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Sri Lanka.

ESTABLISHMENT OF A CERAMIC RESEARCH AND DEVELOPMENT LABORATORY

US/SRL/78/207

SRI LANKA

Technical report: Current Status of Project Activities*

Prepared for the Government of Sri Lanka
by the United Nations Industrial Development Organization

Based on the work of F. von Metzsch,
Expert in Installation, Use and Maintenance
of Ceramic Laboratory Equipment

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Project US/SRL/78/207

Establishment of a Ceramic Research & Development Laboratory in Sri Lanka

ABSTRACT

This Report covers the work done by the "Expert for Installation, Use and Maintenance of the Laboratory Equipment", working as one of 8 experts appointed for this project. This report refers to referees time on duty station from 23.4. to 31.10. 1984 and from 3.4. to 27. 6. 1985

During this time the Ceramic Research Laboratory (CRL) was successfully established in Piliyandala, 20 km SSE of Colombo, Sri Lanka.

In spite of many obstacles the equipment consisting of about 150 items with the total value of about 600,000 US$ could be installed completely. Except 5 pending complaints for faulty supply and 2 breakdowns after use, all machines and instruments are working satisfactory or are ready for work, respectively.

The use of the equipment started in July 1984 and was extended step by step. Now, at the end of the mission, about 90 % of the installed equipment is in current use.

Since July 1984, within 12 months, more than 1000 orders were settled. This figure states that the project is filling an actual gap in Sri Lanka and that it is working as a successful investment. About 70% of the orders came from factories of the Ceylon Ceramics Corporation, 30% were placed by other governmental or private customers.

12 young Research Officers have been selected and were trained on using the equipment and on the performance of laboratory methods.
A laboratory organization was arranged and provisions were made for maintenance.

1984, on September 18th, a ceremonial opening of the Ceramic Research Laboratory was held by the Sri Lankan Minister of Industrial & Scientific Affairs, Mr. Cyrill Matthew. The CRL was already busy at work at this time.

Nevertheless, 12 months later, the CRL is to-day still at the beginning of its operations only. To gain in experiences it needs now a time of consolidation.
At the end of this report recommendations are given to the CRL, to Ceylon Ceramics Corporation, to UNDP Colombo and to UNIDO Vienna.
Main recommendation is to provide a further long term guidance of the laboratory staff by one broad scale laboratory expert for at least 2 years.

CONTENTS

Abbreviations :

CCC	= Ceylon Ceramics Corporation
CRL	= Ceramic Research Laboratory
GM	= General Manager
RO	= Research Officer(s)
TO	= Technical Officer

INTRODUCTION

The idea to establish a Ceramic Research Laboratory in Sri Lanka came from Mr. Sri Pathma, former General Manager of Ceylon Ceramics Corporation. Dr. Bandula Perera, present General Manager of CCC promoted such an establishment. The agreement between UNIDO and the Government of Sri Lanka was signed on 27. April 1983. The total contribution by UNIDO was figured as 1,005,800 US$ and the sum of contribution of CCC was estimated as 1,848,850 Rupees, equivalent to about 72,000 US$.

Sri Lanka is a country with ceramic tradition. Bricks and roofing tiles were fired - without interruptions to be mentioned - since 2500 years. Besides the 24 factories and subsidiaries of the state owned Ceylon Ceramics Corporation, there exists a number of ceramic factories belonging to Small Industries and numerous private potteries.

The deposits of china clay, ball clay, feldspar, quartzite, calcite, dolomite, limestone and even wollastonite secure the basis for ceramic production of any kind.
Ceramic raw materials and products and also domestic deposits of commercial minerals such as ilmenite, rutile, zircon and monazite and the variety of gem stones found in the country, make a laboratory for investigation of such material useful.

The CRL should have as objectives of the project the following:

- to investigate into availability and usage of all local materials.
- to improve present manufacturing processes and to develop new products.
- to investigate and develop new technologies, where ever possible.
- to function as a service institute to industrial and scientific sector of Sri Lanka
- to determine and certificate quality standards
- to train Sri Lankans to ceramic and allied processes and products.

The demands for laboratory work coming to the CRL already before it was complete, show the need for such a laboratory and that the idea of establishing it and the objectives of the project are fully justified.

ACKNOWLEDGEMENTS

Annex A gives a survey about project's counterpart.

All experts of the project were at an advantage as there was always an interested and active counterpart. Proposals of experts were always considered and most of them accepted by management. All decisions could be made in agreement and harmony.
So we could overcome many difficulties.

The referee is personally obliged to Chairman of CCC, Mr. John Sebastian and to General Manager, Dr. Bandula Perera and all members of the management of CCC and its factories for willingly giving their assistance and help to make the venture of CRL a success.
Chief Adviser for the project was in 1984 Professor Yoshimori Kato. The referee has to thank him for the excellent cooperation given to him.
The project would not be at work as it is, if the cooperation between Expert and counterpart would not have been so easy going.

SCHEDULE of PROJECT

Annex B shows the presence of UNIDO experts at project site and the progress of project from January 1984 to August 1985.

PURCHASE of EQUIPMENT

The first choice of the equipment was made by CCC. Chairman and General Manager made the purchase of about 70% of equipment already in 1983, before any expert was appointed.
With regard to long delivery times this was most reasonable.
Further necessary equipment was selected and requested by experts and ordered subsequently by PAC, UNIDO, Vienna.
Specialities with a value below 3,000 US$ were ordered by Field Purchase Orders as listed in Annex C.
Some items could be purchased locally, in particular installation material, consumption material, Chemicals and glassware. Annex D gives a financial survey.

CHOICE of SITE

For the location of the laboratory various places were taken into consideration by CCC. On advice of Mr. Kato in January 1984, the decision was made to install the laboratory in an almost empty two storied building with 12 rooms, within the premises of the CCC factory in Piliyandala, 20 km SSE of Colombo Fort.

This decision was important and the best, since all other proposals would have caused further delay, by the need of construction work. The renovation of the building and the installation of energy alone, took considerable time, almost 6 months. However, while the renovation was being done room by room, we could proceed with laboratory work at least in one room at any time.
The arrangement of rooms is shown in Annex E.

INSTALLATION

- Energy: All equipment was ordered for 220-230 V. However, the actual voltage was measured between 245 and 260 V, which would have reduced the life span of all electrical resistances and heating aggregates. The CCC had to install a new transformer. The installation of which and of the high ampere connections to the kiln department could be achieved in September 1984 only.
The present supply of electrical current has 2 to 8 power cuts per day. In most cases the power cut lasts only some minutes. However, some of the automatic control units get disordered and programme for X-ray equipment always goes back to the start. This cuts the capacity of laboratory very much and is expected to reduce the life span of equipment. Negotiations with the Ceylon Electricity Board did not bring any improvement.

- Local purchase: The infra structure of CCC workshops and stores was much lower than expected. Quality and quantity of consumption articles of the stores did not meet the requirements of a laboratory. Tools and measuring appliances, taps and tubes, socket and plugs had to be purchased. In Colombo are a lot of technical items available. However, it is very difficult to find out where. This purchase took considerable time of Installation Expert. Such purchase could be done by petty cash, admitted by UNIDO. This arrangement was very helpful. Without such petty cash the CRL would not yet be ready for work.

- Delivery of consignments : This took annoying long time: From Colombo harbour to Piliyandala always at least 4 weeks, due to complicated administative rules for imports to Sri Lanka. Air freight was available 1 to 3 weeks after arrival only.
It turned out to be impossible to furnish any expert with equipment, material or chemicals which was ordered at the beginning of a mission in less than 3 months. Although referee did his best and project spent a lot of money for air freight, Mr. Knizek for example, could neither get the necessary raw material for making new stains nor get a dilatometer for the improvement of glazes and development of new glazes although the goods were air freighted by supplier from stock and arrived on Colombo airport in time.

Due to installation problems and the kind of equipment the time between receipt of the consignment until approval of function of the equipment was rather long, in some cases more than 6 months. In most cases the suppliers understood the situation and agreed to extend the warrantee period.

- Installation of equipment : The most expensive equipment was installed by service engineers of the suppliers (Philips and Netzsch-Gerätebau). This was advantageous for correct installation, detection of misfunctions and to make the operators in the CRL familiar with their equipment as well.

INVENTORY of EQUIPMENT

Annex F lists the equipment as arranged in the rooms of CRL per 30. 6. 1985.
All equipment was used for settling orders, most of the equipment is used now weekly.
The Research Officer responsible for the equipment in each room is mentioned.
He has to report weekly about use and maintenance.

USE of EQUIPMENT

The methods of use have been considered as an integrated part of installation.
Consequently emphasis was laid by Installation Expert on systematic use of all functions of each of the equipments with regard to practical application.

The equipment was and is used to fulfill orders of various kind. For example:
- Quality control for factories
- Determination of suitability of raw material
- Identification of minerals
- Analysis of unknown substances
- Development of new bodies and glazes
- Development of new shapes and new decorative methods
- Calibration of measuring equipment in factories
- Improvement of analytical and preparative methods
- Special research work

In particular for the tests Laboratory Method Specifications have been worked out, based on European Standards adapted to the particular equipment in the CRL.
Annex M shows examples of such Laboratory Method Specifications.

From July 1984 to June 1985, i.e. within 12 months, about 1000 orders have been settled, for example:
- In the Chemical Laboratory full chemical analyses of silicates were made. A special field is the determination of lead release of glazes and the cation exchange capacity of china clays.
- In the Physical Laboratory particle size, viscosity, bending strength, shrinkage, whiteness and many other well known methods for material testing were performed, in particular for quality control. CRL could give extended assistance and advice to quality control of materials used in factories. It has started a permanent co-operation between CRL and Piliyandala factory quality control for comparing testing methods and improvement of testing methods as well.
- In the X-Ray division full use was made of diffractometry for identification and

comparison of minerals. The application of this method was demanded from many customers outside CCC. The X-Ray spectrometry will be started after training of operators by Philips in Holland only.

