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UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Government of the
People's Republic of Bangladesh

PROJECT DOCUMENT

Title	:	Analysis of Raw Materials for Non-metallic Mineral Based Industries
Project No.	:	BGD/85/006/B/01/37 Duration: One year
Primary Function	:	Direct Support (UNDP Class & Code) Manufacturing Industry (0520)
Sector (Govt.Class)	:	Industry
Government Implementing Agency	:	Ministry of Education Dhaka University
Executing Agency	:	United Nations Industrial Development Organisation (UNIDO)
Estimated Starting Date	:	June 1986
Government Inputs	:	(in kind) (local currency) UNDP Inputs: 571,500 U.S.Dollars

Signed: _____ Date: _____

on behalf of the Government

_____ Date: _____

on benalf of the Executive Agency

_____ Date: _____

on behalf of UNDP

PART I LEGAL CONTEXT

This Project Document shall be the instrument (therein referred to as a Plan of Operation) envisaged in Article 1, paragraph 2, of the Agreement between the Government of the People's Republic of Bangladesh and the United Nations Development Programme (UNDP) concerning technical assistance under the Special Fund sector of the United Nations Development Programme, signed by the Parties on 12 and 31 July 1972.

PART II A DEVELOPMENT OBJECTIVE

To assist the Government of Bangladesh in developing and expanding the ceramic and refractories industries by upgrading the technical knowledge within these industries, promoting better utilisation of indigenous non-metallic raw materials and improve the efficiency of the present production.

PART II B IMMEDIATE OBJECTIVES

- to improve the present clay mining operations of the Bijaipur region, thereby increasing the utilisation of the existing raw material deposits.
- to improve the capability of testing the raw materials and products of the refractory and ceramics industries at existing laboratories within Government organisations.
- to investigate the potential of other raw material resources such as rice husk ash, zircon and kyanite with a view to manufacturing new products.
- to implement an energy conservation programme at a national level and develop efficient energy application within the refractory and ceramic industries.

- to improve the general knowledge of refractory and ceramic technology among both the students of these industries and the technicians and supervisors of the industries.

PART II C SPECIAL CONSIDERATIONS

None.

PART II D BACKGROUND AND JUSTIFICATION

Background

In a meeting held early 1984 between the Department of Industries, UNIDO and manufacturers of refractories the possibility of developing the refractory industries was discussed. Three firms namely Dhaka Refractories Limited, Mirpur Ceramics and Calcutta Tiles, involved in the manufacture of refractories were represented in this meeting and they indicated that they are the only ones making refractories. These representatives stated that presently a large percentage of the country's requirement for refractories is still provided through imports from abroad. They explained that one of the operational problems which they continuously encounter is, that they are unable to predict the type, grade, quality and composition of raw material which they buy from the clay deposit operated by the Government. The reason for this is that the area is not geologically classified, accordingly therefore on receipt of their orders of raw materials, these are taken from the same area which is currently being mined to fill the order of all types of users i.e. brick manufacturers, refractory manufacturers and ceramics manufacturers.

It was therefore, agreed that the Department of Industries, in collaboration with the Ministry of Minerals and Energy should undertake the geological survey and laboratory tests of the deposits of clay to classify the deposit to assess its' suitability

for the manufacture of refractories and to recommend better mining methods and benefication of raw materials, if this is necessary. The possibility of institutionalizing a laboratory within the Government to service the requirements of the manufacturersfor testing their raw materials and products was also discussed.

The Department of Industries would then seek the assistance of UNDP/UNIDO to send a preparatory assistance mission for a period of three months to provide the two tasks as identified above and also to visit the three manufacturing plants for refractories and submit specific recommendation on how their operations could be improved. This would enable the formulation of a proposal for technical assistance to develop the refractory industry. Finally an analysis would have to be made to estimate the potential market for refractories.

While reviewing this proposal, in order to optimize the benefit from such a mission, the UNIDO suggested that while undertaking the geological survey and laboratory tests of the clay deposit the possibility of utilizing these raw materials for other industrial applications such as production of aggregates should be evaluated. It is already known that the demand for aggregates is increasing and the supply is coming from only one area, Sylhet.

The other important area which would be examined by the mission is energy conservation. Plant visits to major energy users such as cement, fertilizer, ceramics and steel factories would be conducted to enable identification of specific activities where energy savings could be affected.

Justification

The detailed report of the findings of the project DP/BGD/85/006/A/37 "Analysis of Raw Materials for Non-Metallic Mineral Based Industries" is attached to this project document under Annex II and is to be considered as an integral part of this project document.

The following summary of the findings constitute the justification for project.

Within Bangladesh only four main types of clay are known to occur, three of which are important only for the red brick industry, namely the flood plain alluvium north of the Ganges, the deltaic alluvium which extends over the complete area south of Ganges to the Bay of Bengal and the Madhupur clay which forms the low hillocks in many parts of the country.

The only other type of clay found in the country are the deposits of white kaolinitic clays, the major and most important deposits being located in the Bijaipur area of Mymensigh district close to the Indian border. Smaller deposits are known to exist in various localities in Sylhet and the Chittagong Hill Tracts and a number of private companies are attempting to exploit these, albeit on a small scale.

By far the most important deposit, suitable for the requirements of the refractory and ceramic industries however, is that of Bijaipur, which is presently being mined in an unco-ordinated manner in several locations by both the government and a number of private companies, who lease sections of land from the government. In all cases the mines are being developed, where the white clay is exposed in the hillocks by fox-hole type cuttings.

Two grades of clay are generally extracted. The higher grade, having a lower iron oxide content, is used in the manufacture of porcelain tableware, sanitaryware and insulators and the lower grade is utilised by the refractory industry. All of these industries presently suffer from serious quality problems in their production caused directly by the inability of any of the mines to supply a consistent product of known properties.

The hand digging mining methods presently employed, the complex nature of the structure of the deposit with high angles of dip in the clay strata coupled with no precise geological information of the mine

areas and the lack of any trained and experienced mine manager is not only adversely affecting the quality of the clays extracted but has already resulted in a serious shortfall in the quantity of clay mined for the industry resulting in an increasing volume of clay imports from overseas. Planned expansion within both the refractory and ceramic industries, some of which is already at the construction stage, will result in a substantialincrease in demand, which can only be met by an increased level of imports if no improvement in the present mining operations and transportation systems is made. It is estimated that the current level of output of approximately 4,100 metric tons per annum must be increased to a level of 8-10,000 metric tons to cope with this demand.

Much work has been carried out in regard to the possibilities of beneficiating this clay to improve the quality but for the relatively small quantities of clay involved this is uneconomic and in any case much of the silica sand contamination is very fine and has a grain size similar to that of clay particles so that it cannot easily be separated by simple washing. In addition, most of the products presently being manufactured by the refractory and ceramic industries in Bangladesh do not require such treatment, the factories already possessing the equipment to remove much of the iron oxide contamination. A far better and more cost effective method of improving the quality of all products would be achieved by supplying a more consistent material from the mines by observing recognised clay mining and clay stockpiling practices.

Accessibility to the Bijaipur clay deposits is extremely difficult. The deposits can be reached from the Jaria-Jhanjail rail terminus only in the dry season, partly by four-wheel drive vehicle and the last few miles by bullock cart, small motorcycle or by foot through rice fields. During the rainy season lasting from June to October, large country boats can travel to Bijaipur along the Someswari River to within a few miles of the mine sites and the mines

must utilise this period to move as much clay as possible to the railhead. During the dry season only small country boats can travel to Bijaipur and these are sometimes used to transport clay to Jaria, although this is considerably more expensive.

To ensure the maximum production during the dry season and the maximum deliveries during the wet season therefore, requires not only good mine management in regard to clay extraction, clay stockpiling, pumping operations and maintenance of equipment but also requires good organisation in the planning of clay transport and delivery schedules to meet the requirements of customers. Any shortfall in output or deliveries has to be met by an increased level of imports into the country.

In order to achieve the objectives of improving the consistency of the quality of the clays and also of increasing the output from the mines this project provides for a properly organised drilling programme to be undertaken by the Geological Survey of Bangladesh, who have all the required machines and personnel for this work. This drilling programme will be carried out in conjunction with a fully experienced expatriate clay mining engineer who will be provided under this project. In addition to advising the Geological Survey the advisor will re-organise the present mining operations to increase the efficiency of all mines in the area. The advisor will formulate a detailed mining plan, based on the information from the drilling survey to enable the mines to increase their recovery of good quality clays for the refractory and ceramic industries. Part of this plan will include an assessment of both the practicality and economic benefit of utilising a low-cost lightweight overhead cableway system to transport clay from the mine stockpiles to the river to overcome the serious transportation difficulties in this region.

Throughout all of the refractory and ceramic industries it has been clearly identified that there are serious deficiencies in the testing of the raw

materials and finished products at these industries despite the fact that there are laboratory facilities relating to refractory and ceramic product industries within Government organisations at the Bangladesh Institute of Glass and Ceramics, at the Geological Department of Dhaka University at the Bangladesh Council for Scientific and Industrial Research (BCSIR) and also at the Bangladesh Insulator and Sanitaryware Factory.

The laboratory at Dhaka University has full facilities and trained people for carrying out the chemical analysis of raw materials and works closely with the Geological Survey of Bangladesh in the evaluation of these materials although in recent years the amount of work specifically related to the refractory and ceramic industries has been rather limited.

At BCSIR the work is primarily of a research nature and while it has all the facilities to carry out the chemical testing of raw materials and occasionally carries out these tests, the policy of this Institute is not to become too involved with the specific production problems of the refractory and ceramic industries.

By far the most important facilities exist at the Bangladesh Institute of Glass and Ceramics but these are currently not being fully utilised due to a lack of trained personnel and qualified teachers and a general reluctance of the refractory and ceramics industries to properly support the Institute.

It is because of this marked lack of confidence in these laboratories to supply reliable results within a reasonable timespan that manufacturers of refractories, tableware, sanitaryware and heavy clay products still rely on overseas testing laboratories for most of their raw materials testing.

Within the laboratories of these organisations are the complete facilities for both the chemical and physical testing of refractories. Facilities for the testing and development of ceramics are also complete including all necessary equipment for the production

of porcelain and earthenware bodies, casting slips and glazes. In addition a complete pilot plant for the production of refractories and ceramics exists, complete with all necessary grinding equipment, mixers, extruders, presses, pottery machinery, dryers and kilns.

The deficiencies in the testing of raw materials and products in the industries are therefore not due to any lack of equipment but are solely due to the lack of adequately trained personnel in the laboratories. This project therefore provides for well experienced expatriate laboratory and technical personnel to offer their advice in seminars and practical workshops to upgrade the training of local personnel in all manner of chemical and physical testing of refractory and ceramic raw materials and products.

The testing laboratories are not the only weaknesses found within the refractory and ceramics industries. Without exception all companies expressed a concern about the low level of technical expertise within the industries and a desire for better training of their technicians and managerial staff by improving the overall standard of the three year Diploma course in ceramics at the Institute of Glass and Ceramics. Again because of an acute shortage of trained professional staff this course has to be taught by junior instructors of diploma level, who have had virtually no experience in industry. Graduating students are therefore felt to be of limited value to companies in trying to solve their production problems and improving the quality of the production.

