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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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STRENGTHENING GOVERNMENT SUPPORT SERVICES IN THE NON-METALLIC MINERALS SECTOR

DP/ZIM/83/006

ZIMBABWE

Technical report: Increasing the application of local non-metallic minerals

Prepared for the Goverment of Zimbabwe
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Gyorgy Lenkei,
economic adviser in the industrial exploitation of non-metallic minerals

United Nations Industrial Development Organization
Vienna

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Explanatory notes

The monetary unit in Zimbabwe is the dollar ($Zim).

References to tonnes (t) are to metric tonnes.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

PTA	Preferential Trade Area (for Eastern and Southern African States)
SADCC	Southern African Development Co-ordination Conference
ZMDC	Zimbabwe Mining Development Corporation

Mention of the names of firms and commercial products does not imply endorsement by the United Nations Industrial Development Organization (UNIDO).

ABSTRACT

Within the context of the large-scale project "Strengthening of government support services in the non-metallic minerals sector" (DP/ZIM/83/006) an economic adviser was assigned to the project for a period of four months, starting in December 1986.

The purpose of his mission was to study the findings and recommendations contained in earlier reports generated under the project, and to collect and review economic data and other information related to the availability and utilization of local non-metallic minerals, with a view to identifying potential areas of expansion and investment, increasing the application of the available raw materials, diversifying the existing production and substituting imports.

From a range of possible applications the adviser selected two, the production of electric porcelain insulators and of aluminosilicate refractory bricks, for which he elaborated investment opportunity studies.

His main recommendations concern the conducting of further market studies in the countries of the Southern African Development Co-ordination Conference (SADCC) in the fields of refractories, porcelain insulators, sanitary ware, sheet glass, ceramic glazes and high-grade unslacked lime, and the creation of a research and development centre that would be concerned with the exploitation, upgrading and application of non-metallic raw materials as well as with the development of technologies and products for existing and future plants.

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INTRODUCTION

The Zimbabwean authorities are aware of the wealth of different non-metallic minerals that exist in the country. The UNIDO project "Processing of ores of light non-ferrous metals" (SI/ZIM/82/801) drew the attention of the Zimbabwean Government to the possibility of industrially exploiting those resources which might be utilized not only in the existing industries as substitutes for imported raw materials, but also as a basis for new industrial activities in Zimbabwe.

The immediate objectives of the present project, "Strengthening government support services in the non-metallic minerals sector" (DP/ZIM/83/006) the project document of which was signed in June 1984, were to assist in:

(a) The further strengthening of the already developed capability of the laboratories of the Department of Metallurgy in the qualitative and quantitative testing of non-metallic minerals;

(b) The immediate utilization of locally available resources for an increased and diversified production of the existing industries, specifically the ceramics industry;

(c) The establishment of an information base for the industries concerned, and the creation of a systematic non-metallic minerals inventory for that purpose.

In order to achieve those objectives, the inputs by UNDP and UNIDO included various services and equipment, and the assignment of the economic adviser in the industrial exploitation of non-metallic minerals (post No. 11-03) was one of the expert services rendered. During his mission of four months, from December 1985 to April 1986, the expert was attached to the Department of Metallurgy, Ministry of Mines. His job description is reproduced in annex I.

RECOMMENDATIONS

1. The kaolin and clay resources should be further explored in order to obtain a wider range of suitable plastic raw materials.

2. New magnesite and calcite sources, with the required properties for manufacturing basic refractories and high-grade lime respectively, should be exploited.

3. The possibility of purifying the raw materials, first of all the kaolins, to get products of a higher quality should be investigated.

4. The possibility of exporting beneficiated raw materials should be explored.

5. The laboratory-scale investigations for dead-burned magnesite should be continued and, depending on the results of the laboratory tests and the market study, pilot-plant tests should be undertaken.

6. Laboratory-scale investigations for fused kyanite should be started.

7. The manufacturers who are ready to diversify their production or to establish new industries should be given all the necessary help and information.

8. A market study on the manufacture and utilization of refractories in the countries of the Southern African Development Co-operation Conference (SADCC) should be carried out immediately.

9. Market studies should also be carried out in the SADCC countries in such fields as sheet glass, porcelain insulators, sanitary ware, ceramic glazes and high-grade unslacked lime.

10. Pre-feasibility and feasibility studies should be prepared on the production of porcelain insulators and on the diversification of aluminosilicate-based refractories.

11. Possibilities of the application of phosphor gypsum should be further investigated.

12. A research and development centre for non-metallic raw materials should be created, whose task would be the improvement of the quality of those raw materials, the development or adaptation of technologies and the development of new products for existing and future plants.

I. ACTIVITIES AND OUTPUTS

A. Review of findings and recommendations related to the project

The review of three progress and two final reports so far generated by the project experts was the starting point of the work of the economic adviser. The study of the technical report entitled "Processing of kyanite ores in Zimbabwe" by H. E. Cohen, generated under the project "Processing of ores of light non-ferrous metals" (SI/ZIM/82/801), was also necessary because the present project is based mainly on his findings and recommendations.

The latter report also dealt with further aluminosilicate minerals over and above the kyanite and its main point was to draw attention to the abundant reserves of these raw materials as well as to the possibilities of their applications.

The author made the following suggestions for a gradual establishment of mining facilities and the utilization of kyanite:

(a) Three branches of the fine-ceramic industry were mentioned as possible users of kyanite: sanitary ware, porcelain insulator and tableware manufacturing;

(b) The setting up of a kyanite co-operative corporation for the mining, processing and marketing of raw and calcined kyanite was recommended;

(c) Following the establishment of a ceramics industry it was suggested to start the manufacture of refractories on a trial basis;

(d) Product diversification (e.g. ceramic fibres) and the exploration of the export market were suggested for a later date, when the necessary quality controls and operational skills would have been established.

An important proposal concerned the creation of a systematic industrial minerals inventory for Zimbabwe.

The report by J. Vlajcic and I. Budumir entitled "Investigations on the possibility of beneficiating local raw magnesite for the production of basic refractories" (DP/ZIM/83/006) contains information on existing processing methods by which the high lime content in the mined local raw magnesite could be efficiently reduced. The results obtained showed that the problem of beneficiating the examined magnesite had been solved and that the lime content could be reduced by over 50 per cent to the required level.

The main recommendations of the authors were:

(a) To continue the laboratory-scale investigations for the production of high-quality dead-burned magnesite and trial bricks using the prepared semi-product;

(b) To carry out pilot-plant investigations starting with the processing of raw magnesite up to the production of final bricks. The technical data obtained would be necessary for the preparation of a feasibility study;

(c) To explore further markets in the SADCC and PTA countries, and to collect additional information for the preparation of a marketing analysis.