- The thermoanalytical equipment, DTA, thermogravimetry and dilatometer were handicapped for some time by necessary replacement of parts, the repair of which took place in Germany lasting 1 week only, but due to delivery to and fro, we had to wait many months.
- The scanning electron microscope (and the other microscopes) were used under the guidance of Mrs. Dr. Sacher for investigation of section surfaces of minerals and ceramics.
- In the pilot plant under the guidance of Mr. Kato small items were made with new shapes and with new body compositions. Under the guidance of Mr. Knizek new glazes and stains were made.
- In the kiln section test firing of new bodies was performed. Small scale investigations were done in a gradient kiln and almost production scale firing was done in a 1,5 m^2 kiln.
- Heat treatment of geuwda stones to intensify their colour were undertaken. The results were satisfactory.
- Calibration of temperature measuring devices in the factories could be made.

This is a selection of the manifold work of CRL only.

MAINTENANCE

Instructions were given for cleaning, avoidance of corrosion, maintenance and routine check of functions.

An electrical foreman of CCC got the order to check monthly all electrical installations as lamps, plugs, main switches and connections in respect of security, functioning of supply and voltage. He has to report to the head of CRL, at present Dr. Bandula Perera, GM of CCC.

In respect of refilling lubrication oil and pump oil the Technical Officer of the workshop (who could start his work after end of expert's mission only) was instructed to check the fulfilment of these requirements monthly and to report to the head of CRL.

Maintenance agreements were suggested to be arranged after end of warrantee period for X-ray equipment (Philips), balances (Sartorius/EMSO) and electric type writer (Olympia/EMSO). For STA and dilatometer maintenance instructions were given by Netzsch-Gerätebau during training of operators.

All RO were instructed to check the equipment of their room by repeated calibration to be sure of the reliability of results and proper function of equipment as well.

PERSONNEL

From January to May 1984 3 experienced officers of CCC were assisting the experts. The recruitment of personnel for the CRL - as listed in Annex E - was made after a series of interviews in April and Mai 1984 out of about 100 applicants, by GM of CCC, Dr. B. Perera, and UNIDO experts: Prof. Y. Kato and Dr.F.A.von Metzsch. The selection of staff turned out to be satisfactory, in particular because all RO take high interest in learning and in completing their knowledge and skill to perform their tasks.

In June 1985 the staff of CRL consisted of

1 Senior Research Officer

12 Research Officers

1 Administrative Secretary (for laboratory organisation, orders, results, documentation)

1 Project assistant (tor inventory and library)

2 Workmen (pilot plant and cleaning)

1 Driver for project vehicle.

Unfortunately there were still 2 vacancies when experts left project in July 1985: The second RO for Mineralogical Laboratory and the Technical Officer for the Workshop. The workshop man is for any larger laboratory of high importance: There are many items necessary in the laboratory which cannot be purchased but can be made by a skilled workshop man.

Until end of expert's mission no head of the laboratory was installed. Consequently Dr. Bandula Perera, GM of CCC has to look after this function although his manifold responsibilities make it rather impossible to take care of the requirements of CRL.

This was no problem during the presence of experts. They looked after the daily responsibilities and made the necessary decisions. However, it is a considerable draw back to the project that the experts could not instruct the man who will lead the CRL in future.

REPORTS

Annex G shows the simple principle of weekly report referring to the use of equipment. This report shall stimulate the responsible RO to inspect each equipment, including those which are not in use, and to report immediately if anything is wrong.

Annex R shows the form with which each RO has to request for repair, spare parts and consumption material in time.

In addition each RO has to give a monthly report about his work.

TRAINING

The staff has been trained in various forms. Great emphasis was laid on the training on the respective equipment and the methods involved. Orders were given to demonstrate the limits of methods and the tolerances expected. Statistical evaluation of results with average value and standard deviation was introduced.
One to two lectures a week were held by UNIDO experts to give the basic knowledge for all work in the laboratory. To optimize the exchange of knowledge between all sections of CRL a monthly "colloquium" was established: One of the research Officers gives a lecture about his work, the theoretical background, performance of method and all views of application of method and relevance of results for practice.
Considerable effort was laid on the proper function of settlement of orders. By respective organizational training the function of the laboratory could be achieved at an early stage.
The training schedule for external training so far Europe is concerned was prepared by referee. Since the fellowship training started in June 1985, this can be subject of a later report only.

LABORATORY ORGANIZATION

Offer of Services

On occasion of the ceremonial opening in September 1984, servicess of CRL were offered to the public. A three paged list of possible tests and investigations were offered, for the first 6 months free of charge. Annex H shows a copy of the original letter.
The price list of services was established in June 1985 as shown in Annex P.

Acceptance of orders

Orders received from external customers on form 2 as shown in Annex J were accepted by form 3 as shown in Annex K.
In most cases the result could be sent to customer together with the acceptance form.

Internal Laboratory Orders

For development of methods, general programmes for investigations - for instance for a survey about the character of a deposit - orders were given by experts or GM. For such internal orders the form 4 was used as shown in Annex L. Same form was used to forward order instructions given by customers to respective laboratory sections to perform the investigations.

Emphasis was laid on correct sample taking and correct labelling of samples. One sample gets always one order number. If investigations have to be made in different sections of CRL they are numbered a, b, c ... This makes it easier to collect all informations about the sample. Instruction was given how to get reliable results by use of different test methods and various counter checks.
In any case the customer has to get a complete answer on his question. To know his actual desire, the information about "Inducement to this Order" was regarded as essential to enable the CRL not to produce analytic values only, but to put it in the position to advise the customer with regard to suitability of material or to processing.

Laboratory Method Specifications

The figures of laboratory results depend to a certain extent to the method used. Each laboratory is used to have its specific method. The choice of methods is dependant on the target of all investigations, the available equipment and economic aspects.
For CRL Laboratory Method Specifications were proposed in respect of the equipment and of economical considerations. Most important is to use for years the same method to make a comparison of values possible.
Of course such specification of methods will be important iin the case of exchange of personnel. It is basic for comparison of results and methods with other laboratories. So far a Lab. Meth. Spec. is fixed it can be made obligatory by internal order for use. The respective results have to refer to this specification too.
Examples of such Laboratory Method Specifications are given in Annex M.

Submission of results

Most orders came from CCC factories as Piliyandala and Negombo to assist their quality control. In the case of repeated investigation of similar substances, as in production usual, the result figures given by laboratory were listed and statistical evaluation with average (x) and standard deviation (s) was made. The averages and deviations of production periods were compared with the target to advise the factory for actions to be taken in respect of the results obtained. Discussions were held about the results with the factory officers. For such internal customers normally no letter was written.
Unique substances as brought from external customers need more full analysis. The result of which were given with a type written complete report.
Nevertheless, we always tried to have discussions with these customers in detail too.
To establish a good documentation and filing of results was stronly recommended. Some results will be of interest even after many years.

ACQUISITION of ORDERS

Referee made visits to some of the interesting external customers. The persons contacted are listed in Annex N.

Survey about the first 1125 Orders

Annex O gives a survey about CRL's customers and the number of settled orders.

BILLING of SERVICES

For orders accepted in the first 6 months all laboratory work was made free of charge. Billing was started after establishment of the price list shown in Annex P in June 1985. The prices were calculated on base of the estimated budget and the capacity of the sections of the CRL as explained under "Budget" (next section of this report). The result of our independent calculation was very close to the charges of the analytical department of Ceylon Institute of the Scientific and Industrial Research (CISIR).

EQUIPMENT ADMINISTRATION

The high value of equipment makes a correct control of inventory of CRL necessary. We have got a Project Assistant from the book-keeping department of CCC to follow up all movements of equipment items. For each item a hanging file was installed collecting all important dates, spare part lists, operation manuals and the correspondence with the respective supplier. There is one book-keeping of inventory only: In the office of CRL. Any other, anywhere else, can not expected to be reliable. All information should be taken from these mentioned files.

Request for Purchase or Repair

To keep the CRL always ready for work, to be able to use the equipment and to avoid stand stills a smoothe organization for repair and spare part service seems to be important. As mentioned above, the RO have the obligation to make request for repair or purchase in time to maintain the functions of their equipment and performance of all laboratory methods. Since administration rules of governmental corporations for purchase make such operations very slow and with respect of the fact that imported goods may have a long delivery time, early request and subsequent order for necessary parts is essential. The form as shown in Annex R was made to specify the requests and to make immediate purchase order possible without any delay by check-back or further inquiries.

BUDGET for CRL

For such maintenance of the activities of CRL a certain budget has to be given and the authority to such necessary quick actions. A petty cash of 2,000.-- Rs. was conceded by CCC and was as helpful as the petty cash of project.

In 1984 all expenses were paid by project or CCC. In 1985 project has already asked CCC for reimbursement of costs for consumption material. The need of consumption material as chemicals, recording paper, spare parts, will increase from year to year. For a satisfactory performance of the CRL funds for the budget have to be provided.

The annual costs of the CRL were estimated as shown in Annex S. The costs sum up to 1.8 million rupees per year. Consequently the CRL has to cover the expenses by a turn-over of 150,000 Rs. per month. This can be achieved only by full use of capacity of laboratory equipment. Priority has to avoid any standstill of equipment. Saving personal cost has in so far no priority at all.
The Ceylon Ceramics Corporation was asked to provide the necessary funds. This was done in 1984 and 1985 with about 900,000 Rs. This has been sufficient for the time when spare parts were supplied under warrantee and the CRL was not yet full at work.
But it will be not sufficient for the future unless if the costs exceeding the sum of 900,000 Rs/year are covered by the income of CRL by billing to external customers.

Acquisition of orders will be therefore important.

The costs of 900,000 Rs./year should be covered for CCC by the reduction of scrap and by improvement of production quality in the factories Piliyandala and Negombo.

CONCLUSIONS

The Ceramic Research Laboratory established by this UNIDO - project can be of substantive assistance to the Sri Lankan economy, in particular to the ceramic industries. The CRL may become a national training center.
To secure the success of the proper establishment of th CRL, the recommendations given to CRL and to CCC on the next pages should be taken into sincere consideration.

The child is born but needs now further education !