At present there is no reliable consultancy service in the Government sector which can adequately help the refractory and ceramic industries to solve their production problems and aid in the development of new products. To add to the quality of existing refractory and ceramic technology courses therefore and to improve the consultancy service which can be offered by the University and other establishments this project provides for short-term courses of an intensive nature which will be given by expatriate advisors expert in

their particular field of refractories, ceramics and clay mining.

Various potential new products for the refractory and ceramic industries have been identified, some of which could be produced within a fairly short time period providing sufficient expertise is available for the initial development work.

The vast reserves of alluvial clays are underutilised in the country and could be used to produce good quality load-bearing facing bricks and field drainage tiles. Load bearing bricks can reduce the cost of housing by eliminating much of the concrete and steel re-inforcing necessary in framed structures and would reduce the amount of cement presently imported into the country. However the better production facilities and better technical knowledge is required to produce these high quality bricks. The means to improve the technical standard within the brickmaking industry is provided for within this project document.

Brick built structures are aesthetically more pleasing in the environment and require far less maintenance than concrete structures. By utilising more of the cheaper idigenous red clays, which are abundant in this country the production of such bricks would aid the economy of Bangladesh and at the same time improve the quality of the urban environment.

As the quality of aggregates made from field burnt bricks is very poor and the cost of stone aggregate from the distant Sylhet region is extremely high the possibility of utilising other materials for aggregate production was considered. However no suitable mineral deposits for hard aggregates are available in the country and while bloating shales in the Dhaka area have been evaluated for lightweight aggregate production and could be utilised, there is presently no market for such aggregate and therefore must be considered as a long term, not immediate possibility.

The low grade white clay presently only used for refractories would appear to be a suitable material as a major constitutent for a floor tile produced either

as a split-tile or punched tile and the possibilities of salt glazing to reduce the requirement for very expensive imported glaze constitutents will be investigated under this project.

Although large areas of high quality agricultural land are waterlogged for much of the year no manufacturer has yet commenced to produce field drainage tiles. Such tiles are easy to produce with inexpensive low technology equipment and the abundant deltaic alluvium is an ideal material for such a product. The installation of properly designed drainage systems using these tile in high quality agricultural or grazing land increases yields by lengthening the growing season and maintaining aerated soil conditions. Such tile are superior to competing plastic pipes. This project will provide for the manufacture of sufficient tile to enable the Ministry of Agriculture to carry out drainage tests on agricultural land subject to water logging to measure the effect of improved drainage on crop yields.

Apart from the white clay deposits there would seem to be only two other sources of minerals with industrial potential as refractories.

(a) Rice husk ash to be employed to manufacture insulating products.

(b) Minerals from the beach sands of Cox's Bazar namely Zircon, Kyanite and Rutile.

This project will provide for samples to be produced for evaluation by industry.

Within the refractories and ceramics industries, in common with most other energy users producing a wide range of commodities, it would seem that with the exception of the very large concerns no attempts are being made to monitor energy usage. Even at the larger factories although the staff are aware of the need to save energy they are not sure how to achieve it and there is an apparent lack of both the necessary knowledge as well as equipment with which to carry out monitoring on a regular basis.

At all plants there would seem to be scope for substantial energy savings by the application of

suitable insulating materials.

Combustion engineering principles need to be understood, especially with respect to burner design and the efficient and safe firing of kilns and furnaces. Furnace and kiln design, insulation and the utilisation of waste heat are all subjects which deserve study.

Energy audits are required on all factories to pinpoint regions of high energy consumption or loss and to compare performance against target. It is only by involving personnel at all levels, and making them more aware of the need to conserve energy that consistent savings can be made. For this reason this project provides for an expatriate combustion engineer who will carry out seminars and workshops in the educational establishments and provide training and practical help on the factories for specific energy related problems.

PART II E OUTPUTS

1. A well designed plan to improve the mining operations of the white clays in the mines of the Bijaipur region, this to include:

   (a) Detailed methods of winning, clay stockpiling and transportation of the clays.

   (b) A training programme for three mine technicians.

   (c) An increase in output from the mines by an estimated 50%.

   (d) An improvement in the consistency of the quality of the different grades of clays.

2. To establish a workshop and seminar centre at Dhaka University for the refractory and ceramics industries, orientated towards those industries for the training of personnel, improvement of existing products and development of new products by means of the following fully operational units.

   (a) Establishment of a chemical testing laboratory, as an efficient and reliable laboratory capable of testing all the raw materials used in the refractory and ceramics industry and also their finished products.

   (b) Establishment of a physical testing laboratory and pilot plant, as an efficient and reliable laboratory capable of testing all of the physical properties of the raw materials and the finished products of the refractory and ceramics industries.

   (c) A training unit for conducting workshops and seminars for the refractory and ceramic industries.

   (d) Improved library facilities for the staff

and students of the centre.

(e) A consulting unit for providing practical immediate help to the refractory and ceramic industries in regard to all raw material and production related problems encountered by the industries.

3. A programme of testing of examine the possibility of utilising rice husk ash for the manufacture of refractory insulating bricks and rice husk ash cement.

4. A programme of testing to examine the possibility of utilising the Zircon and Kyanite fractions of the sands at Cox's Bajar beach for the manufacture of refractories.

5. A programme of testing to examine the possibility of utilising the lower grade white clay from Bijaipur for salt glazed floor tile.

6. A consultancy service and advisory centre for combustion engineering, embracing kiln and furnace design, burner design, combustion of fuel, kiln, furnace and dryer efficiency, energy audits and advice on the safe application of fuel and power.

7. Syllabi for the planned short-term specialised courses, which are designed for the needs of the industries, encompassing both theoretical and practical training.

8. Provision of well trained expatriate personnel, capable of operating the facilities of the centre and training technical staff for the benefit of the country's refractory and ceramics industries.

(a) One Clay Mining Engineer

(b) One Refractories Technologist

(c) One Ceramic Technologist

(d) One Combustion Engineer

(e) One Research Laboratory Supervisor

(f) Three Technologists/Engineers for short term workshops in the field of:

i Ceramic raw material testing
ii refractories
iii combustion engineering

PART II F ACITIVITIES

		Implementation schedule Planned
1.	Train the counterpart staff and technologists in the use of all chemical and physical testing equipment in the existing laboratories.	Throughout the entire duration of the project
2.	Train the counterpart staff and technologists in the use of all ceramic production machinery and kilns in the existing small ceramic manufacturing factory located at the Institute.	Throughout the entire duration of the project
3.	Offer consultancy services direct technical assistance to all refractory and ceramic manufacturing companies both in the Government sector and private sector to solve specific raw material and production ralated problems, to develop new products and to improve process and quality control.	Throughout the entire duration of the product
4.	Produce the most suitable syllabi for the short courses to be held for the refractories and ceramics industries, all courses to be designed to meet the requirements to the local industries.	During first three months of the project
5.	Organise the programme of the specialised courses with the individuals selected by UNIDO in accordance with the	During first three months of the project

requirements of the industry.

6.	Carry out the programme of the specialised short courses for the refractory and ceramic industries.	From the third month of the project
7.	Carry out a survey of all companies in the refractory and ceramic industries and all other major industrial users of fuel to offer detailed advice on kiln, furnace and dryer design, burner design, combustion engineering, energy audits and inspection of safety procedures in respect to fuel and power.	Throughout the entire duration of the project
8.	Carryout a detailed survey of the current mining operations at Bijaipur, utilising the new information to be obtained from the drilling programme to be done by the Geological Survey and design the most efficient method of mining for each mine area in order to recover the maximum quantities of good quality clays from the deposit.	Throughout the entire duration of the project
9.	Production of a range of insulating brick samples utilising rice husk ash for evaluation by industry.	From the sixth month of the project
10.	Production of a range of zircon and kyanite refractory samples utilising the zircon and kyanite fraction of the	From the ninth month of the project

	Cox's Bazar sands for evaluation by industry.	
11.	Production of a range of salt glazed clay samples utilising compositions based on the lower grade white clays of Bijaipur for evaluation by industry in respect to salt glazed floor tile.	From the sixth month of the project
12.	Production of a range of field drainage tile for assessment by the Ministry of Agriculture in improving the yields of agricultural land. Sizes to be produced initially to be: (i) 4 inch diameter x 12 inch long (ii) 6 inch diameter x 12 inch long	From the sixth month of the project
13.	Provision of up-to-date technical reference books and journals in the English language for the refractories, ceramics and heavy clay industries.	From the second month of the project

PART II G INPUTS

1. Government Contribution

(a) Personnel for the duration of the project

3 Senior laboratory technicians.
3 Junior laboratory technicians.
1 Senior geologist
3 Trainee mining engineers
2 Trainee combustion engineers

(b) Transportation costs and subsistence costs

All costs of the counterpart personnel will be met by the Government or corporation.

(c) Equipment and supplies

(i) Sufficient amounts of deltaic alluvium clay from the Dhaka area, white Kaolinitic clay from the Bijaipur area, rice husks and the refractory fractions of the Cox's Bazaar sands to carry out all the required tests and pilot production of new products under this project.

(ii) Sufficient materials and chemicals for the operation of the laboratories and pilot plant

(d) Premises

(i) Furnished and suitably equipped office accomodation for the international team will be provided by the Government at Dhaka University in accordance with the actual needs of the project.

(ii) Suitable furnished living accomodation for the expatriate mining engineer and counterpart local personnel will be provided by the Government in the neighbourhood of the Bijaipur mine site at the rest house operated by Bangladesh Insulator and Sanitaryware factory.

2. UNDP Inputs

(a) Personnel

UNIDO

11-01 Refractories Technologist/Team

	Leader	12m/m
11-02	Clay Mining Engineer	12m/m
11-03	Ceramic Technologist	10m/m
11-04	Combustion Engineer	10m/m
11-05	Research Laboratory Supervisor	12m/m
11-50	Short term consultants in refractory and ceramic technology, energy conservation and raw material testing	6m/m
	Total	62m/m

Post 11-01 Refractories Technologist/ Team Leader

The expert should be well qualified in a materials science discipline of at least degree standard. He should have extensive experience, a minimum of ten years, in the manufacture and application of refractories of all types, preferably with some overseas experience in developing countries.

The expert must be able to explain the theoretical and practical aspects of refractories technology in both the lecture theatre and on the factory. A sound knowledge of testing methods and some experience of developing new products is also required.

Post 11-02 Clay Mining Engineer

The expert should be a well qualified mining engineer of at least degree standard with a minimum of ten years experience in the mining and quarrying of clays, with special emphasis on the development of new quarries or mines.

His theoretical and practical knowledge should include all aspects of core drilling including the complete evaluation of the core samples obtained. Previous overseas experience in a developing country would be desirable.

The expert will be based at Dhaka University and is to be initially attached to the Geological Survey drilling team as an advisor to help the Geological survey to evaluate all results.

The expert will, on the basis of the results from the drilling programme, develop a comprehensive

mining plan to:-

(a) optimise the utilisation of all the clay deposits in the area

(b) improve the clay stockpiling techniques and testing to improve the consistency of the quality of the various grades of clay.

(c) improve the method of transportation of the clay from the mine to the customer, special emphasis being given to alternative methods of transport from the mine sites to the loading station at the river..

Post 11 03 Ceramic Technologist

This person should be a well qualified technologist or engineer of at least degree standard with a minimum of ten years experience in the ceramic industry preferably with detailed knowledge of the tableware, sanitaryware and heavy clay industries.