The technical report by G. Lenkei under the same project gives information on the application of the mined and sold non-metallic raw materials in the fine-ceramic industry.

The main conclusions and recommendations were:

(a) Sanitary-ware bodies and glazes and porcelain-insulator bodies and glazes could be produced by using domestic raw materials only;

(b) The ceramic bodies and glazes developed on laboratory level should be tried on an industrial scale;

(c) The existing ceramic industries should diversify their production, based on already established processes, namely: sanitary-ware production at Clay Products Ltd., extruded tile production at Willsgrove Bricks and Potteries Ltd., and technical porcelain production at Norbel Potteries Ltd.;

(d) To reduce their importation, research on glazes should be continued.

In his progress reports, M. Grylicki underlined the abundance of alumina-bearing minerals (corundum, kyanite, bauxite, diaspore, kaolins, fire-clays, flint clays, ballclays) which should serve as a basis for the future development of the refractory ceramics industry.

The author stated that:

(a) Because of the versatility in their applications there was still a high demand for aluminosilicate and high-alumina refractories;

(b) His co-operation with the team working on the geological inventory would soon result in valuable information on domestic raw materials in the form of a catalogue of non-metallic raw materials in Zimbabwe.

Within the context of the afore-mentioned project SI/ZIM/82/801, Z. Zika, in his report entitled "Processing of aluminosilicate/kaoline concentrate", also dealt with aluminosilicate-based raw materials. According to the results obtained, Zimbabwean raw materials can be used for the production of electrical porcelain insulators.

The author therefore recommended:

(a) To continue the laboratory and pilot plant investigations for the production of electrical porcelain-insulator bodies;

(b) To investigate and clarify the discrepancy between the consumption figures for electrical porcelain insulator on the one hand and the import figures on the other hand.

After having evaluated these main recommendations the economic adviser would like to make the following comments:

(a) Concerning the report by H. E. Cohen:

(i) The calcined kyanite has been used only in porcelain-insulator bodies during the fine-ceramic technological tests to try and achieve a higher flexural strength. The high alumina content provided by the calcined kyanite can be used as a main component of the high- or super-duty alumina refractories, but it is not needed in the sanitary and tableware bodies;

(ii) There were no practical steps taken towards setting up a kyanite co-operative corporation for mining, processing and marketing of kyanite;

(iii) It is not advisable to wait with the diversification of the aluminosilicate-based refractories till a ceramic industry has been established. At present the raw materials and market situation afford a good opportunity to bring the existing aluminosilicate-based refractory production up-to-date and to extend the range of products by high-duty and super-duty alumino refractories;

(iv) The diversification into exports and into other products (ceramic fibres etc.) should be postponed to a later date when the necessary quality controls and operational skills will be fully ensured;

(v) The creation of a systematic industrial minerals inventory for Zimbabwe has been started within the framework of this project;

(b) Concerning the report by J. Vlajcic and I. Budumir:

(i) Within the framework of contract No. 86/07/mk - Zimbabwe, laboratory-scale investigations on the possibility of obtaining high-quality dead-burned magnesite and magnesite-chrome trial bricks from the upgraded Zimbabwean magnesite ore, are in progress;

(ii) So far the conditions for financing and organizing the pilot plant investigations have not been set;

(iii) The first tripartite review meeting of this project also underlined the urgent need for a market study on the manufacture and use of refractory bricks in the SADCC region. It is understood that the SADCC Council has initiated action to seek financial assistance for that study which will cost about $US 250,000 and should be completed in one year;

(c) Concerning the report by G. Lenkei:

(i) The industrial adaptation of sanitary glaze is nearly completed and the trials on an industrial scale of the developed sanitary body have started;

(ii) The product diversification, by expanding the manufacture of sanitary ware, has continued at Clay Products Ltd.;

(iii) Further research on glazes could not be undertaken to date;

(d) Concerning progress reports by M. Grylicki:

(i) Limited investigations to determine the demand for aluminosilicate-based refractories are in progress;

(ii) Testing of the samples submitted by the Zimbabwe Mining Development Corporation (ZMDC) for the inventory study has started;

(e) Concerning the report by Z. Zika:

(i) The laboratory and partly pilot-plant investigations on electrical insulator bodies and glazes were continued and successfully completed;

(ii) The figures obtained from the Central Statistical Office for electrical porcelain insulator importation were accepted as consumption figures for further calculations.

B. Evaluation of the existing industry based on non-metallic raw materials

The following summary of findings is mainly based on visits by project experts to various companies.

G. and W. Industrial Minerals, Harare

This company is practically the only one concerned with buying, preparing and selling of various non-metallic raw materials. At present the annual sales are about 7,000-7,200 t. The main part of the turnover is made with the paper, rubber, paints and cosmetics industries; the share of the ceramic industry is less than 100 t. The technical equipment of G. and W. is suitable for crushing, dry-milling, classification and packing of plastic and non-plastic raw materials.

Norbel Potteries Ltd., Harare

The company manufactures tableware using domestic raw materials for the bodies, imported glazes and kiln furniture. The main technological equipment are ball mills, mixers, filter presses and vacuum extruders for the preparation of the raw materials, ceramic bodies and glazes. There is a well-equipped workshop for the production of plaster moulds. Handcasting as well as manually and automatically operated wheels are used for shaping. The glaze is applied by spraying and dipping. They have electrically heated top-hat kilns for firing.

There is a possibility of reducing the import of transparent and opaque glazes by making them from local raw materials. Unfortunately, there are no suitable kilns in the country for firing frits at a temperature of 1,380 to 1,420 °C.

Some equipment (ball mills, mixers, filter presses, vacuum extruders) and the professional skills of the staff would permit product diversification, e.g. the production of porcelain insulator.

Willsgrove Bricks and Potteries Ltd., Bulawayo

At this company there are more profiles for producing bricks, tableware and extruded tiles. Domestic raw materials are used for the bodies, but the glazes and the kiln furnitures are imported. Electrically heated top-hat kilns are used for firing. The company started a trial production of various technical ceramics in order to substitute imports.

The technological potentiality of increasing the production of tableware and extruded tiles exists, but the shortage of imported glazes makes it impossible. The possibilities of producing glazes and kiln furniture locally are the same as mentioned for Norbel Ltd.