RECOMMENDATIONS to the future Head of the Ceramic Research Laboratory

1. Take care of good information and actual co-operation between the sections of CRL.
2. Check the accuracy of results by comparison with possible theoretical values
   by double analysis by different methods
   by test analysis of known substances
3. Integrate results of the sections of CRL on same sample.
4. Hold round-table discussions in respect of the results.
5. Pay attention to the submission of logic results in a proper manner to customers.
6. Take care of the documentation of all results.
7. Take care of proper billing.
8. Insist on use of and reference to Laboratory Method Specifications.
9. Complete the Laboratory Method Specifications.
10. Insist on statistic evaluation if more than 3 values of same kind are obtained
    - from one sample (as in bending strength)
    - from a sequence of samples within a certain period (as in factory quality control)
    - from many samples of a large lot (as from a deposit, to evaluate the tolerances of deposit or of a rather homogeneous lot, to evaluate the tolerances of methods involved).
11. Pay attention to the weekly reports about use of equipment and check maintenance.
12. Insist on monthly report about electrical functions from electrical foreman (P.de Silva) and the maintenance, greasing and filling by TO of workshop.
13. RO are obliged to announce any (expected) need. Give order for repair or purchase immediately or, if you have not the authority to do so, forward the request to CCC immediately and follow up.
14. Undertake all necessary steps to avoid any standstill in the CRL.
15. Control inventory files and keep them actual.
16. Insist on reports from Negombo and others using equipment lent from the project.
17. Arrange a weekly colloquium to give the RO one after the other the opportunity to report about his routine work and research work about theory, application of methods and importance of the results for the practice. Give the possibility of discussion and critical review.
18. Make the performance of CRL economic by extended use of equipment. If necessary, make request for additional personnel.
19. If the amount of orders from customers allow, make fundamental investigations about properties of raw materials, intermediates and sales products. Provide good documentation including all findings about tolerances. Certainly such datas will be of importance for years.
20. Offer training by Research Officers of CRL to others. But pay attention on proper instruction.

RECOMMENDATIONS to Ceylon Ceramics Corporation

1. Prolongation of Project

Ceylon Ceramics Corporation should ask UNIDO and UNDP for assistance by a long term expert to keep the CRL on the right way and to make this successful project as efficient as possible.

2. Head of the Ceramic Research Laboratory

First of all, a head for the CRL should be appointed, capable in leading the staff of CRL by knowledge and organization. Knowledge would be welcome in material testing and ceramic processing and developmenmt as well. He should not be a specialist but an authority, capable to establish confidence in the results of CRL and willing to follow up the the recommendations given by experts.

3. Personnel

CRL can earn money only if the expensive equipment is used extensively. All shortcoming of personnel should be avoided.
4 hour use of equipment per day or 20 hours per week only cannot provide any profit.
Due to the combination of some equipment on one control panel the optimum for the respective equipment will be found at more than 40 hours a week.
It would be not wise to run the CRL with the minimum of personnel of the last months.

As shown in Annex S (Budget) a 10 % deprec iation of equipment sums up to 1.5 million Rs.

The personnel costs of 12 "productive" Research Officers was in the last 12 months 405,000 Rs. That is about 27 % of the depreciation. At such a ratio, the management of a "poor" enterprise in Europe would let the machines run day and night to save money.

Originally a staff of 24 persons were planned for the new laboratory. It was wise not to start with so many. To obtain a good working climate, nobody should be without actual task. Now, after establishment of CRL the staff should be increased step by step.
The RO have learnt a lot since the installation of the CRL. They should have the possibility to forward their knowledge to a next generation of young engineers. Such knowledge is not transferred by lectures but by practical work.
Due to the low salaries of a state corporation, it will happen that after some years experience in the CRL the young RO will take opportunity to overtake new responsibilities. Offers from private companies will be attractive. Before such leaving is the case the staff of 1984/85 should have the possibility to train the next and forward all the knowledge the RO have got by training abroad. Such training of the next takes not days or weeks only but 6 - 12 months.

4. Funds for CRL

Funds for budget as estimated in Annex S should be provided by CCC.
The regulations for purchase of actual wanted material should be as flexible as possible.
A petty cash should be provided and always replenished immediately.
Some of the costs will be covered by billing. It should be the target to cover at least all current costs except depreciation by the services of CRL.
If the fund for the CRL are not available a creeping diminuation of the functions of CRL will take place.

5. Supervision of CRL

CCC should supervise all activities of CRL. The following reports should be subject to critical attention:

- Weekly report about use and maintenance of equipment which shows all standstills to be given monthly by by head of CRL to CCC.
- Monthly turnover by billing
- Report about number of orders received and number of settled orders
- Comparison of costs with budget monthly
- Report about move of equipment from room to room and if to others outside CRL, report about the use of the displaced equipment.

6. Recommendation for further Purchase

The following items are recommended for purchase by CCC:

- Small electricity generator for the computing parts of X-ray equipment. This is recommended because of the many power cuts which destroy computer programmes.
- Chemical for chemical laboratory as listed and handed to GM.
  Chemicals have to be ordered always about 8 months in advance !
- Fine mechanical tools and some special material for workshop of CRL.
- Dehumidifier for balance room.

RECOMMENDATIONS to UNDP Colombo

The project is regarded so far as successful. It is recommended to UNDP Colombo to attend the project furtheron. The investment has been done. Now the use should be supervised by the owner. (The equipment belongs still to UNIDO.) UNDP's assistance by persons and funds would be promoting for further success of the project.

All experts of the project are grateful for all assistance given by the personnel of UNDP in Colombo. The neighbourhood of UNIDO office, mail and telex to the project, at least to the resindences of experts, was helpful for the proceeding of the project.

Finally a fact should be mentioned which needs general improvement in a field where UNDP should be able to arrange or at least make requests for improval:
UNDP should undertake steps to improve forwarding of consignments from airport to projects and from harbour as well. Air freight is very expensive and is used in urgent cases only. It seems incredible that the delivery of all air freight consignments took longer than one week from airport to UNDP and even a consignment with a known freight number could not be received within 10 days after arrival on Katunayake airport.
The delay of delivery of said items has been detrimental to efficiency of experts.
It should be made possible that a three months expert can get small consignments as tools or particular substances within his missions time when he recognizes after arrival that he needs such items to make his work successful.

RECOMMENDATIONS to UNIDO headquarter Vienna

The prologantion of the project is not recommendable only but necessary to make the investment efficient. The activity of experts should be extended much beyond the target of the sole establishment of the new laboratory. Guidance by an experienced expert is for the young Research Officers very necessary.
Further Investment of an equipment should be done in close connection with the appointment of an expert or an installation engineer only who will be after delivery of equipment at the CRL to train the staff in using such new equipment in a proper way.
Generally spoken, now software is more important as hardware.
Of course each further expert should have a certain fund to operate. But further development has to be made step by step. Preference should be give to one long term expert instead of many specialized short time experts.

All experts of project are grateful for all assistance given by the various sections of UNIDO Headquarter.
Some misunderstandings arose unfortunately in the procedure of arranging fellowships for external training :
We were told that all arrangements for training abroad is managed by UNIDO Vienna. Thus, after submitting to Vienna names, subject of professional education and general purpose of training of the Research Officers of the CRL, we expected that Vienna would

- contact all mentioned addresses for training of fellows
- find out additional places, if proposed companies/institutes do not accept the fellow
- negotiate the dates of training
- negotiate the costs of training
- inform project about who has been contacted and inform about all achievements
- inform fellows - or at least project - about stipend regulations.

It turned out that this obviously does not belong to the task of the respective department. Our telexes were forwarded to other intermediate offices only, without sufficient information about project, and in addition, informations got lost. The Carl Duisberg Gesellschaft in Germany for instance, did not get the order to negotiate with all addresses which were given by project for respective training.

It is recommended that projects are allowed to arrange the training schedules for their fellows directly with respective training centres and give the complete request to UNIDO which issues the official order - as usual in PAC.
For training there could be regulations similar to purchase. The training companies should know in advance who pays and that they have not to cover any DSA.
It is recommended to make leaflets

- for the training companies/institutes and
- for the trainee fellows with regard to their payments, reimboursement of costs (for instance: railway tickets which could not be purchased in advance).

Such leaflets would make it easier for project to negotiate fellowships.

Since the training of fellows of this project started after the end of referees mission, a final report about the training of the research Officers of the Ceramic Research Laboratory cannot be subject of this report.

End of Text. Annexes A - S follow in the next pages of this report.

Counterpart: Ceylon Ceramics Corporation

Experts of project feel grateful for good co-operation with the following officials :

Chairman :	John Sebastian
General Manager :	Dr. C.S.T.B. Perera
Factories	
Piliyandala :	DGM W.D. Weerasinghe FM Kuruppu (1985) CQCO Lokuliyana
Negombo :	FM Kuruppu (1984) PM Lal B. Samasekera (1984) QA Eleric Fernando
Raw Material Division	GM A.S. de Silva
Boralesgamuwa Kaolin Factory	
Dediawela Ball Clay Factory:	OIC Chandrasena
Owela Feldspar Quarry:	OIC de Silva
Brick & Tile Division	PM Premavansa
Weuda Brick & Tile Factory :	FM Wijesiri
Elayapattuwa Brick & Tile Factory :	FM B.L.S. Chandrasena QA I.A. Ananda
Hungama Lime Plant :	FM Wijenayake AFM Regus
Subsidiaries :	
Lanka Porcelain Ltd. :	GM Premasiri Khongahage FM Dayaweera QCO S. Chandra AFM Mano Wikremaratna
Dankotuwa Porcelain Ltd.:	GM Premasiri Khongahage FM Daya Nissanka
Lanka Wall Tiles Ltd.:	GM Peter Amerasinghe FM Ranjith Munamalpe PM Parakrama Wickramasinghe PMA Ranjith Jayawardana AQO Chandrika Jayasinghe
Lanka Refractories Ltd.:	DGM Kularathna PM Lal B. Samasekera (1985) QA Miss Padna Samarakoon

MISSIONS of EXPERTS

	1984											1985							
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.
Y. Kato	++																++++++++++			
F.A.von Metzsch			++++++++++++++++++++++++++++														++++++++++++			
W. Biehler				++++																
M. Novy									++++++++++++											
I. Sacher												++++++++++++++++++++++++++								
J. Knizek																	++++++++++++			
T. Sivanadian (National Expert)											++++++++++++++++++++++++++++									