The technologist will be based at Dhaka University - Geological Department from where he will be expected to carry out a series of lectures and practical workshops in the chemical and physical testing of ceramic raw materials and products utilising the facilities of the other Government organisations where this is appropriate to the subject being discussed.

These lectures and workshops will involve staff and students of all Government organisations involved in the refractories and ceramic industries and also the technicians, supervisors and management of the private industries.

The technologist will also be expected to visit all ceramic industries to act in a consultative role in helping to solve their production problems and in helping to improve the quality of their production.

The third area of work for which this technologist will be responsible will to be to aid in the development of new products for the industry.

Post 11 04 Combustion Engineer

This person should be well qualified in fuel engineering technology to at least degree standard

with a minimum of ten years experience in the application of combustion science. The expert must be able to demonstrate the theoretical and practical aspects of all kinds of energy usage with particular emphasis placed on energy conservation in industry.

The expert will be based at Dhaka University from where he will be expected to carry out a series of lectures in his subject.

The expert will also be expected to visit all refractory and ceramic industries and all other major users of energy to act in a consultative role in helping these industries to become more aware of the need to conserve energy, advising them on all practical aspects such as energy audits, burner design and operation, kiln and furnace design and all safety aspects of fuel combustion.

Post 11 05 Research Laboratory Supervisor

This person should be well qualified in Materials Science, such as refractories technology and ceramic technology to at least degree standard with a minimum of ten years experience in the management of both research laboratories and production control laboratories within the refractory and ceramics industries. The expert will be expected to demonstrate the full range of tests, both physical and chemical, which are required to control the production processes in the refractory and ceramics industries. A knowledge of the relevant international standards is essential.

The expert will also be expected to aid in the development of new products within these industries and train the national counterpart personnel.

Post 11 50 Short-term Consultants

A number of consultants expert in the fields of raw material testing refractories and ceramic technology and energy conservation will be employed for short periods dependant on specific needs of the industry which will be identified during the course of this project.

(b) Post 13.00 Administrative Support Personnel

Two drivers will be required for the duration

of the project.

(c) Post 14.01 UN Volunteers

A laboratory technician will be supplied under this project to aid the Research Laboratory Supervisor in all his duties.

(d) Fellowship Training

No fellowship training is planned under this project.

(e) Equipment

41 00 Expendable equipment	Estimated cost US $
(i) Three sets of replacement elements for 38 kw kiln manufactured by Kilns and Furnaces Limited Keele Street Works Tunstall Stoke on Trent Staffs England Telex 36638G Kiln specification. Type HT16 1300°C Serial 02626	1,500
(ii) Three sets of replacement kiln furniture for 38kw kiln Kilns and Furnaces Type HT16 manufactured by J. Hewitt & Son (Fenton) PLC Victoria Road Fenton Stoke on Trent ST4 2HR England Telex 36528G	3,000
(iii) Full set of spares to refurbish Rawdon 3 inch horizontal de airing extruder manufactured by Edwards and Jones Limited Whittle Road Stoke on Trent England Telex 36397G	1,500
	6,000

42 00 Non-expendable equipment	Estimated cost US $
(i) 4 - wheel drive Landrover	50,000
(ii) Station wagon for the transportation of project personnel	20,000
(iii) Portable Gallenkamp Orsat Flue Gas Analyser to BS1756 Part 2 for the determination of Carbon	

	Monoxide, Carbon Dioxide and Oxygen in flue gases. Specification Gas Analyser type GAS-210-N plus one complete of spare parts Contact: A. Gallenkamp & Co. Ltd P. O. Box 290 Technico House Christopher Street London EC2P 2ER (Telex 88604)	500
(iv)	100mm and 150mm pipe dies for Boulton extruder	5,000
(v)	Text books on ceramic and refractories technology	5,000
		80,500
(f)	Miscellaneous	
	51.00 Costs for report writing	1,500

PART II H PREPARATION OF WORK PLAN

A detailed work plan for the implementation of the project will be prepared by the leader of the international staff assigned to the project, in consultation with the leader of the national staff. This will be done at the start of the project and brought forward periodically. The agreed upon work plan will be attached to the project document as Annex 1 and will be considered as part of that document.

PART II I PREPARATION OF THE FRAMEWORK FOR EFFECTIVE PARTICIPATION OF NATIONAL AND INTERNATIONAL STAFF IN THE PROJECT

The activities necessary to produce the indicated outputs and achieve the project's immediate objectives will be carried out jointly by the national and international staff assigned to it. The respective roles of the national and international staff will be determined by their leaders by mutual discussion and agreement at the begining of the project and set out in a Framework for Effective Participation of National and International Staff in the project. The Framework which will be attached to the project document as an annex, will be reviewed from time to time. The respective roles of the national and international staff shall be in accordance with the established concept and specific purposes of technical co-operation.

PART II J DEVELOPMENT SUPPORT COMMUNICATION

Appropriate and effective communication and understanding between all of the agencies responsible for promoting the refractory and ceramic industries in Bangladesh have to be established to successfully achieve the objectives of the project, the key relationships have to be developed between:

(a) National and International staff involved in the project. Ministry of Education, Dhaka University Geological Department. The Bangladesh Institute of Glass and Ceramics and The Geological Survey of Bangladesh.

(b) The project staff and students at the University of Dhaka and Institute of Glass and Ceramics with the technicians and managerial staff at the private refractory and ceramic industries.

PART II K INSTITUTIONAL FRAMEWORK

The Government counterpart organisation for this project is Dhaka University - Geological Department, which operates under the Ministry of Education. The wide-ranging scope of this project involving geological evaluation of raw materials, clay mining, refractorie and ceramics technology and also energy conservations demands that a number of other Government Ministries and organisations will be involved in part of this project to varying degrees.

Apart from the Geological Department of Dhaka University these will include:-

- the Geological Survey of Bangladesh in respect to the inputs on the clay mining operations and development of other refractory products.
- the Institute of Glass and Ceramics regarding some of the refractory and ceramic technology inputs
- the Ministry of Energy in respect to energy conservation inputs.
- the Ministry of Industries, who will organise the necessary and vital contact with involved private refractory and ceramic industries
- the Bangladesh Chemical Industries Corporation which is responsible for the only clay mine operated by the Government under the management of the Bangladesh Insulator and Sanitaryware Factory.

The necessary co-ordination between all these involved Ministries and other Government organisations will be carried out by Dhaka University.

PART II L PRIOR OBLIGATIONS AND PREREQUISITES

Obligations

(i) Dhaka University to ensure that it has the required staff, either at the University itself or at other Government organisations, to fulfill the needs of the project.

(ii) Dhaka University to ensure, prior to the project receiving sanction, that all premises required for the project, whether at the University or elsewhere are in a satisfactory condition with all services such as water, electricity and gas connected and that all existing equipment is clean and in good working order.

(iii) The Geological Survey of Bangladesh to arrange a comprehensive drilling programme in the region of the Bijaipur clay mines, to which the Mining engineer for this project will be attached. All arrangements for this drilling programme must be fully completed with all necessary machines, equipment and personnel at the clay mine site before the mining engineer departs from his home country to commence the assignment

(iv) Prior to the commencement of the project Dhaka University must confirm its' ability to co-ordinate this project effectively.

The Project Document will be signed by the Resident Representative on behalf of the UNDP and UNDP assistance to the project will be provided only if the prior obligations stipulated above have been met to UNDP's satisfaction.

Pre-requisites

Non applicable.

PART II M FUTURE UNDP ASSISTANCE

It is anticipated that the current project will provide the basic groundwork for an improvement in clay mining techniques, an improvement in the knowledge of refractory and ceramic technology and also an improvement in the awareness within all industries for energy conservation.

However, due to the present low standard of technical training and the virtual lack of any well qualified personnel within the refractory and ceramic industries, it would be advisable to continue a similar programme of training and development after the current project is complete with ammendments necessary once the present project has been evaluated fully.

A period of three to five years is thought necessary to have a lasting impact on the quality of students and technicians within these industries.

PART III SCHEDULES OF MONITORING, EVALUATION AND REPORTS

PART III A TRIPARTITE MONITORING REVIEWS, TECHNICAL REVIEWS

The project willbe subject to periodic review in accordance with the policies and procedures established by UNDP for monitoring project and programme implementation.

PART III B EVALUATION

The project will be subject to evaluation in accordance with the policies and procedures established for this purpose by UNDP. The organisation, terms of reference and timing of the evaluation will be decided by consultation between the Government, UNDP and the Executing Agency concerned.

It is recommended that this evaluation should take place during the final month of the project, to determine what, if any, future assistance is required.

PART III C PROGRESS AND TERMINAL REPORTS

All advisors will prepare bi-monthly progress reports for assessment by the UNDP representative and in addition the refractories technologist as team leader will prepare the Agency Terminal Report for the project at the termination of the project.

PART IV PROJECT BUDGET

The project budget covering the UNDP inputs is attached.

The project budget covering the Government counterpart contribution in kind will be determined by the UNDP Resident Representative in his discussions with the Government.

UNIDO

PROJECT BUDGET/REVISION

3. COUNTRY	4. PROJECT NUMBER AND AMENDMENT	5. SPECIFIC ACTIVITY
Bangladesh	BGD/85/006/ B/01/37	

10. PROJECT TITLE
Analysis of raw materials for non-metallic mineral based industries.

15. INTERNATIONAL EXPERTS (functional titles required except for line 11-50)	16. TOTAL		17. FIRST YEAR		18. SECOND YEAR		19.		20.	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
11-01 CLAY MINING ENGINEER	12	78,000	6	39,000	6	39,000				
02 REFRACTORIES TECHNOLOGIST	12	78,000	6	39,000	6	39,000				
03 CERAMIC TECHNOLOGIST	10	65,000	4	26,000	6	39,000				
04 COMBUSTION ENGINEER	10	65,000	4	26,000	6	39,000				
05 RESEARCH LABORATORY SUPERVISOR	12	78,000	6	39,000	6	39,000				
06										
07										
08										
09										
10										
11										
12										
13										
14										
15										
16										
11-50 Short term consultants	6	39,000	3	19,500	3	19,500				
11-99 Sub-total—International experts[a]	62	403,000	29	188,500	33	214,500				

21. REMARKS

[a] If more than 16 experts are required check here ☐ and attach continuation sheet 1A. This sub-total *must* include all experts.

4. PROJECT NUMBER	16. TOTAL		17. FIRST YEAR		18. SECOND YEAR		19.		20.	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
OPAS EXPERTS (functional titles required)										
12-01										
12-02										
12-03										
12-99 Sub-total–OPAS experts[b]										
ADMINISTRATIVE SUPPORT PERSONNEL										
13-00 Clerks, secretaries, drivers 2 Drivers	24	10,000	12	5,000	12	5,000				
13-50 Freelance interpreters (non-UNDP projects)										
13-99 Sub-total–Administrative support personnel		10,000		5,000		5,000				
UN VOLUNTEERS (functional titles required)										
14-01 LABORATORY TECHNICIAN	12	30,000	6	15,000	6	15,000				
14-02										
14-03										
14-04										
14-99 Sub-total–UN Volunteers[b]		30,000		15,000		15,000				
15-00 Project travel		12,000		6,000		6.000				
16-00 Other personnel costs (including UNIDO staff mission costs)										
NATIONAL EXPERTS (functional titles required)										
17-01										
17-02										
17-03										
17-04										
17-05										
17-99 Sub-total–National experts[b]										
19-99 TOTAL–PERSONNEL COMPONENT		455,000		214,500		240,500				

[b] If additional individual budget lines are required, check here ☐ and attach continuation sheet 1A. These sub-totals must include budget lines listed on page 1A.