Stewart Tiles Ltd., Harare

So far this small company used press powder, imported glaze and kiln furniture which came from a manufacturer who closed down in the recent past. At present, a drum mill, a filter press and an edge-runner mill are being put into operation to manufacture press powder. The raw tiles are manufactured by manually driven fly-presses, dried and fired in electrically heated driers and kilns respectively. A glazing conveyor belt and a chamber kiln are under construction to increase the production. The possibilities of producing glazes and kiln furniture locally are the same as mentioned for Norbel Ltd.

Earthen Fire Ltd., Harare

At present this small company manufactures electrically heated kilns, driers and crucibles. The wall-tile production will start in the near future. Mechanical presses, a glazing conveyor belt, electrically heated driers and kilns will be put into operation. The glazes and kiln furniture ought to be imported too.

Clay Products Ltd., Bulawayo

This company produces refractories, earthenware pipes, fittings, pots and sanitary ware.

Their main products (70 per cent in value) are aluminosilicate refractories, mainly of normal-duty quality: bricks and various types of shapes. So called "clay-cast" shapes, made from refractory concrete, are also manufactured. The main raw materials, the fire-clays and flint clay, come from their own deposits, whereas the alumina and high-alumina refractory cements are imported. In the present technological process the firing in bee-hive kilns is the most critical point.

Based on the existing raw materials and some experience in manufacture, there is a good possibility to go into higher grades of aluminosilicate refractories (high-duty and super-duty alumina) which are now being imported. In this case the pressing and, first of all, the firing operations ought to be modernized and expanded.

In the recent past the company has started to produce sanitary ware using domestic raw materials in the casting slip. The glaze is imported. That production is intended to increase the output of the electrically heated top-hat kiln step by step. With the present technology there is a possibility to improve the casting properties of the slip and to substitute the imported white glaze by a domestic one.

Redcliff Castables Ltd., Redcliff

This small factory is manufacturing castables based on the grog obtained from used high-alumina, magnesite and chrome-magnesite bricks. The refractory alumina cements are imported. Aluminosilicate-based crucibles are also manufactured, which are phosphate bound and tempered in an electrical kiln at 500 °C.

Zimglass Ltd., Gweru

Zimglass is manufacturing various kinds of glass products, mainly glass containers. There is no sheet-glass production. All raw materials for glass manufacture are available in the country except for sodium carbonate. They are

importing the refractories for relining their kilns (worth about $Zim 250,000 per year). The glass melting furnaces are heated basically with electrical energy but partially a liquified petroleum gas heating is also used.

Circle Cement Ltd., Harare

The main output that company is Portland cement, produced by the dry system in coal-heated rotary kilns. The refractories for lining the kilns are imported ($Zim 300,000 in value per year). Other products of the company are: cement waterproofing compound, agricultural lime, coloured waterproof cement wash etc.

The United Portland Cement Ltd. at Bulawayo, which is the other main cement manufacturer in the country, is at the same time one of the biggest manufacturers of calcined lime. (Not visited.)

Lime manufacturers

The two main producers of calcined lime are: United Portland Cement Ltd. at Bulawayo and Early Worm Mining Co. in the Glendale area, north of Harare. (Not visited.)

Brick manufacturers

There is a large number of brick manufacturers in the country. The bricks are based on local clays. Two companies were visited: Mt. Hampden Ltd., Harare and Willsgrove Bricks and Potteries Ltd., Bulawayo. Mining and preparing of the raw materials is quite well mechanized, and for firing bee-hive kilns are mainly used.

C. Evaluation of the raw materials situation

The evaluation of the raw materials situation is done by industrial branches: the present yearly production, the possible reserves and other relevant information.

Fine-ceramic industry

The production of kaolin and various plastic raw materials is about 72,000 to 75,000 t, of which the fire-clays represent 10,000 t, and kaolin about 1,000 t. These raw materials are crushed or milled, but not washed. They are suitable for manufacturing sanitary bodies and glazes, porcelain-insulator bodies and glazes, earthenware bodies, floor- and wall-tile bodies.

Possible reserves of the plastic raw materials are above 100 million t. There ought to be a wider variety of kaolins and fire-clays in the future. The possible reserves of various brick clays are over 1,000 million t. The brick clays are potential raw materials for floor- and wall-tile production too.

The feldspar production is about 2,000 t, that of quartz sand and rough quartz about 32,000 to 35,000 t. The feldspars are potassium and lithium feldspars which can be used both in the bodies and glazes.

These non-plastic raw materials are crushed, milled and packed. The possible reserves are above 1,000 million t.

Refractory industry

The raw materials of the refractory industry will be discussed in three groups as follows:

For aluminosilicate-based refractories, fire-clays, flint clays, kyanite, corundum and bauxite are used. The production is as follows: fire-clay - see fine ceramic above, kyanite 1,500 t, bauxite 18,000 to 20,000 t. There are no data about the production of flint clay, but it was mined. There was no production of corundum in 1985; earlier it was 5,000 to 8,000 t/year.

These raw materials are suitable for the production, besides the present normal-duty bricks, of super- and high-duty alumina refractories. The kyanite ought to be calcined. The possible reserves are several millions of tonnes for each raw material.

For basic refractories the main raw materials are magnesite, dolomite and chrome ore. The production of magnesite is about 18,000 to 20,000 t. No figures were available on chrome ore and dolomite, but both are being mined. The mined magnesite contains about 4 per cent of lime and up to 1 per cent of silica. This magnesite needs to be beneficiated for the production of appropriate dead-burned magnesite which must not contain more than 3 to 4 per cent CaO and 0.5 to 1 per cent Fe_2O_3. The quality of chrome ore and dolomite is suitable for basic refractories. The possible reserves run into millions of tonnes for each raw material.

For the production of further types of refractories and insulating products there are a few good raw materials such as quartzites, silica sands, refractory clays, flint clays, ball clays for silica and quartz-chamotte refractories; graphite, ball clays, fire-clays for carbon refractories; vermiculite, diatomaceous earth and perlite for various insulating products; talc for cordierite refractories.

The production of various quartz raw materials and clays was given earlier. The production of graphite is about 10,000 to 12,000 t; talc 300 to 500 t; vermiculite 80 to 100 t. Perlite has not been mined till now. The possible reserves are several millions of tonnes for each raw material.

Glass industry

All raw materials required for the manufacture of various glass products are available, except sodium carbonate. For the main raw materials - quartz sands with low content of Fe_2O_3 and feldspars - the reserves are above hundreds of millions of tonnes. The possible reserves of calcite and fluorspar are lower and are estimated at 500,000 and 100,000 t respectively.

Cement industry

The cement industry has all the necessary raw materials (limestone, clays) for its present and future production. With these and other alumina-bearing raw materials there is a possibility for product diversification, e.g. refractory-alumina cement production.

