
21 shifts/wk
Furnace Air Flow 120,556 Nm³/hour
Off-Gases (B)
Evap Cooling Water 3,110 liters/hr
Bake Furnace Fume Treatment
Fresh Alumina 37,847 mT/yr
Reacted Alumina 38,204 mT/yr
Recycled Iron 916 mT/yr
Cell Relining
Cell Relining Rate 6.1 per month 73 cells/yr
New Cathode Wt. 79 mT
Spent Cathode Wt. 114 mT
5 shifts/wk
Cathode Relining Materials 3,802 mT/yr
Cast Iron 139 mT/yr
Spent Potlining (F) 5,143 mT/yr
Spent Cathodes 73 cells/yr
Relined Cathodes 73 cells/yr
Cast Iron 1,929 mT/yr
Recycled Butts 31,967 mT/yr
Anode Rodding
Gross Carbon Factor 0.504 mT/mT-Al
Scrap Rate 0.50%
40 assys/hr
8 shifts/wk
Recycled Iron 1,909 mT/yr
Replacement Stubs 2,893 pieces/yr
Baked Blocks 153,394 mT/yr 121,164 blocks/yr
Rodded Assemblies 2,312 assys/wk 120,558 assys/yr
Cleaned Spent Anodes 2,312 assys/wk 120,558 assys/yr
Anode Cleaning
Rough Cleaning 97.00% removal
Anode Cover 300 kg/butt
Carbon 261 kg/butt
8 shifts/wk
Waste Dust (E) 1,400 mT/yr
Spent Anodes 2,312 assys/wk 120,558 assys/yr
Anode Storage
Total Storage Rqmt. 680 assys
Cooling Period 24 hours
Spent Anodes 330 assys/day
Cover Bath 35,082 mT/yr
Bath Crushing
Storage Capacity 1,600 mT
Cover Bath 96 mT/day
Off Gases (C) 0.18 kg-F/mT
Fresh Alumina 580,265 mT/yr
Potrooms Fume Treatment
Inlet Loadings (Tot F) 30.54 kg/mT-Al
Scrubbing Efficiency 99.20%
Reacted Alumina 599,279 mT/yr
Gas Collection 5,000 Nm³/cell-hr 2,997,000 Nm³/hr
Aluminum Fluoride 2,613 mT/yr
Cryolite 149 mT/yr
Roof Emissions (D) 0.47 kg-F/mT
Potrooms
Physical Parameters
2 potlines
600 cells
599.4 operating cells
8.22 years cell life
16 anodes/cell
0.551 changes/cell-day
90 8-hr shifts/anode
Process Parameters
180 kAmps
12,800 DC-kwh/mT
95.50% C.E.
4.10 volts/cell
1.384 mT/cell-day
Material Usage per mT
Alumina 1.920
Petroleum Coke 0.358
Coal Tar Pitch 0.083
Aluminum Fluoride 0.009
Cryolite 0.000
Gross Carbon Factor 0.504
Net Carbon Factor 0.400
21 shifts/wk
Hot Metal 302,779 mT/yr
Metal Casting
Products P1020 Sows
Average Metal Grade 99.86%
Melt Loss 0.50%
21 shifts/wk
Cast Metal Product 301,689 mT/yr
Natural Gas 908,713 Nm³/yr
Dross Generation 2,708 mT/yr
Plant Power Demand 465 mWatts 3,974,940 mWh/yr
Power Station
Auxiliary Ratio 6.50%
Auxiliary Power 32 mWatts
Process Power 454 AC-mW
Rectification
Rectifier Efficiency 97.50%
Process Power 442 DC-mW
Note:Waste and off-gas streams specified in corresponding Environmental Data Sheets.

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
220kA Case (Rev. 2.3)

Summary of Operating Parameters

Technical Performance	Performance Parameters		Annual Usage	
Potrooms				
Average Current	220	kAmps		
Average Cell Voltage	4.50	volts/cell		
Unit Energy Consumption	14,200	DC-kwh/mT		
Current Efficiency	94.50%	C.E.		
Potrooms Molten Metal Production	366,188	mT(hot)/year		
Number of Potlines	2	potlines		
Number of Cells per Potline	300	cells/line		
Number of Cells	600	cells		
Average Operating Cells	599.4	operating cells		
Nominal Production	1.674	mT/cell-day		
Alumina Consumption (Chemical)	1.892	mT/mT-Al(hot)		
Alumina Consumption (Physical)	1.920	mT/mT-Al(hot)	703,193	mT/yr
Nominal Bath Ratio	1.08	weight ratio		
Aluminium Fluoride Consumption	0.009	mT/mT-Al(hot)	3,361	mT/yr
Cryolite/Cold Bath Consumption	-0.001	mT/mT-Al(hot)	-391	mT/yr
Anodes/Cell	16	anodes/cell		
Anode Weight (Baked)	1.266	mT		
Anode Changes per Cell-Day	0.658	changes/cell-day		
Anode Exchange Rate	394	anodes/day		
Gross Carbon Factor	0.497	mT/mT-Al(hot)	182,171	mT/yr
Net Carbon Factor	0.400	mT/mT-Al(hot)	146,475	mT/yr
Potrooms Environmental				
Pot Hooding Efficiency	98.50%	% captured		
Gas Collection Draft	5,000	Nm^3/cell-hr		
Aggregate Gas Collection	2,997,000	Nm^3/hr		
Tail Gas Scrubber Water	0	liters/hour	0	m^3/year


Material Flow Diagram
Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
220kA Case (Rev. 2.3)
Cathode Blocks
1,050 mT/yr
1,168 pc/yr
Side Wall Block
166 mT/yr
Ram Mix
292 mT/yr
Misc Other
113 mT/yr
Refractory Brick
1,335 mT/yr
Collector Bars
856 mT/yr
1,168 pc/yr
Cell Relining
Materials
Storage
400 mT
Cathode Blocks
Losses
10 mT/yr
Cast Iron
163 mT/yr
Cast Iron
Storage
800 mT
Losses
0 mT/yr
Coal Tar Pitch
29,998 mT/yr
Coal Tar Pitch
Storage
14,000 mT
Losses
0 mT/yr
Coal Tar Pitch
29,998 mT/yr
Petroleum Coke
131,245 mT/yr
Petroleum Coke
Storage
30,000 mT
Losses
262 mT/yr
Petroleum Coke
125,434 mT/yr
Green Mill
Green Block Weight
1.325 mT/block
Green Mix
197,486 mT/yr
Green Scrap
3,950 mT/yr
26 mT/hr
18 shifts/wk
Off-gases (A)
Recycled Carbon
38,104 mT/yr
Packing Coke
5,548 mT/yr
Green Anodes
193,536 mT/yr
146,079 blocks/yr
Refractory
1,071 mT/yr
Packing Coke
5,548 mT/yr
Natural Gas
13,308,405 Nm³/yr
Recycled Block 1,849 mT/yr
Carbon Baking
Baked Block Weight
1.266 mT/block
4.65% bake loss
86 sections
Operating Level
3.67 avg. fires
Anode Storage
6,000 blocks
21 shifts/wk
Furnace Air Flow 120,556 Nm³/hour
Off-Gases (B)
Evap Cooling Water
3,110 liters/hr
Bake Furnace
Fume Treatment
Reacted Alumina
46,205
mT/yr
Fresh Alumina 45,773 mT/yr
Alumina
703,193 mT/yr
Alumina
Storage
112,500 mT
Losses
1,406 mT/yr
Aluminum Fluoride
3,361 mT/yr
Aluminum Fluoride
Storage
1,000 mT
Losses
7 mT/yr
Cryolite
-391 mT/yr
Cryolite
Storage
600 mT
Losses
-1 mT/yr
Recycled Iron
816 mT/yr
Cathode Relining Materials
3,802 mT/yr
Cast Iron
139 mT/yr
Cell Relining
Cell Relining Rate
6.1 per month
73 cells/yr
New Cathode Wt.
79 mT
Spent Cathode Wt.
114 mT
5 shifts/wk
Spent Potlining (F)
5,143 mT/yr
Spent Cathodes
73 cells/yr
Relined Cathodes
73 cells/yr
Recycled Butts
36,254 mT/yr
Baked Blocks
183,086 mT/yr
144,618 blocks/yr
Cast Iron
2,302
mT/yr
Anode Rodding
Gross Carbon Factor
0.497 mT/mT-Al
Scrap Rate
0.50%
40 assys/hr
9 shifts/wk
Recycled Iron
2,279 mT/yr
Replacement Stubs
3,453 pieces/yr
Rodded Assemblies
2,760 assys/wk
143,895 assys/yr
Cleaned Spent Anodes
2,760 assys/wk
143,895 assys/yr
Anode Cleaning
Rough Cleaning
97.00% removal
Anode Cover
300 kg/butt
Carbon
248 kg/butt
9 shifts/wk
Waste
Dust (E)
1,652
mT/yr
Spent Anodes
2,760 assys/wk
143,895 assys/yr
Anode Storage
Total Storage Rqmt.
812 assys
Cooling Period
24 hours
Spent Anodes
394 assys/day
Cover Bath
41,873 mT/yr
Bath Crushing
Storage Capacity
1,600 mT
Cover Bath
115 mT/day
Off Gases (C)
0.18 kg-F/mT
Fresh Alumina
701,787 mT/yr
Potrooms
Fume Treatment
Inlet Loadings (Tot F)
30.54 kg/mT-Al
Scrubbing Efficiency
99.20%
Reacted Alumina
724,782 mT/yr
Gas Collection
5,000 Nm³/cell-hr
2,997,000 Nm³/hr
Aluminum Fluoride
3,355 mT/yr
Cryolite
-391 mT/yr
Roof Emissions (D)
0.47 kg-F/mT
Potrooms
Physical Parameters
2 potlines
600 cells
599.4 operating cells
8.22 years cell life
16 anodes/cell
0.658 changes/cell-day
75 8-hr shifts/anode
Process Parameters
220 kAmps
14,200 DC-kwh/mT
94.50% C.E.
4.50 volts/cell
1.674 mT/cell-day
Material Usage per mT
Alumina 1.920
Petroleum Coke 0.358
Coal Tar Pitch 0.082
Aluminum Fluoride 0.009
Cryolite -0.001
Gross Carbon Factor 0.497
Net Carbon Factor 0.400
21 shifts/wk
Hot Metal
366,188 mT/yr
Metal Casting
Products
P1020 Sows
Average Metal Grade
99.86%
Melt Loss
0.50%
21 shifts/wk
Cast Metal Product
364,852 mT/yr
Natural Gas
1,098,964 Nm³/yr
Dross Generation
3,276 mT/yr
Plant Power Demand
651 mWatts
5,333,197 mWh/yr
Power Station
Auxiliary Ratio
6.50%
Auxiliary Power
42
mWatts
Process Power
609
AC-mW
Rectification
Rectifier Efficiency
97.50%
Process Power
594 DC-mW
Note:Waste and off-gas streams specified in corresponding Environmental Data Sheets.

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
220kA Case (Rev. 2.3)

Summary of Operating Parameters

Carbon Production				
Baked Carbon Production	184,936	mT/yr		
Baked Carbon Production	396	blocks/day	144,618	blocks/year
Weight Loss on Baking	4.65%	Green to Baked		
Total Capacity	86	sections		
Operating Level	3.67	avg. fires		
Packing Coke Utilization	0.030	mT/mT-C(bk)	5,548	mT/yr
Refractory Consumption	0.006	mT/mT-C(bk)	1,071	mT/yr
Anode Baking Fuel Consumption	2.52	mBTU/mT-C(bk)	465,847	mBTU/year
Baking Natural Gas Consumption	71,962.3	N-liters/mT-C(bk)	13,308,405	Nm^3/year
Rodding Room Capacity	40	assys/hour		
Rodding Room Utilization	9	8-hr shft/wk		
Rodding Room Iron Consumption	0.33	kg/mT-Al(hot)	120	mT/yr
Green Mill Production Throughput	26	mT/hr		
Green Mill Utilization	18	shifts/wk		
Green Anode Butt Content	19.69%			
Green Anode Coke Content	64.81%			
Green Anode Pitch Content	15.50%			
Petroleum Coke	0.358	mT/mT-Al(hot)	131,245	mT/yr
Coal Tar Pitch	0.082	mT/mT-Al(hot)	29,998	mT/yr
Cell Reconstruction				
Average Cell Life	8.22	years cell life		
Cell Relining Rate	6.1	per month		
SPL Generation	0.014	mT/mT-Al(hot)	5,143	mT/yr
Bottom Blocks Usage	0.00284	mT/mT-Al(hot)	1,039	mT/yr
Side Blocks Usage	0.00045	mT/mT-Al(hot)	166	mT/yr
Ramming Paste Usage	0.00080	mT/mT-Al(hot)	292	mT/yr
Bars and Cast Iron Usage	0.00272	mT/mT-Al(hot)	995	mT/yr
Brick and Other Usage	0.00395	mT/mT-Al(hot)	1,448	mT/yr
Recycled Iron	0.003	mT/mT-Al(hot)	916	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
220kA Case (Rev. 2.3)

Summary of Operating Parameters

Metal Casting				
Cast Metal Production	364,852	mT(cast)/year		
Average Metal Grade	99.86%	purity		
Melt Loss	0.50%	% lost metal		
Dross Generation	0.89%	mT/mT-Al (hot)	3,276	mT-Al_2O_3/yr
Metal Casting Fuel Consumption	0.105	mBTU/mT-Al(cast)	38,468	mBTU/year
Casting Natural Gas Consumption	3012.1	N-liters/mT-Al(cast)	1,098,964	Nm^3/year
Electrical Power				
Plant Power Demand	651	mWatts		
Process Power	609	mWatts	5,333,197	mWh/yr
Auxiliary Power	42	mWatts	370,757	mWh/yr

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
220kA Case (Rev. 2.3)

Summary of Operating Parameters

Inventories and Capacities	Capacity (mTs)	Average Stock (mTs)	Spec'd Capacity
Raw Materials			
Alumina	122,082	83,016	112,500
Petroleum Coke	23,827	16,015	30,000
Coal Tar Pitch	9,450	5,663	14,000
Cathode Blocks	350	262	400
Cast Iron	54	41	800
Aluminum Fluoride	770	490	1,000
Cryolite/Clean Bath	147	82	600
Green Blocks	3,548	3,548	6,000
Baked Blocks	3,662	3,662	(for both)
Cover Bath in Processing	719	719	1,600
WIP Materials			
Aluminum in Cells	3,596	3,596	
Cover Bath in Cells	2,877	2,877	
Carbon in Cells	7,260	7,260	
Molten Bath in Cells	3,596	3,596	
Alumina in Hoppers	2,398	2,398	
Blocks in Baking	11,759	11,759	
Packing Coke	4,300	4,300	
Rodded Carbon (Safety Stock)	165	165	
Rodded Carbon (WIP)	364	364	
Spent Anode Carbon	98	98	
Spent Anode Cover Bath	118	118	
Anode Rods (piece count)	10,492	10,492	
Finished Goods			
Aluminum Ingot	0	0	

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Environmental Performance Indicators

	Performance Indication Rate	Performance Indication Units	Predicted Annual Total	Predicted Annual Units
Plant Environmental Summary				
Air Emissions (Primary Constituents)				
Gaseous fluoride	0.324	kg/mT-Al	98.0	mT/yr
Particulate fluoride	0.333	kg/mT-Al	101.0	mT/yr
Alumina dust	2.092	kg/mT-Al	633.5	mT/yr
SO_x	17.306	kg/mT-Al	5,239.9	mT/yr
POMs	0.056	kg/mT-Al	17.0	mT/yr
Total Fluoride	0.657	kg/mT-Al	199.0	mT/yr
Total Particulate Matter	2.843	kg/mT-Al	860.9	mT/yr
Water Effluent				
No Sources				
Solid Waste				
Anode Cleaning Dust (from shot blasting)	3.8	mT/day	1,400	mT/yr
Spent Potlining	14.1	mT/day	5,143	mT/yr
Green Mill				
Air Emissions (Stream "A" on Material Flow Diagram)				
Rate of Flow	66,000	Nm^3/hr		
POMs	0.040	kg/mT-Al	12.1	mT/yr
Cooling Water Effluents (Not shown on Material Flow Diagram)				
Rate of Flow	0.000	liters/hr		
Benzo(a)pyrene	0.000	mg/kg-Al	0.000	mT/yr
Antimony	0.000	mg/kg-Al	0.000	mT/yr
Nickel	0.000	mg/kg-Al	0.000	mT/yr
Aluminum	0.000	mg/kg-Al	0.000	mT/yr
Fluoride	0.000	mg/kg-Al	0.000	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility

12 November, 1999
Base Case (Rev. 2.3)

Environmental Performance Indicators

	Performance Indication Rate	Units	Predicted Annual Total	Units
Carbon Baking				
Air Emissions				
(Stream "B" on Material Flow Diagram)				
Rate of Flow	120,556	Nm^3/hr		
Gaseous Fluoride	0.007	kg/mT-Al	2.2	mT/yr
POMs	0.014	kg/mT-Al	4.2	mT/yr
Air Emissions				
(Stream "C" on Material Flow Diagram)				
Rate of Flow	2,997,000	Nm^3/hr		
Gaseous fluoride	0.020	kg/mT-Al	5.9	mT/yr
Particulate fluoride	0.165	kg/mT-Al	50.1	mT/yr
Alumina dust	0.092	kg/mT-Al	28.0	mT/yr
PFCs	0.030	kg/mT-Al	8.9	mT/yr
CO_2	1379	kg/mT-Al	417,531.8	mT/yr
CO	197	kg/mT-Al	59,647.4	mT/yr
SO_x	17.0	kg/mT-Al	5,161.3	mT/yr
NO_x	0.000	kg/mT-Al	0.0	mT/yr
Organics	0.000	kg/mT-Al	0.1	mT/yr
Scrubber Water Effluents				
(Not shown on Material Flow Diagram)				
Rate of Flow	0.000	liters/hr		
Dissolved fluoride	0.000	kg/mT-Al	0.0	mT/yr
Suspended particulate fluoride	0.000	kg/mT-Al	0.0	mT/yr
Suspended alumina dust	0.000	kg/mT-Al	0.0	mT/yr
Dissolved PFCs	0.000	kg/mT-Al	0.0	mT/yr
Dissolved CO_2	0.000	kg/mT-Al	0.0	mT/yr
Dissolved CO	0.000	kg/mT-Al	0.0	mT/yr
Dissolved SO_x	0.000	kg/mT-Al	0.0	mT/yr
Dissolved NO_x	0.000	kg/mT-Al	0.0	mT/yr
Suspended Organics	0.000	kg/mT-Al	0.0	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Environmental Performance Indicators

	Performance Indication Rate	Units	Predicted Annual Total	Units
Potrooms Roof Monitors				
Air Emissions				
(Stream "D" on Material Flow Diagram)				
Rate of Flow		Nm^3/hr		
Gaseous fluoride	0.297	kg/mT-Al	89.9	mT/yr
Particulate fluoride	0.168	kg/mT-Al	50.9	mT/yr
Alumina dust	2.000	kg/mT-Al	605.6	mT/yr
PFCs	0.000	kg/mT-Al	0.1	mT/yr
CO_2	21.000	kg/mT-Al	6,358.4	mT/yr
CO	3.000	kg/mT-Al	908.3	mT/yr
SO_x	0.260	kg/mT-Al	78.6	mT/yr
NO_x	0.000	kg/mT-Al	0.0	mT/yr
Organics	0.002	kg/mT-Al	0.6	mT/yr
Anode Cleaning				
Solid Wastes				
(Stream "E" on Material Flow Diagram)				
Rate of Generation	3.8	mT/day	1,400	mT/yr
Fine Cleaning Dust (Cryolite-Alumina)	3.6	kg/mT-Al	1085	mT/yr
Fine Cleaning Dust (Carbon)	1.0	kg/mT-Al	315	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Environmental Performance Indicators