TIME TABLE of INSTALLATION

Decision for Site	x																			
Achievement of Water Supply	x------																			
Start Work of Chemical Laboratory	x------																			
Start X-Ray Diffractometry		x------																		
Start Work Physical Laboratory			x....x------																	
Acceptance of Orders			x------																	
Achievement of 220 V			x------																	
Ceremonial Opening			18.9.1984																	
Start Kiln Firing			x------																	
Start Work Electron Microscope													x------							
Start Training Overseas																			x------	

Start X-Ray Spectrometry after Training of Operators at Philips in November 1985

ANNEX C

FIELD PURCHASE ORDERS

The following items were ordered by Field Purchase Orders

FPO No.	Supplier	Items	Value (US$)
Already delivered :			
004672	AGROB-Anlagenbau	Spray Gun with 6 Nozzles	539
		Stirrers & Vessels for glazing station	1,829
004673	Retsch	Additional Test Sieves	231
004675	PHILIPS	Printer KSR 34 for XRD	2,643
005777	CEC	Color Shade Guide	81
005778	Steeg & Reuter	Grinding & Polishing Accessories	417
005779	Karl Kolb	Sample Holder for Permeability Meter	286
005780	Montan	Tools for Lathe	1,048
004100	Corning Medical	Li-Filter for Flame Photometer and Ti-Filter for Colorimeter	242
004101	Karl Kolb	Water Jet Pump and Bellow Hand for Orsat Apparatus	56
004677	Gallenkamp	1 Meker Burner	0
004678	Karl Kolb	2 Meker Burners	50
004685	Retsch	Additional Test Sieves	427
004689	Bruno Lange	Baryt Standard and Powder Cuvettes	170
007783	Ceramic Instruments	1 Meker Burner	32
007784	AGROB-Anlagenbau	Dilatometer	3,449
Still pending :			
004676	Verlag Schmidt	Interceram Monographs	170
004679	Sartorius	100 Aluminium Dishes for IR Drier	20
004686	Isekyu	Dilatometer	1,800
007780	Boulton	Gasket for Autoclave	0
007782	Reichert	Glasfibre Lamp	380
Sum Value			13,870 US$

ANNEX D

LOCAL PURCHASE in COLOMBO

Duty Free Purchase	Rs.	
4 Air Conditioners NATIONAL	47,000	
1 Overhead Projector	10,415	
1 Electrical Type Writer OLYMPIA	17,700	
1 Vacuum Cleaner HOOVER	4,335	
1 Copier U-BIX	44,500	
Sum duty free purchase	124,550	124,550 Rs.
Further Purchase of Eqipment		
2 Statistical Calculators CANON	1,950	
2 Simple Calculators	700	
1 Mechanical Floor Balance 150 kg AVERY	4,500	
1 Magnetic Stirrer BAIRD & TATLOCK	7,500	
1 Mincer for Extrusion	2,100	
1 Hot Plate	1,700	
1 Clip-on Multimeter	1,350	
Sum of further purchase of equipment	19,800	19,800 Rs.
Gas Cylinders (Helium and Oxigen)	19,280	19,280 Rs.
Chemicals and Glassware 1984	96,263	
Chemicals and Glassware 1985	54,421	
Sum of Chemicals and Glassware for Chemical Lab. including some oxides for making stains	150,684	150,684 Rs.
Sundries (Tools, Installation Material, Stationary)	40,400	40,400 Rs.
Sum of Local Purchase in Colombo		354,714 Rs.
Corresponding to approximately		13,000 US$

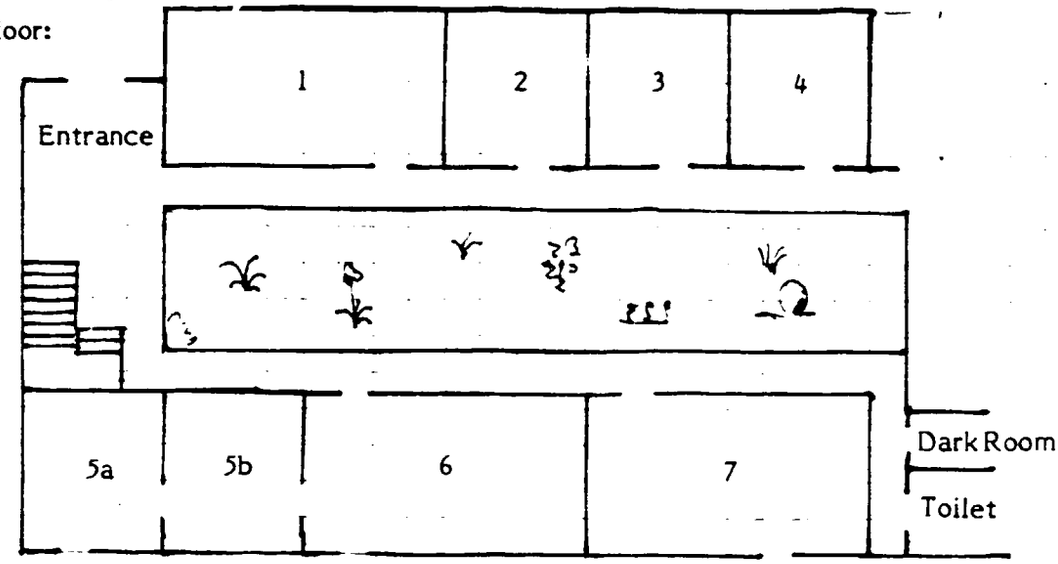
Consumption material, such as propane gas, petrol for project vehicle, all building and construction material, electrical installation material and material for furniture was purchased by counterpart, Ceylon Ceramics Corporation.
The respective installation work was done by CCC as well.
The most costly items were the repair of a transformer and a new electrical supply line, the installation of an additional water pump the furniture and the painting of the rooms.

On behalf of the project we are grateful for this considerable contribution by CCC.

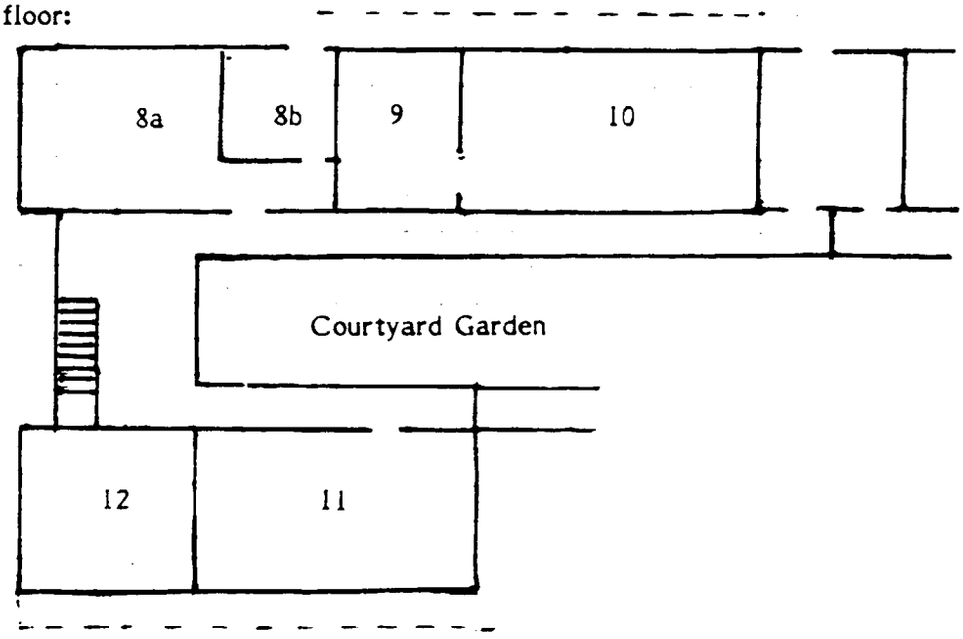
ANNEX E

Site of Laboratory in Piliyandala

Ground floor:



Upper floor:



Room no	Division	Research Officers
1	X-Ray and Thermoanalysis	H.W.S. Siritunga, C.L. Ranatunga
2	Electron Microscope	N. Karunasinghe, NN
3	Workshop (and sample preparation)	NN
4	Store Room (in future: sample preparation)	B.D.S.R. Silva, SRO
5	Pilot Plant, Body Preparation	C.E. Alles, G.M.A.G.B. Gaspe
6	Pilot Plant, Forming	- " - - " -, Mrs. R.D. Hemalatha
7	Kiln Room	P. Mithraratne, N. Dharmasiri
8	Physical Laboratory, Material Testing	A.S. Pannila, K.P.A. Jayakody
9	Chemical Laboratory, Balance Room	K.A.N. Dharmasiri
10	Chemical Laboratory, Experimental Room	Miss M.L.C. Pigera
11	Meeting (Conference, Lecture) Room	Mrs. C.M.N. Perera
12	Office	Mrs. D. Talwatte

INVENTORY

Y13 = Inventory Number
CCC = belongs to CCC
o = not inventarised, low value, or consumptive items

Room 1	Responsible RO: Mr. Siritunga
U 1	Air Conditioner
o	Dehumidifier
o	Humidity Control (Brit.)
o	Humidity Control (Japan)
P 1	Zephir Cooler (for P 2 & P 3)
P 2	X-Ray Diffractometer PHILIPS
P 5	On -Line-Recorder 8203 A
P 9	Printer KSR 34
P 3	X-Ray Fluorescence Spectrometer PHILIPS
P 4	Hewlett-Packard Computer HP 85
P 6	Argon-Methane Cylinder 1
P 7	Argon-Methane Cylinder 2
P 8	Helium Gas Cylinder
N 1	STA Unit (for Simultane Thermo Analysis) NETZSCH
N 2	Measuring Unit (Control Panel) for N1 & N 3
N 3	Differential Dilatometer NETZSCH
N 4	Thermostat for STA
N 5	Thermostat for Dilatometer
M 3	Test Piece Extruder
S16	Sartorius Balance 1501 B MP8-1
S11	Vibratom Mill (located in room no 3)
O 3	Drying Oven
o	Desiccator
o	Small Agate Mortar
Room 2	Responsible RO: Mr. Karunasinghe
U 2	Air Conditioner
J 5	JEOL Scanning Electron Microscope (SEM)
J 5	Photo Equipment for SEM
F 3	Polarising Microscope (Thorough Light)
F 4	Refractive Index Liquid Set
S 4	Stereo Microscope
K 2	Micrometer Dispensing Device
M18	MOHS Hardness Set (incomplete)
o	Desiccator
o	Microscopic Slides
o	Mineral Collection
Room 3	Responsible RO: Mr. Karunasinghe
N 6	Stone Sawing Machine with Diamond Wheels 200 & 350 mm
S12	Grinding & Polishing Machine
I 4	Hand Throwing Machine (used for Grinding) (from room no. 6)
o	Imbedding Resins
S11	Vibration Mill (from room no. 1)
B11	BOLEY Lathe with Chucks, Collars & Cutting Tools