Lime industry

The slacked and unslacked lime is used in numerous branches of industry (metallurgical industry, building industry, food industry etc.) with various quality requirements. The technical requirements are highest for the ferro-chrome

alloys smelters (CaO: min. 90.0%; Fe_2O_3I max. 0.6%; silica: max. 2.0%). There are calcite deposits which meet these requirements.

The production of limestone is over one million tonnes (cement and steel industry). The calcite production is 200 to 300 t.

The possible reserves of limestone are in the order of 1,000 million t. The calcite reserves are about 0.5 million t.

Brick industry

The brick clays of various qualities are satisfactory for the present and future brick production. The possible reserves are above 1,000 million t.

The production figures of non-metallic raw materials and the possible reserves are given in annexes II and III respectively.

Non-metallic raw materials are also used in other fields, e.g. limestone, hydrated lime, diatomaceous earth, zeolites in agriculture and food industry; talc and kaolin in the cosmetic industry; kaolins in the paper and rubber industries; apatite in the fertilizer industry.

At present the non-metallic mineral products sector has a share of 5 per cent in the total net output of the manufacturing sector of Zimbabwe, which corresponds to the sixth place in terms of net output. It is significant that the foreign ownership is over 50 per cent in this sector, which is above the average in the entire manufacturing sector (48 per cent).

D. Production and market, and possibilities of their expansion

Fine-ceramic industry

The production of various fine-ceramic products is as follows:

Sanitary ware - 155 to 170 t/year (12,000 to 13,000 pieces/year)

Wall and floor tiles - 10,000 to 12,000 m^2/year

Earthenware and stoneware - 1,400 to 1,600 t/year.

At present there is a shortage of tiles and sanitary ware. The import of tiles was 6,800 m^2 in 1983. The importation of porcelain insulators is considerable, namely 607 t in 1984.

In 1983 the export of earthenware and stoneware was 127 t with a value of $Zim 120,000.

The consumption of sanitary ware, tiles and tableware depends mainly on the general standard of living. The need for sanitary ware and tiles is closely related with housing and infrastructure development programmes. The proposed national housing programme for the period 1985 to 2000 provides for housing for all Zimbabweans and the elimination of the housing shortage by the year 2000. According to that programme a total of 146,000 housing units (42 per cent in urban areas) need to be built every year, for which suitable building materials and an appropriate building materials industry is needed. Should this large-scale programme be implemented in its entirety, the demand for sanitary ware and tiles will increase significantly. A slower growth is to be expected for the demand of tableware.

There is no doubt that the consumption of porcelain insulators will increase, depending on the general economic and social policy. The growth rate depends, first of all, on the rate of industrialization and rural electrification, but it ought to be calculated with an increase of porcelain insulator importation in mind.

At present it is difficult to determine the demand, partly due to the lack of market data and also because, to date, the National Development Plan for 1985/86-1990/91 has not been confirmed as the rates and tendencies of development are not yet definite.

However, the demand for these products ought to be at a level similar to that in the more advanced of the developing countries. With the present population of Zimbabwe that would mean:

Sanitary ware - 4,500 to 5,000 t/year

Wall tiles - 2 to 2.5 million m^2/year

Tableware - 5,500 to 6,500 t/year

Porcelain insulators - 2,500 to 3,000 t/year.

These demands seem excessive when compared with the present production and will perhaps exist in the early nineties. Therefore, the production capacities of sanitary ware, wall tiles and tableware should be developed gradually, mainly based on the existing manufacturing facilities. For example, the production of sanitary ware can be doubled to 25,000 pieces per/year (325 t/year) with the existing labour and equipment. Only some additional experience in shaping and a casting slip with better casting properties would be needed.

A typical feature of fine-ceramic technologies is the wide range of possibilities in the degree of their mechanization. A fully mechanized production line for wall tiles, for instance, would have an output of 1,000 m^2/day with 12 to 15 workers, while with a technology mechanized at a minimum level, 140 to 160 workers would be required for the same production.

With regard to porcelain insulators it should be noted that imports cost over $Zim 1 million per year and that consumption will increase, depending on the above-mentioned factors. By producing them locally, imports could be practically stopped. The production could start with insulators for low and medium voltages. The raw materials are available and there is some experience in fine-ceramics manufacturing, factors which are a good basis for the introduction of a porcelain insulator production.

Consequently, an investment opportunity study was prepared and data from that study (see annex IV) show that the investment is profitable and involves considerable savings in foreign exchange. The level of mechanization chosen is medium, but a more labour-intensive technology is applicable too. The investment cost will reduce if the plant is connected with an existing fine-ceramic plant.

It may be assumed that all SADCC countries have similar problems with the supply of porcelain insulators. It would therefore be advisible to undertake a market study to explore the market situation in the region. Depending on the conclusions of such a study the proper capacity of a porcelain-insulator factory could be determined.

The determination of the proper capacity is important because, for example, a plant with a capacity of 2,000 to 3,000 t/year would afford a further opportunity for the creation of new jobs, the improvement of the foreign exchange situation and for increasing profitability. Based on the results of the market study a pre-feasibility and a feasibility study should be prepared.

Refractory industry

The production of aluminosilicate-based normal-duty refractories is about 20,000 t/year, corresponding to a value of about $Zim 2 million. The production of refractory castables and crucibles by Redcliff Castables is not known but it can be neglected in this context. The local demand for normal-duty refractories is being met and about 10 per cent of the production are being exported, worth $Zim 200,000.

The importation of high- and super-duty alumina and basic refractories is significant and has been increasing steadily. In 1980 it accounted for a value of $Zim 4.5 million, in 1983 for $Zim 7.2 million, and in 1984 for $Zim 8.5 million. The share of alumina and basic refractories was about 50 per cent each.

Since refractories constitute an essential structural element of equipment working at high temperatures (kilns, furnaces, boilers etc.) they are needed to sustain and develop, first of all, the metallurgical and related industries, but also the building-materials, the glass and the fine-ceramic industries. Therefore a continuously increasing demand for these products has to be taken into account when considering the general development of the country.

The increasing demand can be met either by augmenting imports or by expanding the domestic production. As most of the raw materials are available, an expansion of the domestic production would seem to be more economical.

Taking into consideration the present conditions, two alternatives are suggested:

(a) To substitute the imports of high- and super-duty alumina refractories by improving and diversifying the product range of the existing refractory industry;

(b) To stop the importation of high- and super-duty alumina, as well as of ordinary magnesite and chrome-magnesite refractories and to start exporting ordinary magnesite and chrome-magnesite refractories by erecting a new refractory plant. The importation of basic refractories will only be reduced by 20 per cent in value; 80 per cent will invariably have to be imported as this represents the super-magnesite refractories.