	Performance Indication		Predicted Annual	
	Rate	Units	Total	Units
Pot Relining				
<u>Solid Waste (Spent Potlining)</u>				
(Stream "E" on Material Flow Diagram)				
Rate of Generation	14.1	mT/day	5,143	mT/yr
Carbon	5.1	kg/mT-Al	1,543	mT/yr
Sodium	2.9	kg/mT-Al	874	mT/yr
Aluminum	2.0	kg/mT-Al	617	mT/yr
Fluoride	2.9	kg/mT-Al	869	mT/yr
Calcium	0.5	kg/mT-Al	154	mT/yr
Lithium	0.1	kg/mT-Al	15	mT/yr
Magnesium	0.1	kg/mT-Al	15	mT/yr
Silicon	0.7	kg/mT-Al	206	mT/yr
Iron	0.2	kg/mT-Al	51	mT/yr
Sulfur	0.0	kg/mT-Al	10	mT/yr
Cyanide	0.0	kg/mT-Al	2	mT/yr
Balance as Oxide	2.6	kg/mT-Al	786	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility

12 November, 1999
220kA Case (Rev. 2.3)

Environmental Performance Indicators

	Performance Indication Rate	Units	Predicted Annual Total	Units
Plant Environmental Summary				
Air Emissions (Primary Constituents)				
Gaseous fluoride	0.324	kg/mT-Al	118.5	mT/yr
Particulate fluoride	0.333	kg/mT-Al	122.1	mT/yr
Alumina dust	2.092	kg/mT-Al	766.2	mT/yr
SO_x	17.306	kg/mT-Al	6,337.2	mT/yr
POMs	0.056	kg/mT-Al	20.6	mT/yr
Total Fluoride	0.657	kg/mT-Al	240.7	mT/yr
Total Particulate Matter	2.843	kg/mT-Al	1,041.2	mT/yr
Water Effluent				
No Sources				
Solid Waste				
Anode Cleaning Dust (from shot blasting)	4.5	mT/day	1,652	mT/yr
Spent Potlining	14.1	mT/day	5,143	mT/yr
Green Mill				
Air Emissions (Stream "A" on Material Flow Diagram)				
Rate of Flow	66,000	Nm^3/hr		
POMs	0.040	kg/mT-Al	14.6	mT/yr
Cooling Water Effluents (Not shown on Material Flow Diagram)				
Rate of Flow	0.000	liters/hr		
Benzo(a)pyrene	0.000	mg/kg-Al	0.000	mT/yr
Antimony	0.000	mg/kg-Al	0.000	mT/yr
Nickel	0.000	mg/kg-Al	0.000	mT/yr
Aluminum	0.000	mg/kg-Al	0.000	mT/yr
Fluoride	0.000	mg/kg-Al	0.000	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility

12 November, 1999

220kA Case (Rev. 2.3)

Environmental Performance Indicators

	Performance Indication Rate	Units	Predicted Annual Total	Units
Carbon Baking				
Air Emissions				
(Stream "B" on Material Flow Diagram)				
Rate of Flow	120,556	Nm^3/hr		
Gaseous Fluoride	0.007	kg/mT-Al	2.6	mT/yr
POMs	0.014	kg/mT-Al	5.1	mT/yr
Air Emissions				
(Stream "C" on Material Flow Diagram)				
Rate of Flow	2,997,000	Nm^3/hr		
Gaseous fluoride	0.020	kg/mT-Al	7.1	mT/yr
Particulate fluoride	0.165	kg/mT-Al	60.6	mT/yr
Alumina dust	0.092	kg/mT-Al	33.8	mT/yr
PFCs	0.030	kg/mT-Al	10.8	mT/yr
CO_2	1379	kg/mT-Al	504,973.0	mT/yr
CO	197	kg/mT-Al	72,139.0	mT/yr
SO_x	17.0	kg/mT-Al	6,242.2	mT/yr
NO_x	0.000	kg/mT-Al	0.0	mT/yr
Organics	0.000	kg/mT-Al	0.1	mT/yr
Scrubber Water Effluents				
(Not shown on Material Flow Diagram)				
Rate of Flow	0.000	liters/hr		
Dissolved fluoride	0.000	kg/mT-Al	0.0	mT/yr
Suspended particulate fluoride	0.000	kg/mT-Al	0.0	mT/yr
Suspended alumina dust	0.000	kg/mT-Al	0.0	mT/yr
Dissolved PFCs	0.000	kg/mT-Al	0.0	mT/yr
Dissolved CO_2	0.000	kg/mT-Al	0.0	mT/yr
Dissolved CO	0.000	kg/mT-Al	0.0	mT/yr
Dissolved SO_x	0.000	kg/mT-Al	0.0	mT/yr
Dissolved NO_x	0.000	kg/mT-Al	0.0	mT/yr
Suspended Organics	0.000	kg/mT-Al	0.0	mT/yr

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Environmental Performance Indicators

	Performance Indication Rate	Units	Predicted Annual Total	Units
Potrooms Roof Monitors				
Air Emissions				
(Stream "D" on Material Flow Diagram)				
Rate of Flow		Nm^3/hr		
Gaseous fluoride	0.297	kg/mT-Al	108.8	mT/yr
Particulate fluoride	0.168	kg/mT-Al	61.5	mT/yr
Alumina dust	2.000	kg/mT-Al	732.4	mT/yr
PFCs	0.000	kg/mT-Al	0.2	mT/yr
CO_2	21.000	kg/mT-Al	7,689.9	mT/yr
CO	3.000	kg/mT-Al	1,098.6	mT/yr
SO_x	0.260	kg/mT-Al	95.1	mT/yr
NO_x	0.000	kg/mT-Al	0.0	mT/yr
Organics	0.002	kg/mT-Al	0.7	mT/yr
Anode Cleaning				
Solid Wastes				
(Stream "E" on Material Flow Diagram)				
Rate of Generation	4.5	mT/day	1,652	mT/yr
Fine Cleaning Dust (Cryolite-Alumina)	3.5	kg/mT-Al	1295	mT/yr
Fine Cleaning Dust (Carbon)	1.0	kg/mT-Al	357	mT/yr

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
220kA Case (Rev. 2.3)

Environmental Performance Indicators

	Performance Indication		Predicted Annual	
	Rate	Units	Total	Units
Pot Relining				
<u>Solid Waste (Spent Potlining)</u>				
(Stream "E" on Material Flow Diagram)				
Rate of Generation	14.1	mT/day	5,143	mT/yr
Carbon	4.2	kg/mT-Al	1,543	mT/yr
Sodium	2.4	kg/mT-Al	874	mT/yr
Aluminum	1.7	kg/mT-Al	617	mT/yr
Fluoride	2.4	kg/mT-Al	869	mT/yr
Calcium	0.4	kg/mT-Al	154	mT/yr
Lithium	0.0	kg/mT-Al	15	mT/yr
Magnesium	0.0	kg/mT-Al	15	mT/yr
Silicon	0.6	kg/mT-Al	206	mT/yr
Iron	0.1	kg/mT-Al	51	mT/yr
Sulfur	0.0	kg/mT-Al	10	mT/yr
Cyanide	0.0	kg/mT-Al	2	mT/yr
Balance as Oxide	2.1	kg/mT-Al	786	mT/yr

SITE SELECTION ANALYSIS FOR B.A.S.S.

Objectives		Alternatives											
		A. CFM Site in Beira			B. Beira Industrial Site			C. Dondo Industrial Site			D. JCI Savanne Site		
MUST		**Info**		**Go/No**	**Info**		**Go/No**	**Info**		**Go/No**	**Info**		**Go/No**
Minimum 100 ha. Area		Minimal - no buffer		Go	200 ha. plus		Go	250 ha.		Go	8000 ha. Available		Go
In Beira Area		In Beira		Go	In Beira		Go	Near Beira		Go	Near Beira		Go
Port Access		In the Port of Beira		Go	Adjacent to Port of Beira		Go	25 km to Port of Beira		Go	25 km to Port of Beira		Go
Government Support		Not Preferred		Go	Municipal Support		Go	Regional Support		Go	Regional Support		Go
Trainable Workforce		In Beira		Go	In Beira		Go	From Beira & Dondo		Go	From Beira & Region		Go
Tax & Duties Concessions		Eligible for FTZ		Go	Eligible for FTZ		Go	Eligible for FTZ		Go	Site is Designated FEZ		Go
WANT	**Wt.**	**Info.**	**Sc.**	**Wt. Sc.**	**Info.**	**Sc.**	**Wt. Sc.**	**Info.**	**Sc.**	**Wt. Sc.**	**Info.**	**Sc.**	**Wt. Sc.**
Minimum Site Development Cost	10	Fill and seawall needed	7	70	Fill and short road connection needed.	8	80	Rail connection needed.	10	100	Low land with no access	6	60
Positive Impact on Beira Infrastructure	8	In Beira	9	72	In Beira	10	80	25 km outside Beira	7	56	In remote area	6	48
Good Logistics	9	In port.	10	90	Close to port and rail	9	81	On main road and rail	8	72	No road, rail or dock	6	54
Expansion/Buffer Area	8	Very limited	4	32	Adequate, but near existing residential	7	56	Need to rezone planned adjacent residential	8	64	Adequate	10	80
Minimal Environmental Impact	6	Mangroves at water front	7	42	Wetlands, but zoned industrial	8	48	Zoned industrial	10	60	Wetlands with mangroves	5	30
Housing Available	5	Available in Beira	9	45	Available in Beira and adjacent to site	10	50	Available in Beira and limited in Dondo	8	40	Available in Beira, but none locally	6	30
Compatability with Neighbours	8	Will severely limit port expansion	5	40	No current neighbours	9	72	Adjacent to cement factory and future residential	7	56	No current neighbours and no planned residential	10	80
Expat Living and Travel	4	Close to Beira accommodation and airport	9	36	Close to Beira accommodation and airport	10	40	25 km travel on Beira - Harare road	8	32	Initially difficult	7	28
Operating Costs	9	Close to raw materials import point	10	90	Short distance to port	9	81	25 km from port, but on main road and rail	7	63	25 km from port with no existing road or rail	6	54
Total Weighted Score				**517**			**588**			**543**			**464**

Technical Report

PRE-FEASIBILITY STUDY FOR DELIVERING 625 MW TO THE BEIRA AREA

ABB

TABLE OF CONTENTS

INTRODUCTION

The intent of this report is to serve as an initial step in scoping electrical infrastructure development for supplying the Beira area. The purpose of this report is to:

- list the power supply alternatives that can been considered in the short term for the Beira Aluminum Smelter,
- identify the alternative(s) that is/are both technically and economically best,
- list potential roadblocks for the different alternatives (political and technical).

The Beira Aluminum Smelter will require between 485 MW and 625 MW power depending on the final production level of the smelter. This study uses a 625 MW infeed to Beira Aluminum Smelter as the base alternative. The consequences if the capacity of the power delivery system is reduced to 485 MW or increased to 800 MW (625 MW to Beira Aluminium Smelter plus 175 MW to future loads in the Beira area) are briefly described in the report. This is to ensure that the selected alternative does not unnecessarily limit further development of the Beira region in terms of new loads and new generation.

Because prolonged outages have huge operational and financial implications, the smelter requires a very reliable power supply. The study, therefore, uses an (N-1)-criterion for the reliability of the power delivery system. This means that one item of equipment in the transmission system can be taken out of service without interfering with the 625 MW power infeed to Beira. Only the case of transmission line towers collapsing has however not been considered in the (N-1)-criterion, as it a very unlikely event. The consequences if an N-criterion is applied are also discussed in the report.

The study is also based on a number of assumptions, since little site investigation, etc. has been done. All prices given in this report are based on preliminary prices, in local currencies, with December 1999 as the base month. The accuracy of the overall price of each alternative, therefore, varies according to exchange rates with respect to USD.

POWER SOURCES

The alternatives for power sources are:

1. Cahora Bassa power station
2. Eskom grid
3. New gas fired generation in Beira

Possible future sources can only be considered as long-term alternatives, and they are not considered in this phase of the study. These projects may improve the power situation if they go ahead, though. These sources include:

- Moatize – There are still too many uncertainties surrounding this project. In addition, indications are that the busbar energy price from Moatize would be around 20 mils, which makes it extremely unattractive for this project.
- Mepanda Uncua – The project is currently under investigation, but it also has too many uncertainties. The long lead-time to build the dam also means that this power will certainly not be available before 2007 to 2008, which is too late for the Beira Aluminum Smelter. Mepanda Uncua may become an alternative at a later stage though.
- North Bank of Cahora Bassa – This project is currently under investigation, but it has a long lead-time.

TRANSMISSION ALTERNATIVES

Cahora Bassa power

DC tapping of existing HVDC line

This alternative is to install an HVDC tap on the existing Cahora Bassa to Apollo intertie. There are in principle two different technical solutions to do this tapping:

1. An HVDC converter tapping station close to the existing HVDC line (e.g. at Chibata or Chimoyo) and two new 220 kV AC lines to Beira.
2. Installing a T-junction on the existing HVDC line and build a bipolar HVDC line to a new HVDC converter station in Beira.

Alternative 2 is selected because it has several advantages compared with 1:

- Economy - A bipolar HVDC line is cheaper than two AC lines and an additional AC substation.
- Construction – The construction of an HVDC converter station in Beira will be easier than at an inland site (infrastructure, transport of heavy equipment, etc).
- Operation and maintenace – It will be easier to keep a well-trained staff, to operate and maintain the converter station, at Beira than at an isolated inland site.

Therefore, for the DC tapping alternative, it is assumed that:

1. The existing HVDC scheme is fully operational and the transmission link performs acceptably. The only modifications in Songo and Apollo will be to the control equipment. (This case with a tapping is similar to the case with parallel-connected converters. The original equipment was designed for this, but it is understood that the control equipment commissioned in 1998 no longer has this feature).
2. A new bipolar 533 kV HVDC line will be built from the T-junction to Beira (and possibly disconnecting switches at the T-junction point).
3. An HVDC converter station will be built in Beira. The converter station is connected both to the 110 kV lines feeding the smelter and the existing 110 kV network in Beira.
4. The rating for the tapping needed to secure 625 MW infeed at the AC busbar in Beira will be 2 x 325 MW. The HVDC equipment will have an overload capability of 650 MW per pole in case one of the DC lines or one of the converters is out of service.

5. The tapchanger range of the new converter transformers will be large enough to handle the case where 1 of the 4 series connected bridges in the existing stations at Songo or Apollo is out of service. Operation with 2 or more bridges out of service will be impossible.

6. An SVC will be needed to cope with load shedding of up to half the connected load in a single block.

7. Measures will be taken to achieve a short circuit power in the range of 1000 MVA. This will be needed in the AC system at the tapping station to allow commutating of the converters. For estimating purposes, the installation of synchronous condensers is assumed, but further system studies will show which combination of the following is actually the most cost effective:

    - Synchronous machines.
    - 220 kV line(s) from Caia and/or Chibata to Beira.

There are no technical limitations to lowering (485 MW) or increasing (800 MW) the power into Beira for this alternative. There is, however, no good way to reduce the reliability to N-criterion.
A price estimate for a DC tapping on the existing Apollo-Cahora Bassa line is:

Item	Size	Price (MUSD)
HVDC tapping station	2 x 325 MW	150
Synchronous condensers		20
533 kV HVDC line Chibata–Beira	1 x 200 km	24
Control system modifications in Songo and Apollo		10
SVC Beira	100 Mvar	5
TOTAL		**209**

A new HVDC intertie from Cahora Bassa

This alternative is a full rated intertie between Cahora-Bassa and Beira including:

1. A 2 x 325 MW converter station in Cahora Bassa. The converter station should have an overload capability of 650 MW per pole.
2. A bipolar 350 kV HVDC line Cahora Bassa to Beira
3. A 2 x 325 MW converter station in Beira. The converter station should have an overload to up to 650 MW per pole.
4. An SVC to cope with load shedding of up to half the connected load in a single block.
5. Measures to achieve a short circuit power in the range of 1000 MVA at Beira. For the purpose of price estimating, the installation of synchronous condensers is assumed, but further system studies will show which combination of the following is actually the most cost effective:
    - Synchronous machines.
    - 220 kV line(s) from Caia and/or Chibata to Beira.

There are no technical limitations to lowering (485 MW) or increasing (800 MW) the power into Beira in this alternative. The reliability can be reduced to an N-criterion design if it is changed to a monopolar transmission with:

- 650 MW in one pole,
- metallic return operation mode (i.e. the HVDC line is still build as a bipolar line).

A price estimate for a new HVDC intertie from Cahora Bassa to Beira is:

Item	Size	Price (MUSD)
HVDC converter stations	2 x 325 MW	235
HVDC line Songo-Beira	600 km	72
Synchronous condensers		20
SVC Beira	100 Mvar	5
TOTAL		**332**

First step in the Mepanda Uncua to Maputo HVDC intertie

This alternative is to find a solution that later can be upgraded to a 2000 MW to 3000 MW transmission system from Mepanda Uncua to Maputo. The final power level depends on the amount of power that will be delivered to Maputo. It is assumed that:

1. The transmission system will be built for 2000 MW in the sending station (650 MW in tapping station in Beira and 1350 MW in Maputo).
2. A 2 x 500 MW, 500 kV converter station will be built at Matambo (or any other location found suitable in the area between Mepanda Uncua and Matambo). The converters will have an overload capability of 650 MW per pole. The converters will also be built to allow them to be connected in parallel in case the transmission is upgraded to 2000 MW. These two converters will then together be one of the two poles.
3. A 2 x 325 MW, 500 kV converter station will be built in Beira, with an overload capability of 650 MW per pole. This converter will in future be used as a taping station.
4. A 500 kV HVDC line, designed for 2000 MW, will be built between Matambo and Beira. The line can be extended to Maputo in the next phase.
5. Either a new AC line will be built between Songo and Matambo, or the existing 220 kV AC line, which is strung with a single conductor, will be upgraded.
6. An SVC will be needed to cope with load shedding of up to half the connected load in a single block.
7. Measures will be taken to achieve a short circuit power in the range of 1000 MVA at Beira. For the purpose of price estimating, the installation of synchronous condensers is assumed, but further system studies will show which combination of the following is actually the most cost effective:
   - Synchronous machines.
   - 220 kV line(s) from Caia and/or Chibata to Beira.

There are no technical limitations to lowering (485 MW) or increasing (800 MW) the power into Beira in this alternative. The reliability can be reduced to an N-criterion if the design is changed to a monopolar transmission with:

- 1000 MW in one pole in the sending end,
- 650 MW in the receiving end,
- metallic return operation mode (i.e. the HVDC line is still build as a bipolar line).

A price estimate for the first step in a Mepanda Uncua-Maputo HVDC intertie is:

Item	Size	Price (MUSD)
HVDC converter stations	2 x 500 MW	260
HVDC line Matambo-Beira	500 km	83
AC line upgrade Songo-Matambo	100 km	12
SVC Beira	100 Mvar	5
Synchronous condensers		20
TOTAL		**380**

AC system from Cahora Bassa

The simplest alternative is new transmission lines from Songo to Beira. To achieve the desired power transfer level of 650MW firm, two 400 kV lines with approximately 30% series compensation will be needed.

Based on load flow studies, it has been concluded that each 400 kV line should be associated with a 100 Mvar line reactor to control overvoltages during energisation and low load conditions. With these reactors connected, to survive either a line trip or shedding of half the connected load, an SVC with a dynamic range of approximately 250 Mvar and a mechanically switched capacitor of 100 Mvar will be needed.

By omitting the second 400 kV line, the system can be downgraded to N-criterion reliability. However, it may be difficult to attain 800 MW operation with only a single line. Operation of up to 800 MW is quite feasible with two lines.

A price estimate for a new AC system from Cahora Bassa is:

Item	Size	Price (MUSD)
Songo sub-station extensions	3 x 315 MVA	13
400 kV line Songo-Beira	2 x 600 km	180
Line reactors	2 x 100 Mvar	4
Series capacitor k=30%	2 x 175 Mvar	6
Beira sub-station	3 x 315 MVA	12
Shunt capacitor	100 Mvar	1
SVC Beira	250 Mvar	13
TOTAL		**229**

A more complicated, but perhaps more cost-effective solution, is reinforcing and extending the existing network. There are two 220 kV lines from Matambo to Caia and one 220 kV line, currently operated at 110 kV, from Matambo to Chibata. These lines could be extended with three lines to Beira. Two of these are Caia to Beira, and the other is Chibata to Beira. In order to get 650 MW firm, each of the 220 kV lines must be re-inforced to get a transfer capacity of around 350 MW. It is thought that this could be done with about 65% series compensation and SVCs at Caia, Chibata, and Beira. To mitigate overvoltages following line energisation, it is estimated that three 30 Mvar line reactors will also be needed at Beira.