4. PROJECT NUMBER	16. TOTAL		17. FIRST YEAR		18. SECOND YEAR		19.		20.	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
SUBCONTRACTS										
21-00 Subcontracts										
TRAINING										
31-00 Individual fellowships										
32-00 Study tours; UNDP group training										
33-00 In-service training		20,000		10,000		10,000				
34-00 Non-UNDP group training										
35-00 Non-UNDP meetings										
39-99 TOTAL–TRAINING COMPONENT		20,000		10,000		10,000				
EQUIPMENT										
41-00 Expendable equipment		6,000		6,000		-				
42-00 Non-expendable equipment		80,500		80,500		-				
43-00 Premises										
49-99 TOTAL–EQUIPMENT COMPONENT		86,500		86,500		-				
MISCELLANEOUS										
51-00 Sundries		10,000		4,000		6,000				
55-00 Hospitality (non-UNDP projects)										
56-00 Support costs (CC and DC projects only)										
59-99 TOTAL–MISCELLANEOUS COMPONENT		10,000		4,000		6,000				
SURPLUS/DEFICIT										
81-00 Surplus/Deficit (ADM/FS use only)										
99-99 PROJECT TOTAL		571,500		315,000		256,500				
[c] COST SHARING (UNDP/IPF projects only)										
[c] NET UNDP CONTRIBUTION										

[c] For information only – *not* for PAD input

Annex II

MISSION REPORT

"ANALYSIS OF RAW MATERIALS FOR NON-METALLIC MINERAL BASED INDUSTRIES"

U.N.I.D.O Project : DP/BGD/85/006/A/01/37

Date : December 1985

CONTENTS

INTRODUCTION

The following report details the findings of the mission, contracted under Project Number DP/BGD/85/006/A/01/37, under each of the specific activities itemised in the terms of reference for this preparatory assistance document. A condensed form of this report constitutes the justification for the project.

1. Review of geological data and clay mining operations

a) Flood plain alluvium

These are abundant in Bangladesh, the flood plain covering several thousand square miles north of the Ganges. The alluvium consists of sand, silt and clay with sand and silt being dominant.

b) Deltaic alluvium

This alluvium extends over the complete area south of the Ganges to the Bay of Bengal and also consists of sand, silt and clay with clay being the dominent component.

Both of these alluvium deposits are widely used for the manufacture of low quality red bricks generally fired in Bull's trench kilns using wood, coal or gas as the fuel.

c) Modhupur Clay

Modhupur clay forms the low hillocks in some parts of Dhaka, Mymensingh, Sylhet, Comilla and Rajshahi districts and mostly underlies a thin mantle of recent alluvium in the districts of Rangpur, Bogra and Dinajpur. These red and yellow coloured clays are also used occassionally for low quality red bricks.

d) White Clays

Sizeable deposits of white kaolimitic clay are located in the Bijaipur area, Mymensingh district and smaller deposits in various localities at the Sylhet district and Chittagong Hill Tracts near Patia.

Small deposits of white clay were also discovered in the Ambati area of Rajshahi district at depths of approximately 1350 feet in seams varying from 14 to 39 feet in thickness. No estimate of reserves of this deposit was possible due to insufficient numbers of drill holes and its depth makes economic extraction unlikely.

By far the most important deposit of white clay for the refractory and ceramic industries is that in Bijaipur. The Geological survey mapped the area in the period 1957-1958 and produced a detailed publication titled, "Report on the white clay and Ferruginous rocks of the Bijaipur area, Mymensingh district, East Pakistan" by A.B. Roy (Information release no.17, June 1960).

The Geological survey initially worked closely with the Minerals Development Corporation identifying two distinct grades of material and arranging clay analysis but once commercial extraction commenced the Geological servey became less involved and has carried out no further detailed work on the deposit since that period.

The deposit of white clay continues for about six and a half miles between Gopalpur and Bhedicura, two small villages four and half miles and two miles east and west, respectively of Bagaria. The white clay is a part of the Dihing series and is interbedded with various clay and sandstone beds generally comprising ferruginous sandstone, pebbly sandstone and yellowish brown clay. The average total thickness of the white clay beds is 10 feet and the quantity of the white clay occurring in the hillocks above the level of the plains was estimated to be about 200,000 tons at the time of the survey and has recently been reassessed at 450,000 tons up to a depth of 150 feet down the dip. However, the true reserves can only be estimated accurately by carrying out a comprehensive drilling programme in the area.

The white clay does not occur as a single bed but as several beds of varying thicknesses interbedded with yellowish brown clay and pebbly sandstone. The maximum thickness of a single bed is approximately seven and a half feet and the minimum thickness is ten inches, with a dip varying from 40^{o} to 75^{o} in the majority of the deposits.

The physical and chemical tests carried out at that time indicated that the clay was suitable for the manufacture of a good type of pottery but was not suitable for making fine quality china.

Compared with Indian and English China clay the plasticity of the clay is very low because of the high percentage of fine sand in the deposit i.e.:-

Clay	Water of Plasticity (%)
Mymensingh clay	20
English China Clay	42
Indian China Clay	36

Due to the relatively high iron content in this clay, Mymensingh clay is not a white burning clay. On firing to 1300C the colour is cream, with a shrinkage of 8%, the body remaining porous. The P.C.E. value is cone 28, which indicates that its refractoriness is lower than that of other china clay and is unsuitable as a material for high grade refractories.

The original chemical analyses of the deposits showed a wide variation in the composition of the clay with an R_2O_3 value varying from 17-40%.

1.1 Utilization of Bijaipur clays

The Bijaipur deposits are presently being mined in several locations by:-

1) Bangladesh Chemical Industries Corporation (BCIC) utilizing the management of Bangladesh Insulator and Sanitaryware Factory (BISF);

2) Oxydental Ltd. (2 open pit mines);

3) Tajma Ceramic Industries Ltd.;

4) Calcutta Tiles and Refractories Industries Ltd.;

5) Peoples Ceramic Industries Ltd.;

6) Dhaka Refractories Ltd.

In all cases the mines are being developed where the white clay is exposed in the hillocks. All mining is carried out by hand, two grades being extracted, no.1 grade being of a lower iron content than no.2 grade, as shown by the following recent analysis carried out by BISF.

	No.1 Grade	No.2 Grade
Loss on Ignition	8.53	7.70
SI02	66.62	67.38
Al203	22.02	20.99
Cao	0.52	0.71
Mgo	0.32	0.20
Fe_2O3	0.87	1.88
Ti02	trace	-

No.1 Grade is used in the manufacture of porcelain tableware, sanitaryware and insulators and while this grade would also be the best clay for the refractory producers the quantity mined is insufficient for their needs and all of the No.2 grade therefore has to be used by the refractory industry, as this is the only material available to them. Small amounts of No.2 grade are also used in the production of floor pavers.

1.2 Beneficiation of Bijaipur Clays

Much work has been carried out in regard to the possibilities of beneficiating this clay by washing and magnetting to remove the silica sand and iron oxide contaminants from the material and a washing plant was actually built in the mine area. This plant never proved successful because much of the silica is of a very fine particle size (down to 2 micron) and could not be separated from the clay particles, which are of similar size. Similarly it was found that although the free iron oxide could be removed by a magnetic separator, the clay still contained chemically combined iron which cannot be removed by this process, hence

this semi-beneficiated clay, although much more expensive than the raw clay, still was not suitable for high quality porcelain tableware.

The manufacturers of the medium quality tableware for the domestic market prefer to utilize the raw clay and, depending on the precise quality received at factory, adjust the body composition to maximize the use of the local material, while maintaining the fired body colour to an acceptable degree of whiteness for their particular price range of product.

Typical body compositions for this type of porcelain have been:-

	I %	II %
Bijaipur clay	28	32
China clay (Indian)	16	14
Ball clay (Indian)	6	-
Ball clay (U.K.)	4	9
Feldspar (Sylhet)	23	23
Quartz (Sylhet)	16	14
Biscuit Body	7	8

Manufacturers of slightly higher quality ware, who have control of their own mine do carry out repeated washing and magneting at the factory to reduce the iron oxide content from in excess of 1% to 0.34%, the majority of which is within the clay structure. The company has not considered installing any chemical treatment due to the high capital cost and subsequent high running costs involved. The policy is to utilize the maximum quantity of local raw materials, recognising that the quality may be slightly inferior to the international standard and to supply products to all sectors of the local market at a reasonable cost.

In the manufacture of sanitaryware, the

thixotropic nature of the Bijaipur clay limits its use to 15% - 20% of the body composition which is typically:-

Bijaipur clay	15%
Feldspar (Sylhet)	44%
Ball Clay (Indian black)	8%
Ball Clay (Indian white)	4%
China Clay (Indian)	25%
China Clay (U.K.,WBB)	4%
	100%
Fired rejects	4% of total raw materials.

In the body composition for insulators the silica content of the Bijaipur clay reduces the need for a quartz addition to the body and therefore is no detriment to the product. As a refined clay would be more costly and additional quartz would also be required there is no technical or economic reason for adding a refined clay to this body composition.

For the production of refractories, which are a relatively low priced product, the benefits gained by removing the course fraction of sand within the clay would be more than outweighed by the additional costs of the clay, except for a small number of relatively high quality products which are manufactured by a factory already possessing its own washing facilities.

Within all of the existing industries therefore there is virtually no product which would benefit to a significant degree by using an expensive semi-beneficiated clay.

1.3 Existing Mining Operations at Bijaipur

The oldest and largest developed mine is that

operated by Bangladesh Chemical Industries Corporation (BCIC) and the main working section is now 70 feet below the surface of two plain having commenced in the outcropping in a 30 feet high hillock. In this location the dip of the clay bearing strata is approximately 70 - 75^{o} and the present method of working is to work horizontally through the clay and sandstone, which results in large amounts of overburden and sand stone being removed in comparison with the cross-section of clay. The best quality clay no.1 grade containing the lowest iron oxide content is found beneath the lower quality no.2 grade and the difference between the two is clearly discernible.

As no detailed geological survey of the area has been carried out with a comprehensive drilling programme, it is difficult to establish with any degree of certainty the areas containing the largest deposits of the better quality clay, which can be most econimically worked. The present method relies more on the intuitive guesswork of the mine manager rather from any sure knowledge.

In situ the clay is very hard and difficult to break and although facilities do exist at the Bangladesh Chemical Industries Corporation mine for using jack hammers, the compressor is out of commission due a lack of spare parts. Hand winning with pick and shovel is the only alternative and is the method used in all mines in the area.

Other possible methods of winning the clay, such as the high pressure water blast method or by the more expensive shaft mining, system could only be considered once the complete characteristics of the deposit and reserves have been accurately identified and this can only be achieved by a properly organized drilling programme. Within this project the Geological Survey of Bangladesh

who have all required machines and personnel, will undertake this programme in conjunction with an expatriate mining engineer.