In the first case, the investment should be carried out at Clay Products Ltd. Of the existing technology, the firing should be modernized and expanded by a tunnel kiln to reach a capacity of 30,000 to 35,000 t/year. For the production of high- and super-duty alumina refractories the dry-pressing technology would have to be adopted for shaping. The firing would be carried out in shuttle or top-hat kilns at a temperature range of 1,400 to 1,600 °C. The estimated investment cost is about $Zim 4.5 million and the yearly sales revenue about $Zim 5 million.

The advantages of this proposal are as follows:

(a) All necessary raw materials are available;

(b) There is experience in the production of aluminosilicate-based refractories;

(c) The investment could be realized at relatively low cost, since the infrastructure, the raw material storage and part of the preparation facilities already exist;

(d) The normal-duty refractories have already been introduced to the export market and therefore expansion is easier and almost guaranteed.

The disadvantage of the first proposal is that all basic refractories would still need to be imported in future.

In the second case a new plant would be built with a minimum capacity of 15,000 t/year. According to international experience and trends this capacity is needed for an economical production. The yearly output of that plant would be: 4,000 t of high- and super-duty alumina, 8,000 t of chrome-magnesite and 2,000 t of ordinary magnesite. For the high- and super-duty alumina refractories, the raw materials and the market are guaranteed. From the 8,000 t of chrome-magnesite the domestic market would absorb only 1,000 t, the remaining 7,000 t could be exported to Zambia. The existing raw materials are suitable for chrome-magnesite refractories. At present the production of ordinary magnesite is not certain because of the quality of the raw magnesite available. If pilot-plant tests give appropriate dead-burned magnesite and final bricks, then normal magnesite bricks can become potential products. However, the beneficiated raw magnesite cannot be used for super-mangesite refractories which represent 80 per cent of the imported basic refractories.

The estimated investment cost is about $Zim 10 to 12 million and the yearly sales revenue about $Zim 9 million.

The advantages of the second proposal are:

(a) Domestic raw materials can be used in a wider range of products, starting with the basic refractories;

(b) New possibilities for exportation will be created;

(c) The importation of basic refractories will be reduced by 20 per cent.

The disadvantages of the second proposal are:

(a) The raw material situation concerning the basic refractories is uncertain;

(b) The beneficiation of raw magnesite increases the production costs, first of all, the energy costs;

(c) Fifty per cent of the new production ought to be exported to a new market;

(d) The cost of investment will be relatively higher;

(e) Three different products would have to be manufactured with a relatively limited production capacity;

(f) The beginning of the project is uncertain because of the raw materials problems, which will delay the reduction of importation of refractories;

(g) The investor is uncertain.

To gather more details on the economical character of the first proposal an investment opportunity study (annex V) was made which showed that such investment would be a good proposition. The repayment period of 4.54 years is favourable, the annual foreign exchange savings are considerable and, in addition, there is about $Zim 1 million export revenue.

Glass industry

The production of bottling glass products at Zimglass is about 16,000 t/year. The company is currently considering an expansion of its glass-making facilities by introducing the production of sheet and plate glass. At present the importation of these products accounts for approximately $Zim 3.5 million per year.

The new plant for sheet and plate glass will cost about $Zim 15 million of which about $Zim 3 to 5 million will be required in foreign currency for imports. Besides the import substitution there is some export potential to the countries of the Preferential Trade Area (PTA). After having secured a good raw materials base, additional experience in glass technology and a market that will absorb the products, the project will be implemented in the near future.

Cement industry

In the last years the production of cement was between 550,000 and 650,000 t/year. The domestic consumption was about 480,000 to 520,000 t and the exports were in the range of 40,000 to 160,000 t/year. The exportation increased whereas the domestic consumption decreased in the last two years. An expansion of the capacities will not be needed in the near future, while a diversification of the existing production by refractory cement for the domestic and export markets should be considered.

Lime industry

The production of calcined lime which is of low grade, is about 700 to 750 t/year at Early Worm Mining Co. The yearly importation of lime approximates 60,000 t or $Zim 7.5 million, of which $Zim 5.5 million are spent on the high-grade unslacked lime, imported mainly for Zimbabwe Alloys Ltd.

To reduce or stop this importation which is of outstanding economical interest, the problem may be approached in two steps:

(a) As a first step the importation of 18,000 to 20,000 t of low-grade lime worth $Zim 2 million should be stopped. The raw materials and essential equipment are available, e.g. at Early Worm Mining Co. By some modernization and expansion of that plant, a suitable capacity could be established within a short time. The estimated costs are about $Zim 3 to 3.5 million;

(b) In the second step the question of raw materials has to be clarified, as the raw materials mined at present are not suitable for the production of

high-grade hydrated lime. There are appropriate calcite occurrences in the country but they cannot be mined because of transportation problems. For the creation of a good raw material base, either new occurrences must be discovered or selective exploitation of the existing mines should be considered.

Once suitable raw material sources are known, a decision can be made to install a plant.

Further it should be taken into consideration that ferro-chrome alloy smelters will be ready to revert to local lime if:

(a) The price is competitive;

(b) The stipulated minimum specifications are met;

(c) The deposits are large enough to ensure long-term supplies.

For the determination of the capacity of the plant it is suggested to consider also export possibilities to other SADCC countries.

Brick industry

The production of bricks decreased from 140 million pieces in 1980 to 95 million pieces in 1985. Raw materials and production capacities are available for a higher production, although the equipment is not up-to-date.

Ceramic glazes

At present the tableware and tile production consumes about 150 to 170 t of fritted glazes. The sanitary-ware production will need about 15 to 20 t of raw glazes in the near future. All of those glazes are imported, which corresponds to $Zim 170,000 to 200,000 per year.

Because of the forseeable increase in the wall-tile and sanitary-ware production, the possibility of making frits and raw glazes locally should be considered. All raw materials required for the production of white sanitary glazes are available. Ball mills and mixers are necessary equipment, as well as a kiln for the firing of SnO_2 at 650 to 700 °C.

For the manufacture of frit glazes a few raw materials would have to be imported (e.g. borax, boric acid) but most of the raw materials are available in the country. Various mixers are used to prepare the composition of the raw materials. Oil- or gas-heated rotary kilns or electrically heated melting furnaces are needed to melt the various frits at 1,380 to 1,430 °C.