For (N-1)-criterion reliability at a reduced power level, or N-criterion reliability at the nominal power level, one of the lines and its associated series capacitor can be omitted. Preferably this should be the Chibata-Beira line rather than one of the Caia-Beira lines. Operation up to 800 MW with (N-1)-criterion reliability will probably be impossible.

Although apparently possible at this stage, this option really needs full-scale simulation before the feasibility or otherwise can be determined with any degree of confidence. If it can be done, large amounts of reactive power compensation and fast controls will be needed. These simply cannot be assessed in a pre-feasibility study. Notwithstanding these reservations, using component sizes based on preliminary studies, a price estimate for this alternative is:

Item	Size	Price (MUSD)
220 kV line Caia-Beira	2 x 200 km	48
Series capacitor k=65%	2 x 260 Mvar	8
SVC Caia	250 Mvar	13
220 kV line Chibata=Beira	1 x 200 km	24
Series capacitor k=65%	1 x 260 Mvar	4
SVC Chibata	250 Mvar	13
Beira sub-station	3 x 315 MVA	12
SVC Beira	250 Mvar	13
Line reactors	3 x 30 MVAR	2
TOTAL		**137**

The above solution requires very high degrees of reactive power compensation, and may prove unworkable. Should detailed studies show that it is not possible to accomplish the above reinforcement with 220 kV lines, 400 kV lines could be used. In this case the price of the lines increases, and 220/400 kV substations must also be built. At 400 kV, the size of the line reactors needed to control overvoltages also increases. The implications of increasing or reducing the power transfer levels, or downgrading the reliability of this system are the same as for the 220 kV alternative.

A price estimate to reinforce the existing AC system with new 400 kV lines is:

Item	Size	Price (MUSD)
Series capacitor k=65%	2 x 260 Mvar	8
Caia sub-station	2 x 315 MVA	8
400 kV line Caia-Beira	2 x 200 km	60
SVC Caia	250 Mvar	13
Series capacitor k=65%	1 x 260 Mvar	4
Chibata sub-station	1 x 315 MVA	3
400 kV line Chibata-Beira	1 x 200 km	30
SVC Chibata	250 Mvar	13
Beira sub-station	3 x 315 MVA	12
SVC Beira	250 Mvar	13
Line reactors	3 x 100 Mvar	6
TOTAL		**170**

Eskom power

AC system from Maputo

Two 400 kV lines from Maputo to Beira, series compensated to 45% would give a transfer capacity of around 650 MW to 700 MW firm. Based on loadflow studies and preliminary dynamic studies, controlling overvoltages during energisation and low-load conditions will require approximately 800 Mvar of reactors and an intermediate switching station. This station would probably be at Pande. The reactors could be configured as 200 Mvar per line at Pande and at Beira. To survive a line trip or shedding of half the connected load, two SVCs at Beira each with a dynamic range of 250 Mvar and four 100 Mvar mechanically switched capacitors would be needed.

By omitting the second 400 kV line and its associated reactive power compensation equipment, the system can be downgraded to N-criterion reliability at the nominal power transmission level (625 MW). However, due to rapidly escalating reactive power compensation requirements as the load increases, it will probably not be possible to attain the upper power transmission limit (800 MW) with only a single line. Operation of up to 800 MW is quite feasible with two lines.

A price estimate for an AC transmission system from Maputo is:

Item	Size	Price (MUSD)
Series capacitors k=45%	2 x 340 Mvar	10
400 kV line Maputo-Pande-Beira	2 x 850 km	255
Pande switching station		6
Beira sub-station	3 x 315 MVA	12
Line reactors	4 x 200 Mvar	16
Shunt capacitors	4 x 100 Mvar	4
SVC Beira	2 x 250 Mvar	26
TOTAL		**329**

<u>HVDC intertie from Maputo</u>

The simplest alternative is a full rated intertie between Maputo and Beira. The same technical issues as for an intertie to Cahora Bassa must be resolved.

There are no technical limitations to lowering (485 MW) or increasing (800 MW) the power into Beira in this alternative. The reliability can be reduced to N-criterion if the design is changed to a monopolar transmission with:

- 650 MW in one pole
- metallic return operation mode (i.e. the HVDC line is still build as a bipolar line).

A price estimate for an HVDC intertie from Maputo is:

Item	Size	Price (MUSD)
HVDC converter stations	650 MW	235
HVDC line Maputo-Beira	850 km	102
Synchronous condensers.		20
SVC Beira	100 Mvar	5
TOTAL		**352**

First step in the Mepanda Uncua to Maputo HVDC intertie

This alternative is to find a solution that later can be upgraded to a 2000 MW transmission from Mepanda Uncua. The following is assumed:

1. A converter station with the rating of 2 x 500 MW, 500 kV is built in Maputo. The converter station should have an overload to up to 650 MW per pole. The converters will also be built to allow them to be connected in parallel in case the transmission is upgraded to 2000 MW. (These two converters will then together be one of the two poles).
2. A 2 x 350 MW converter station in Beira, with a continuous overload rating up to 650 MW. This converter will in future be used as a taping station.
3. A HVDC line between Beira and Maputo rated 500 kV and designed for 2000 MW. This line can be extended up to Mepanda Uncua in a second phase.
4. An SVC is needed to cope with load shedding of up to half the connected load in a single block.
5. Measures to increase the short circuit level in Beira to the required 1000 MVA. For the purpose of price estimating, the installation of synchronous condensers is assumed, but further system studies will show which combination of the following is actually the most cost effective:
    - Synchronous machines.
    - 220 kV line(s) from Caia and/or Chibata to Beira.

There are no technical limitations to lowering (485 MW) or increasing (800 MW) the power into Beira in this alternative. The reliability can be reduced to an N-criterion if the design is changed to a monopolar transmission with:

- 675 MW (1350 MW/2) in one pole at the sending end,
- 650 MW at the receiving end,
- metalic return operation mode (i.e. the HVDC line is still build as a bipolar line).

A price estimate for this first step in the Mepanda Uncua-Maputo HVDC intertie is:

Item	Size	Price (MUSD)
HVDC converter stations	2 x 500 MW	260
HVDC line Beira-Maputo	850 km	140
Synchronous condensers		20
SVC Beira	100 Mvar	5
TOTAL		**425**

New generation

The simplest alternative is to generate all the power with gas turbines. Currently, there are no turbines large enough to supply 650 MW with a single machine. Thus two or three machines will be required. To achieve the required availability, an additional machine would be required. Thus, installed generating capacity will have to be 900 MW to 1000 MW. In other words, about 250 MW to 350 MW additional generating capacity is needed to get the required availability, if gas turbines are the only source. Increasing or reducing the power, and downgrading to an N-criterion are technically very simple for this alternative, since they involve adding or omitting machines.

A price estimate for new generation in Beira is:

Item	Size	Price (MUSD)
Gas turbines	900 MW	270
Beira sub-station	3 x 315 MVA	12
TOTAL		**282**

Perhaps a cheaper alternative is to extend the existing AC network to get the additional capacity. A 400 kV Caia-Beira line could provide a Cahora-Bassa Beira capacity of around 200 MW to 220 MW at a much lower price than that of an additional machine. The impact of increasing or reducing the power, or downgrading to N-criterion reliability are the same as for the previous alternative. Down grading to an N-criterion by omitting a machine saves more than omitting the transmission line and associated equipment.

A price estimate for this hybrid scheme is:

Item	Size	Price (MUSD)
Gas turbines	675 MW	203
Beira sub-station	3 x 315 MVA	12
Caia sub-station	1 x 315 MVA	3
400 kV line Caia-Beira	200 km	30
Line reactor	1 x 100 Mvar	1
TOTAL		**249**

CONCLUSIONS

The estimated prices and potential roadblocks for each of the various alternatives are tabulated below. From the table, it is feasible to bring power from Cahora Bassa with either AC or DC for an investment in the range of 230 MUSD. The alternative to upgrade the existing AC network, although cheaper, has not used as a base because it will consume virtually the entire capacity of the EdM network and block other smaller infrastructure projects in the region. The alternative to build a new HVDC intertie as part of a future 2000 MW Mepanda Uncua to Maputo intertie is a very attractive long-term proposition for Moçambique as a whole.

The alternatives to bring power from Eskom may be subject to the fewest potential roadblocks, but also require a much greater capital investment. Power supplied by new generation in Beira involves a slightly higher capital investment than for power from Cahora Bassa, but a lower primary energy cost may offset this. The primary energy cost for natural gas in Beira is currently unestimated.

Power source	Transmission alternative	Potential roadblocks	Price (MUSD)
Cahora Bassa	Tapping station on existing HVDC intertie	Negotiations with HCB and Eskom regarding use of their HVDC link. Negotiations with Eskom to release a block of power from their allocation. Poor reliability of the existing HVDC link.	209
	New HVDC intertie with limited upgrade potential	Negotiations with Eskom to release a block of power from their allocation.	332
	New HVDC intertie as part of future 2000 MW Mepanda Uncua to Maputo intertie	Negotiations with Eskom to release a block of power from their allocation. Coordination and cost-sharing with the Mepanda Uncua project	380
	New AC system	Negotiations with Eskom to release a block of power from their allocation.	229
	Reinforced and extended AC system	Negotiations with Eskom to release a block of power from their allocation. Negotiations with EdM regarding use of their AC system.	170

Power source	Transmission alternative	Potential roadblocks	Price (MUSD)
Eskom	New AC system	None.	329
	New HVDC intertie with limited upgrade potential.	None.	332
	New HVDC intertie as part of future 2000 MW Mepanda Uncua to Maputo intertie.	Coordination and cost-sharing with the Mepanda Uncua project	425
New generation	None	Concession to use natural gas for power generation.	282
	Reinforced and extended AC system	Concession to use natural gas for power generation.	249

1.PROCESS AND PLANT DESCRIPTION

1.1 General

The PIDS system (Pot Integrated Dry Scrubber) as proposed is a decentralised location of the Fume Treatment and Fluoride Recovery plant. There is a patent pending on the system.

Please refer to the enclosed preliminary drawings:

- Key Plan, F239.6146, 9.9A-004, Rev.1
- General Arrangement, F239.6146, 9.9A-003, Rev.1
- Isometric View, F239.6149, 9.9A-005, Rev.1

As shown on the Key Plan there will be a total of 24 PIDS for the two potlines. Four PIDS will thus serve two adjacent potrooms sections; whereof three PIDS treating 2x13 cells and one PIDS treating 2x11 cells.

One PIDS system, as proposed, consists of a total of 2 reactor/filter modules built together including a small integrated fresh alumina silo. The inlet duct system will be arranged so that under normal operating condition the gas from one potroom section will be treated in one reactor/filter module while the gas from the opposite potroom section (across the courtyard) will be treated in the other reactor/filter module. The purpose of this split up, is to return the collected fluorides to the same pots or group of pots from which they were emitted. An interconnecting damper will be provided to give flexibility in case one module is out for service. In the PIDS systems, there is one fan connected to each filter / reactor module.

There are inspection platforms for access to fans and motors, pulse valves, filter hopper level and for access to inlet dampers and recirculation screws.

There is also a service hoist which will be used for lifting filter top lids and to bring service equipment up to filter top level.

1.2 Alumina Handling System

The integrated fresh alumina hopper in each PIDS has a holding capacity of approx. 80 metric tonnes, sufficient for 24 hours consumption of the related 26 cells.

At the outlet of the silo there is a vibrating screen followed by a rotary feeder which carefully controls the alumina feed into the reactor / filter modules.

The feeder is speed controlled by means of a frequency converter, so that the alumina feed quantity can easily be changed (like if a pot is taken out of service).

Reacted alumina is collected in the filter hoppers and is reinjected into the reactor by means of a recirculation feeder.

The PIDS has a storing capacity for reacted alumina of 10 metric tonnes; this coupled with the 4-tonne storing capacity in each pot alumina hopper gives (assuming pot hopper is topped up continuosly):

(4x26) + 10 = 114 tonnes, sufficient for 33 hours alumina consumption.

The height of the alumina feed flange at each pot alumina hopper will dictate the final height of the reacted alumina outlet of the PIDS (i.e the overall height of the PIDS). Airslide inclination between PIDS and pots to be less than 2 degrees. Section A-A on the Key Plan gives an impression of what it may look like, before further detailing is done.

Fluidizing air to the PIDS airslides and fluidized hoppers, will be supplied by two blowers (one is stand-by) located on ground level under the filter

1.3 Electrical and Control System

The overall electrical and control system is designed to meet all operational, control and monitoring demands all in line with your project specification and requirements to operate the system.

Due to the distributed location of the various Pot Integrated Dry Scrubbers (PIDS) and the Central Control Room (CCR) we have foreseen a set-up which include the following control and electrical main components:

- One centralised Operator Supervisory and Data Collection System (SCADA) with PC's installed in The Central Control Room located in between the potlines for supervision of all PIDS.

For each of the 24 PIDS the following imported equipment is included:

- One Plant Control Panel with an Operator Touch-panel for MMI for each PIDS and an autonomous PLC for the plant and for the filter bag pulse control.
- One LV Plant Power Distribution and Motor Starter Panel.
- One lot of Frequency Converters
- One lot plant Instrumentation.
- One lot plant Lighting and Socket Outlets.
- One lot plant Cables including Cable Trays, Conduits, etc.

All motors can be remote operated from the SCADA system or from the Operators Touch-Panel. An emergency stop button and a safety switch will be installed next to the motor operated equipment in the field. Locally a selection between Local and Remote control will be possible.

The two Main Fans, the fresh alumina Rotary Feeder and the Recirculation Feeders are all speed controlled through frequency converters.

2. TECHNICAL DATA

This section covers one PIDS system only.
There will be a total of 24 identical PIDS systems
The data given relate to a PIDS treating gas from 26 pots, one out of four PIDS will treat gas from 22 pots.

		Unit	Value
2.1	**Fume Treatment Plants PIDS**		
	No. of pots per plant		26
	Gas volume for each plant at 135°C,	m^3/h	222.000
	Gas temperature expected at plant inlet (design)	°C	135
	Alumina consumption per plant, approx	T/h	3,4
	Ductwork		
	No. of potroom manifolds per plant		4
	Average gas velocity in manifolds	m/s	18
2.2	**Reactors and Filters**		
	No. of filter compartments per plant (PIDS)		2
	Filter area per plant	m^2	2880
	Filter area per bag filter compartment	m^2	1440
	No. of bags per bag filter compartment		600
	No. of solenoid valves per bag filter comp.		20
	No. of bags per pulse pipe		30
	Filter bag material	Polyester Needle felt	
	Material weight, approx.	g/m^2	520
	Bag installed by use of	Steel snap-ring	
2.3	**Alumina Injection and Recirculation System**		
	Primary alumina quantity per injection point (normal)	T/h	1,7
	Alumina recirculation system	As req.	

		Unit	Value
2.4	**Reacted Alumina Handling System**		
	Airslide conveying of alumina from bag filter outlet to pots		
	Design airslide conveying rate, each side	T/h	1,7
2.5	**Main Fans**		
	Number and type per plant		2
	Normal flow per fan	Nm^3/h	74270
	Inlet Total Pressure	Pa	3470
	Pressure Increase	Pa	3860
	Fan Power Demand	kW	150
2.6	**Compressed Air Requirement (from plant air system)**		
	Bag pulsing (free air volume)	m^3/min	3,5
	Pressure (max)	bar g	3,5

2.7 Motor List

Motor No.	Service	Installed Power(kW)	Voltage(V)
1	Main fan	160	460
2	Main fan	160	460
3	Fluidization blower	37	460
4	Fluidization blower	37	460
5	Recirculation feeder no. 1	1,5	460
6	Recirculation feeder no. 2	1,5	460
7	Rotary feeder	1,5	460
8	Vibrating screen	1,5	460

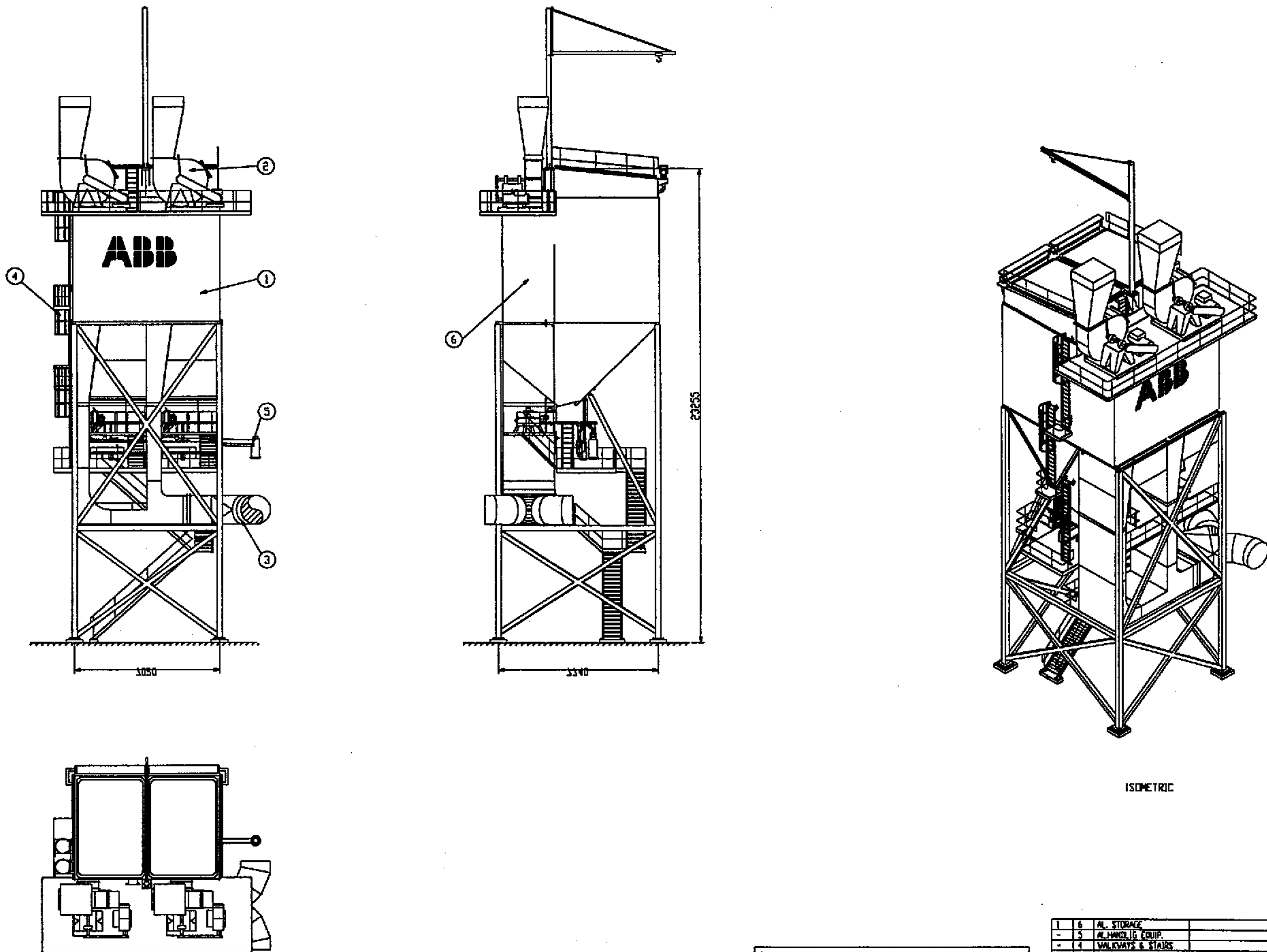
All technical data are preliminary and may change after final design and final selection of subcontractors.