1.4 Accessibility to the Bijaipur clay deposits

Accessibility to the clay deposits is extremely difficult. Bijaipur is 16 miles north of Jaria Jhanjail a railway terminus linked directly with Mymensingh junction. The distance on rail from Dhaka to Jaria - Jhanjail is 116 miles. The clay deposits can be reached from the Jaria - Jhanjail terminus only in the dry season, partly by four-wheel drive vehicle and the last few miles by bullock cart, small motorcycle or by foot through rice fields.

During the rainy season lasting from June to October, large country boats can travel to Bijaipur along the Someswari river to within a few miles of the mine sites and the mines must utilise this period to move as much clay as possible to the railhead. During the dry season only small country boats can travel to Bijaipur and these are sometimes used to transport clay to Jaria, although this is considerably more expensive.

To ensure the maximum production during the dry season and the maximum deliveries during the wet season therefore requires good mine management in regard to clay extraction clay stockpiling, pumping operations and maintenance of equipment. Good organization of delivery schedules to meet the requirements of customers is also necessary, as any shortfall in output or deliveries has to be met by an increased level of imports into the country.

The current level of output of 4,116 metric tons per annum is insufficient for the needs of the country, and should be increased to a level of

8 - 10,000 m. tons per annum based on current needs and planned expansions in production capacity within the refractory and ceramic industries. In order to achieve this target this project provides for an expatriate clay mining advisor to re-organize the present mining operations to increase the efficiency of all mines in the area. The advisor will formulate a detailed mining plan, based on the information from the drilling survey to be carried out by the Geological Survey, to enable the mines to increase their recovery of good quality clays for the industry. Part of this plan will include an assessment of both the practicality and economic benefit of utilizing a low-cost lightweight overhead cableway system to transport clay from the mine stockpiles to the river to overcome the serious transportation difficulties in this region.

1.5 Production of China Clay from Bijaipur, Mymensingh

Period	Quantity (M.ton)	Value (thousand taka)
1976 - 77	4186	1145
1977 - 78	5870	1404
1978 - 79	7422	1775
1979 - 80	10442	5755
1980 - 81	9982	5443
1981 - 82	5862	3196
1982 - 83	2269	1275
1983 - 84	2613	1435
1984 - 85	4116	6124

2. Evaluation of existing laboratory facilities

Laboratory facilities relating to the refractory and ceramic products industries exist within Government organisations at the Bangladesh Institute of Glass and Ceramics, at the Geological Department of Dhaka University and at the Bangladesh Council for Scientific and Industrial Research (BCSIR).

The laboratory at Dhaka University has full facilities and trained people for carrying out the chemical analysis of raw materials and works closely with the Geological Survey of Bangladesh in the evaluation of these materials although in recent years the amount of work specifically related to the refractory and ceramic industries has been rather limited.

At BCSIR the work is primarily of a research nature and while it has all the facilities to carry out the chemical testing of raw materials and occasionally carries out these tests, the policy of this Institute is not to become too involved with the specific production problems of the refractory and ceramic industries.

By far the most important facilities exist at the Bangladesh Institute of Glass and Ceramics but these are currently not being utilized fully due to a lack of trained personnel and qualified teachers and a reluctance of the refractory and ceramics industries to properly support the Institute.

Manufacturers of refractories, tableware and heavy clay products therefore still rely on overseas testing laboratories for most of their raw material testing. The Institute has complete facilities for both the chemical and physical testing of refractories including refractoriness-under-load, cold crushing strength and reversible thermal expansion machines. A full range of kilns is available some of which require minor repairs such as replacement of elements.

Facilities for the testing and development of ceramics are also complete including all necessary equipment for the production of porcelain and earthenware bodies, casting slips and glazes.

Within the Institute is a complete ceramic production plant including all grinding equipment, mixers, extruders, presses, pottery machines, dryers and kilns suitable for all types of ceramics. Extensive

mouldmaking facilities are also available in this production plant.

Much of the equipment was supplied under the Colombo plan when the Institute was first established in 1951 and more laboratory equipment has since been supplied under UNDP projects.

Although this production facility is ideal for providing practical training for students from the refractories and ceramics industries it is used infrequently due to a lack of trained staff. Similarly the fully equipped laboratories are also underutilized with much of the equipment having never been used since delivery.

However it is this Institute which should have the greatest potential for satisfying the needs of the industry in terms of training technicians, supervisors and senior managerial stall, offering consultancy services on specific factory problems and in the development of new products, body compositions and glazes. If the Institute could act as the focal point for the refractory, ceramic and glass industries, in full partnership and collaboration with all companies within these industries, it would become a more effective organization in developing these industries.

The Institute offers two courses for the industry, a one year artisan course in ceramics technology for new entrants to the industry which is presently suspended due to lack of staff and a three-year diploma course in glass and ceramics technology for entrants at the supervisory level, which is presently being taught by junior instructors of diploma level. A total of 45 students are enrolled in the three classes of this diploma course.

The shortage of professional staff at Dhaka University and the Glass and Ceramics Institute and the lack of training of some at the existing staff in the

use of certain testing equipment requires that this project provide the necessary expertise to broaden the technical knowledge of these staff. This will be achieved by providing training workshops and seminars in all forms of chemical and physical testing. These workshops will be based at Dhaka University - Geological Department but will utilize equipment both at the University itself and also at the Institute, dependant on the requirements of the workshop.

To add to the quality of existing refractory and ceramic courses and to improve the consultancy service which can be offered by the University this project provides for short term courses of an intensive nature, which will be given by expatriate advisors, expert in their particular industry i.e. refractories, ceramics, clay mining and combustion engineering. These courses will be industry biased so that they can offer immediate assistance in solving technical problems occuring on local factories, while at the same time they will offer up-to-date knowledge of modern production techniques.

It should be noted that in addition to the three afore-mentioned government laboratories, a modern laboratory, supplied with all the latest testing equipment by UNIDO is established at the Bangladesh Insulator and Sanitaryware Factory (BISF) and is fully equipped to carry out the full range of tests required for the sanitaryware, insulator and tableware industries. As the BISF factory is operated by Bangladesh Chemical Industries Corporation (BCIC), a government corporation these testing facilities could also be utilized by industry in cooperation with Dhaka University.

3. Identification of the requirements of the refractory and ceramic industries to improve production methods and product quality.

3.1 REFRACTORIES INDUSTRY

The refractories industry of Bangladesh presently

consists of three firms with the following approximate production capacities:

Dhaka Refractories Ltd.	8000/9000t per annum
Mirpur Ceramics Works Ltd.	1500t per annum
Calcutta Tile & Refractories Industries Ltd.	1000/1500t per annum

Two other companies; Savar Refractories Ltd., and Conforce Ltd., are in the process of erecting small plants. Both Mirpur Ceramics Works Ltd., and Conforce operate much larger works producing building bricks.

The bulk of the refractories produced fall under the classification of low alumina or fireclay grades and are manufactured from Bijaipur and imported clays to which is added a varying proportion of grog (chamotte). Bricks and shapes are moulded by hand or using light friction or screw presses. Both soft-mud and stiff-plastic processes are employed depending upon the shape being manufactured.

With only slight modification the process of manufacture involved grinding the clay, adding a quantity of ground grog, mixing with water and then extruding a column which was cut into suitably sized clots. Generally the clay and grog were wetted down and allowed to age on a soaking floor before being extruded. The clots are then used directly for hand moulding or placed on the floor or in racks to allow them to dry back into a suitable condition for pressing. Once moulded the material is similarly dried on the floor or in racks before being set in the kilns. Burning is carried out in small batch kilns of the downdraft type burning natural gas through simple imspirator burners. Occasionally a Hoffman kiln had been employed and at one works there was a shuttle kiln using forced draft burners. The firing temperature varied between 1200/1350^{o}C with a temperature

limit of 1400°C being imposed by the kiln brick-work. Measurement of temperature was by means of Seger cones and sometimes pyrometer.

Not unexpectidely it was found that manual labour was employed to a far greater extent than in European plants producing similar products. The works which were visited varied widely in their approach to manufacture and consequently there were considerable differences in the quality of material produced. When poor the products showed a lack of uniformity in terms of shape, finished dimensions, degree of firing and composition.

Apart from indigenous Bijaipur clay other imported clays were being used and additions of high alumina material, chiefly in the form of calcined bauxite was employed to increase the overall refractoriness of the products when this was required. Where a works laboratory operated the equipment and skills necessary for its use were limited. One works could carry out the determination of refractoriness and two works had small high temperature kilns. None of the facilities were employed on a routine basis and testing when required was obtained elswhere. With one exception (a degree in ceramics) management lacked any theoretical training in the production of refractories. However, all were conscious of the fact and fully aware that such knowledge was necessary and must be acquired if high quality materials are to be produced. It was felt that given the present facilities production improvements and therefor ultimate quality, could be achieved by paying more attention to the following:-

a) control incoming raw materials by means of simple tests which need not be quantitative;

b) control the batch on a routine basis;

c) use dry-press methods for standard sizes in order to improve the shape and produce a more uniform body;

d) from the previous raw material and batch control procedures instigate the use of optimum firing temperatures for each product;

e) apply simple control systems, including final inspection to an agreed standard, to all finished products.

It must be appreciated that the Bijaipur clay is of relatively low alumina content and there are obvious limitations to its use as a refractory raw material. Management at all the works expressed a desire to have a reliable source of clay supply of constant composition. Indeed one works had installed a cascade system for washing the clay although it had seldom been used. There was a general belief that improved quality results from increasing the alumina content of the batch and to a certain extent this is true. However, although the refractoriness of the batch may be modified and the S.K. (Seger cone expressing refractoriness) value increased there is a considerable difference shown in certain other properties. Bricks made from materials such as flint clay, andalusite or mullite, to name some high alumina minerals, possess much better hot strength and exhibit lower shrinkage in use than bauxite doped clay bricks having equivalent alumina content. Some improvement could also be made to the existing products, including those with calcined bauxite additions, by relating the firing temperature more closely to the properties required for a specific application. e.g. thermal shock, density etc. The production of certain high alumina grades from natural materials would be restricted by the firing temperature which is attainable with the existing kilns. Also the necessary burners required to

produce higher temperatures employ forced draft which demands a steady power supply.

At one works attempts had been made to utilize the waste heat from the kiln for drying purposes. Apart from this, energy conservation was not practiced although the benefits to be gained were broadly appreciated. There was a shortage of instruments with which to measure the energy consumed and enable the different stages of the process to be monitored. Kiln design, especially with regard to insulation as a means of reducing fuel consumption and burner design to obtain efficient combustion are two areas which could offer further study produce energy savings.

To summarize quality could be improved by applying more technical controls to the production process. This requires that suitably trained staff are available and that management has the facility to obtain assistance from a reliable national source when necessary.

Future development of the Refractories Industry in Bangladesh.

The present demand for high grade refractories is given in section 4. Sometime in the future, dependant upon the rate of growth of the user industries, the demand for these qualities can be expected to increase. The future demand for low alumina refractories is expected to remain static or even show a decline. The manufacture of high grade refractories, to comply with international standards of quality requires sophisticated plant and considerable technical expertise. Neither are cur ly available in Bangladesh.

3.2 Ceramic Industry

The ceramic industry consisting of the tableware, sanitaryware, insulator and heavy clay sectors have a number of common problems, which are seriously affecting the quality of their production.