The introduction of a domestic frit and raw glaze production would offer important advantages, such as:

(a) Foreign exchange savings would be significant; the production would most likely be profitable or at least self-financing in spite of the relatively small quantities;

(b) It would offer a good opportunity to gather substantial knowledge on ceramic glazes and on glass melting.

E. Research and development

The utilization of the mined and of the up-to-now unexploited non-metallic raw materials is of vital interest to the national economy. Basically there are two possibilities for the exploitation of that national treasure:

(a) To export the raw materials;

(b) To develop and diversify the silicate industry based on these raw materials.

In both cases the preparation and beneficiation of the raw materials is of great importance: prepared and beneficiated raw materials yield better prices on the export market and, on the other hand, properly treated raw materials are a condition for the manufacture of up-to-date products.

To determine suitable methods for the preparation and beneficiation of the various raw materials and to choose appropriate technologies, continuous research and development is a requirement. The improvement of the existing technologies and the selection and adaptation of new technologies also calls for continuous research and development.

The existing ceramic laboratory should therefore be converted, step by step, into a research and development centre. The main functions of that centre would be:

(a) To document on a continuous basis the existing and newly explored non-metallic raw materials;

(b) To investigate and develop the applicable methods for the beneficiation of the raw materials at laboratory and pilot-plant level;

(c) To participate in the development and improvement of new and existing products;

(d) To improve the existing technologies, first of all, technologies related to heat treatment;

(e) To participate in the selection and adaptation of the new technologies;

(f) To advise on and participate in research and development activities for the silicate industry of the SADCC countries.

II. CONCLUSIONS

The conclusions that can be drawn from the experience gained during the activity are as follows:

1. The findings and recommendations contained in the experts' reports indicate many possibilities of application of the available raw materials.

2. It is probable that the geological inventory which is in preparation will indicate further raw material sources with additional possibilities of applications.

3. Additional kaolin and clay sources are needed to obtain a wider range of suitable plastic raw materials.

4. It would also be necessary to undertake prospecting for new magnesite sources with lower CaO content, to exploit further calcite occurrences with the required Fe_2O_3 and SiO_2 content which are also easily accessible, and to search for more fire-clays.

5. The possibilities of purifying the raw materials, first of all the kaolins, to get products of a higher quality need to be investigated.

6. Laboratory-scale investigations for the production of high-quality dead-burned magnesite are in progress. Depending on the results of the laboratory tests and the market study, pilot-plant investigations should be carried out starting with the processing of raw magnesite up to the production of the final bricks.

7. Further investigations are needed to explore the feasibility of manufacturing ceramic glazes.

8. So far the situation of the non-metallic raw materials was examined mainly with a view to their immediate utilization for an icreased and diversified production of existing industries, specifically of the ceramic industry. Further market and economic investigations are therefore needed to explore the possibilities of exporting crude or beneficiated raw materials, such as raw and calcined kyanite, calcined flint-clay, dead-burned magnesite etc.

9. The existing manufacturers have an interest to diversify their production. Clay Products Ltd., for example, intends to increase their present sanitary-ware production from pilot-plant to industrial level. They are considering manufacturing high- and super-duty alumina refractories. G. and W. Industrial Minerals Ltd. seem to be interested in manufacturing calcined lime, and Zimglass Ltd. in making sheet glass to reduce the present importation.

10. Investment opportunity studies for electro-porcelain insulators and aluminosilicate-based refractories (annexes IV and V) show that these investments would be profitable; the repayment periods are favourable and the foreign exchange savings significant.

11. There was no possibility to prepare pre-feasibility studies for a preliminary project selection and definition due to a lack of detailed economic data and offers for the technical equipment.

12. More information is needed on the market possibilities in the SADCC countries, first of all, in the field of refractories, glass, porcelain insulators, sanitary ware and high-grade unslacked lime. The exploration of the export markets and their consideration in future investments is important with regard to profitability and foreign-currency revenue.

13. An appropriate development and research centre will be needed in the future for a further exploitation and improvement of the raw materials; for advising on their application; for the development of existing technologies; and for the elaboration of plans for the future development of non-metallic raw materials. The economical and efficient utilization of the immense value represented by the non-metallic raw materials is unconceivable without such a centre.

Annex I

JOB DESCRIPTION

Post title: Economic adviser in the industrial exploitation of non-metallic minerals

Duration: Four months

Date required: As soon as possible

Duty station: Harare, with travel within the country

Purpose of project: Industrial and commercial exploitation of non-metallic minerals to provide further support towards the expansion of industrial operations of mining and building materials sector.

To create new sources of foreign exchange through import substitution.

To increase the utilization of locally available non-metallic resources for increased and diversified production of existing industries, e.g. glass and ceramic industries.

Duties: The expert will be attached to the Department of Metallurgy, Ministry of Mines, and will be expected to:

(a) Study all findings and recommendations of the other project experts assigned to the project for the testing, classification and up-grading, and technological application of locally available non-metallic minerals;

(b) Collect and review relevant economic data and information to identify potential investment areas to expand the industrial utilization of local resources;

(c) Analyze in detail the reports and feasibility studies on building materials (ceramic tiles, sheet glass and sanitary ware production) prepared for the Government and provide comments in view of the findings of the project team;

(d) Prepare, whenever possible, financial information on the proposed/planned production units while giving due consideration to the economy, i.e., job creation, improvement of foreign exchange situation, social factors and impact on the overall industrial set-up;

(e) In view of the above, identify one or two investment areas with potential for the processing and manufacturing of building materials, with possible interlinkage with other industries, indigenous or international;

(f) Train counterpart staff of the project (or other technicians attached to the project activities) in the promotion of investment projects, to demonstrate preliminary project viability. In this respect, prepare one or two studies for the identification of investment opportunities (opportunity studies) and for the preliminary project selection and definition (prefeasibility studies).

The expert will also be expected to prepare a final report setting out the findings, achievements and recommendations of his mission.

Qualifications: An industrial economist with experience in the financing, preparation and evaluation of industrial investment projects. Experience in the refractory-brick, sheet-glass, ceramic wall- and floor-tiles, sanitary-ware, and electrical-insulators manufacturing industries will be an advantage.