3. EQUIPMENT SPECIFICATION	ABB Local Supply	ABB Imported Supply
The equipment information given is approximate and preliminary and subject to final design.		
There will be 24 identical Fume Treatment Plants of the PIDS design, and the following list is for one plant only treating gas from 26 pots. (One out of four PIDS will treat gas from 22 pots).		
GAS DUCT SYSTEM The gas ducts are made of mild steel and designed to withstand the maximum negative pressure that may be experienced.		
Quantity		
26 only **POT INSULATION SLEEVES**		X
26 only **POT DAMPERS**	X	
26 only **BRANCH DUCTS**	X	
1 set **POTROOM DUCTING** from branch ducts to inlet Fume Treatment Plant.	X	
1 set **SUPPORT STEEL** for Potroom ducting.	X	
1 set **GAS DUCT** to plant inlet.	X	
1 set **EXPANSION JOINTS** for ductwork.		X
EXHAUST FAN SYSTEM		
Quantity		
2 only **SINGLE INLET MAIN EXHAUST FANS.** The fans have backward curved impeller blades, split casing with inspection door, drain plug, flexible coupling and cooling disc with guard. Bearings equipped with sun protection cover and vibration detectors.		X
2 sets **VIBRATION DAMPERS**		X
2 only **MAIN FAN AND MOTOR SUPPORT FRAME**		X
2 only **EXPANSION JOINTS** for fan inlet.		X
2 only **MAIN FAN MOTORS**		X

Quantity			ABB Local Supply	ABB Imported Supply
FILTER SECTION				
For the collection of particles and fluoride gas, the fabric filter will be provided containing 2 filter chambers, made of mild steel panels, minimum plate thickness 4 mm.				
Quantity				
1	**set**	**SUPPORT STEEL**	X	
2	**sets**	**FILTER CHAMBERS** made of mild steel plates 4 mm suitably braced and stiffened. Including dust collection hopper and access door.	X	
2	**sets**	**INTEGRATED REACTOR** and inlet/outlet ducts. 4 mm mild steel suitably braced and stiffened.	X	
2	**only**	**FILTER TOP SECTIONS** containing - Arrangement for fixing location of filter bags and filter bag pulse cleaning system. - Ejector pipes, pressure air manifold and pulse valves for bag cleaning. - Inspection windows. - Filtertop lids for access to the filter bags.	X	X
1	**only**	**SERVICE HOIST**		X
1200	**only**	**FILTER BAGS**		X
1200	**only**	**FILTER CAGES**		X
SILO				
Quantity				
1	**only**	**BUFFER SILO** (80 T capacity), integrated between the filtercompartments	X	
ALUMINA TRANSPORT WITHIN FTP				

The alumina will be metered and diverted to the 2 reactors. Thereafter the alumina will be collected in the filter chamber and transported to the individual pots.			ABB Local Supply	ABB Imported Supply
Quantity				
1	set	**SILO shut off valves**		X
1	only	**VIBRATING SCREEN**		X
1	only	**ROTARY FEEDER**		X
2	only	**AIRSLIDE** for fluidized transport to reactors.		X
2	only	**RECIRCULATION FEEDERS** including gear motor.		X
2	set	**REACTED ALUMINA COLLECTING AIRSLIDES**		X
1	set	**REACTED ALUMINA AIRSLIDES TO POTS**		X
1	set	**SUPPORT STEEL** for airslides and air piping.	X	
1	lot	**CHUTES** for vertical transport of alu mina within FTP.	X	
2	only	**BLOWERS** w/motor for fluidization		X
1	set	**FLUIDIZATION AIR** piping.	X	
MISCELLANEOUS EQUIPMENT:				
1	set	**PRESSURE RED. VALVES** with air drier/filter for bag pulsing		X
1	set	**PLATFORMS & STAIRS** for filter & silos access to inspection and maintenance points.	X	
1	set	**Pulse air piping**	X	

ELECTRICAL AND INSTRUMENTATION.
See scope in section 1.3



PRELIMINARY

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DATE: ....

SIGN: ....

SCALE 1:100

0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

Amount	No.	Description	Dn. Designation Resm. no.	Material	Weight
1	6	AL. STORAGE			
-	5	AL.HANDLIG EQUIP.			
-	4	WALKWAYS & STAIRS			
-	3	DUCTWORK			
2	2	FAN			
1	1	BAGFILTER			

ABB Environmental
Flakt Systems for the Aluminium Industry

MOZAMBIQUE, BEIRA ALUMINIUM SMELTER
BASS, PIDS (Pot Integrated Dry Scrubber)
GENERAL ARRANGEMENT

Date	Drawn by	Checked by	Approved	Assembly No.	Sub No.	Scale
29.04.99	RJ					1:100

Drawing No. F239. 6146 9. 9A-0031

Rev.	Date	Drawn by	Checked	Approved	Reason for Issue
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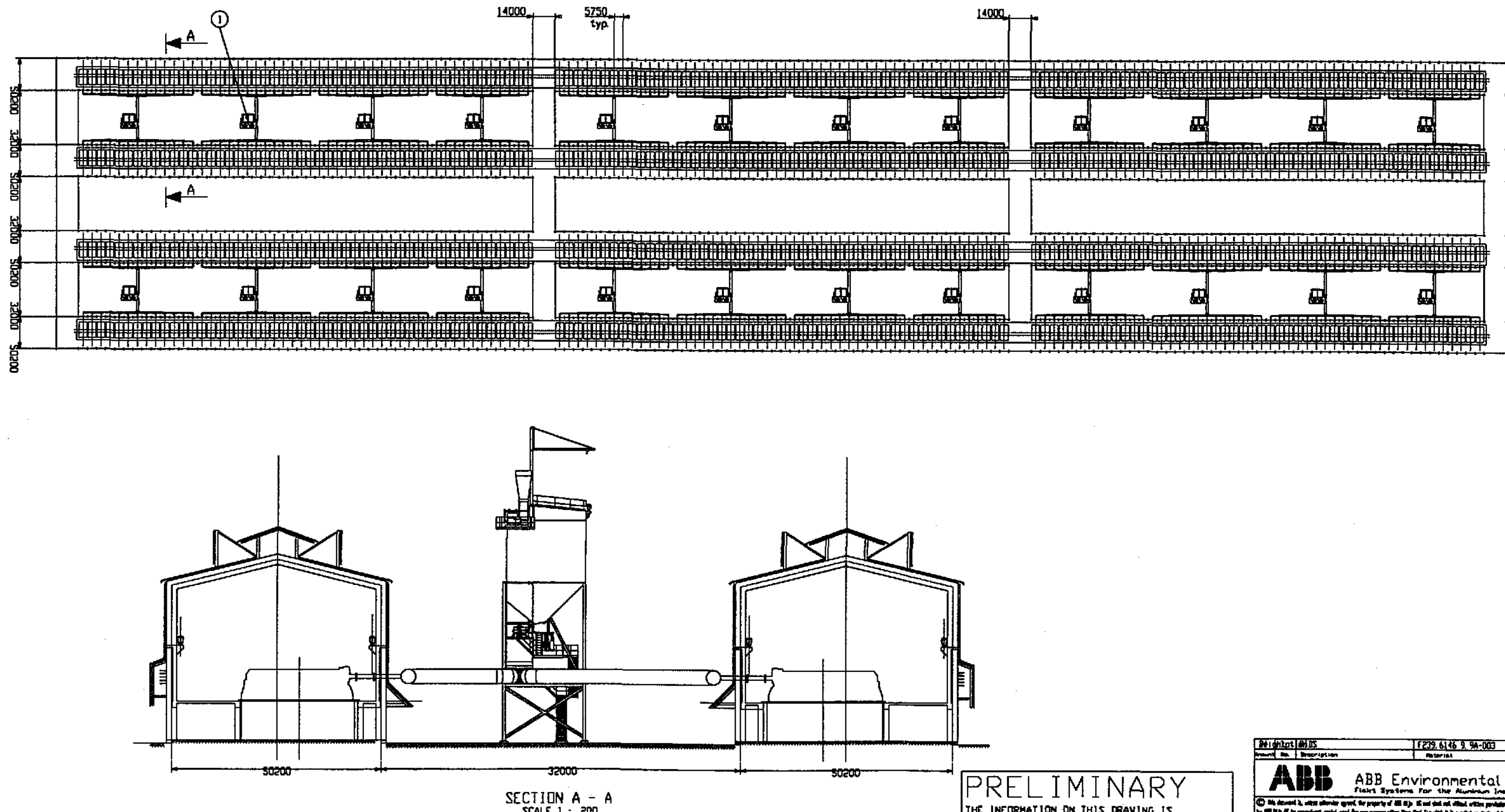

SECTION A - A
SCALE 1 : 200

PRELIMINARY

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DATE: ....
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Rev.	Date	Drawn by	Checked	Approved	Reason for issue
1	29.04.99				FOR INFORMATION

ABB Environmental
Fläkt Systems for the Aluminium Industry

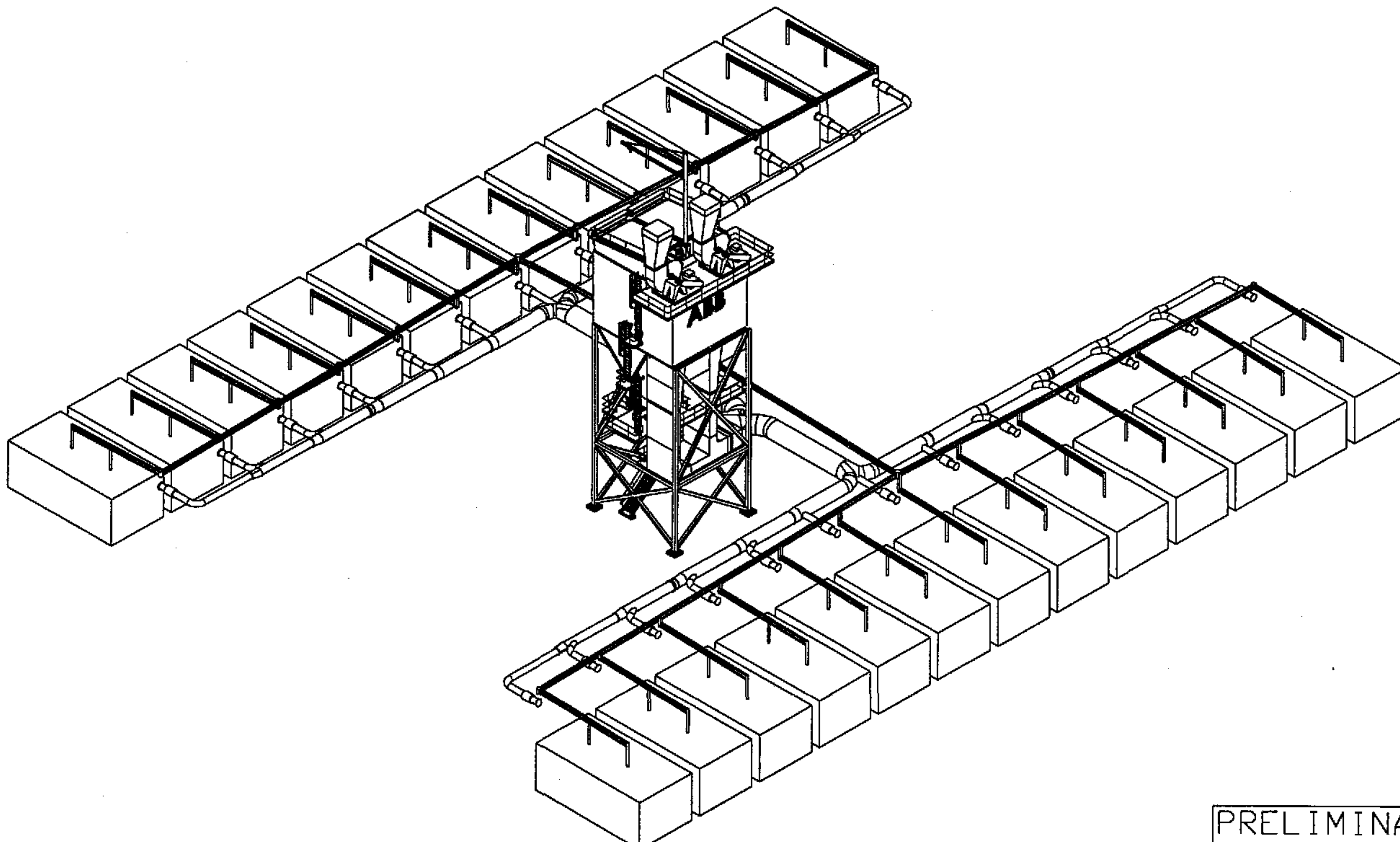
MOZAMBIQUE BEIRA ALUMINIUM SMELTER
BASS, PIDS (Pot Integraded Dry Scrubber)
KEY PLAN

Date	Drawn by	Checked by	Approved	Assembly No.	Sub No.	Scale
29.04.99	RJ					1:1300

Drawing No. F239. 6146 9. 9A-004

Material: F239.6146 9.9A-003

Last Print date



PRELIMINARY

THE INFORMATION ON THIS DRAWING IS NOT CONFIRMED AND MUST NOT BE USED FOR FABRICATION OR AS BASIS FOR THE PREPARATION OF OTHER DOCUMENTS AND DRAWINGS.

DATE: ....
SIGN: ....

ABB Environmental
Fläkt Systems for the Aluminium Industry

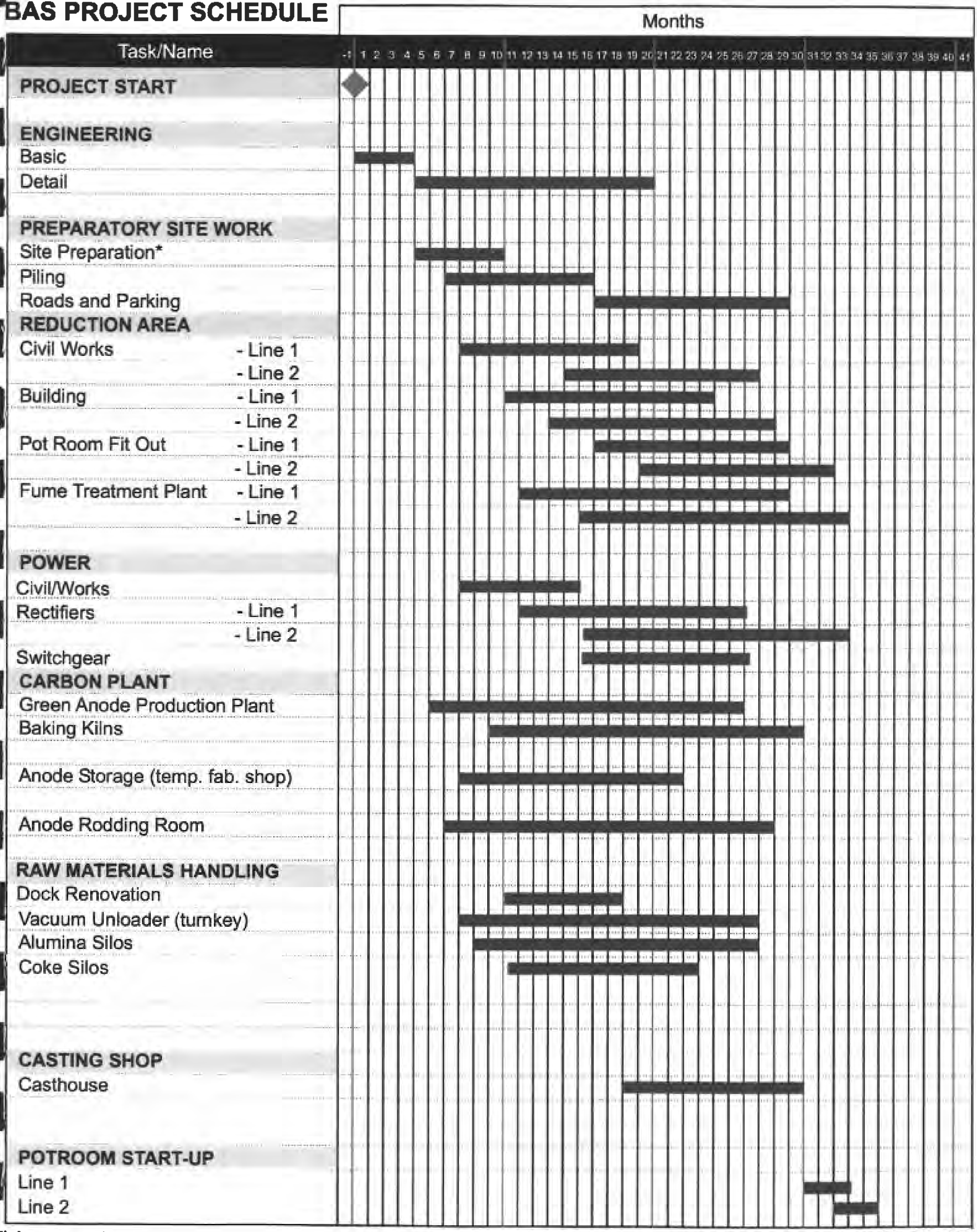
MOZAMBIQUE, BEIRA ALUMINIUM SMELTER
BASS, PIDS (Pot Integrated Dry Scrubber)
ISOMETRIC VIEW

Date	Drawn by	Checked by	Approved	Assembly No.	Sub No.	Scale
29.04.99	RJ					1:100

Drawing No. F239. 6146 9. 9A-0051

Rev.	Date	Drawn by	Checked	Approved	Reason for issue
1	29.04.99	RJ			FOR INFORMATION

BAS PROJECT SCHEDULE



* Assumes that land is drained and raised above flood level prior to this activity.

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BASS Aluminum Reduction Facility
Capital Cost Estimate

Revision 2.3 (12 November, 1999)

100000	**REDUCTION PLANT**	**$437,945,490**	
110000	POTROOM BUILDINGS	$58,692,713	
111000	FOUNDATIONS AND SLABS		
111100	BUILDING FOUNDATIONS		$5,549,833
111200	BUILDING SLABS		$4,366,500
111300	POT SUPPORT STRUCTURES		$6,189,600
111400	POTROOM FLOORING SYSTEM		included
111500	UTILITY TRENCHES (INCL BUS TRENCHES)		$3,957,300
111900	MISCELLANEOUS CIVIL WORKS		$1,000,000
112000	POTROOM STRUCTURE		$20,298,333
114000	CRANE RAIL SYSTEM		
114100	CRANE RAILS AND SUPPORTS		$6,600,000
114200	RAIL STOPS AND BUMPERS		included
114300	POWER FEEDING RAIL SYSTEM		$2,710,000
115000	UTILITIES DISTRIBUTION		
115100	POTABLE WATER DISTRIBUTION		$864,280
115200	COMPRESSED AIR DISTRIBUTION		$1,925,360
115300	NATURAL GAS DISTRIBUTION		$888,388
116000	POWER DISTRIBUTION		$1,784,173
117000	LIGHTING		$892,087
118000	INTERIOR STRUCTURES AND OFFICES		$666,859
118100	CELL LINES OFFICE AND COMPUTER ROOM		incl
118200	CELL LINE OFFICE		incl
118300	AIR CONTROL AND PROCESS CONTROL OFFICE		incl
118500	CELL LINE LUNCHROOM		incl
118600	TOILET FACILITIES		incl
119000	MISCELLANEOUS POTROOM BUILDING ITEMS		$1,000,000

BASS Aluminum Reduction Facility
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120000	**REDUCTION PROCESS SYSTEM**		
121000	**CATHODE SYSTEMS**	**$81,093,456**	$81,093,456
122000	**CONDUCTORS (POT TO POT)**	**$77,665,073**	
122100	POT RING BUSS SYSTEM		$52,296,960
122200	ANODE FLEXES		$8,368,158
122300	SWITCH PLATES		$90,000
122400	FEEDER AND CROSSOVER BUS		$3,206,555
122500	BUS TRENCH FORCED AIR COOLING SYSTEM		incl
122600	CATHODE FLEX TABS		$7,814,400
122900	MISCELLANEOUS AND FITOUT		$5,889,000
123000	**SUPERSTRUCTURE SYSTEMS**	**$104,041,620**	
123100	SUPERSTRUCTURE FRAME ASSEMBLIES		$9,100,728
123200	ANODE BUSS SYSTEM		
123210	ANODE BUSS		$12,692,592
123220	ANODE CLAMPS AND BRACKETS		$6,528,000
123300	ANODE JACKING SYSTEMS		$7,732,800
123400	ALUMINA SYSTEMS		$15,000,000
123500	ANODE ASSEMBLIES		
123510	ANODE ROD ASSEMBLIES		$16,006,000
123520	ANODE CARBON BLOCK		$6,057,900
123530	CAST IRON		$131,000
123600	POT FUME COLLECTION		
123610	POT COVERS		$3,840,000
123620	END DOORS		$300,000
123630	CONNECTING DUCT		with FTP
123640	INSULATED DUCT TRANSITION		with FTP
123650	DAMPER SYSTEM		with FTP