Room 5 Responsible RO: Mr. Alles

A 1	AVERY Sliding Scale Platform Balance 150 kg
A 3	Stirrer 0.12 kW
A 4	Glaze Pump with Motor 0.56 kW (two parts) with 2 Nozzles
A 5	Mixer with 40 ltr. tub & Agitator
A 6	7 Plastic Vessels with 2 Metal Racks
I 1	Jaw Crusher
N14	Ball Mill 100 ltr. NETZSCH with Spare Lining in Store Room
CCC	Ball Mill 100 ltr. (from Negombo)
CCC	Rack - used for Shaking - used for Ball Milling
B 2	Muller Mixer (Edge Runner)
B 8	Jar Mill, Rack with 6 Jars 9" (5 ltr.)
B 9	Jar Mill, Rack with 6 Jars 11" (10 ltr.)
O 5	OSK Pot Mill, Rack with one 15 cm Jar (1.5 ltr)
F 1	Small NORTON Jar Mill, Rack with 400 ml Jar
F 2	Small NORTON Jar Mill, Rack with 400 ml Jar
N 7	High Speed Stirrer (Blunger)
N 8	Filter Press with 16 Filter Plates & Clothes
S13	Hydrometer (0 - 60 g/ltr.)
o	3 Aluminium Tubs
o	Various Plastic Tubs
o	2 kg Spring Balance

Room 6 Responsible RO: Mr. Alles

H 1	HÄNDLE De-airing Extrusion Machine (Vacuum Extruder) with 14 Dies
I 3	Handthrowing Machine
I 4	Handthrowing Machine (lent to room 3)
I 5	Jigger Machine
I 6	Jigger Machine
S 5	IR Quick Drier SARTORIUS with 480 g Balance (transferred to Negombo)
S17	Platform Balance 11,000 g SARTORIUS (from Room 9)
S18	Platform Balance 12,000 g (sent to SARTORIUS, Wien, for repair)
M 9	Needle Penetrometer BATY for Testing non-plastic Surfaces
B 5	Clay Hardness Tester SE for Testing Pug Mill Clay
M 4	Test Piece Extruder BRCA
M 5	Test Piece Extruder BRCA (transferred to Negombo)
M 6	Green Strength Tester
G 1	GALLENKAMP Viskosimeter
M 1	Large MEMMERT Drier with Fan Air Revoulution
M 2	Small MEMMERT Drier

Room 7 Responsible RO: Mr. N. Dharmasiri

Glaze Station:

N 9	Spraying Box
A 2	Compressor with Spray Gun with 6 Nozzles
O 4	OSK Drying Oven
	Stirrers and Vessels see room 5

Kiln Section

K 1	Gradient Kiln 1400^{o}
N10	Small NABER Super Kanthal Kiln 1400^{o}
N11	Large NABER Kiln 1200^{o}
I 7	Gas Kiln
I 8	Gas Kiln (transferred to Negombo)
B11	BICKLEY PCE Kiln 1800^{o}

o	Oxigen Cylinder
o	Seger Cones
o	Thermochrome Crayons
B 6	Buller's Ring Gauge
B 7	Buller's Ring Gauge
C 2	Filament Pyrometer
J 1	6-Channel Printing Recorder JUMO (sent to JUMO for repair)
O 7	Calibrator for Thermocouples (sent to OEGUSSA, Wien, for repair)
O 7	Potentiometer
O 8	Potentiometer
R 3	Microvoltmeter DEGUCAL (sent to OEGUSSA for repair)
R 4	System Voltmeter UDS (sent to ROHDE & SCHWARZ, Wien, for repair)
R 5	High Voltage Tester UHP
B 1	Autoclave
CCC	Chain Block for Autoclave
K 3	Adiabatic Calorimeter with Beckmann Thermometer
o	Equipment for Thermoshock dry
M17	CANNON Statistic Calculator

Room 8 — Responsible RO: Mr. Pannila

O 2	OSK Drying Oven
O 7	Humidity Chamber (Material Test Cabinet)
G 8	Multi Test Tube Drier
R 1	RETSCH Agate Mortar Motor Grinder
R 2	Laboratory Sieving Machine RETSCH VIBRO with 20 Sieves
G 4	Stirrer Handilab Minor with 3 Rotors
S14	Hydrometer (0 - 60 g/ltr.)
S15	Hydrometer (0 - 60 g/ltr.)
K 6	Andreasen Sedimentation Apparatus
K 7	Andreasen Sedimentation Apparatus
S 8	Sedimentograph (Centrifugal Particle Size Analyzer)
S 9	Sedimentograph (Centrifugal Particle Size Analyzer)
M 5	Permeability Meter GF with Sample Holder
M 7	Green Strength Tester BRCA
M12	Glaze Thickness Tester
T 1	Bend & Tensil Strength Tester TONI 6300
C 6	Sample Splitter
K 4	Thermostat (8 ltr/min)
B14	BROOKFIELD Viscosimeter
G 2	GALLENKAMP Universal Viscosimeter
G 6	Viscosimeter REDWOOD
F 5	Vacuum Pump
B14	Digital Vacuum Meter
B15	Mercury Vacuum Torr Meter
L 1	Colorimeter LF 90 LANGE with Measuring Head, Standards and 3 Filters
S 6	IR Quick Drier SARTORIUS with 480 g Balance
S10	Platform Balance 11,000 g SARTORIUS 1501
M 11	Needle Penetrometer BATY for Testing non-plastic Surfaces
M13	Thickness Tester
M14	Moisture Expansion Measuring Device with Standard Steel Block
M16	CANNON Statistic Calculator
K 8	Vernier Caliper 200 mm
K 9	Vernier Caliper 200 mm
o	Micrometer Screw
o	Micrometer Screw

Room 9	Responsible RO: Miss Pigera
S 1	Analytical Balance SARTORIUS 2024 MP 6
S17	Platform Balance 11,000 g SARTORIUS (lent to room 6)
CCC	METTLER Analytical Balance
C 5	Centrifuge HETTICH ROTANTA
H 2	6 Platinum Crucibles (48.99 g)
	2 Platinum-Gold Moulds (88 g)
	3 Platinum Dishes (66.25 g)
	6 Nickel Crucibles
K 12	ORSAT Apparatus
T 2	pH - Meter TPS
S 7	IR Quick Drier SARTORIUS with Balance 480 g
M 14	Ion sensitive Electrodes for Pb and F
	with Ag/AgCl-Reference Electrode
B 12	Magnetic Stirrer
CCC	Flame Photometer CORNING
CCC	Colorimeter CORNING

Room 10	Responsible RO: Miss Pigera
C 2	Crucible Furnace Simon Müller
C 4	Crucible Furnace Simon Müller
O 1	OSK Drying Oven
G 5	Stirrer Handilab Minor with 3 Rotors
L 2	Water Destillation Plant
G 9	Multi Test Tube Drier
o	Sandbath
o	Heating Plate
o	Glassware
o	Chemicals

Room 11 & 12	Responsible: Mrs. N. Perera
U 3	Split Type Air Conditioner
E 1	Electric Type Writer OLYMPIA
H 3	Vacuum Cleaner HOOVER
U 5	U-BIX Copier with stand
M 15	Overhead Projector
o	Magic Board
o	Books according to separate List
N 13	Jeep NISSAN Patrol

Dark Room	Responsible RO: Mr. Karunasinghe
U 4	Split Type Air Conditioner
o	Developing Tank and Darkroom Appliances