Language: English

Annex II

PRODUCTION FIGURES ON NON-METALLIC RAW MATERIALS
(In tonnes)

Mineral	1980	1981	1982	1983	1984
Limestone	1 217 878	1 409 210	1 270 13[illegible]	1 305 130	1 152 127
Magnesite	78 217	60 194	60 660	24 072	21 642
Phosphate	130 337	122 235	121 608	132 911	134 447
Barytes	195	-	300	980	700
Bauxite	4 281	5 139	7 533	23 145	22 726
Beryl	9	42	52	48	19
Calcite	-	-	90	432	250
Clay	69 153	78 403	85 490	63 097	65 501
Corundum	18 681	12 202	8 714	5 157	-
Feldspar	1 263	2 393	666	1 645	1 399
Fire-clay	17 005	14 658	11 746	9 255	8 900
Graphite	7 385	11 218	8 225	19 862	12 334
Kaolin	4 450	4 657	2 442	470	1 350
Kyanite	716	870	2 207	-	874
Lithium	21 030	16 444	9 787	19 193	22 548
Mica, block	5	7	17	3	0.5
Quartz, rough	102 846	94 022	63 635	14 610	7 359
Quartz, sand	63 259	47 248	34 979	32 812	24 778
Talc	456	386	270	552	285
Vermiculite	-	-	-	-	97

Annex III

POSSIBLE RESERVES OF NON-METALLIC MINERALS

	Million tonnes
Apatite	30
Amblygonite	0.1
Barytes	2
Bauxite	3
Brick clay	1,000
Calcite	0.5
Celestite	0.001
Corundum	10
Diatomaceous earth	0.1
Dolomite	1,000
Dunite	100
Epidote	1
Feldspar	1,000
Fire-clay	1
Flint clays	50
Fluorspar	0.01
Garnet	50
Graphite	10
Gypsum	No natural occurrence
Kaolin	100
Kyanite	100
Limestone	1,000
Lepidolite	0.2
Magnesite	10
Mica	20
Montmorillonite	0.01
Nepheline syenite	1,000
Perlite	5
Quartz	1,000
Quartzite	1,000
Serpentine	1,000
Silica sand	1,000
Talc	1,000
Vermiculite	100
Zeolites	0.001
Zircon	100

Annex IV

INVESTMENT OPPORTUNITY STUDY FOR ELECTRO PORCELAIN INSULATORS

A. General economic data

Economic characteristics

(a) GNP at constant 1980 prices

	1980	1981	1982	1983
Total ($Zim)	3,306	3,867	3,765	3,827
Rate of increase (%)	11.6	10.8	-2.7	1.5
GNP per capita ($Zim)	461	509	-	-

Government revenues in GNP in 1982: 28%

(b) Balance of payments (in million $Zim)

	1980	1981	1982	1983
Exports	909.2	971.7	968.4	1,150.2
Imports	809.4	1,017.7	1,081.8	1,061.6
Visible balance	99.8	-46	-113.4	88.6

National economic justification of project

The expected economic benefits are import substitution, diversification of the fine-ceramic production based on non-metallic raw materials, creation of jobs, profitability.

B. Project sponsor

At present unknown.

C. Market and demand for electro-porcelain insulators

There is no domestic production; all insulators are imported. In 1983 about 320 t of a value of $Zim 764,000 and in 1984 about 610 t worth $Zim 1,210,000 were imported. The local demand is expected to grow, e.g. with the electrification of rural areas. In the near future the demand is expected to reach 700 to 900 t/year. The possibility of exporting is not excluded.

The insulators are used mainly for low and middle voltages (10 to 33 kV).

The present import price is about $Zim 2,000/t.

D. Supply of raw-material inputs

All plastic and non-plastic raw materials required for the manufacture of the porcelain insulator bodies are available (mined and sold), including suitable white and brown glazes.

E. Location and site

Close to or on the premises of an existing fine-ceramic plant.

F. Project engineering

Capacity

Approximately 1,000 t/year. Expected output approximately 80 to 100 per cent, i.e. 800 to 1,000 t/year.

Existing process

The main steps of the usual process are as follows: wet body preparation, plastic shaping, drying, glazing and firing.

Ball mills and various types of mixers (Netzsch Ltd., Federal Republic of Germany) are used for the wet preparation of the raw materials. Manually or automatically operated filter presses (Boulton Ltd.; Netzsch Ltd.) are used for dewatering of the porcelain slip, and vacuum presses (Dorst Ltd., Federal Republic of Germany; Kema Ltd., German Democratic Republic; Netzsch Ltd.) to obtain homogenized and de-aerated plastic porcelain bodies. The shaping can be carried out by throwing or turning. The glazing may be applied by spraying or dipping. Oil-heated shuttle or top-hat kilns can be used for firing (Riedhammer Ltd., Federal Republic of Germany; Bickley Ltd., Federal Republic of Germany).

This technology and equipment are widely used in developed countries (Czechoslovakia, Federal Republic of Germany, Hungary etc.).

The installed electrical energy will be about 1,200 to 1,400 kW, the oil consumption 1,100 to 1,300 t/year.

G. Manpower and management

The approximate labour requirements is 180 to 220 staff.

H. Financial analysis

Investment costs

The estimated total cost is about $Zim 5 million for equipment and construction but excluding infrastructure, of which some $Zim 3 to 3.5 million have to be in foreign exchange.

Financing

Depending on sponsors.

Production costs

	Million $Zim
Operating cost	1.35
Depreciation (5%)	0.25
Interest (6%)	0.18
Production cost	1.78

Commercial profitability

	Million $Zim
(a) Rate of return	
Sales revenue (2,000 x 1,000)	2.00
Operating cost	-1.35
Depreciation (5%)	-0.25
Operating profit	0.40
Interest (average 6%)	-0.18
Gross profit before tax	0.22
Corporate tax (45%)	-0.10
Net profit	0.12

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total investment outlay}} \times 100$$

$$= \frac{0.12 + 0.18}{5} \times 100 = \frac{0.3}{5} 100 = 6\%$$

(b) Repayment period

$$\text{Repayment period} = \frac{\text{total investment outlay}}{\text{net profit + interest + depreciation}}$$

$$= \frac{5}{0.12 + 0.18 + 0.25} = \frac{5}{0.55} = 9.1 \text{ years}$$

I. National economic benefits

Job creation, specific capital requirement:

Total: $\frac{\$Zim\ 5,000,000}{200}$ = about $Zim 25,000/job

Foreign exchange: $\frac{\$Zim\ 3,250,000}{200}$ = about $Zim 16,250/job

Annual foreign exchange savings

	Million $Zim
Import substitution	2.00
Current imports (mainly oil)	0.65
Foreign exchange savings	1.35

Annex V

INVESTMENT OPPORTUNITY STUDY FOR AN EXPANSION OF THE ALUMINOSILICATE-BASED REFRACTORY PRODUCTION

A. General economic data

Economic characteristics

(a) GNP at constant 1980 prices

	1980	1981	1982	1983
Total (million $Zim)	3,396	3,867	3,765	3,823
Rate of increase (%)	11.6	13.8	-2.7	1.5
GNP per capita ($Zim)	461	509	-	-

Government revenues in GNP in 1982: 28%

(b) Balance of payments (in million $Zim)

	1980	1981	1982	1983
Exports	909.2	971.7	968.4	1,150.2
Imports	809.4	1,017.7	1,081.8	1,061.6
Visible balance	99.8	-46	-113.4	88.6

National economic justification of project

The expected economic benefits are import substitution, diversification of the existing production, creation of jobs, profitability.