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123700	INDICATORS AND INSTRUMENTATION		$300,000
123800	ACCESS PLATFORMS AND INSULATION		$2,463,600
123900	MISC ITEMS AND FITOUT LABOR		$23,889,000
124000	**POT CONTROL AND ELECTRICAL EQUIPMENT**	**$6,178,000**	
124100	POT CONTROL CABINETS		$6,178,000
124200	CELTROL POT COMPUTERS		incl
124300	POT CONTROL SYSTEM (CB AND SC)		incl
124400	ALARM ANNUNCIATION SYSTEMS		incl
124500	FIELD WIRING AND MULTIPLEXING SYSTEM		incl
124600	WORKSTATIONS		incl
124900	MISCELLANEOUS POT CONTROL SYSTEMS		incl
130000	**POTLINE PROCESS SUPPORT EQUIPMENT**		
131000	**OVERHEAD CRANE SYSTEMS**	**$38,966,117**	
131100	POT TENDING MACHINES		$34,818,117
131200	TRANSFER GANTRY CRANE		$672,167
131300	CATHODE TRANSPORT CRANE		$968,333
131400	CRANE SPARE PARTS		$2,507,500
132000	**ANODE TRANSPORTATION SYSTEMS**	**$2,411,000**	
132100	ANODE PALLETS		$931,000
132200	PALLET HAULERS		$1,480,000
133000	**MOLTEN MATERIALS TRANSPORTATION SYSTEMS**	**$3,800,000**	
133100	METAL TAPPING CRUCIBLE ASSYS		$2,100,000
133500	CRUCIBLE TRANSPORT VEHICLES		$1,500,000
133600	BATH CRUCIBLE ASSYS		$200,000

134000	**SOLID MATERIALS DISTRIBUTION EQUIPMENT**	**$1,600,000**	
134200	COVER BATH BUCKET SYSTEMS		$800,000
134300	FLUORIDE DISTRIBUTION HOPPERS		$400,000
134900	BATH ADDING MACHINES		$400,000
135000	**GENERAL UTILITY VEHICLES**	**$87,000**	$87,000
136000	**SPECIALTY EQUIPMENT**	**$1,760,067**	
136100	ANODE BRIDGE RAISING BEAM		$1,420,333
136200	SUPERSTRUCTURE LIFTING BEAMS		$200,000
136300	SUPERSTRUCTURE STANDS		$39,733
136900	MISCELLANEOUS SPECIALTY EQUIPMENT		$100,000
137000	**POT EXCHANGE EQUIPMENT**	**$1,605,167**	
137100	POTSHELL LIFTING BEAMS		$515,667
137200	PORTABLE GROUNDING SAFETY SYSTEM		$400,000
137400	THERMAL BAKING SYSTEMS		$589,500
137900	MISC CELL EXCHANGE TOOLS AND EQPT		$100,000
138000	**PROCESS MONITORING EQUIPMENT**	**$1,200,000**	
138100	POT AUDITING EQUIPMENT		$200,000
138200	POTROOMS AIR MONITORING SYSTEMS		$1,000,000
139000	**OTHER SUPPORT EQUIPMENT AND TOOLS**	**$300,000**	$300,000
140000	**POTLINE ALUMINA AND GAS TREATMENT**	**$50,000,000**	
140100	MISCELLANEOUS STRUCTURES AND CIVIL WORKS		$5,000,000
141000	FRESH ALUMINA DAY SILOS		incl
142000	FRESH ALUMINA CONVEYOR SYSTEM		$0
143000	PRIMARY POTROOM GAS TREATMENT SYSTEMS		$45,000,000
144000	POTROOM AND PRIMARY DUCTWORK		incl
145000	REACTED ALUMINA AIR SLIDE SYSTEM		incl

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170000	**POTLINE SUPPORT SYSTEMS**		
171000	**POT RELINING FACILITY**	**$4,241,641**	
171100	CIVIL WORKS AND STRUCTURE		$1,066,373
171300	CELL LINING AREA		
171310	OVERHEAD CRANES		$426,000
171320	LINING MACHINES		$500,000
171350	SMALL EQUIPMENT AND TOOLS		$100,000
171390	MISCELLANEOUS CELL LINING EQPT AND INSTRUM		$100,000
171400	CELL DELINING AREA		
171410	CATHODE TILTING STATION		$200,000
171420	DELINING MACHINE		$125,000
171430	SPL CONTAINMENT/SHIPPING SYSTEMS		$100,000
171440	SPL STORAGE FACILITY		$215,168
171500	SHELL AND SUPERSTRUCTURE REPAIR FACILITY		$400,000
171600	POT REBUILDING MOBILE EQUIPMENT		$759,100
171900	MISCELLANEOUS UTILITY EQUIPMENT		$250,000

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172000	**CRUCIBLE CLEANING FACILITY**	**$4,048,238**	
172100	CIVIL WORKS AND STRUCTURE		$1,145,238
172200	CRUCIBLE CLEANING MACHINE		$2,000,000
172300	SIPHON LEG CLEANING MACHINE		$300,000
172400	OVERHEAD CRANE		$213,000
172500	PREHEATING EQUIPMENT		$50,000
172600	DUST COLLECTION SYSTEM		$200,000
172700	CRUCIBLE RELINING FACILITIES		$100,000
172800	SMALL EQUIPMENT AND TOOLS		$20,000
172900	MISCELLANEOUS CRUCIBLE CLEANING ITEMS		$20,000
174000	**POTROOM GENERAL SERVICES SHOP**	**$255,400**	
174100	VEHICLES		$215,400
174200	EQUIPMENT		$40,000

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200000	**ANODE MANUFACTURING**	**$152,081,696**	
210000	GREEN MILL	$42,278,020	$42,278,020
220000	ANODE BLOCK HANDLING AND STORAGE	$4,653,088	
221000	ANODE STORAGE BUILDING		$753,088
223000	AUTOMATIC STACKING AND RETRIEVAL SYSTEM		$3,800,000
224000	MOBILE EQUIPMENT AND TOOLS		$100,000
230000	ANODE BAKING OPERATIONS	$71,798,100	$71,798,100
240000	ANODE RODDING OPERATION	$32,599,401	
241000	ANODE RODDING BUILDING		$2,560,499
241100	FOUNDATIONS AND SLABS		incl
241200	STRUCTURAL STEEL		incl
241300	SIDING AND ROOFING		incl
241400	UTILITIES DISTRIBUTION		incl
241500	POWER DISTRIBUTION		incl
241600	LIGHTING		incl
241700	INTERIOR STRUCTURES AND OFFICES		incl
241800	FIRE PROTECTION SYSTEM		$170,000
241900	MISCELLANEOUS RODDING FACILITIES		
241910	UNDERGROUND SERVICES AND CONTROL ROOM RQMTS		$400,000
242000	ANODE ASSEMBLY PROCESSING SYSTEMS		$28,616,000
243000	HANDLING AND CONVEYING SYSTEMS		incl
244000	ROD REPAIR FACILITIES		incl
245000	GENL PURPOSE DUST COLLECTION SYSTEMS		incl
246000	INSTRUMENTATION AND CONTROL SYSTEMS		incl

247000	POTLINE COVER BATH HANDLING SYSTEM		
247010	MISCELLANEOUS STRUCTURES AND CIVIL WORKS		$258,202
247200	BATH CRUSHING SYSTEM		incl
247300	CRUSHED BATH BLENDING AND STORAGE		$250,500
247400	CRUSHED BATH HOPPER TRAILERS AND TOW MOTORS		$140,000
248000	TOOLS AND SUPPORT EQUIPMENT		
248100	OVERHEAD CRANES		incl
248200	JIB BOOMS AND HOISTS		incl
248300	MOBILE EQUIPMENT (ALL OF CARBON)		$104,200
248400	SMALL TOOLS		$50,000
248900	MISCELLANEOUS TOOLS AND SUPPORT EQUIPMENT		$50,000
249000	MISCELLANEOUS ANODE RODDING ITEMS		
249100	COLLECTOR BAR CASTING AREA		incl
250000	ANODE ASSEMBLY STORAGE	$753,088	$753,088

300000	**METAL PRODUCTS**	**$6,399,719**	
310000	METAL PRODUCTS BUILDING	$3,756,394	$3,756,394
340000	CASTING BAY SYSTEMS AND EQUIPMENT	$2,154,125	
341000	SOW CASTING SYSTEM		
341100	CASTING WHEEL		$971,750
341200	SOW COOLING SECTION		incl
341300	MOLD PREHEAT STATION		incl
341400	SOW DISCHARGE CONVEYOR		$247,250
341500	SOW PULLER		incl
341600	SOW STACKER		incl
341700	FINISHED PRODUCT SCALE SYSTEM		$90,563
341800	CRUCIBLE TILTING STATION		$48,300
341900	AUTOMATIC SKIMMER		$42,263
343000	SOW MOLDS AND EQUIPMENT		
343100	SOW MOLDS AND WEDGES		$216,000
343200	SOW MOLD STANDS		$50,000
345000	SOW CASTER COOLING WATER SYSTEM		$140,000
346000	SOW CASTER REFRACTORY CONCRETE FLOOR SLAB		$60,000
347000	CASTING BAY CRANE		$213,000
348000	PNEUMATIC TUBE SYSTEM		$75,000
349000	INSTRUMENTATION AND CONTROL SYSTEM		incl
370000	METAL PRODUCTS MOBILE EQUIPMENT	$489,200	$489,200

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400000	**MATERIAL HANDLING AND RECEIVING**	**$38,992,486**	
410000	MARINE TERMINAL FACILITIES	$15,856,638	
411000	WHARF SITE INFRASTRUCTURE		$500,000
412000	WHARF BUILDINGS		$145,238
413000	SHIP DOCK IMPROVEMENTS		$3,005,000
414000	VACUUM UNLOADING SYSTEM		
414100	VACUUM UNLOADING CRANE		$8,000,000
414200	DOCK CONVEYOR SYSTEM		$1,600,000
414300	TRUCK LOADING FACILITY		$500,000
417000	PRIMARY STORAGE SILOS		
417100	ALUMINA STORAGE SILO AND FEED SYSTEMS		$0
417200	PETROLEUM COKE SILO AND FEED SYSTEMS		$0
418000	MATERIAL TRANSPORTATION EQPT FLEET		$2,106,400
419000	DOCK TO PLANT CONVEYOR SYSTEM		$0
430000	RAW MATERIAL STORAGE AND HANDLING	$23,135,848	
431000	FRESH ALUMINA HANDLING AND STORAGE		
431100	ALUMINA TRUCK RECEIVING STATION		$0
431200	ON-PLANT ALUMINA STORAGE SILO AND FEED SYSTEMS		$16,500,000
432000	PETROLEUM COKE HANDLING AND STORAGE		
432100	COKE TRUCK RECEIVING SYSTEM		$100,000
432200	ON-PLANT COKE STORAGE SILO AND FEED SYSTEMS		$4,000,000
432300	COKE DISTRIBUTION SYSTEM (TO G/M BINS)		$99,000
433000	PITCH STORAGE SHED		$887,568
434000	BULK MATERIALS WAREHOUSE AND EQPT		$1,549,280

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500000	PLANT POWER AND UTILITIES	$84,858,064	
510000	MAIN ELECTRICAL SUBSTATION AND SWITCHYARD	$21,000,000	$21,000,000
520000	PRIMARY PROCESS POWER STATION	$38,275,000	
521000	RECTIFIER CONTROL TRANSFORMERS		$38,275,000
522000	RECTIFIERS		incl
523000	POWER STATION DC BUSS WORK		incl
524000	RECTIFIER CONTROL ROOM		incl
525000	MONITORING AND CONTROL SYSTEMS		incl
525100	LINE LOAD CONTROL SYSTEM		incl
525200	POWER METERING SYSTEM		incl
525300	POWER SYSTEMS MONITORING AND CONTROL		incl
525400	EMERGENCY SHUTDOWN SYSTEM		incl
525500	STARTUP AND TECHNICAL SERVICES		incl
530000	PLANT POWER DISTRIBUTION SYSTEM	$10,452,000	
531000	POWER DISTRIBUTION TRANSFORMERS		$1,625,000
532000	POWER DISTRIBUTION LOOP		$5,297,000
532100	POWER CABLING		incl
532200	CABLE TRAYS AND STRUCTURES		incl
532400	POWER TOWERS		incl
532500	UNDERGROUND DISTRIBUTION		incl
533000	LOAD CENTERS		$1,200,000
533100	STRUCTURES		$800,000
533200	TRANSFORMERS		incl
533300	SWITCH GEAR		incl
533400	CONTROLS AND INSTRUMENTATION		incl
534000	INFRASTRUCTURE		$1,530,000

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540000	**PLANT UTILITY SYSTEMS**	**$11,935,105**	
541000	COMPRESSED AIR SUPPLY AND DISTRIBUTION		
541100	AIR COMPRESSOR BUILDING		incl
541200	AIR COMPRESSORS		$7,288,804
541300	CHILLER/DRIER SYSTEM		incl
541400	MAIN RESERVOIR AND HEADER SYSTEM		incl
541500	COMPRESSOR ROOM POWER SUPPLY SYSTEM		incl
541600	INSTRUMENTATION AND CONTROLS		incl
541700	COMPRESSED AIR DISTRIBUTION AND INTERTIES		incl
541900	OTHER COMPRESSED AIR EQUIPMENT		incl
542000	NATURAL GAS SUPPLY AND DISTRIBUTION		$452,730
543000	LPG SUPPLY AND DISTRIBUTION		$50,000
544000	POTABLE WATER SUPPLY AND DISTRIBUTION		$428,000
545000	INDUSTRIAL WATER SUPPLY AND DISTRIBUTION		$1,276,144
546000	PROCESS DIESEL OIL TANKAGE AND DISTRIBUTION		$100,000
547000	VEHICLE FUELING SERVICES		$100,000
548000	COOLING WATER		$799,677
549000	PIPE BRIDGES		$1,439,750
550000	**PLANT FIRE PROTECTION SYSTEM**	**$1,370,619**	$1,370,619
560000	**PLANT ENVIRONMENTAL SYSTEMS**	**$1,825,340**	
562000	SEWAGE TREATMENT PLANT		$1,148,444
563000	SOLID WASTE DISPOSAL SYSTEMS		
563100	FLAMMABLE MATLS STORAGE BLDG		$26,896
563200	SOLID WASTE COLLECTION AND HANDLING EQUIPMENT		$100,000
563300	LAND FILL		$50,000
563400	SITE ENVIRONMENTAL MONITORING SYSTEMS		$500,000

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600000	**NON-PROCESS FACILITIES**	**$20,457,297**	
610000	**MAINTENANCE AND ENGINEERING OPERATIONS**	**$10,608,310**	
611000	MAINTENANCE SHOP BUILDINGS		$4,449,674
612000	CENTRAL MAINTENANCE SHOPS		
612100	MACHINE SHOP		$418,107
612200	FABRICATION SHOP		$310,650
612300	GARAGE		$87,801
612400	ELECTRICAL SHOP		$62,237
612500	HYDRAULIC SHOP		$50,000
612600	INSTRUMENT SHOP		$150,000
612700	PAINT SHOP		$50,000
612800	REFRACTORIES SHOP		$50,000
613000	SPECIALIZED MAINTENANCE FACILITIES		
613100	PTM CRANE MAINTENANCE FACILITY		$722,752
614000	MAINTENANCE SUPPORT VEHICLES AND MOBILE EQUIPMENT		$4,207,089
616000	MAINTENANCE PARTS AND SUPPLIES SYSTEMS		
616100	PLANT STORES AND WAREHOUSE FACILITY		with 611 000
616200	RECEIVING TRUCK DOCK FACILITY		$50,000
620000	**ADMINISTRATION AND GENERAL SUPPORT FACILITIES**	**$9,050,176**	
621000	MAIN OFFICE BUILDING		$653,573
622000	CHANGE HOUSE		$978,423
623000	PLANT FOOD SERVICES		
623100	KITCHEN		$193,651
623200	SEPARATED LUNCHROOMS		$406,668
623300	VEHICLE FLEET		$219,100
624000	HIRING AND ACCOUNTS OFFICE		$193,651

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625000	SECURITY AND SAFETY FACILITIES AND EQUIPMENT		
625100	GATEHOUSE FACILITY		$96,826
625200	PLANT SECURITY OPERATIONS		
625210	SITE MONITORING SYSTEM		$1,000,000
625220	EMERGENCY MONITORING AND SHUTDOWN SYSTEM		$500,000
625300	FIRST AID FACILITY		$203,334
625400	INDUSTRIAL HYGIENE FACILITY		included
625500	EMERGENCY RESPONSE EQUIPMENT		$339,275
625600	PLANT TRAFFIC SAFETY SYSTEMS		$50,000
625700	LAUNDRY		$193,651
626000	LABORATORIES AND TECHNICAL OPERATIONS		
626100	BUILDING AND FACILITIES		$472,025
626110	LABORATORY FACILITIES		incl
626120	TECHNICAL OFFICES		incl
626200	LABORATORY EQUIPMENT		$700,000
627000	COMMUNICATION AND INFORMATION SYSTEMS		
627100	TELEPHONE SYSTEM		$150,000
627300	PUBLIC ADDRESS SYSTEM		$500,000
627400	MANAGEMENT INFORMATION SYSTEMS		$2,000,000
627410	PLANT DATA NETWORK		incl
627420	CENTRALIZED COMPUTING FACILITIES AND EQUIPMENT		incl
627430	INDIVIDUAL AND WORKGROUP COMPUTING EQUIPMENT		incl
627500	TELEVIDEO SYSTEMS		$100,000
627600	SATELLITE COMMUNICATION SYSTEM		$100,000
630000	**ON-SITE EMPLOYEE FACILITIES**	**$798,811**	
633000	TRAINING CENTER		$798,811

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700000	**SITE DEVELOPMENT AND FACILITIES**	**$78,123,765**	
710000	**SITE DEVELOPMENT**	**$38,380,165**	
710100	RELOCATION COSTS		$2,500,000
711000	SITE PREPARATION		
717100	ESTABLISH SURVEY BASELINE GRID		$2,500,000
711200	SITE WORK CLEAR & GRUB		included
711300	CUT & FILL		$20,303,372
711400	LEVELING, EXCAVATION, BACKFILL ROADS		$377,778
711500	LAND MINE REMOVAL		$309,200
712000	DRAINAGE		$1,952,147
713000	ROADS		$7,370,168
714000	PARKING AND PAVING		$500,000
715000	LIGHTING		$500,000
716000	FENCING		$197,500
717000	LANDSCAPING		$100,000
718000	RAIL SERVICE		$770,000
719000	MISCELLANEOUS SITE ITEMS		$1,000,000
720000	**PILING AND SOIL IMPROVEMENT**	**$39,743,600**	
721000	PILING		$26,743,600
722000	SOIL IMPROVEMENT		$13,000,000

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800000	**OFF-SITE FACILITIES**	**$4,000,000**	
810000	EXPATRIATE LIVING COMPLEX	$2,500,000	
811000	EXPATRIATE HOUSING		local contract
812000	EXPATRIATE TRANSPORTATION		$2,500,000
813000	MEDICAL TREATMENT FACILITY		included
814000	EXPATRIATE DEPENDENTS SCHOOL		included
815000	GUEST HOUSE		included
816000	EMPLOYEE RECREATION FACILITY		included
820000	BEIRA MEDICAL FACILITY	$500,000	$500,000
830000	BEIRA EDUCATIONAL FACILITY	$500,000	$500,000
840000	CITY ROADS AND TRANSPORTATION INFRASTRUCTURE	$500,000	$500,000

900000	**INDIRECT COSTS**	**$360,955,840**	
910000	EPCM SERVICES	$129,720,000	
911000	PRELIMINARY ENGINEERING		$6,000,000
912000	PROJECT MANAGEMENT		$4,800,000
913000	ENGINEERING		$48,000,000
914000	PROCUREMENT AND EXPEDITING		$3,600,000
915000	CONSTRUCTION MANAGEMENT		$48,000,000
914000	OFFICE EXPENSES		$8,280,000
915000	TRAVEL AND LIVING EXPENSES		$11,040,000
920000	TECHNOLOGY FEES	$0	incl w/ eqpt
930000	INSURANCE	$10,000,000	$10,000,000
940000	FREIGHT, DUTY, FEES	$74,000,000	$74,000,000
950000	OWNERS COSTS	$12,000,000	
951000	DEEDED PROPERTY		$0
952000	OWNERS MANAGEMENT TEAM		$4,000,000
953000	OWNER START-UP TEAM		$8,000,000
960000	WORKING CAPITAL		
961000	SPARE PARTS		incl w/eqpt
962000	FIRST FILL		incl w/financials
963000	CASH RESERVES		incl w/financials
970000	FINANCING COST	$15,000,000	
971000	FINANCING FEES		$15,000,000
972000	INTEREST DURING CONSTRUCTION		incl w/financials
980000	CONSTRUCTION INDIRECTS	$25,235,840	$25,235,840
990000	CONTINGENCY AND ESCALATION	$95,000,000	
992000	EVALUATED CONTINGENCY		$95,000,000

RISK ANALYSIS INPUT

(Basic Model)

		TARGET x 1,000,000	PROB	MINIMUM	MAXIMUM	FIXED x 1,000,000
1	Reduction Plant Building	49	40	-10%	50%	-
2	Reduction Plant Pots	245	50	-10%	20%	-
3	Reduction Plant Equipment and Support Items	112	50	-15%	15%	-
4	Anode Manufacturing Green Mill	42	60	-5%	20%	-
5	Anode Manufacturing Baking and Block Storage	60	50	-10%	20%	-
6	Anode Manufacturing Rodding and Cooling	38	60	-10%	20%	-
7	Metal Products	6	-	-	-	6
8	Marine Terminal Facilities	4	40	-5%	100%	-
9	Raw Material Storage and Handling	42	60	-10%	40%	-
10	Plant Power	61	50	-5%	30%	-
11	Other Utilities	17	50	-15%	20%	-
12	Maintenance and Administration Facilities	23	50	-30%	20%	-
13	Site Development	51	50	-10%	50%	-
14	Piling	23	40	-10%	50%	-
15	Off-Site Facilities	24	60	-5%	30%	-
16	EP&CM Services	130	55	-25%	15%	-
17	Fees and Insurance	90	40	-5%	20%	-
18	Freight and Other Indirect Costs	97	50	-20%	50%	-
		1,114				

OTE: PROB is the probability that the actual cost will fall at or below the target estimate.