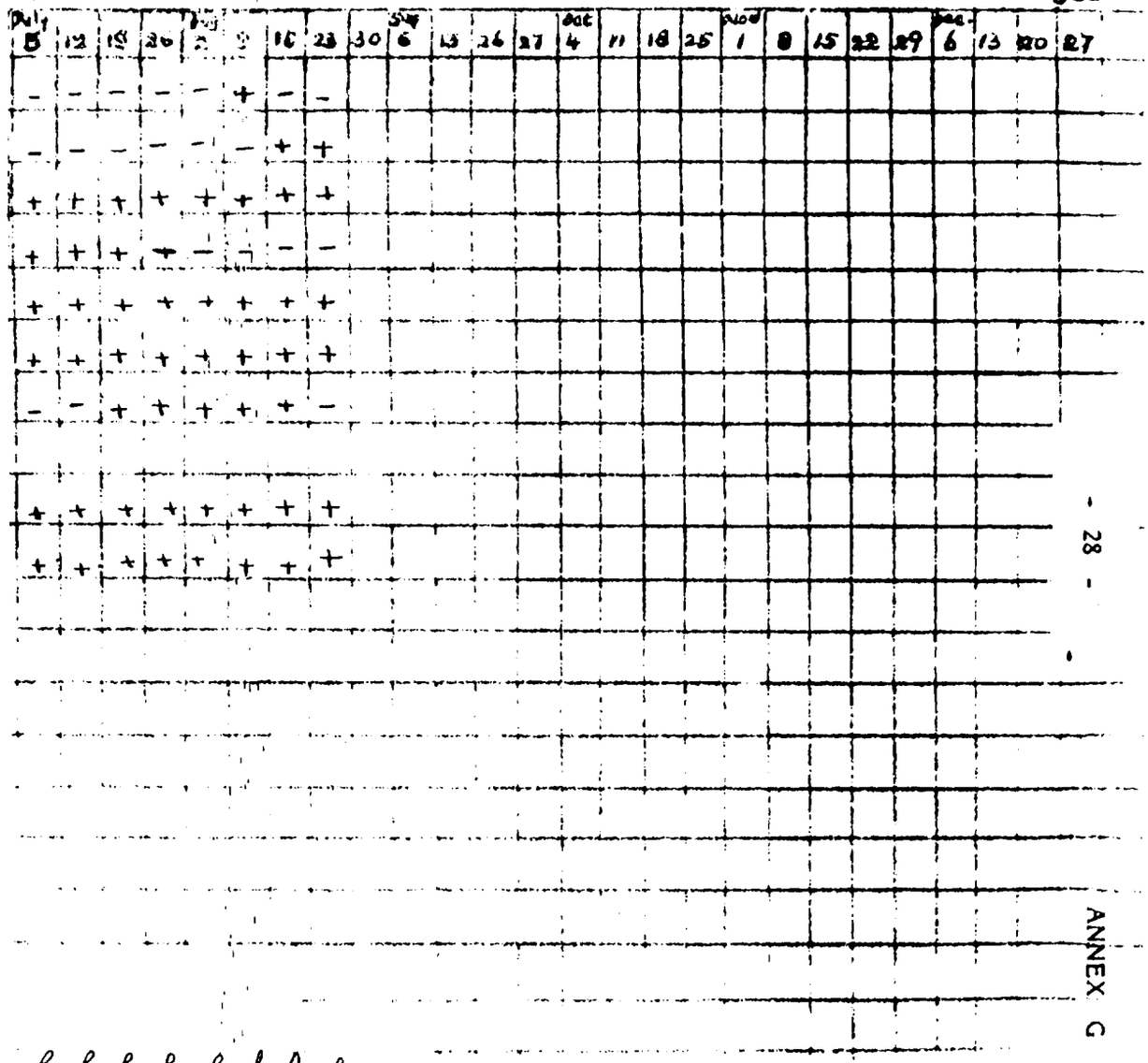
Store Room	Responsible RO: Mr. S. Silva
B 3	Muller Mixer
o	Spare Heating Spirals for large NABER Kiln (N 11)

Equipment belonging to Room No. 10

Responsible Officer Miss L. Pigera

C3	Crucible furnace Simon Muller
C4	Crucible Furnace Simon Muller
O1	Electric Drying Oven OSK
G5	Stirrer Handilab Minor with 3 rotors
L2	Water distillation plat
G9	Multi test tube drier
o	Glass micro Kjeldahl apparatus. Soxhletapparatus.
0	Chemicals
0	Sand bath
0	Heating Plate

1985



Use of Equipment + = Used - = not used 0 = Not in function

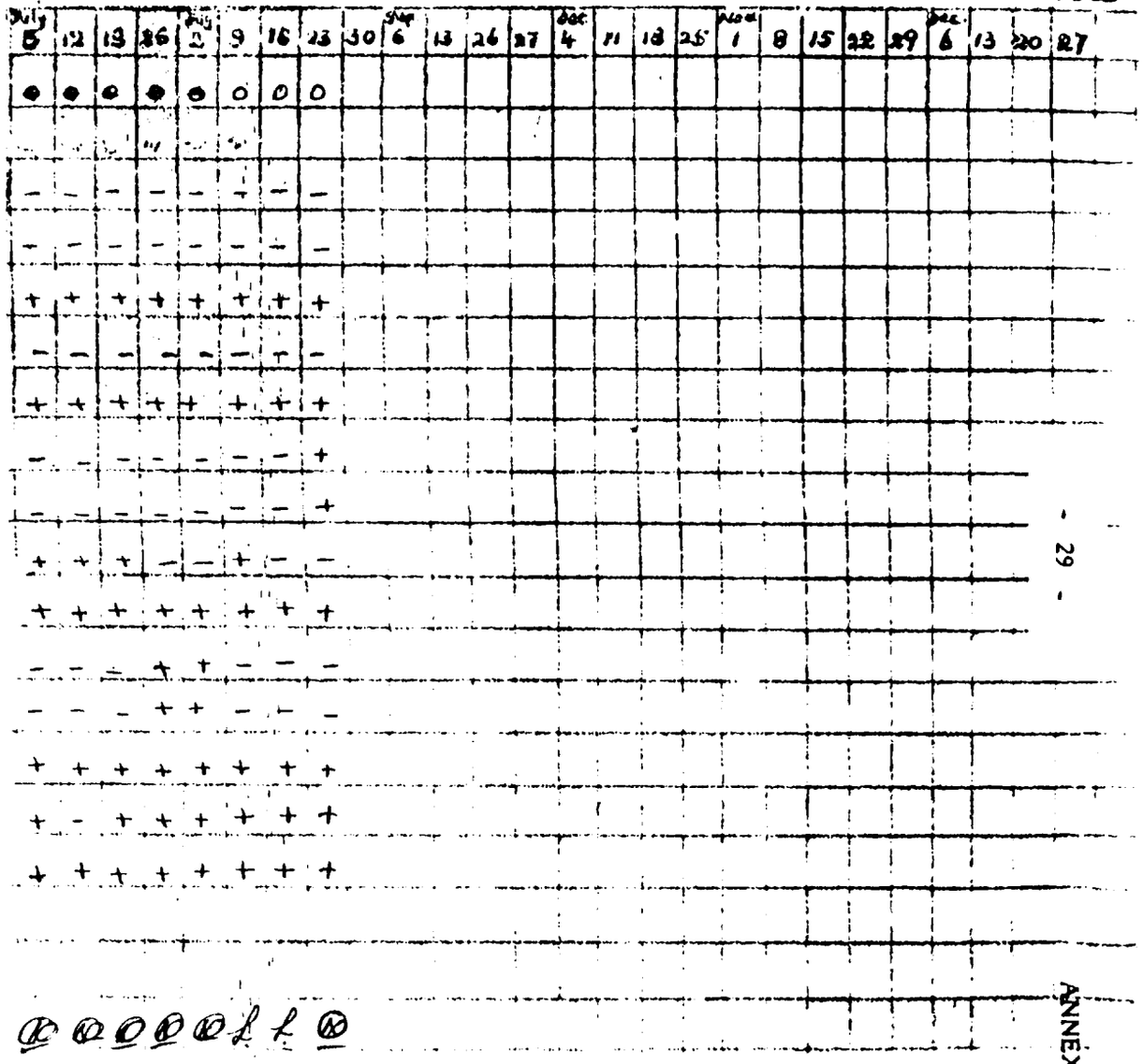
ANNEX G

Equipment belonging to Room No. 9

Responsible officer Mr. K.A.N. Dharmasiri

s 1	Analytical Balance 2024 MP 6 (sentfor repairs)
S17	Platform Balance 11000g (given to room no.6)
ccc	Meiler analytical balance
C5	Centrifuge Rotanta HETTICH
H2	6 platinum Crucibles (4899g)
	2 pt/Au Moulds
	3 Pt - Dishes (6625g)
	6 Ni - Crucibles
K12	Orsat Apparatus
I2	pH - meter IPS
S7+7a	IR quick dryer and balance
M14	Ion sensitive electrodes Pb and F with Ag/Agcl Reference electrode
B12	Magnetic Stirrer
ccc	Flame photometer corning
ccc	Colorimeter corning

1985



Use of Equipment + = Used - = Not Used 0 = Not in function

ANNEX G

CERAMIC RESEARCH LABORATORY

established by
United Nations Industrial Development Organization (UNIDO)
and Ceylon Ceramics Corporation

ANNEX H

Piliyandala

18. 9. 1984

Dear Sirs,

we are glad to inform you that our newly established laboratory is able to serve you in the field of quality control of raw materials, intermediates, refractories and sales products and can assist you as well in all kind of investigations with regard to mineral material and ceramic products.

The laboratory has been established by close co-operation between the Ceylon Ceramics Corporation and UNIDO, with financial support by the Federal Republic of Germany for the equipment. It is operated under the guidance of UNIDO - experts by selected personnel devoted to research work.

The donation of the extensive functional equipment makes it possible to offer our services at an extremely low price. Furthermore, we have decided to offer our services to you without any charges, for a period of six months from today.

Analyses, tests and investigations belonging to our laboratory routine are listed in the annexture attached hereto.

The testing procedures are performed according to standard methods of laboratory. These are based on British, American or German standards and refer to Sri Lanka standards.

You should not seek for assistance when you are in in trouble only, but secure the fundamental properties of your purchased material and your sales products in time.

We invite you to make use of the services of our laboratory and are looking forward to hearing from you.

Dr. Bandula Perera
GM Ceylon Ceramics Corp

Professor Y. Kato
UNIDO Chief Adviser

Dr. P. A. [illegible]
UNIDO Expert

CERAMIC RESEARCH LABORATORY

LABORATORY METHODS

H 2

A. Minerals and unfired materials

1. Free moisture of sample
2. Amount of soluble components
3. p_H - Value
4. Loss on ignition
5. Measurement of colour
6. Measurement of whiteness
7. Bulk density (apparent density) - Hg method
8. Specific gravity
9. Cation exchange capacity and individual exchangable cations
10. Air permeability of powders
11. Porosity
12. Sieve analysis 4 - 2 - 1.0 - 0.5 - 0.25 - 0.125 - 0.063 mm aperture dry (8) (16) (30) (60) (120) (240) (BSS mesh)
13. Sieve analysis (residue) wet 0.063 - 0.045 mm aperture
14. Particle size distribution 63 - 36 - 20 - 11.2 - 6.3 - 3.6 - 1.12 - 0.63 micron
15. Viscosity of fluids
16. Casting rate
17. Amount of water for moulding or pug mill plasticity (Pfefferkorn)
18. Drying properties of bodies
19. Wet/dry shrinkage
20. Bending strength (Modulus of Rupture)
21. Melting point and vitrification range
22. Determination of minerals by polarizing microscope
23. Scanning electron microscope observations
24. Differential Thermal Analysis (DTA)
25. ThermoGravimetric Analysis (TGA)
26. Differential dilatometer analysis of thermal expansion
27. Determination of minerals by X-ray diffractometer
28. Determination of free crystalline quartz in clay by X-ray diffraction
29. Quantitative determination of elements by X-ray fluoresc.spectrometer
30. Chemical analysis of anions
31. Chemical analysis of silicates
32. Flame photometry of alkali in minerals

CERAMIC RESEARCH LABORATORY

LABORATORY METHODS

H 3

B. Investigation of materials by firing
(raw materials, bodies, glazes, frits, pigments)

Forming by desired method (casting into mould, hand throwing, extrusion by pug mill, vacuum extrusion, dry pressing up to 50 MPa/mm^2 (50 N/mm^2, 500 kp/cm^2)

Firing at any desired temperature up to 2000°C with desired firing curve

Pyrometric Cone Equivalent (PCE)

Tests after firing:

1. Colour (whiteness)
2.
3. Shrinkage
4. Water absorption (porosity)
5. Apparent (bulk) density
6. Bending stregth (modulus of rupture)
7. Compressive strength
8. Thermal epansion
9. Moisture expansion
10. DTA of fired body compared with raw mixture
11. Observation of mineralogical composition by X-ray diffractometry and scanning electron microssope

and all properties mentioned under C, if desired.