Apart from isolated exceptions the general level of housekeeping on all factories is extremely poor. Tableware manufacturers are downgrading much ware because of glaze defects resulting from poor housekeeping in the bisque storage areas and glazing departments. Similarly glaze defects in sanitaryware can be attributed to poor housekeeping and ineffective cleaning of the ware prior to glazing. To prevent needless losses of this type, management must ensure that all areas are cleaned thoroughly on a daily basis.

As in the refractory industry, the management of all factories, except those leasing their own min expressed serious concern about the quality of clays from Bijaipur which was stated to vary from one shipment to the next thus necessitating constant changes in body composition and causing production problems on the factories. Clay shipments were stated to be erratic and insufficient for the requirements of the industry, the shortfall having to be met by imported clays from India and Europe.

Testing of raw materials for the smaller factories appears to be a problem due the lack of trained personnel both within the factories and at the Government testing laboratories. While the larger factories have their own testing facilities they all expressed a desire for an improved consultancy service to be provided by the Government laboratories to reduce their dependence on overseas laboratories.

Kiln insulation appears inadequate on all factories including plants with new facilities. Insulation on kiln walls is particularly poor and this is one area where large fuel saving may be achieved. Other areas causing fuel inefficiency are in the use of imported saggars and in some cases locally made saggars to support the ware in the kiln. The locally made saggars

are particularly thick and heavy in order to achieve sufficient mechanical strength but this results in an extremely low product weight to kiln furniture weight ratio in the kiln and hence a high fuel consumption per kilogram fired ware. With gas firing using properly designed burners profiled biscuit setters, either ring or solid type, manufactured to high quality standards and with a much thinner cross-section can substantially reduce the fuel consumption in the kiln. The life of such setters is many times longer than the low strength saggers and the large savings both in fuel and sagger replacement costs justifies the initially higher purchase price of these setters.

One company previously using furnace oil burners converted to gas but decided not to purchase new gas burners solely because of price considerations. Following the conversion losses of ware in the kiln increased due to their inability to control the burners properly due to a deficiency of air. In addition the complete lack of any instrumentation or themocouples on the kiln causes difficulties in assessing the correct temperatures and this also leads to inefficiences in the utilization of fuel.

A similar situation exists in the sanitaryware industry where locally constructed shuttle kilns are poorly insulated and no attempts are made to utilize waste heat from the kilns for drying purposes, which could substantially reduce fuel costs for relatively small amounts of capital expenditure. No temperature control exists for the mould dryers or the ware dryers and as no checks are carried out on the moisture content of ware entering the kiln, residual moisture could probably be one cause of the extremely high firing losses or this factory.

Since the body composition was changed some years ago first quality ware has fallen from in excess of 80% to less than 10% and all efforts made to correct the situation have failed .

The lack of well trained personnel at the University and the Institute of Glass and Ceramics

and the inability of the factory to seek assistance from overseas due to financial constraints were stated to be the main factors in being totally unsuccessfull in solving these production problems.

Serious problems have also been encountered with the design of moulds for western type water closets and with their production. All attempts to solve these problems have so far failed, again because of lack of expertise within the country.

Within the red brick industry the quality of the product is generally poor and with isolated exceptions the bricks are of varying sizes, are underfired and there is little or no attempt at any form of quality control. On the majority of the few Hoffmann kiln plants existing in the country control of the firing is very poor with high top temperatures, low bottom temperatures and in almost every chamber on some factories the ware normally collapses during the firing cycle. Very little or no instrumentation is used on the kilns leading to serious inefficiences in fuel consumption but manufacturers generally appear complacent about these inefficiencies and are reluctant to invest in modern instrumentation, control and safety equipment.

In summary therefore, as in the refractory industry the ceramic industry could also improve quality significently by applying more technical controls to the production processes, by having suitably trained people at the factory and by having the facility to obtain assistance from a reliable government laboratory when necessary.

4. DOMESTIC MARKET POTENTIAL FOR THE REFRACTORY AND CERAMIC INDUSTRIES

4.1 Domestic Market Potential for Refractory Products

Together the three main producers of refractories in Bangladesh have an installed capacity of approximately 10000/12000 t per annum. When a significant proportion of the output is in the form of holloware for the casting of steel the figure of tonnage becomes less relevant. The products are chiefly low alumina firebricks produced from the local Bijaipur clay and

bricks of higher alumina made from imported clays or by adding bauxite to the local clay.

The import figures for refractories, as supplied by the Department of Industries do not give a complete breakdown into the different qualities but only into broad groups. The figures were also found to fluctuate widely and although the average imports taken over the last seven years amounts to 20000 t per annum the spread, during the same period, was considerable. This is in all probability due to the influence of capital projects which have been completed at different times. A more realistic figure for the imported refractories which are required solely for maintenance and day by day operation would be about half this, perhaps 10000t per annum.

Most of the imported refractories are high alumina basic or silica qualities which cannot be manufactured in Bangladesh at present because the necessary brickmaking plant is not available. In addition to the above qualities small tonnages of cements,castables and monlithic refractories; together with insulating bricks and specials such as crucibles and saggers, also have to be imported.

The following are the principal industries which use refractories:-

4.1.1. Iron and Steel

This industry is the largest user and as such will account for somewhere in the region of 60/70% of all refractories consumed. Chittagong Steel Mills Limited has over 95% of the steel ingot capacity in Bangladesh and is therefore the largest single user of refractories in the country. The steelworks at Chittagong has a rated capacity of 250000 ingot t but there would appear to be insufficient room in the casting bay to achieve this tonnage. In view of this and taking into account a realistic furnace availability a more comfortable capacity is suggested to be 150000 ingot tons.

Steel making operations requiring refractories are:

Open-hearth furnaces. There are four, each of 60t capacity, cold charged and with oxygen assistance, a tap to tap time of about 8h.
The roof, side walls, end walls, uptakes and hearth are all constructed of basic refractories. The qualities vary with magnesite for the hearth, metal clad internally plated magnesite chrome for the side walls, metal clad chrome magnesite for the roof and a chrome brick in the launders.
The working hearth is of grain magnesite, fettled with dolomite which is calcined at the works. The top courses of the regenerators are of forsterite above medium/high alumina firebricks.
A recent change to natural gas firing has caused increased wear on the ends and as a result the forsterite or high alumina in the regenerators will be extended for future campaigns.
In the Foundry there is a small electric arc furnace and a cupola.
Four or five similar electric arc furnaces are located elsewhere in the Country.
All require high grade basic and high alumina refractories for their operation. There was some mention of a sponge iron plant being installed in which case steelmaking would probably be carried out in large electric arc furnaces. This would increase the demand for basic and high alumina refractories.
Mill furnaces. These comprise; Pusher type triple zone reheating furnaces, Billet reheating furnace, Sheet bar reheating furnace and a Normalising furnace. Once installed reheating furances should only require maintenance to be carried out annually apart from perhaps minor hearth repairs. The demand for refractories is not large and will include low alumina, medium alumina and high alumina qualities. For calcining lime and dolomite there are 3 shaft furnaces and a rotary kiln.
All require high grade refractories although the quantity on an annual basis is small.

Casting pit refractories. At present this constitutes the main application for the local products, in the form of ladle lining and uphill casting ware. Ladle lives were said to be variable and for this application it is desirable to have dense, well shaped uniformly fired bricks. The quality of the jointing cement is also very important. Without these properties the ladle performance is likely to be poor and there is some possible danger to the operators since breakouts become more frequent. A similar importance must be attached to the quality of stopper rod sleeves, stoppers, and the guides, trumpets and runners employed in uphill casting. With poor materials in these areas there a possibility of non-metallic inclusions and consequently higher rejection of finished steel. Future development at Chittagong Steel Mills may include a changeover to continuous casting in order to relieve the load on the existing casting bay. Should this occur there will be reduction in the demand for low alumina refractories and a greater demand forhigh alumina materials and special qualities in the form of slide gate and nozzles. Steelmaking applications demand that the quality of the refractories of every type used must be accurately specified if the best conversion costs are to be obtained. Quality control of incoming materials is of paramount importance and it is recommended that materials are always purchased on the basis of technical merit rather than price. Apart from physical and chemical properties this includes that materials are well packed and protected against deterioration when stored.

4.1.2 Cement Industries

Production of cement in Bangladesh has varied between 157000 and 345000mt annually since 1945. A provisional figure for 1984 is 24000mt of which more than half willbe produced by grinding imported cement clinker. There are two rotary kilns presently operating

at Chhatak, one of 3.5m diam F.L. Smidth kiln and one very old smaller Polysius kiln. Both are lined with high alumina refractories in the burning zone with lower alumina grades in the transition, charging and discharge zones. A trial with castable is to be made shortly. Two new factories are proposed located at Surma and Joypurhat each having two kilns of an unknown diameter. An alternative and more common lining in the burning zone of rotary cement kilns is basic material. Uniform properties and accuracy of size are essential if economic lives are to be achieved.

Assuming the new kilns have a capacity for producing 100000t cement each the total demand for refractories for this industry is estimated to be 750/800 mt annually.

4.1.3 Glass Industry

The glass industry requires a relatively small quantity of refractories for under normal operating conditions repairs to the furnace are only needed every few years. The bulk of the refractories could be classed as specials of high quality. Silica bricks are used to build the roof, upper walls and archs. Fusion cast refractories are used for the bath and melting channels and the regenerator filling may be high alumina or basic with low alumina firebrick for the bottom courses. At Osmani Glass there are two tanks here also, following the changeover to natural gas firing increased wear was occurring leading to an upgrading of materials in certain sections of the furnaces.

4.1.4. Power Generation

Steam generating plant relies havily upon castable and insulating refractories. The annual tonnage requirement is comparatively small since repairs need only to be undertaken every two or three years.

4.1.5 Chemical Industries

These include Sugar and Fertilizer factories and Papermills. Refractories are employed in comparatively small amounts but tend to be of a special nature in the form of castables cements and individually shaped products. At the plants visited there was considerable

scope for the application of insulating materials of all types.

4.1.6. Ceramic Industries

Here refractories are required for the repair of kilns, where employed kiln cars and kiln furniture. Demand is low but the qualities needed tend to be of a special type and high grades are necessary when temperatures exceed 1200/1300C. At all the works visited there was again scope for the wider use of insulation.

4.1.7 Capital Projects

These are usually tied in with guarantees with respect to plant performance especially when this comes from overseas. Therefore until the commissioning period is over all refractories have to be imported.

4.1.8 Demand Forecast

The following forecast is made on the basis of information obtained during the assignment it should be treated with reserve and with due regard to the accompanying text.

The estimate is made assuming a steel output of 150000mt.

	Possible demand annually mt.
Low alumina firebricks	10000
Medium/high alumina firebricks	3000
High alumina firebricks	2500
Basic chrome magnesite roof quality	1200
Basic brick, other types including magnesite	2400
Basic ramming material	300/400

With the exception of the magnesite and forsterite types which are burned all the other basic bricks are metal clad, with metal inserts and chemically bonded.

Included in the figures for alumino silicates there will be sufficient equivalent grade cement.