RISK ANALYSIS

(Basic Model)

TO BE THIS CONFIDENT OF NOT HAVING A COST OVERRUN	ADD THIS CONTINGENCY ABSOLUTE	RELATIVE
100 Percent	444	40 Percent
99.95 Percent	197	18 Percent
95 Percent	128	11 Percent
90 Percent	108	10 Percent
85 Percent	95	8 Percent
80 Percent	81	7 Percent
75 Percent	74	7 Percent
70 Percent	66	6 Percent
65 Percent	59	5 Percent
60 Percent	51	5 Percent
55 Percent	47	4 Percent
50 Percent	41	4 Percent
45 Percent	33	3 Percent
40 Percent	27	2 Percent
35 Percent	23	2 Percent
30 Percent	15	1 Percent
25 Percent	11	1 Percent
20 Percent	3	0 Percent
15 Percent	-5	0 Percent
10 Percent	-14	-1 Percent
5 Percent	-35	-3 Percent
0.05 Percent	-92	-8 Percent
0 Percent	-210	-19 Percent

NOTE: The above analysis is predicated on a target cost of $ 1,113,192,000 US excluding all contingency and escalation.

RISK ALLOCATION

(Basic Model)

		PERCENTAGE	DOLLARS X 1,000,000
18	Freight and Other Indirects	16.7%	15.8
1	Potrooms Building	14.4%	13.6
2	Reduction Cells	14.1%	13.3
13	Site Development	11.7%	11.1
17	Fees and Insurance	10.2%	9.6
10	Plant Power	8.7%	8.2
14	Piling	6.7%	6.3
9	Raw Material Handling	5.0%	4.7
5	Anode Baking and Storage	3.5%	3.3
8	Marine Terminal	2.7%	2.6
15	Off-Site Facilities	2.5%	2.4
4	Green Mill	2.4%	2.3
6	Anode Rodding	0.9%	0.9
11	Other Utilities	0.5%	0.5
3	Potroom Equipment	0.0%	0.0
7	Metal Products	0.0%	0.0
12	Maintenance and Admin	0.0%	0.0
16	EP&CM Services	0.0%	0.0
		100.0%	95

Kaiser K220 PreBake

Beira Reduction Facility

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Base Case (Rev. 2.3)

Unit Cost Basis

	Rate	Units	Basis of Estimate
Alumina			
Assumed LME Price	$1,565	US$/mT	
% Cost of LME	12.50%		FOB Refinery
Freight	$18.00	US$/mT	Ocean Freight, 30,000 T vessels
LOI Discount	99.00%		Commercial Practice Assumed
Total Alumina Price	$211.67	US$/mT	
Electricity	$0.013	US$/kwh	Assumed 10 mils at the dam head + 3 mils to wheel
Petroleum Coke			
Cost of Coke	$200.00	US$/mT	FOB RSA Calciner
Freight	$12.00	US$/mT	Ocean Freight
Total Coke Price	$212.00	US$/mT	
Coal Tar Pitch			
Cost of Pitch	$359.00	US$/mT	FOB Europe Port
Freight	$18.00	US$/mT	Ocean Freight
Total Cost of Pitch	$377.00	US$/mT	
Spares & Consumables			
R&M Spare Parts, Matls	$11.84	US$M/yr	Calculated from industry benchmarks
Bake Furnace Brick	$0.49	US$M/yr	Calculated from predicted usages
Cast Iron and Stub Blanks	$0.05	US$M/yr	Calculated from predicted usages
Pot Shell Replacement	$0.38	US$M/yr	Allowance
Misc Chemicals	$0.60	US$M/yr	Allowance
Recycled Iron Credit	($0.12)	US$M/yr	Calculated from predicted usages
TOTAL PER YEAR	$13.24	US$M/yr	Total of above
SPL Disposal Charge	$40.00	US$/mT	Untreated, but contained
R&M Matls Factor	1.0%	% of asset/yr	Industry Benchmark
Anode Rod Assembly Cost	$0.00	each	Included in Capital Estimate

Kaiser K220 PreBake
Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Unit Cost Basis

	Rate	Units	Basis of Estimate
Aluminum Fluoride			
Cost of AlF^3	$842.00	US$/mT	FOB US Port
Freight	$18.00	US$/mT	Ocean Freight
Total Cost of AlF^3	$860.00	US$/mT	
Cryolite (or Cold Bath)			
Cost of Cryolite	$750.00	US$/mT	FOB US Port
Freight	$18.00	US$/mT	Ocean Freight
Total Cost of Cryolite	$768.00	US$/mT	
Cathode Material			
Bottom Blocks Cost	$2,221.00	US$/mT	30% graphitic
Side Blocks Cost	$2,221.00	US$/mT	Same as bottom block
Ramming Paste Cost	$720.00	US$/mT	Current International cost
Bars and Cast Iron Cost	$542.00	US$/mT	Piece cost, converted to $/mT
Brick and Other Cost	$551.00	US$/mT	Piece cost, converted to $/mT
Bottom Blocks Usage	0.00343	mT/mT-Al(hot)	From technical data and estimated cell life
Side Blocks Usage	0.00055	mT/mT-Al(hot)	From technical data and estimated cell life
Ramming Paste Usage	0.00096	mT/mT-Al(hot)	From technical data and estimated cell life
Bars and Cast Iron Usage	0.00329	mT/mT-Al(hot)	From technical data and estimated cell life
Brick and Other Usage	0.00478	mT/mT-Al(hot)	From technical data and estimated cell life
Total Cathode Matls Usage	0.01302	mT/mT-Al(hot)	Calculated
Total Cathode Matls Cost	$1,072	US$/mT	Calculated per mT of cathode material
Fuel			
Natural Gas Baking	$1.85	US$/mBTU	Allowance
Natural Gas Casting	$1.85	US$/mBTU	Allowance
Labor			
Hourly Rate	$5.70	US$/hr	From staffing plan, includes expat housing
Productivity	9.09	m-h/mT-Al	

Fluor Daniel Smelter Operating Costs Model

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Item	Cost $	Cost Unit	Usage	Unit	US$M/yr	US$/mT	US$/lb
Cast Metal Production			301,689	mT/yr			
Molten Metal Production			302,779	mT/yr			
Alumina	$211.67	mT	581,428	mT/yr	$123.1	$407.94	$0.185
Electricity							
Process Power	$0.013	AC-k Wh	3.97E+09	k Wh/yr	$51.7	$171.28	$0.078
Plant Auxiliary Power	$0.013	AC-k Wh	2.76E+08	k Wh/yr	$3.6	$11.91	$0.005
Anode Carbon							
Coke	$212.00	mT	108,364	mT/yr	$23.0	$76.15	$0.035
Pitch	$377.00	mT	25,133	mT/yr	$9.5	$31.41	$0.014
Spares & Consumables					$13.2	$43.89	$0.020
Electrolyte Chemicals							
Aluminum Fluoride	$860.00	mT	2,618	mT/yr	$2.3	$7.46	$0.003
Cryolite/Cold Bath	$768.00	mT	149	mT/yr	$0.1	$0.38	$0.000
Cell Relining							
Cathode Materials	$1,072.16	mT	3,941	mT/yr	$4.2	$14.01	$0.006
SPL Disposal Costs	$40.00	mT	5,143	mT/yr	$0.2	$0.68	$0.000
Fuel							
Baking Fuel	$1.85	M Btu	390,297	M Btu/yr	$0.7	$2.39	$0.001
Casting Fuel	$1.85	M Btu	31,809	M Btu/yr	$0.1	$0.20	$0.000
Labor	$5.70	wk-hr	2,741,440	wk-hr/yr	$15.6	$51.80	$0.024
Total Operating Cost					**$247.2**	**$819.50**	**$0.372**

Kaiser K220 PreBake

Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Target Staffing Plan

	Ghanean	US Expat	Local	Total
Direct Production Manpower				
Potrooms General Management	2	2	8	12
Potrooms Line Management	10		138	148
Carbon (General)	1		1	2
Green Mill	1		11	12
Anode Baking	2	1	25	28
Anode Rodding	1		15	16
Cast House	4	1	36	41
General Services	1		20	21
Laboratory	2	1	24	27
Environmental	1		20	21
Maintenance and Engineering				
General Management	2	1		3
Engineering	2	3	10	15
Planning and Stores	2		17	19
Core Maintenance	6		71	77
Production Maintenance				
Potrooms Operations	1		76	77
Green Mill			6	6
Anode Baking			8	8
Anode Rodding			6	6
Cast House			8	8
General Services			11	11
Environmental			9	9
Cell Reline	1		23	24
Management and Administration				
General Management	1	2	4	7
Accounting and MIS	2	1	18	21
Supply		1	10	11
Personnel	1		8	9
Security			20	20
Total Target Staffing				
Employees	86	26	1206	1318
Effort-hours/yr	178,880	54,080	2,508,480	2,741,440
Cost of Labor				
Average hourly rate (US$, all inclusive)	$38.46	$115.38	$1.00	
Paid hours per person-year	2,080	2,080	2,080	
Total Manpower Cost (MM$/yr)	$6.9	$6.2	$2.5	$15.6
Average Hourly Rate				$5.70
Manpower Productivity (m-h/t)				9.09

Kaiser K220 PreBake
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Base Case (Rev. 2.3)

Balance Sheets	1-May-04 Year 0		1-May-05 Year 1		1-May-06 Year 2		1-May-07 Year 3	
Assets								
Current Assets:								
Cash and marketable securities	$0		$0		$0		$0	
Accounts receivable	$0		$0		$0		$0	
Inventories	$38,155,268		$38,155,268		$38,155,268		$38,155,268	
Prepaid expenses	$0		$0		$0		$0	
Total Current Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Plant, Property and Equipment:								
Land		$0		$0		$0		$0
Buildings and equipment at cost	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Less: Accumulated depreciation	$0		$185,868,653		$371,737,307		$557,605,960	
Net Property, Plant and Equipment		$1,301,080,574		$1,115,211,921		$929,343,267		$743,474,614
Other Assets:								
Investments	$0		$0		$0		$0	
Goodwill	$0	$0	$0	$0	$0	$0	$0	$0
Total Assets		$1,339,235,842		$1,153,367,189		$967,498,536		$781,629,882
Liabilities and Shareholders Equity								
Current Liabilities:								
Accounts payable	$0		$0		$0		$0	
Estimated tax liability	$0		$0		$0		$0	
Accrued expenses payable	$0		$0		$0		$0	
Deferred income	$118,035,802		$118,035,802		$118,035,802		$118,035,802	
Notes payable, current portion	$0		$0		$0		$0	
Total Current Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Notes payable		$736,579,713		$659,652,379		$574,801,530		$481,211,043
Total Liabilities		$854,615,515		$777,688,181		$692,837,331		$599,246,844
Shareholders' Equity:								
Paid in capital	$602,656,129		$602,656,129		$602,656,129		$602,656,129	
Retained Earnings	($118,035,802)		($226,977,121)		($327,994,925)		($420,273,091)	
Total Shareholders' Equity		$484,620,328		$375,679,008		$274,661,204		$182,383,038
Total Liabilities and Shareholders' Equity		$1,339,235,842		$1,153,367,189		$967,498,536		$781,629,882

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Balance Sheets	30-Apr-08 Year 4		30-Apr-09 Year 5		30-Apr-10 Year 6		30-Apr-11 Year 7	
Assets								
Current Assets:								
Cash and marketable securities	$0		$0		$0		$0	
Accounts receivable	$0		$0		$0		$0	
Inventories	$38,155,268		$38,155,268		$38,155,268		$38,155,268	
Prepaid expenses	$0		$0		$0		$0	
Total Current Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Plant, Property and Equipment:								
Land		$0		$0		$0		$0
Buildings and equipment at cost	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Less: Accumulated depreciation	$743,474,614		$929,343,267		$1,115,211,921		$1,301,080,574	
Net Property, Plant and Equipment		$557,605,960		$371,737,307		$185,868,653		$0
Other Assets:								
Investments	$0		$0		$0		$0	
Goodwill	$0	$0	$0	$0	$0	$0	$0	$0
Total Assets		$595,761,229		$409,892,575		$224,023,922		$38,155,268
Liabilities and Shareholders Equity								
Current Liabilities:								
Accounts payable	$0		$0		$0		$0	
Estimated tax liability	$0		$0		$0		$0	
Accrued expenses payable	$0		$0		$0		$0	
Deferred income	$118,035,802		$118,035,802		$118,035,802		$118,035,802	
Notes payable, current portion	$0		$0		$0		$0	
Total Current Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Notes payable		$377,980,735		$264,117,707		$138,526,786		$0
Total Liabilities		$496,016,537		$382,153,508		$256,562,587		$118,035,802
Shareholders' Equity:								
Paid in capital	$602,656,129		$602,656,129		$602,656,129		$602,656,129	
Retained Earnings	($502,911,438)		($574,917,062)		($635,194,795)		($682,536,663)	
Total Shareholders' Equity		$99,744,692		$27,739,067		($32,538,666)		($79,880,533)
Total Liabilities and Shareholders' Equity		$595,761,229		$409,892,575		$224,023,922		$38,155,268

Kaiser K220 PreBake

Beira Reduction Facility

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Base Case (Rev. 2.3)

Balance Sheets	29-Apr-12 Year 8		29-Apr-13 Year 9		29-Apr-14 Year 10		29-Apr-15 Year 11	
Assets								
Current Assets:								
Cash and marketable securities	$0		$0		$0		$0	
Accounts receivable	$0		$0		$0		$0	
Inventories	$38,155,268		$38,155,268		$38,155,268		$38,155,268	
Prepaid expenses	$0		$0		$0		$0	
Total Current Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Plant, Property and Equipment:								
Land		$0		$0		$0		$0
Buildings and equipment at cost	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Less: Accumulated depreciation	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Net Property, Plant and Equipment		$0		$0		$0		$0
Other Assets:								
Investments	$0		$0		$0		$0	
Goodwill	$0	$0	$0	$0	$0	$0	$0	$0
Total Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Liabilities and Shareholders Equity								
Current Liabilities:								
Accounts payable	$0		$0		$0		$0	
Estimated tax liability	$0		$0		$0		$0	
Accrued expenses payable	$0		$0		$0		$0	
Deferred income	$118,035,802		$118,035,802		$118,035,802		$118,035,802	
Notes payable, current portion	$0		$0		$0		$0	
Total Current Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Notes payable		$0		$0		$0		$0
Total Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Shareholders' Equity:								
Paid in capital	$602,656,129		$602,656,129		$602,656,129		$602,656,129	
Retained Earnings	($682,536,663)		($682,536,663)		($682,536,663)		($682,536,663)	
Total Shareholders' Equity		($79,880,533)		($79,880,533)		($79,880,533)		($79,880,533)
Total Liabilities and Shareholders' Equity		$38,155,268		$38,155,268		$38,155,268		$38,155,268

Kaiser K220 PreBake

Beira Reduction Facility

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Base Case (Rev. 2.3)

Balance Sheets	28-Apr-16 Year 12		28-Apr-17 Year 13		28-Apr-18 Year 14		28-Apr-19 Year 15	
Assets								
Current Assets:								
Cash and marketable securities	$0		$0		$0		$0	
Accounts receivable	$0		$0		$0		$0	
Inventories	$38,155,268		$38,155,268		$38,155,268		$38,155,268	
Prepaid expenses	$0		$0		$0		$0	
Total Current Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Plant, Property and Equipment:								
Land		$0		$0		$0		$0
Buildings and equipment at cost	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Less: Accumulated depreciation	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Net Property, Plant and Equipment		$0		$0		$0		$0
Other Assets:								
Investments	$0		$0		$0		$0	
Goodwill	$0	$0	$0	$0	$0	$0	$0	$0
Total Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Liabilities and Shareholders Equity								
Current Liabilities:								
Accounts payable	$0		$0		$0		$0	
Estimated tax liability	$0		$0		$0		$0	
Accrued expenses payable	$0		$0		$0		$0	
Deferred income	$118,035,802		$118,035,802		$118,035,802		$118,035,802	
Notes payable, current portion	$0		$0		$0		$0	
Total Current Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Notes payable		$0		$0		$0		$0
Total Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Shareholders' Equity:								
Paid in capital	$602,656,129		$602,656,129		$602,656,129		$602,656,129	
Retained Earnings	($682,536,663)		($682,536,663)		($682,536,663)		($682,536,663)	
Total Shareholders' Equity		($79,880,533)		($79,880,533)		($79,880,533)		($79,880,533)
Total Liabilities and Shareholders' Equity		$38,155,268		$38,155,268		$38,155,268		$38,155,268

Kaiser K220 PreBake

Beira Reduction Facility

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Base Case (Rev. 2.3)

Balance Sheets	27-Apr-20 Year 16		27-Apr-21 Year 17		27-Apr-22 Year 18		27-Apr-23 Year 19	
Assets								
Current Assets:								
Cash and marketable securities	$0		$0		$0		$0	
Accounts receivable	$0		$0		$0		$0	
Inventories	$38,155,268		$38,155,268		$38,155,268		$38,155,268	
Prepaid expenses	$0		$0		$0		$0	
Total Current Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Plant, Property and Equipment:								
Land		$0		$0		$0		$0
Buildings and equipment at cost	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Less: Accumulated depreciation	$1,301,080,574		$1,301,080,574		$1,301,080,574		$1,301,080,574	
Net Property, Plant and Equipment		$0		$0		$0		$0
Other Assets:								
Investments	$0		$0		$0		$0	
Goodwill	$0	$0	$0	$0	$0	$0	$0	$0
Total Assets		$38,155,268		$38,155,268		$38,155,268		$38,155,268
Liabilities and Shareholders Equity								
Current Liabilities:								
Accounts payable	$0		$0		$0		$0	
Estimated tax liability	$0		$0		$0		$0	
Accrued expenses payable	$0		$0		$0		$0	
Deferred income	$118,035,802		$118,035,802		$118,035,802		$118,035,802	
Notes payable, current portion	$0		$0		$0		$0	
Total Current Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Notes payable		$0		$0		$0		$0
Total Liabilities		$118,035,802		$118,035,802		$118,035,802		$118,035,802
Shareholders' Equity:								
Paid in capital	$602,656,129		$602,656,129		$602,656,129		$602,656,129	
Retained Earnings	($682,536,663)		($682,536,663)		($682,536,663)		($682,536,663)	
Total Shareholders' Equity		($79,880,533)		($79,880,533)		($79,880,533)		($79,880,533)
Total Liabilities and Shareholders' Equity		$38,155,268		$38,155,268		$38,155,268		$38,155,268