C. Investigation and test of sales products or pilot plant products

1. Colour and/or whiteness
2. Hardness (Mohs scale)
3. Resistance against acids and alkali
4. Water absorption and water permeability
5. Bending strength
6. Compressive strength
7. Refractoriness under load (thermal load test)
8. Apparent (bulk) density
9. Thermal expansion
10. Moisture expansion
11. Thermal shock resistance, Harkort test (wet method)
12. Oven proof test (dry method)
13. Autoclave test (1h, 345 kPa)
14. Ink test, Malachite green test, Fuchsine (Magenta) test

CERAMIC RESEARCH LABORATORY

LABORATORY METHODS

H 4

C. continued (Investigation of sales products)

15. Lead release
16. Cadmium release
17. Abrasion test
18. Dish washing test
19. Water permeability
20. All test methods described in Sri Lanka Standards referring to ceramic and mineral products

D. Miscellaneous

1. Water analysis
2. Caloric value of fuel
3. Gas analysis of flue gas (ORSAT)
4. Calibration of pyrometers and recorders
5. Statistical evaluation of variation of any quality control figures
6. Regression analysis of two variables of quality control figures
7. Computer programmed calculations

9. Supply of distilled water
10. Supply of standard solutions

E. Preparation of prototypes

1. Casting into plaster moulds (your design / our design)
2. Jiggering onto moulds " / "
3. Handthrowing, handforming " / "
4. By extrusion
5. By dry pressing (with or without profile your/our design)
6. Glazing by dipping or spraying
7. Decorating, painting (your design / our design)
8. Firing under all thinkable conditions
9. Making of models, moulds and case moulds

F. Consultancy work in industrial processing and quality control system

This is a survey only. Please contact us for details.

Form No 2
ANNEX J

ORDER TO CERAMIC RESEARCH LABORATORY

From

Ceramic Research Laboratory
c/o Ceylon Ceramics Corporation
PILIYANDALA

(address of sender)

ORDER for Investigation

Inducement to this order (we like to know - to compare - to be advised)

We are requesting for the following investigations:

Results to be sent to :

copy to

Sample sent on by

handed on by

Label of sample

Description of sample (name)

Origin of sample (deposit supplier / factory stock / date of supply

Copy of this order please deliver with / put into package of sample

.....
(Signature)

Order / sample received on :

laboratory order on :

Results notified on :

For laboratory personnel;
The following standard methods are to be applied:

Form No 3
ANNEX K

CERAMIC RESEARCH LABORATORY

To:

Piliyandala

..... 198.....

Dear Sir,

We thank you for your order dated ..... concerning

.....

This order is accepted under our order no .....

○ The result is shown below.

○ The result is shown in attached ..... nos. of documents.

○ The result will be sent to you within .....

According to our price list we charge

for Ceramic Research Laboratory

ANNEX L

CERAMIC RESEARCH LABORATORY

INTERNAL LABORATORY ORDER No..... DATE:

given by.....
(Customer, Factory, Name of officer) (personal signature of forwarding person F.e. Administrative Secretary)

Inducement to this order:

Kind of sample:

Label inscription

Sent by:

Brought by

Collected by

Received on

Kind of Order

To be settled by:
(Laboratory, Name, Lab. Spec. No.)

Result(s)

Date

Signature of Research Officer

Form 4

CERAMIC RESEARCH LABORATORY ANNEX M

LABORATORY METHOD SPECIFICATION NO. 1 ISSUE DATE: 8/84

SAMPLING

Terms: Single Sample means a part of the whole of a certain material taken at one place and at one certain time.

Collected Sample means the mixture of several single samples, take at different places and/or at different time.

Part Sample means a part of a sample separated by sample splitter according to instruction to operate this equipment.

Rules of Sampling

1. Sampling has to be done with the aim to obtain a representative sampl.

2. Sampling should be done preferably by the same person. If change of personnel is necessary, at comparison of samples a personal factor should be taken into consideration.

3. Sampling of clear Solutions

It is sufficient to take a single sample. Stirring of the solution at the moment of samling is recommended.

4. Sampling of milky Emulsions or muddy Dispersions

After intensive stirring at least two samples have to be taken immediatly, one from the top and one from the very bottom of the vess (According to the kind of investigation or the kind of dispersion decision must be taken to mix the samples to a collected sample or to analyse the samples separatedly.)

5. Sampling of mineral raw material

Sampling of mineral material is admissable only by taking a collected sample, consisting of 10 single samples from different places of the heap or the deposite including all different sizes and colours. (in the approximate ratio of occurrance of such colours and sizes in the heap).

6. Preparation for Analysis

Collected samples of mineral material have to be crushed or ground before analysis or before splitting into part samples. No part must n be retained after crushing or grinding, neither dust nor larger particles.

7. Labelling of Samples

All samples have to be labelled from the beginning and must be marked with the following information:

Name of material (name, origin, designation)
Sample taken on (date)
at (location)
by (name)

(in case) mixture of ... single samples
(in case) part sample no ...

M 2

CERAMIC RESEARCH LABORATORY

LABORATORY METHOD SPECIFICATION NO. 2 ISSUE DATE: 8/84

LOSS ON IGNITION (LoI)

A. General

LoI shows the loss of weight of a dried sample by firing at 950°- 1000°C.

LoI includes : Loss of chemical bonded water
Loss by explusion of CO_2 from carbonates
Loss by combustion of elementary Carbon to CO_2
Loss by combustion of any organic compound to CO_2 and H_2O
(As bituminous components or additives like CMC)

Since some of the carbon, for instance graphite, will not be completely expelled it is essential to work always under the same conditions, i.e. same temperature and same time.

B. Rules for Determination of Loss of Ignition :

1. Dry sample at 110°for at least 3 hours.
2. Cool sample in desiccator.
3. Weigh (porcelain) crucible, preferably an unglazed one (1)
4. Fill 10 - 20 g of sample into the crucible and weigh with an accuracy of 0.001 g (W_1)
5. Anneal crucible with sample for 4 hours at 9/10 temperature in crucible furnace.
6. Cool sample in desiccator.
7. Weigh crucible with annealed sample (W_2) - with an accuracy of 0.001
8. Figure out result:

$$LoI = \frac{W_1 - W_2}{W_1 - W_c} \times 100 = \% \text{ LoI}$$

Annotation

Plaster of Paris $MgSO_4$, $1/2H_2O$ is expected to have LoI of 6.20%

$CaCO_3$ is expected to have a LoI of 43,96%
$MgCO_3$ is expected to have a LoI of 52,19%
Graphite is expected to have a LoI of 100,00%

M 3

CERAMIC RESEARCH LABORATORY

LABORATORY METHOD SPECIFICATION NO. 12 ISSUE DATE: 19/10/84.

Dry Sieving

A. General

1. For quality control sieving is done on the Retsch Vibro with the amplitude 40, for 20 minutes

2. For the evaluation of properties of new materials it should be proved that a higher amplitude and longer time does not change result more than 1% of each fraction. Such increase in the fractions of smaller diameters could take place because of splitting of conglomerates by longer and more vigorous vibration.

3. The following method should be adopted for standard sieving:-

Aperture (mm)	4.000	2.000	1.000	0.500	0.250	0.125	0.063
Corresponding BSS mesh		8	16	30	60	120	240

4. The sieves with aperture 0.710 and 0.045 mm
= 22 350 mesh
are used on special request only.

B. Procedure

1. Inspect and observe that sieve screens are clean and dry. Check from time to time the weight of the sieves.
2. Put 100g of dry sample on the upper sieve.
3. Switch on the Vibro at amplitude 40, for 20 minutes.
4. Weigh the sieves with residue and the pan with the contents.
5. If differences in appearence are observed in the fractions, then keep these fractions for mineralogical (microscopical) investigations, in particular if the fractions have different colours.

C. Result

Use the following form:-

Sieving Report Type of Material ..... Amplitude ..... Vibro -Time .....