B. Project sponsor

Clay Products Ltd., Bulaway.

C. Market and demand for aluminosilicate refractories

The domestic aluminosilicate-based refractories, mortars etc. are manufactured to normal duty quality. In 1985 the production was $Zim 2 million, which covered the domestic demand. There was export to some SADCC countries with a value of $Zim 200,000 which could be increased to $Zim 1 million per year. The local sales price is about $Zim 100/t.

The importation of refractory building materials increased from $Zim 4.5 million in 1980 to $Zim 8.5 million in 1984, of which about 50 per cent was aluminosilicate-based high- and super-duty alumina refractories and mortars. The import price of these refractories is about $Zim 1,000/t.

D. Supply of raw material inputs

All necessary raw materials for the manufacture of normal-, high- and super-duty alumina refractories, mortars and ramming masses are available and mined.

E. Location and site

At Clay Products Ltd., Bulawayo, by reconstruction and expansion of the existing plant.

F. Project engineering

Capacity

Approximately 10,000 t/year of normal-duty and 4,000 t/year of high- and super-duty alumina refractories, mortars and ramming masses.

Existing process

The reconstruction of the plant and the expansion of the production involves significant changes in technology.

The preparation of the raw materials with high Al_2O_3 content needs a fine grinding, i.e. 80 to 85 per cent below 0.063 mm. Conventional tube mills or vibrational mills (e.g. Palla type) are applicable for that purpose. The kyanite has to be calcined if it is used as high-alumina bearing raw material. Generally oil-heated rotary kilns are used for the calcination of the kyanite at 1,500 to 1,600 °C (e.g. kilns of that type, made in Hungary, are used for the calcination of dolomite in Yugoslavia). The fusion of kyanite by electrical energy may also be a solution to obtain calcined kyanite. Hungary has great experience in the production of electrically fused mullite and corundum.

The prepared raw materials have to be mixed. The Eirich (Federal Republic of Germany) or the Sione (Italy) intensive mixers are the best for that purpose.

Dry-pressing will be used for shaping. The specific pressure must be 800 to 1,200 kp/cm^2 and therefore the total pressure ought to be 800 to 1,000 depending on the dimensions of the products. The hydraulic presses of Laies Ltd. (Federal Republic of Germany) or of Bucher Ltd. (Switzerland) are well known.

Significant changes will apply to the firing technology: tunnel kilns will be used for the firing of the normal-duty refractories and shuttle or top-hat kilns to fire the high- and super-duty refractories at 1,400 to 1,600 °C.

G. Manpower and management

The approximate labour requirement is about 45 people in addition to the existing labour force.

H. Financial analysis

Investment costs

The estimated total cost is about $Zim 4.5 million (equipment and construction) of which some $Zim 2.5 to 2.8 million have to be in foreign exchange.

Financing

Financing by Clay Products Ltd.; a joint venture could be considered.

Product costs

	Million $Zim
Operating cost	3.52
Depreciation (5%)	0.23
Interest (6%)	0.16
Production cost	3.91

Commercial profitability

	Million $Zim
(a) Rate of return	
Sales revenue (10,000 x 100 + 4,000 x 100)	5.00
Operating cost	-3.52
Depreciation (5%)	-0.23
Operating profit	1.25
Interest (6%)	-0.16
Gross profit before tax	1.09
Corporate tax (45%)	-0.49
Net profit	0.60

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total investment outlay}} \times 100$$

$$= \frac{0.60 + 0.16}{4.5} \times 100 = \frac{0.76}{4.5} \times 100 = 16.88\%$$

(b) Repayment period

$$\text{Repayment period} = \frac{\text{total investment outlay}}{\text{net profit + interest + depreciation}}$$

$$= \frac{4.5}{0.60 + 0.16 + 0.23} = \frac{4.5}{0.99} = 4.54 \text{ years}$$

I. National economic benefits

Job creation, specific capital requirement

Total: $\frac{\$Zim\ 4,500,000}{45}$ = about $Zim 100,000/job

Foreign exchange: $\frac{\$Zim\ 2,650,000}{45}$ = about $Zim 58,800/job

Annual foreign exchange savings

	Million $Zim
Import substitution	4.00
Current imports (mainly oil)	-1.20
Foreign exchange savings*	2.80

*In addition to $Zim 1 million surplus export revenue.

Annex VI

SOME BASIC DATA USED IN THE PREPARATION OF THE INVESTMENT OPPORTUNITY STUDIES

Gross labour costs	$Zim/month
Unskilled worker	220
Semi-skilled worker	380
Technician	500
Higher technician	800
Engineer	1,200

Raw material prices	$Zim/tonne
Kaolin, raw	60
Kaolin, milled	190
Ballclay	95
Fire-clay	70
Feldspar	100
Magnesite, crude	118
Flint clay	75
Kyanite, calcined	240
Silica, milled	170

Oil prices	$Zim/$m^3$
Heavy fuel oil	150
Diesel oil	670

Specific oil consumption	kg/l kg of product
Aluminosilicate refractories	0.10
Basic refractories	0.12
Procelain insulators	0.80

Construction prices	$Zim/$m^2$
Industrial constructions	160

Import costs	$Zim/tonne
Super alumina refractories	1,000
Magnesite refractories	500
Chrome-magnesite refractories	500
Porcelain insulators	2,000
High-grade lime	130

Annex VII

INSTITUTIONS AND MANUFACTURERS WITH WHOM MEETINGS WERE HELD

Ministry of Mines
Ministry of Industry and Technology
Ministry of Public Construction and National Housing
Central Statistical office
Confederation of Zimbabwe Industries
Zimbabwe Mining Development Corporation
Geological Survey Department
G. and W. Industrial Minerals
Clay Products Ltd.
Zimbabwe Phosphate Industries Ltd.
Zimbabwe Iron and Steel Company Ltd.
Stewart Tiles Ltd.
Circle Cement Ltd.
Earthen Fire Ltd.

Annex VIII

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