Kaiser K220 PreBake

Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Balance Sheets		26-Apr-24 Year 20
Assets		
Current Assets:		
Cash and marketable securities	$0	
Accounts receivable	$0	
Inventories	$38,155,268	
Prepaid expenses	$0	
Total Current Assets		$38,155,268
Plant, Property and Equipment:		
Land		$0
Buildings and equipment at cost	$1,301,080,574	
Less: Accumulated depreciation	$1,301,080,574	
Net Property, Plant and Equipment		$0
Other Assets:		
Investments	$0	
Goodwill	$0	$0
Total Assets		$38,155,268
Liabilities and Shareholders Equity		
Current Liabilities:		
Accounts payable	$0	
Estimated tax liability	$0	
Accrued expenses payable	$0	
Deferred income	$118,035,802	
Notes payable, current portion	$0	
Total Current Liabilities		$118,035,802
Notes payable		$0
Total Liabilities		$118,035,802
Shareholders' Equity:		
Paid in capital	$602,656,129	
Retained Earnings	($682,536,663)	
Total Shareholders' Equity		($79,880,533)
Total Liabilities and Shareholders' Equity		$38,155,268

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Income Statements	1-May-04 Construction Period	1-May-05 Year 1	1-May-06 Year 2	1-May-07 Year 3	30-Apr-08 Year 4	30-Apr-09 Year 5
Net sales	$290,522,772	$479,453,130	$489,042,192	$498,823,036	$508,799,497	$518,975,487
Other revenue	$0	$0	$0	$0	$0	$0
Total revenues	$290,522,772	$479,453,130	$489,042,192	$498,823,036	$508,799,497	$518,975,487
Expenses:						
Cost of goods sold	$137,651,636	$242,802,608	$245,264,011	$247,774,641	$250,335,485	$252,947,545
Selling, general, and administrative expenses	$0	$0	$0	$0	$0	$0
Interest expense	$0	$75,867,710	$67,944,195	$59,204,558	$49,564,737	$38,932,016
Depreciation on plant and equipment	$0	$185,868,653	$185,868,653	$185,868,653	$185,868,653	$185,868,653
Income tax	$0	$0	$0	$0	$0	$0
Total expenses	$137,651,636	$504,538,972	$499,076,859	$492,847,852	$485,768,876	$477,748,214
Income before extraordinary items	$152,871,136	-$25,085,842	-$10,034,667	$5,975,183	$23,030,621	$41,227,272
Extraordinary items	$0	$0	$0	$0	$0	$0
Net Income	$152,871,136	-$25,085,842	-$10,034,667	$5,975,183	$23,030,621	$41,227,272
Retained earnings at beginning of period	$0	-$118,035,802	-$226,977,121	-$327,994,925	-$420,273,091	-$502,911,438
Plus: Net Income	$152,871,136	-$25,085,842	-$10,034,667	$5,975,183	$23,030,621	$41,227,272
	$152,871,136	-$143,121,644	-$237,011,788	-$322,019,741	-$397,242,470	-$461,684,165
Cash dividends on common stock	$270,906,937	$83,855,477	$90,983,137	$98,253,350	$105,668,967	$113,232,897
Retained earnings at end of period	-$118,035,802	-$226,977,121	-$327,994,925	-$420,273,091	-$502,911,438	-$574,917,062

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Income Statements	30-Apr-10 Year 6	30-Apr-11 Year 7	29-Apr-12 Year 8	29-Apr-13 Year 9	29-Apr-14 Year 10	29-Apr-15 Year 11
Net sales	$529,354,996	$539,942,096	$550,740,938	$561,755,757	$572,990,872	$584,450,690
Other revenue	$0	$0	$0	$0	$0	$0
Total revenues	$529,354,996	$539,942,096	$550,740,938	$561,755,757	$572,990,872	$584,450,690
Expenses:						
Cost of goods sold	$262,110,385	$266,956,906	$271,921,647	$277,007,611	$282,217,880	$287,555,618
Selling, general, and administrative expenses	$0	$0	$0	$0	$0	$0
Interest expense	$27,204,124	$14,268,259	$0	$0	$0	$0
Depreciation on plant and equipment	$185,868,653	$185,868,653	$0	$0	$0	$0
Income tax	$0	$0	$0	$0	$0	$0
Total expenses	$475,183,162	$467,093,819	$271,921,647	$277,007,611	$282,217,880	$287,555,618
Income before extraordinary items	$54,171,834	$72,848,278	$278,819,291	$284,748,146	$290,772,992	$296,895,072
Extraordinary items	$0	$0	$0	$0	$0	$0
Net Income	$54,171,834	$72,848,278	$278,819,291	$284,748,146	$290,772,992	$296,895,072
Retained earnings at beginning of period	-$574,917,062	-$635,194,795	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663
Plus: Net Income	$54,171,834	$72,848,278	$278,819,291	$284,748,146	$290,772,992	$296,895,072
	-$520,745,228	-$562,346,517	-$403,717,372	-$397,788,517	-$391,763,670	-$385,641,591
Cash dividends on common stock	$114,449,567	$120,190,145	$278,819,291	$284,748,146	$290,772,992	$296,895,072
Retained earnings at end of period	-$635,194,795	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663

Kaiser K220 PreBake

Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Income Statements	28-Apr-16 Year 12	28-Apr-17 Year 13	28-Apr-18 Year 14	28-Apr-19 Year 15	27-Apr-20 Year 16	27-Apr-21 Year 17
Net sales	$596,139,703	$608,062,497	$620,223,747	$632,628,222	$645,280,787	$658,186,402
Other revenue	$0	$0	$0	$0	$0	$0
Total revenues	$596,139,703	$608,062,497	$620,223,747	$632,628,222	$645,280,787	$658,186,402
Expenses:						
Cost of goods sold	$293,024,072	$298,626,575	$304,366,548	$310,247,505	$316,273,049	$322,446,882
Selling, general, and administrative expenses	$0	$0	$0	$0	$0	$0
Interest expense	$0	$0	$0	$0	$0	$0
Depreciation on plant and equipment	$0	$0	$0	$0	$0	$0
Income tax	$0	$0	$0	$0	$0	$0
Total expenses	$293,024,072	$298,626,575	$304,366,548	$310,247,505	$316,273,049	$322,446,882
Income before extraordinary items	$303,115,632	$309,435,923	$315,857,199	$322,380,718	$329,007,738	$335,739,521
Extraordinary items	$0	$0	$0	$0	$0	$0
Net Income	$303,115,632	$309,435,923	$315,857,199	$322,380,718	$329,007,738	$335,739,521
Retained earnings at beginning of period	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663
Plus: Net Income	$303,115,632	$309,435,923	$315,857,199	$322,380,718	$329,007,738	$335,739,521
	-$379,421,031	-$373,100,740	-$366,679,464	-$360,155,945	-$353,528,925	-$346,797,142
Cash dividends on common stock	$303,115,632	$309,435,923	$315,857,199	$322,380,718	$329,007,738	$335,739,521
Retained earnings at end of period	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663	-$682,536,663

Kaiser K220 PreBake

Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Income Statements	27-Apr-22 Year 18	27-Apr-23 Year 19	26-Apr-24 Year 20
Net sales	$671,350,131	$684,777,133	$698,472,676
Other revenue	$0	$0	$0
Total revenues	$671,350,131	$684,777,133	$698,472,676
Expenses:			
Cost of goods sold	$328,772,803	$335,254,711	$341,896,611
Selling, general, and administrative expenses	$0	$0	$0
Interest expense	$0	$0	$0
Depreciation on plant and equipment	$0	$0	$0
Income tax	$0	$0	$0
Total expenses	$328,772,803	$335,254,711	$341,896,611
Income before extraordinary items	$342,577,328	$349,522,422	$356,576,065
Extraordinary items	$0	$0	$0
Net Income	$342,577,328	$349,522,422	$356,576,065
Retained earnings at beginning of period	-$682,536,663	-$682,536,663	-$682,536,663
Plus: Net Income	$342,577,328	$349,522,422	$356,576,065
	-$339,959,335	-$333,014,240	-$325,960,598
Cash dividends on common stock	$342,577,328	$349,522,422	$356,576,065
Retained earnings at end of period	-$682,536,663	-$682,536,663	-$682,536,663

Kaiser K220 PreBake

Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Sensitivity of Breakeven LME Price

		Breakeven LME Price			
		Payback Period of Loan			
		20	**15**	**10**	**7**
Annual Interest Rate	**6%**	$824	$869	$965	$1,090
	7%	$844	$889	$983	$1,108
	8%	$866	$909	$1,002	$1,127
	9%	$888	$930	$1,022	$1,146
	10%	$911	$951	$1,042	$1,165
	11%	$934	$973	$1,062	$1,185
	12%	$958	$996	$1,083	$1,205
	13%	$983	$1,019	$1,104	$1,225
	14%	$1,008	$1,042	$1,126	$1,246

Capital Cost/mT	Breakeven LME Price
$3,000	$1,036
$3,200	$1,065
$3,400	$1,095
$3,600	$1,125
$3,800	$1,155
$4,000	$1,185
$4,200	$1,215
$4,400	$1,244
$4,600	$1,274
$4,800	$1,304
$5,000	$1,334

Kaiser K220 PreBake

Beira Reduction Facility

12 November, 1999

Base Case (Rev. 2.3)

Sensitivity of Internal Rate of Return

		Internal Rate of Return					
		Capital Cost per Tonne					
		$3,500	$3,910	$4,000	$5,000	$5,500	$6,000
LME Ingot Price	$1,300	20.1%	17.1%	16.6%	11.7%	9.9%	8.3%
	$1,400	23.6%	20.3%	19.7%	14.2%	12.2%	10.5%
	$1,500	27.1%	23.5%	22.8%	16.6%	14.4%	12.6%
	$1,600	30.7%	26.6%	25.8%	19.1%	16.7%	14.6%
	$1,700	34.2%	29.8%	28.9%	21.6%	18.9%	16.7%
	$1,800	37.8%	33.0%	32.0%	24.0%	21.1%	18.7%
	$1,900	41.2%	36.1%	35.1%	26.5%	23.4%	20.8%
	$2,000	44.7%	39.3%	38.2%	29.0%	25.6%	22.8%

		Internal Rate of Return				
		Owner's Investment Percentage				
		65%	55%	45%	35%	25%
LME Ingot Price	$1,300	16.2%	16.6%	17.1%	17.8%	18.8%
	$1,400	18.7%	19.4%	20.3%	21.5%	23.4%
	$1,500	21.2%	22.2%	23.5%	25.3%	28.3%
	$1,600	23.6%	24.9%	26.6%	29.2%	33.5%
	$1,700	26.0%	27.6%	29.8%	33.1%	39.0%
	$1,800	28.4%	30.3%	33.0%	37.1%	44.5%
	$1,900	30.7%	32.9%	36.1%	41.1%	50.1%
	$2,000	33.0%	35.6%	39.3%	45.0%	55.6%

		Internal Rate of Return				
		Change in Operating Cost				
		($50)	($25)	$25	$50	$75
LME Ingot Price	$1,300	18.9%	18.0%	16.3%	15.4%	14.4%
	$1,400	22.0%	21.2%	19.4%	18.6%	17.7%
	$1,500	25.1%	24.3%	22.6%	21.8%	20.9%
	$1,600	28.3%	27.5%	25.8%	25.0%	24.1%
	$1,700	31.4%	30.6%	29.0%	28.2%	27.3%
	$1,800	34.5%	33.8%	32.2%	31.4%	30.5%
	$1,900	37.7%	36.9%	35.3%	34.6%	33.8%
	$2,000	40.7%	40.0%	38.5%	37.7%	37.0%

Kaiser K220 PreBake
Beira Reduction Facility
12 November, 1999
Base Case (Rev. 2.3)

Sensitivity of Operating Cost

Power $/kwh	Operating Cost/mT
$0.008	$752
$0.009	$766
$0.010	$780
$0.011	$794
$0.012	$808
$0.013	$823
$0.014	$837
$0.015	$851
$0.016	$865
$0.017	$879
$0.018	$893

Alumina % of LME	Operating Cost/mT
12.00%	$808
12.25%	$815
12.50%	$823
12.75%	$830
13.00%	$837
13.25%	$845
13.50%	$852

Labor m-h/mT	Operating Cost/mT
7.5	$814
8.0	$816
8.5	$819
9.0	$822
9.5	$825
10.0	$828
10.5	$831

PRIMARY ALUMINUM SPECIFICATIONS

SPECIAL CONTRACT RULES FOR PRIMARY ALUMINIUM

1. SIZE OF LOT

25 tonnes

2. MAJOR CURRENCY

The LME uses US dollars as its major currency for each contract, the currency in which dealings on the floor are transacted and which is used for the announcement of the Official Prices. However, Sterling, Deutschmarks and Japanese Yen also constitute good currencies for clearing purposes for all LME metals. Therefore the LME announces the exchange rates each day that the Clearing House will use for evaluating the Settlement Prices.

3. MINIMUM PRICE MOVEMENT

50 cents per tonne

4. DELIVERY DATES

Daily for 3 months forward, then every Wednesday for the next 3 months and then every third Wednesday of the month for the next 21 months. (A total of 27 months forward).

5. QUALITY

The aluminium deliverable under this contract shall be:

a) primary aluminium of minimum 99.70% purity with maximum permissible iron content 0.20% and maximum permissible silicon content 0.10%, or

b) primary aluminium with impurities no greater than in the registered designation P1020A in the Registration Record of Aluminium Association

Designations and Chemical Composition Limits for Unalloyed Aluminium of the Aluminium Association Inc., U.S.A. (May 15th, 1982)

c) The aluminium deliverable under this contract shall be of brands listed in the LME-approved list of aluminium brands.

6. SHAPES AND WEIGHTS

Aluminium delivered may be in the form of ingots, T-bars or sows and ingots shall be securely strapped in bundles suitable for stacking. Ingot weight shall be within the permitted range 12kg to 26kg each. T-bar weight shall not exceed 5% more than 675kg each, and the weight of each sow shall not exceed 5% more than 750kg.

7. WARRANTS

a) Warrants shall be for 25 tonnes each (2% either more or less).

b) Each parcel particularised in each Warrant shall comprise either ingots, T-bars or sows, shall lie at one warehouse, be the production of one country and shall consist of aluminium of one brand shape and size subject, in the case of ingots, to the necessity of including different shapes and sizes at the bottom of each parcel for the purpose of palletisation. Each parcel of ingots placed on warrant shall be delivered securely strapped in bundles not exceeding two tonnes each. Additionally, on and after 18th December 1995, each parcel placed on warrant shall be securely strapped in bundles to permit safe handling without bundle distortion and breakage.

c) Warrants must contain the warning regarding entrapped moisture referred to in the Special Rules for Placing Aluminium on Warrant.

8. TRADED OPTIONS

London Metal Exchange traded options contracts for Primary Aluminium, denominated in US Dollars, Sterling, Japanese Yen or Deutschmarks, are available against the underlying futures contract.

Primary Aluminium options are available against monthly prompt dates out to a total of 27 months. Under LME rules the declaration date (i.e the last day that the option can be declared) is the first Wednesday of the prompt month, and the prompt date is the third Wednesday of that month.

As with LME prompt and futures contracts, all options traded are registered with the Clearing House and form a substantial part of the day-to-day business. LME traded options could be called commodities in their own right, as they can be freely bought and sold on the market until expiry - the only variable being the premium.

LME Primary Aluminium Traded Options

Currency	*Strike Price Gradation*	*Tick Size For Premium*
US Dollars	US$ 25 gradations for Strikes from US$ 25 to US$2000 US$50 gradations for Strikes from US$ 2025 to US$ 4950 US$100 gradations for all Strikes over US$ 5000	Min: US$ 0.01
Sterling	STG 25 gradations for all Strikes over STG25	Min: STG 0.01
Japanese Yen	JY 10,000 gradations for Strikes from JY 10,000 to JY 390,000 JY 20,000 gradations for all Strikes over JY 400,000	Min: JY 10
Deutschmarks	DEM 50 gradations for Strikes up to DEM 50 to DEM 4950 DEM 200 gradations for all Strikes over DEM 5000	Min: DEM 0.10

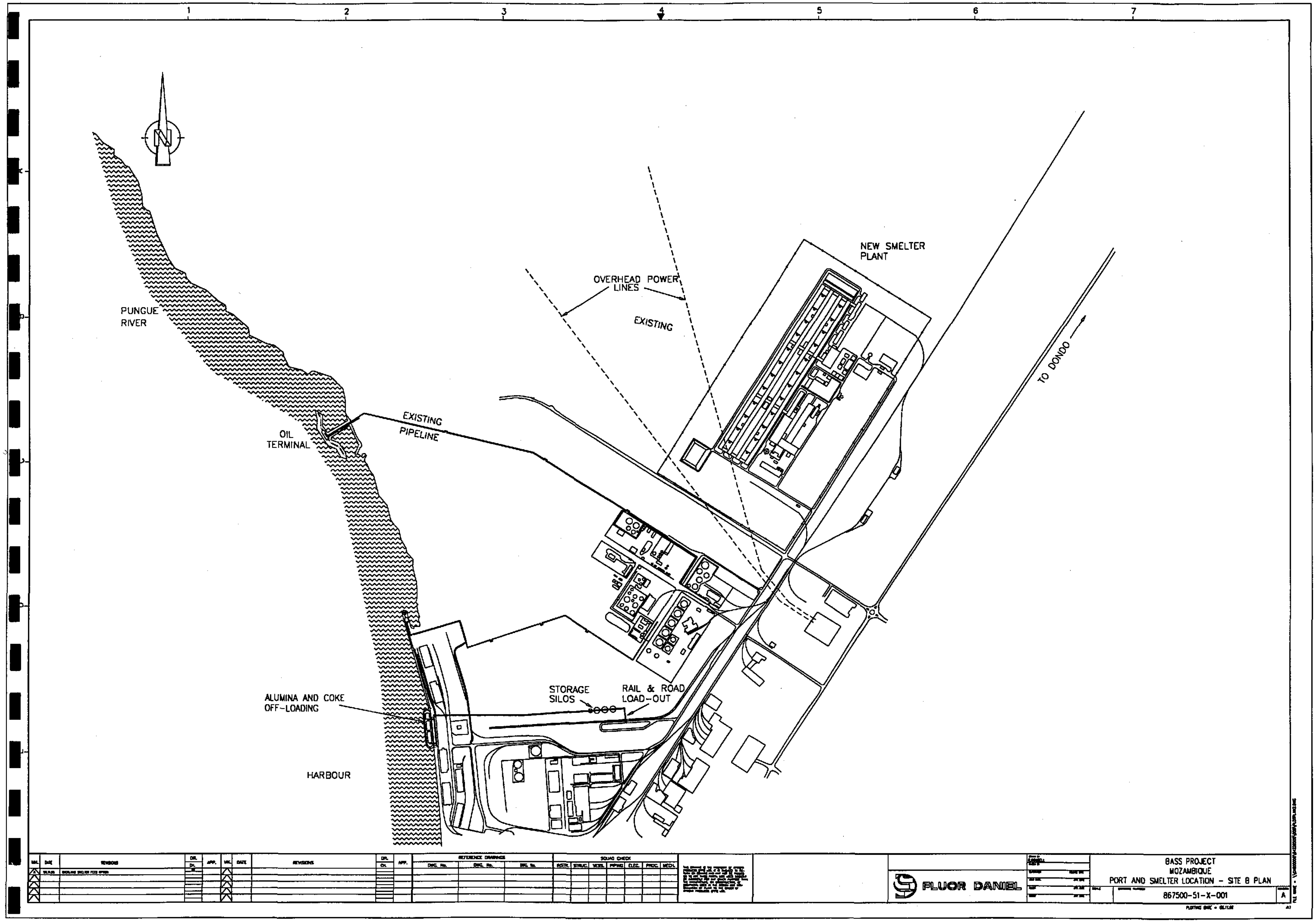
9. DELIVERY POINTS

LME-approved warehouses are situated at Delivery Points around the world. The locations approved for the storage of High-Grade Primary Aluminium are listed below. This list is subject to change; locations can be added or deleted at the discretion of the Board of Directors.