	Other refractories for which there is a demand but expected to be in smaller amounts
Refractory castables	Steady demand

Low temperature insulation	Increasing demand
High temperature insulation	Increasing demand
Specials, crucibles, kiln furniture burner blocks etc	Steady/Increasing

4.1.9 Quality Note

It was found that many of the refractories were specified in terms of S.K. value (Seger cone) without reference to other properties. This can be most misleading and the need for a complete specification should be understood

4.2 Domestic Market Potential for Porcelain and Ceramic Tableware

Up to 1984 the demand for porcelain tableware in Bangladesh was met by three major producers, whose products catered for all sectors of the market except for the extremely high quality products, which had to be imported.

The most recent production statistics supplied by the Department of Industries indicate that the demand is still increasing.

COMPANY	ANNUAL SANCTIONED CAPACITY (M.ton)	AVERAGE ANNUAL PRODUCTION 1980-83	1983-84 PRODUCTION (M.ton)
Peoples Ceramic Industries Ltd.	2,850	1,862	2,890
Tajma Ceramic Industries Ltd.	1,200	520	530
National Ceramic Industries Ltd.	450	315	500
	4,500	2,697	3,920

In addition to the major companies, small quantities of low grade porcelain ware, such as tea-cups, tea-pots plates and salt jars are made by Imperial Pottery Works Dhaka Refractories and Bangladesh Pottery Industries Limited and earthenware such as curry cups, plates, tea cups and tea-pots is manufactured by Bengal Ceramic Industries Limited

COMPANY	ANNUAL SANCTIONED CAPACITY (M.ton)	AVERAGE ANNUAL PRODUCTION 1980-83 (M.ton)	ACTUAL PRODUCTION 1983-84 (M.ton)
Imperial Pottery Works	600	27	28
Dhaka Refractories	N.A	N.A.	20
Bengal Ceramic Industries Ltd.	1,200	260	265
Total;	1,800	287	313

Value of Porcelain tableware imports	(Thousand taka)
1979-80	762
1980-81	460
1981-82	1,349
1982-83	139
1983-84	13
1984-85 (July-May)	50

In 1981-82 the importation of 1501 extremely high quality expensive dinner sets distorted the value of the imports in this particular year. Imports generally have declined substantially, as the quality of the local producers has steadily improved and the high duties and import restrictions have protected the local industry. Early in 1985 a new porcelain tableware factory operated by Monno Ceramic Industries Limited with a rated capacity of 4,200 M.tons was commissioned and is expected to produce approximately 2,500 M.tons of high quality ware during 1985, based solely on imported raw materials.

The importation of tableware into the country has now been banned except for small quantities of personal or diplomatic imports, and it is hoped that some exports of high quality ware can be achieved during 1986.

Even with the added capacity of the new factory the general opinion of all manufacturers is that the demand for tableware, especially that for the medium quality ware is far greater than the production capacity of the country and at least one other manufacturer is planning to double production during 1985-86.

In addition a new stoneware factory built by Bengal Fine Ceramics Limited will be commissioned during early 1986..

A study carried out by Bangladesh Chemical Industries Corporation estimated the demand for tableware to bein excess of 12,000 tons basing their estimates on the following assumptions, which they believe to be realistic

a) Approximately 70% of urban households use 25 pieces of porcelain and ceramic ware of

different types weighing a total of 25lb on average.

b) Approximately 10% of the rural households use 12 pieces of porcelain and ceramic ware of different types weighing a total of 6lb on average.

c) Consumption by hotels and restaurants amounts to approximately 10% of the total requirement of urban and rural households.

During 1984/85 the actual production within the country should increase to approximately 6,700 tons and in 1985/86 to over 8,000 tons, if there is no delay on planned expansions within the industry. The general opinion of manufacturers is that the BCIC estimate of the true demand is overstated to some extent under present economic conditions but that the tastes and habits of the people are changing, especially in the larger village areas, where a substantial increase in the use of porcelain is observed.

Current Prices of Porcelain and Earthenware Tableware

Price per set of 1 dozen cups and 1 dozen saucers

	Taka	
Low quality earthenware/ porcelain	50	(no excise duty)
Medium quality porcelain	159	(including 30% excise duty)
Medium - high quality	200	(including 30% excise duty)
Export quality porcelain	200	upwards (including 30% excise duty)

4.3 Market Potential for sanitaryware

No imports of sanitaryware such as wash basins and water closet pans have been allowed since 1979-80 and the total domestic market is met by two manufacturers Bangladesh Insulator and Sanitaryware Factory (BISF) and Dhaka Ceramics and Sanitaryware Limited whose total installed capacity is far in excess of current demand.

	Installed Capacity (M.ton)	1983-84 Production (M. ton)	1985 Estimated Production (M. ton)
BISF	4,000	1,317	1,400
Dhaka Ceramics and Sanitaryware Ltd.	1,800	341	500
Total	5,800	1,658	1,900

At the current levels of output it is becoming increasingly more difficult to sell all of the production, as most of the distributors in the city areas appear to be fully stocked and with factory stocks already at high levels. the expectation is that production may have to be reduced slightly in the near future. Unless there is substantial additional investment in new housing construction and institutional buildings the opinion of the manufacturers is that the demand for sanitaryware will remain at approximately the 1,500 to 1,900 M. ton per year level despite the rising population. Sanitaryware in the rural areas is still quite rare due to its relatively high cost and low rate of permanent building in these areas. Early market studies carried out before the construction of the BISF plant estimated the annual demand to be in excess of 5,000 M. tons per annum by 1980 but these estimates proved to be too optimistic as planned building was frequently delayed or reduced due to changing economic conditions.

In the urban areas there is a strong demand for western closets of various colours, while in the smaller communities the eastern type pan is still prevalent and is expected to remain so. Because of

this stronger demand for western style closets Dacca Ceramics and Sanitaryware Limited is planning to deversify its product range to includes these items.

4.4 Market potential for insulators

Very few insulators are now imported into the country, these being limited to a small number of specialised high tension insulators, the latest available statistics being:

Year	Weight (Kg.)	Value(thousand taka)
1979-80	1,521	119,728
1980-81	nil	-
1981-82	12,137	846,590

The total requirements of the country for both high and low tension insulators are otherwise met by BISF apart from a very small quantity of low tension insulators produced by Imperial Pottery works.

	Installed Capacity M.ton	1983-84 Production M.ton	1985 Estimated Production
BISF	2,400	341	950
Imperial Pottery Works	10	9	9
	2,410	350	959

Demand is currently limited by the production of transformers within the country and expectations are that the demand will not exceed the current 950M.tons per year production rate for some considerable time.

4.5 Market Potential for Building Bricks

Numerous small brickfields throughout the country supply low quality hand made brick for general building purposes and also as a major base material for aggregate production.

In and around Dhaka city are approximately 400 brick fields and a further 800 elsewhere in the country. The production capacity of a single unit varies from approximately 160,000 bricks per season up to 600,000 bricks in some cases equating to a total brick production in these Bull's trench type kilns of a minimum 192 Million bricks per year.

Four extruded brick factories utilising Hoffmann-type kilns produce a further 50 million brick per year, therefore the total annual production of the country is a minimum of 240 million bricks.

Note:-

As there is no production reporting procedure for the brick fields, obtaining accurate production statistics is virutally impossible. Production varies tremendously dependent on local demand and prevailing weather conditions.

Natural gas is currently supplied to 104 brickfields to being located in the Dhaka area and although the Government is discouraging the use of wood for firing bricks because of the serious problem of deforestation in recent years, it is still commonly used in the Chittagong area and many rural areas. Imported coal is still used in some areas, although the high price of $80 per ton for is tending to discourage its use, as it reduces the demand for bricks in the immediate locality of these brickfields .

Only one factory in the entire country is producing products of a quality high enough to be acceptable to be used as a facing brick in structural brick buildings, i.e. buildings in which the bricks are used as the load bearing materials, not merely as an in-fill material between re-inforced concrete frames. If more bricks of this standard could be produced in the country specifically for load bearing construction the cost of housing could be reduced by

eliminating much of the concrete and steel re-inforcing necessary in framed structures, and would also reduce the amount of cement presently imported into the country, thus saving valuable foreign exchange.

Brick built structures are aesthetically more pleasing in the environment, and require far less maintenance than concrete structures. By utilising more of the cheaper idigenous red clays, which are abundant in this country the production of such bricks, would aid the economy of Bangladesh and improve the quality of the urban environment.

Current prices of field burnt bricks are approximately 1.5 - 1.6 Taka per piece, while prices of good quality facing bricks can demand prices of 1.9 - 2.6 Taka per piece dependent on the standard required. This price differential would indicate that close to urban centres investment is new machines and better quality control would be justified.

5. OTHER INDUSTRIAL APPLICATIONS FOR THE INCREASED UTILISATION OF RAW MATERIAL RESOURCES AVAILABLE IN THE COUNTRY

5.1 Aggregates

Throughout the country there is an extreme shortage of suitable materials for the production of aggregates which are used for road building and reinforced concrete in most construction work.

Stone washed down from India into Sylhet during each annual monsoon period is collected from the river courses and transported to all major towns,where it is broken by hand into the various sized fractions. This material is very expensive, hard stone costing 7,500 to 8,000 Taka per one hundred cubic feet in Dhaka and soft stone approximately 6,000 Taka per one hundred cubic feet.

By far the most common aggregate is broken brick chips and a high proportion of the field burnt bricks is converted into aggregate by hand breaking. As the majority of bricks are underfired with high porosity and low strength this type of aggregate, although much cheaper than stone at a cost of 1,400 Taka per hundred cubic feet in Dhaka, produces inferior concrete and roads built with the materials quickly collapse and require constant repair.

However a review of existing geological information shows that the country has virtually no alternative material with few reserves of stone formations from which hard aggregates could be obtained. All major accessible rock structures are found in India close to the Bangladesh border. However five holes drilled by the Geological Survey in the Madhyapara area of Dinajpur proved the existance of inexhaustible reserves of hard igneous rock at about 500 feet below the surface. The rocks are of excellent quality for all construction purposes.

The principal source of gravel in the country is Bholagana in Sylhet. Other smaller sources are Telulia in Dinajpur and Patysam of Rangpur. The reserves have been estimated at 180 million cubic feet with replenishment by floods. In 1976 the U.S. Department

of the Interior Geological Survey produced a report entitled "Lightweight Aggregate Production from Claystone and Shale in Bangladesh, which suggests that the production of lightweight aggregate is feasible since bloating clays have been found near Dhaka. However further studies and a pilot plant would be necessary to evaluate the scheme fully. The market for such aggregates is presently very small, as alternative lightweight walling blocks or flooring systems are already manufactured locally by Mirpur Ceramic Works Lirited, which meet all current requirements.

5.2 Floor Tiles

No floor tile are presently manufactured in Bangladesh although Bangladesh Insulator and Sanitaryware Factory intend to recommence trial production of both floor and wall tile in 1986. However these tile are not intended for heavy duty pedestrian areas such as shopping areas, airports, bus stations etc. The Bijaipur No. 2 grade clay would be a suitable material as the major constituent for a floor tile produced either as a split-tile or as an extruded punched tile. Dependant on the body composition split-tile could be salt glazed spray glazed or produced as an unglazed quarry tile. Punched tile could be produced unglazed or spray glazed.

It should be noted that the market for floor tiles is very small in Bangladesh and any proposed production facility should be carefully designed to operate economically at low levels of output.