Belgium	Antwerp	**Spain**	Barcelona Bilbao
France	Dunkirk		
Germany	Bremen Hamburg	**Sweden**	Gothenburg Helsingborg
Italy	Genoa Leghorn Trieste	**UK**	Avonmouth Goole Hull Liverpool Newcastle Sunderland
Netherlands	Rotterdam Vlissingen		

USA	Baltimore Chicago Detroit Long Beach Los Angeles New Haven New Orleans Pittsburgh St. Louis Toledo

Japan	Hakata Kobe Moji Nagoya Osaka Yokohoma
Singapore	Singapore


PUNGUE
RIVER
OIL
TERMINAL
EXISTING
PIPELINE
OVERHEAD POWER
LINES
EXISTING
NEW SMELTER
PLANT
TO DONDO
STORAGE
SILOS
RAIL & ROAD
LOAD-OUT
ALUMINA AND COKE
OFF-LOADING
HARBOUR
FLUOR DANIEL
BASS PROJECT
MOZAMBIQUE
PORT AND SMELTER LOCATION - SITE B PLAN
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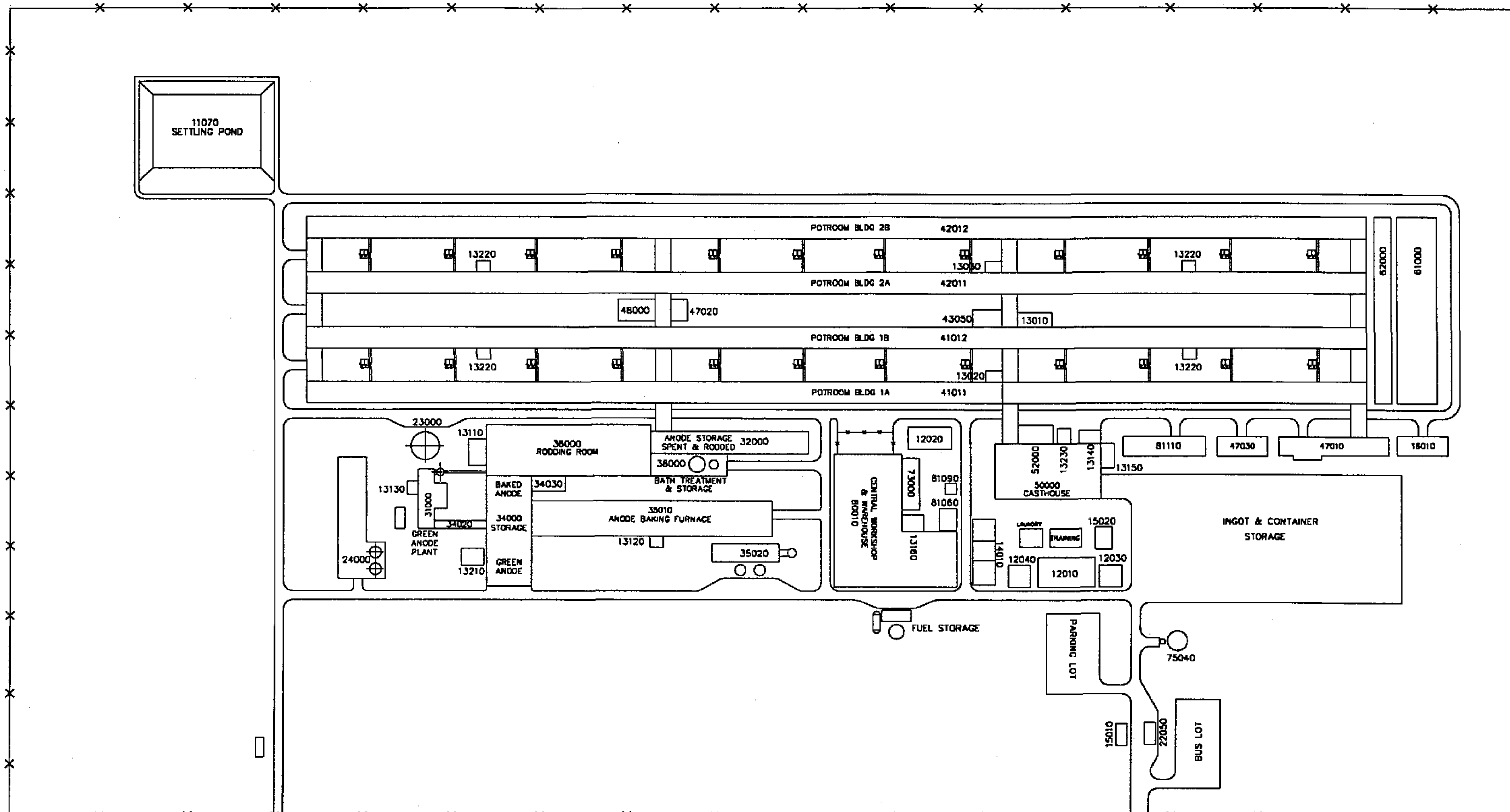

LEGEND

11070 SETTLING POND
12010 MAIN OFFICE BUILDING
12020 PRODUCTION AND PLANT ENGINEERING
12030 HIRING AND PAYROLL BUILDING
12040 PLANT KITCHEN
13010 POTROOM OFFICE AND COMPUTER ROOM
13020 POTLINE 1 OFFICE
13030 POTLINE 2 OFFICE
13110 RODDING ROOM OFFICE
13120 BAKING FURNACE OFFICE
13130 GREEN ANODE PLANT OFFICE
13150 LABORATORY
13160 MAINTENANCE SHOPS AND WAREHOUSE OFFICE
13210 CARBON PLANT LUNCHROOM
13220 POTROOM LUNCHROOM
13230 MAINTENANCE SHOP & CASTHOUSE LUNCHROOM
14010 PLANT CHANGE HOUSE AND SHOWERS
15010 GATE HOUSE
15020 MEDICAL & FIRST AID BUILDING
16010 SPENT CATHODE LINING MATERIAL STORAGE BUILDING
22000 PLANT ALUMINA HANDLING AND STORAGE
22050 TRUCK SCALE
23000 PLANT COKE HANDLING AND STORAGE
24000 PITCH HANDLING AND STORAGE
31000 GREEN ANODE PLANT
32000 SPENT AND RODDED ANODE STORAGE
34000 GREEN AND BAKED ANODE STORAGE
34020 GREEN ANODE HANDLING (COOLING)
34030 CARBON PLANT MAINTENANCE SHOP
35010 ANODE BAKING FURNACE
35020 ANODE BAKING FLUE GAS SCRUBBER
36000 RODDING ROOM
37000 BUTT CRUSHING
38000 BATH TREATMENT AND STORAGE
41011 POTROOM BUILDING 1A
41012 POTROOM BUILDING 1B
42011 POTROOM BUILDING 2A
42012 POTROOM BUILDING 2B
43020 POTROOM FUME TREATMENT PLANT
43050 FUME TREATMENT CONTROL ROOM
44011 POTLINE 1 CRUSHED BATH SILOS
44012 POTLINE 2 CRUSHED BATH SILOS
45021 POTLINE 1 FRESH ALUMINA BINS
45022 POTLINE 2 FRESH ALUMINA BINS
45031 POTLINE 1 REACTED ALUMINA BINS
45032 POTLINE 2 REACTED ALUMINA BINS
47010 POTROOM SERVICE SHOP BUILDING
47020 POTROOMS MAINTENANCE SHOP
47030 POT LINING MATERIAL STORAGE BUILDING
48000 POT TENDING CRANE MAINTENANCE
50000 CASTHOUSE
13140 CASTHOUSE OFFICE
52000 CRUCIBLE CLEANING BUILDING AND PREHEATING
81000 SWITCHYARD
82000 POTLINE RECTIFIER/TRANSFORMERS
73000 COMPRESSOR BUILDING
75040 WATER STORAGE
80010 CENTRAL WORKSHOPS AND WAREHOUSE
81060 PAINT SHOP
81090 FLAMMABLE STORAGE BUILDING
81110 BAGGED MATERIAL STORAGE BUILDING

SCALE (METERS)

REFERENCE	NUMBER	No.	DATE	REVISION	DRN.	APPR.
		A	2-19-99	ISSUED FOR REVIEW AND COMMENT ONLY		

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"* UNLESS OTHERWISE SPECIFIED"		APPROVALS	DATES
*FRACTIONS:	*DECIMALS:	DRAWN BY: EPI/RPS	9-8-99
0 to 48" = ± 1/16"	.X = ± 0.02"	CHKED BY:	
UP to 120" = ± 1/8"	.XX = ± 0.01"	APPROVED:	
OVER 120" = ± 1/4"	.XXX = ± 0.005"	APPROVED:	
*SURFACES: (250)	*ANGLES: = ± 2°	SCALE: 1 = 2000 mm (2000)	
	WORK TO DIMENSIONS DO NOT SCALE	TIME CREATED: 2-19-99 FILE NAME: OM3.DWG	

KAISER ALUMINUM

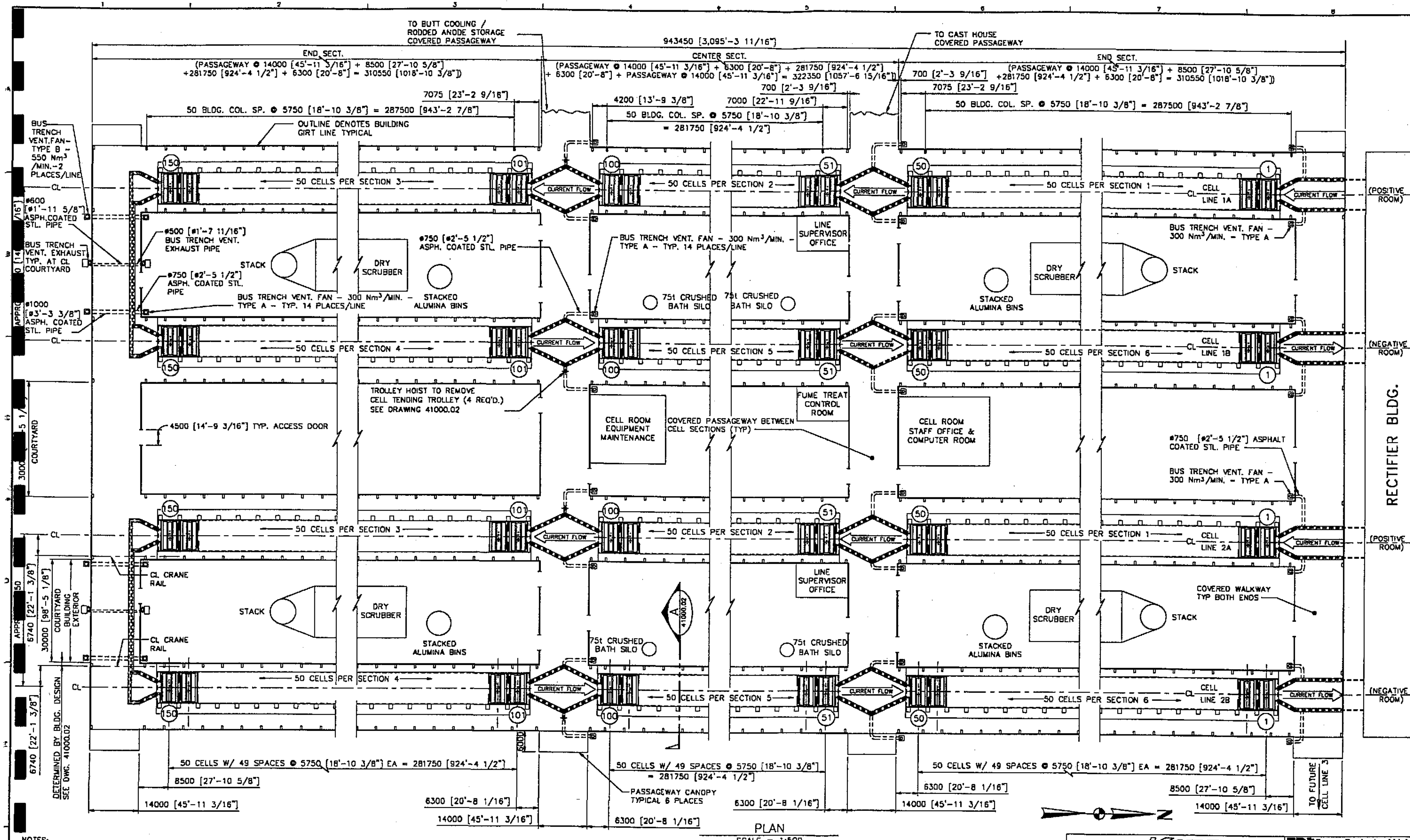
KAISER ALUMINUM TECHNICAL SERVICES, INC.
407 West Riverside Ave.
Spokane, WA 99201, USA

MOZAMBIQUE SMELTER
PLANT
PLOT PLAN GENERAL ARRANGEMENT

MZBQ

DRAWING NUMBER 11000.01o

REV No. B



NOTES:

1. FOR TYPICAL CELL PLAN, SEE DRAWING 41000.07
2. FOR TYPICAL CELL FOUNDATION PLAN, SEE DRAWING 41000.03
3. FOR BUS TYPE, CELL TYPE AND THEIR RESPECTIVE LOCATIONS, SEE DRAWING 41300.01

NOTE: DIM'S. IN [XXX] ARE IN FEET & INCHES.

PRELIMINARY PRINT
ENERGY PRODUCTS OF IDAHO

E	10/19/99	REVISED CELL COUNT	DAW		
D	8/27/99	INCREASED CELL COUNT FROM 288 TO 300 CELLS TOTAL	DAW		
C	3-99	UPDATED DIM'S WITH METRIC AND ENGLISH			
B	1-99	KATI REVIEW AND COMMENT	RPS	MT	
A		ISSUED FOR REVIEW AND COMMENT ONLY			
No.	DATE	REVISION	DRN.	APPR.	

REFERENCE | NUMBER

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*DECIMALS: .X = ± 0.02"; .XX = ± 0.01"; .XXX = ± 0.005"
*SURFACES: (250)
*ANGLES: = ± 2°
WORK TO DIMENSIONS DO NOT SCALE

APPROVALS	DATES
DRAWN BY: EPI/DC	03/10/99
CHKED BY: MK	07/20/99
APPROVED: MK	07/20/99
APPROVED:	
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FILE NAME: 4100001.DWG	

KAISER ALUMINUM

KAISER ALUMINUM TECHNICAL SERVICES, INC.
THE PAULSEN CENTER
407 West Riverside Ave., Suite 1150
USA Spokane, WA 99201

P-86-180 REDUCTION CELL
CELL ROOMS & AUXILIARY FACILITIES
PLAN

DRAWING NUMBER 41000.01 REV No. E

KATSI

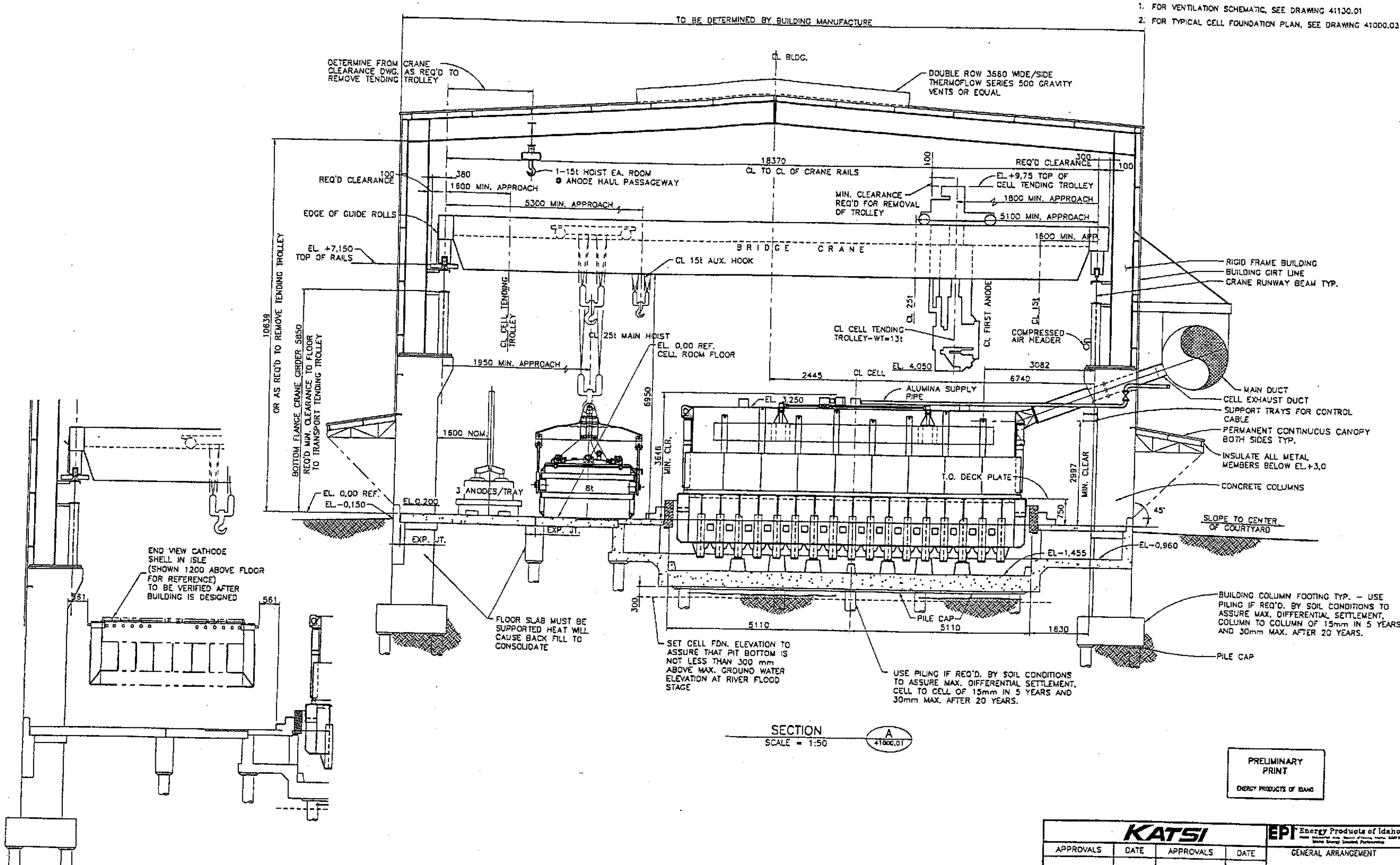
APPROVALS	DATE	APPROVALS	DATE

EPI Energy Products of Idaho

CELL ROOMS AND AUXILIARY FACILITIES PLAN

PROJECT No. 1260	DWG BY DC		
DRAWING No. 41000.01	DATE 03/10/99		
SHEET	SCALE 500		
REVISION A	PLOT SC.		

NOTES:
1. FOR VENTILATION SCHEMATIC, SEE DRAWING 41130.01
2. FOR TYPICAL CELL FOUNDATION PLAN, SEE DRAWING 41000.03



SECTION A (41000.01)
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PRELIMINARY PRINT
ENERGY PRODUCTS OF IDAHO

No.	REFERENCE	NUMBER
1	CELL ROOMS & AUX. FACILITIES PLAN	41000.01

No.	DATE	REVISION	DRN.	APPR.
B	1-99	KATI REVIEW/COMMENT	RPS	
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*SURFACES: (250)
*ANGLES: = ± Z
WORK TO DIMENSIONS DO NOT SCALE

APPROVALS	DATES
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CHKED BY:	
APPROVED:	
APPROVED:	
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KATSI — APPROVALS / DATE / APPROVALS / DATE

EPI Energy Products of Idaho
GENERAL ARRANGEMENT
PROJECT No. 1228 | DWG. BY OPS
DRAWING No. 02030 | DATE 7.7.98
SHEET | SCALE
REVISION B | PLOT SC.

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P-86-180 REDUCTION CELL
TYPICAL CELL ROOM
CROSS SECTION

DRAWING NUMBER 41000.02 | REV No. B