5.3 Field Drainage Tiles

Although large areas of high quality agricultural land are water logged for a considerable proportion of each year no manufacturer has yet commenced to produce field drainage tiles. Such tiles are easy to produce with inexpensive low technology equipment and the abundant deltaic alluvium is an ideal material for such a product. The installation of properly designed drainage systems in high quality agricultural or grazing land increases yields by lengthening the growing season and maintaining aerated soil conditions. As ceramic field drainage tiles are a low cost product adequate draining can be achieved economically with very short

pay back periods. Such tiles are also superior in all respects to competing plastic pipe systems achieving higher water flow rates for equivalent sized pipes and have a much longer life due to their resistance to deformation and higher strength characteristics.

The facilities already exist within Government organisations to produce sufficient quantitites of these tile to enable the Ministry of Agriculture to carry out tests with drainage systems on good quality land, which is subject to water lagging for lengthy periods and to measure the effect of drainage on crop yields.

5.4 Refractories

Apart from the deposits of white clay the only other mineral resources suitable for the manufacture of refractories would appear to be:-

a) Rice Husk Ash. To be used for the manufacture of insulating products. With this material it may be possible to manufacture an intermediate duty insulating brick which can be used up to a temperature of 1200/1250 C. This would form a back up insulation for kilns and furnaces or as a hot face material in low temperature kilns. It is also possible to manufacture an insulating brick from the Bijaipur clay by the addition of combustible material. This would not have the insulating properties of a brick made from rice husk ash but it will be much stronger.

b) Minerals from the Beach sands of Cox's Bazaar
   (i) Zircon. This may be used in ladle bricks To make zircon bricks and zircon nozzles.
   (ii) Kyanaite. To make high alumina refractories.
   (iii) Rutile. For special applications.

c) The Bijaipur clay may also be used, together with imported graphite to manufactur pumbago crucibles.

d) Some of the clay bearing sands might be suitable as an alternative ladle lining material.

6. SKILLED MANPOWER REQUIREMENTS OF THE REFRACTORY AND CERAMICS INDUSTRIES

The manufacture of modern ceramics and refractories is an applied science which demands from its practitioners possession of a wide range disciplines. To work in these industries a senior technologist needs to have a sound basic knowledge of mathematics, physics and chemistry, together with some specialist subject such as mechanical engineering, chemical engineering or physical chemistry. For higher management positions in addition to the studies in physical science a business and general management training is also desirable.

6.1 Refractories Industry Staff Requirements

The refractories industry in Bangladesh is comparatively small for there is only one works having a capacity in the region of 10000 t per annum. As judged by international standards this would be considered a small plant, further emphasised by the fact that the products are of a quality which in comparison to basic and high alumina refractories, are of low value. There is at present a small but steady demand for refractories of a higher grade and of a type which cannot be manufactured locally. As other industries are developed within Bangladesh this demand will increase and this should create a market situation which would favour installation of plant with which to manufacture a far wider range of refractories.

At the moment there would appear to be nobody in Bangladesh with any experience of manufacturing a full range of refractories and what practical knowledge is available is confined solely to the production of alumino-silicate materials. Higher management at all the works visited were well aware of the situation and realised that any future plans envisaged for extending the product range could be placed in jeopardy by the shortage of suitably qualified staff. The laboratory facilities existing at each works varied enormously although it was perhaps significant that the restriction to their greater

use was being caused by the lack of trained personnel rather than for want of equipment. Limited testing was being carried out but manufacturers had come to rely upon overseas laboratories for any experimental work and the testing required to satisfy customer's specifications.

In addition to possessing or having available staff with the necessary knowledge of making good quality refractories the manufacturer needs also to have an understanding of the service conditions likely to be encountered by his products. Such knowledge is not readily obtained unless some time can be spent working in the industry concerned and this is seldom possible. Very large European producers do have members on their staff who are professionally qualified and considered to be expert in a particular branch of operation within the major industries. The alternative is to develop a close working relationship with personnel of other industries so that their requirements and problems arising from the use of refractories are better understood. Any personnel allotted this task need to acquire special skills and have had an extremely sound technical education.

Refractories technology should not be confined to the manufacturing industry alone for refractories constitute an essential material in every industry where heat is being used as a means of production. Operators within the different industries should preferably have some idea of the importance of the properties of refractories together with the principles of refractories engineering. An in-depth knowledge is not necessary, just sufficient to juuge performance and appreciate the various property differences between different products.

It is suggested that the refractories industry in Bangladesh has openings now and in the near future for the following classes of personnel:

Professional	-	Graduate with Higher Degree
Senior Technician	-	Diploma or Graduate
Junior Technician	-	Metric. Plus extra studies
Supervisory grades	-	Relevant craft training

6.2 Ceramics Industry Staff Requirements

Although the majority of companies have been established for many years and a number of their personnel have received some training in overseas countries in various aspects of ceramic production technology their needs are very similar to the refractories industries. Most companies stated that a lack of expertise was an important factor in not solving the many production problems faced by the industry. Some of the industries' requirements for the junior technician class of personnel are being met by the existing Diploma course students but there is a definite need, recognised by the management of the companies within the ceramic industry to improve the standard of this course. The industry would like to see graduates of this course enter the industry more able and qualified to solve normal production problems having acquired a sound technical knowledge of the industry during the course of their studies.

Some specialist needs especially for mouldmakers and hand-painting artisans were also identified but there are presently no trained teachers for such crafts in Bangladesh.

In both the refractories and ceramic industries combustion engineering is an area of technology which would be of significant benefit to these industries providing that suitably trained personnel were available.

To ensure that a major and lasting improvement is made in the training of personnel for the refractories and ceramic industries it is recommended that a team of fully experienced expatriate personnel be employed to carry out a series of seminars and workshops in their respective specialised fields.

This will give the added support required to improve the standard of existing educational courses and will be an opportunity to concentrate on the major areas of weakness within the refractory and ceramic industries to generally improve the quality of production, reduce fuel consumption and improve the level of technical knowledge of the industries' technicians and management.

7. ENERGY CONSERVATION

During this project visits were made to all the firms connected with the manufacture of ceramics and refractories and also to other major industrial units producing a wide range of commodities. It would seem that with the exception of the very large concerns no attempts were being made to monitor energy usage. Even at the larger factories, although the staff were aware of the need to save energy, they were not sure how to tackle the job and there was an apparent lack of both the necessary knowledge as well as equipment with which to carry out monitoring on a regular basis. At every plant visited there was seen to be scope for energy saving by the application of suitable insulating materials. We were told that a major energy conservation programme for Bangladesh is being formulated by a committee made up from the Engineering Department of Dhaka University, the Ministry of Minerals and Energy together with representatives from the major industries. The refractories works and ceramic plants being comparatively small users were not represented.

It is suggested that there are three main areas which could profitably be examined by both the ceramic and refractories manufacturers in regard to energy conservation. A similar view would be of benefit to all other industries.

a) Combustion Engineering principles need to be understood especially with respect to burner design and the efficient and safe firing of kilns and furnaces. Furnace and kiln design, insulation and the utilisation of waste heat are all subjects which deserve study.

b) Providing that the necessary instrumentation is available with which to measure energy consumption the findings should be used to compile regular energy audits the purpose being to:

(i) pinpoint regions of high energy consumption or loss,

and

(ii) compare performance against targets.

c) Frequently review all process operations to

determine whether or not a change of practice or replacement of old or obsolete equipment could be justified by the saving of energy as as result of such changes.

Staff and workers at all levels must be made aware of the need to conserve energy. This could be implemented by means of posters, short lectures and more involvement of personnel in energy saving schemes. At each large factory one staff member should be installed as Energy Manager with this as his sole responsibility. At a smaller factory this could be made an extra duty for one of the staff.

There is an obvious need for specialist workers in this subject and this suggests that a national training programme could be justified.

8. SUMMARY OF CONCLUSIONS

This project has clearly identified a number of factors, which are contributing significantly to restrict the development of and also reduce the efficiency of the refractory and ceramic industries in Bangladesh, these being:-

(i) A basic lack of detailed knowledge of the clay deposits and a lack of trained mining engineers has resulted in the present clay mining operations being inefficient and disorganised, producing clays of varying qualities and in quantities insufficient for the present demand of the country. This inevitably results in production problems for the user companies and an increased level of clay imports.

(ii) Despite the fact that a number of organisations within the country possess the facilities for raw material and product testing a lack of well trained personnel in these laboratories has resulted in the fact that there is no laboratory within the country, which has the full confidence of the refractory and ceramic industries to produce reliable and meaningful test results. All important testing is still therefore carried out by overseas laboratories.

(iii) Within the refractory and ceramic industries and also the educational establishments associated with these industries there is a serious lack of well trained technical managers and technicians which is seriously affecting the standard of teaching, the quality of the industries' production and also restricting the development of new or improved products.

(iv) Throughout all industries in Bangladesh, including the refractory and ceramic industries there is very little awareness of the importance of conserving energy. Few attempts are made to monitor energy usage and management is generally unaware of energy costs and the potential for savings and increased profits by the correct use of insulation, instrumentation

and attention to burner design and control.

9. RECOMMENDATIONS

In each of the four areas outlined i.e. clay mining, materials testing, training and fuel conservation, the most cost effective way of obtaining significant improvements in the level of knowledge within the refractory and ceramic industries would be to establish a team of well experienced international personnel, who would offer advice in their respective field of specialisation by means of seminars and practical workshops. The seminars and workshops would be attended by members of the educational establishments, students and the management and technicians of the industries.

The experts would also be available to offer direct consultation with the industries giving on-the-spot recommendations in the ways to improve quality and in solving specific production problems.

The length of each assignment would be determined specifically by the requirements of the industry.

Annex III

Companies and Organisations Visited

1. Dacca Refractories Ltd.
2. Mirpur Ceramic Works Ltd.
3. Calcutta Tile and Refractories Industries Ltd.
4. Savar Refractories Ltd.
5. Conforce Ltd.
6. Master Industrial Corporation Ltd.
7. Chittagong Steel Mills
8. Chittagong Cement Clinker
9. Bengal Steel Works
10. T.S.P. Complex
11. Peoples Ceramic Industries Ltd.
12. Monno Ceramic Industries Ltd.
13. National Ceramic Industries Ltd.
14. Bengal Fine Ceramics Ltd.
15. Dacca Ceramics and Sanitary Wares Ltd.
16. Bangladesh Insulator and Sanitaryware Factory
17. Bengal Glass Works Ltd.
18. Shams Glass Works Ltd.
19. Ali Class Works Ltd.
20. Usmania Glass Sheet Factory Ltd.
21. Jazmnna Glass Works Ltd.
22. Geological Survey of Bangladesh
23. Petrobangla
24. Dhaka University
25. Bangladesh Institute of Glass and Ceramics
26. Bangladesh Council for Scientific and Industrial Research
27. Housing and Building Research Institute
28. Bangladesh Oil, Gas and Minerals Corporation
29. Ministry of Industries
30. Bijaipur clay mines of:-
    - (i) Bangladesh Chemical Industries Corporation
    - (ii) Oxydental Ltd.
    - (iii) Tajma Ceramic Industries Ltd.
    - (iv) Calcutta Tiles and Refractories Ltd.
    - (v) Peoples Ceramic Industries Ltd.
    - (vi) Dacca Refractories Ltd.