Aperture (mm)	4.000	2.000	1.000	0.500	0.250	0.125	0.063
Weight (g) sieve + residue							
Weight of sieve	361.5	331.0	299.0	257.7	237.8	216.4	218.8
Residue (g)							
(% of input)							
Undersize (%)							

Show result graphically on attached graph paper

ANNEX N

CONTACTS to PROSPECTIVE CUSTOMERS and related INSTITUTES

Sri Lanka Standards Institution (to offer CRL services and to harmonize Laboratory Method Specifications of CRL with Sri Lankan Standards)	Dr. N.R. De Silva, Director General Mr. Ranatunga
Geological Survey Department (to offer CRL services and for exchange of experiences)	L.K. Sevirathne, Director O.C. Wickramasinghe, Chief Chemist
Mineral Sands Corporation (to offer CRL service for quality control and supervision of seperation of the Pulmoddai mineral sands)	R.S. Sirisena, Chairman Mr. Thiryakeradjah, Marketing Manager Antony Paul, Chief Chemist, Pulmoddai Dr. Hans Portisch, UNIDO Expert
University of Moratuwa (for general co-operation in particular in research work)	Prof. Ayal De S. Jayatilake Dr. Mohan J. Edirisinghe Mr. Lal Fernado
Hemas (Drugs) Ltd. (to offer supply of laboratory porcelain by CRL)	M.H. Esufally, Director
Ceylon Institute for Scientific and Industrial Research (CISIR) (mutual offer of services)	Mr. Wijeratne, Director P. Prijananda
Lanka Cement Corporation, Puttalam plant (to offer services of CRL for investigations about life span of refractories)	WM M.W. Wickramasinghe CB D.A. Abeygooneratna
State Mining & Mineral Development Corporation (exploration of new deposit of brick & tile clay)	Sumith M. Abeywickrama, Marketing Manager

ANNEX O

CERAMIC RESEARCH LABORATORY

established by
United Nations Industrial Development Organization (UNIDO)
and Ceylon Ceramics Corporation

Piliyandala
25. 6. 1985

Report on Orders received

		1984	1-6 1985
Internal orders for training and research (comparison of methods)	(approx)	50	20
Orders from CCC factories	(approx)	409	417
Orders from customers outside CCC, see below		95	113
Total number of orders		574	550

Customers:

Abhagiriya Project
A.G.A.'s Office Horama
Ceylon Institute of Scientific and Industrial Research (CISIR)
Ceylon Gems
Ceylon Glass Corporation
Cultural Triangle Project
Dankotuwa Parcelain Ltd.
Ellawela Exports Ltd.
Export Development Board
Geological Survey Department
Hemas (Drugs) Ltd.
Industrial Development Board
Institute of Fundamental Studies
Jethawana Project
Lanka Refractories Ltd.
Lanka Porcelain Ltd.
Lanka Wall Tiles Ltd.
Mineral Sands Corporation
Sigiriya Project
Sumagi Tile Industries

and

13 individual persons as independant experts, advisers, dealers

CERAMIC RESEARCH LABORATORY

ANNEX P

established by
United Nations Industrial Development Organization (UNIDO)
and Ceylon Ceramics Corporation

Pillyandala
24. 6. 1985

P R I C E L I S T
of Services

June 1985

C o n t e n t s :

X-ray Fluorescence Spectrometry (XRF)

(of Na, Mg, Al, Si, (P), K, Ca, Ti, (V), (Cr), Mn, Fe, Zr.)

Grinding if particle size is not below 45 µm	200
Sample preparation (Melting with $Li_2B_4O_7$ or $(NaPO_3)_x$)	400
Pressing of disk (for routine test of homogeneous substances only)	100
Charge for each element, qualitative determination only	... x)
quantitative determination (only with similar standards possible)	... x)

X-ray Diffractometry (XRD)

(of crystalline substances and minerals)

Grinding, if particle size is not below 45 µm (if sample can be ground manually - no charge) (for samples with hardness 7 or more - surcharge)	200
Identification of one expected mineral (cut range)	400
Whole range XRD ($\theta = 5^\circ - 140^\circ$) with qualitative search for all minerals involved	800

Differential Thermo Analysis (DTA) & Thermogravimetric Analysis (TGA)

Grinding, if necessary	200
DTA curve (one speed, up & down)	350
DTA and TGA curve (one speed, up & down)	500

Thermal Expansion in Differential Dilatometer

Comparing with laboratory standard or with customers standard

Green curve of raw material or unfired body (including preparation of 25 mm sample)	500
Thermic expansion curve of a 25 mm sample	400
Cutting sample out of larger fired pieces	100
Preparation of fired samples 25 mm long	300
Moisture expansion of 25 mm sample	500

x) to be evaluated after start of work with this equipment

Mineralogical Investigations

Microscopy incl. Scanning Electron Microscope (SEM)

Review of sieve residue as obtained in Phys. Lab.	150	Rs
Size of particles (maximum / minimum) and bubbles	200	
Investigation of minerals in powder (uniform powder oder mixture of how many minerals)	300	
Refractive index of a mineral	200	
Preparation of a polished surface	200	
- " - if imbedding under vacuum is necessary	400	
Preparation of a thin section	200	
- " - if imbedding under vacuum is necessary	400	
Preparation of a sample for SEM	200	
Investigation of surface by microscope	acc. to time spent	
Investigation of surface by SEM	800	
Photographs, first of each	40	
further copies	20	

Other Mineralogical Investigations

Mohs hardness of even surfaces	25	
Mohs hardness of minerals	50	
Bulk density of minerals (mercury method; pieces necess.)	150	
Determination and separation of heavy minerals by heavy fluids	100	

Jodethane	1.935
Bromoform	2.8
Tetrabromethane	2.96
Dijodmethane	3.32

XRD and DTA see page 2

Since most of the investigation have to be adapted to the kind of sample and the kind of customer's question, the above prices can be a directrix only.

Physical Material Testing

Free moisture (sample in an air-tight bag necessary)	100	Rs.
Whiteness (or color) of an even solid surface or powder	80	
if pressing and firing included additional	70	
Bulk density	150	
Specific gravity of water insoluble powder	300	
Sieve analysis dry (4 sieves)	225	
-"- -"- wet (2 sieves)	400	
-"- -"- (1 sieve)	225	
Mineralogical analysis of residue (in Mineral ogical Lab.)	150	
Ceramic check of residue by mixing with white glaze (in Pilot Plant)	150	
Particle size by Andreasen method (63/36/20/11.5/6.3/3.6 um)	1200	
Particle size by sedimentograph (5.0 - 0.1 um)	300	
Air permeability of powders and plaster moulds	500	
Viscosity (single measurement)	150	
Viscosity in dependance of temperature	600	
Viscosity in dependance of additives	600	
Casting rate	600	
Need of water to obtain a certain viscosity	600	
Need of water to obtain in a clay(mixture) a certain viscosity (Pfefferkorn) to be performed in the pilot P	600	
Need of water for pugmill plasticity by Händle extruder	800	
Bending strength of clay (w/d shrinkage included) acc.to BRCA	300	
-"- -"- after firing (d/f shrinkage incl.) acc.BRCA	450	
-"- -"- of 10 green samples	150	
-"- -"- of 10 fired samples	200	
Moisture expansion acc. to BRCA (10 samples 100 mm long)	200	
Water absorption by vacuum (30 torr) (10 samples	150	
by boiling method (10 samples)	200	
Properties of plaster	1200	
Autoclave test (4,2 kp/cm = 0.42 N/mm = 60 psi / 3 h) and close watch of glaze cracks (10 pieces)	200	

Chemical Analysis

of raw materials as explained on page 6.

If customer does not request for less elements or additional elements, the following prices apply:

Kaolin, Ball Clay, unfired bodies	2100 Rs.
Silicates (rocky), Glass	2400
Feldspar	2000
Chrome Ore	2300
Bauxite	2200
Magnesite	1900
Dolomite	900
Limestone, Sea shells	400
Sand, Sea sand, Quartz sand	1700
Sodium Silicate (fluid)	400
Borax (BO_3 and Na and crystal water)	200

All prices include double analysis, at least partly, by different Methods.

If grinding is necessary, there will be a charge of 200 Rs.

Analysis of solutions and soluble compounds are listed on page 7

	Kaolin, Ball clay, unfired bodies	Silicate rock, Glass	Feldspar	Chrome Ore	Magnesite	Dolomite	Bauxite	Limestone, Sea shells	Sodium silicate (fluid)	Sand
Grinding of sample if necessary	-	(200)	(200)	(200)	(200)	(200)	(200)			
Decomposition	1200	1200	1200	1500	1200	200	1500	200		1200
Si	200	200	200	200	200	200	200		200	200
Al	100	100	100	100	100	100	100			
Ti	200	200					200			
Fe	100	100	100	100	100	100	100			100
Mg		100		100	100	100				
Ca		100	100	100	100	100		100		100
Na	100	100	100						100	
K	100	100	100							
other elements		100(Ba)		100 (Cr)						
		100(Mn)								
LoI	100	100	100	100	100	100	100	100	100	100
(without grinding)	2100	2400	2000	2300	1900	900	2200	400	400	1700

Chemical Analysis of Solutions and soluble Substances

pH - value	25	Rs.
Buffer capacity of solution or dispersion (casting slip)	100	
Electrometric titration curve	150	
Acidity, "Normality" (Titration)	50	
Determination of Anions:		
Carbonate, CO_3^{--} by titration	50	
by LoI on dried substance	100	
Chloride, Cl^- by titration	50	
Sulfate, SO_4^{--} by precipitation	150	
Phosphate, PO_4^{---}	250	
Borate, BO_3^{---}	100	
Fluoride, F^- (F_2^{--}) by ion sensitive electrode	200	
Total contents of soluble substances in clay	400	
Identification of soluble substances per cation	100	
per anion as above		
Total contents of solids	100	
Cation exchange capacity of clay	960	
Individual exchangable cations, per cation	100	
Oil absorption of kaolin	100	
Determination of cat-ions in solution		
Sodium, Potassium and Calcium	100	(each)
Lead	120	
Lead release of glaze, per sample	150	

Small Scale Pilot Plant Production

Milling up to 2 kg	100	Rs
40 kg	200	
Filterpressing per kg	5	
Example: 30 kg plastic body for forming: 400 Rs.		
Preparation of granulate for dry pressing, per kg	20	
Example: 10 kg grains for "dust" pressing: 400 Rs.		
Manufacture of master mould from a given model. Price depends on difficulty. So far no other regulations, charge will be per kg plaster	100	
Handforming per kg fired item	100	
Jiggering per kg fired item (including working mould)	80	
Casting per kg fired item (including working mould)	80	
Hydraulic pressing per piece (Ø 5 cm, 4x4 cm, 4x10 cm)	20	
Extrusion without vacuum, per kg	10	
with vacuum	20	
Drying per kg fired items	10	
Glazing per kg glaze (including rfrits and stains)	500	
Biscuit firing below 1200°, per dm^3 (liter) kiln requirement	25	
Glost firing per dm^3 (liter) kiln requirement	25	

Further Services

Evaluation of body composition (water contents and sand) for optimal pugmill plasticity	800
Determination of PFEFFERKORN plasticity	300

Kiln Department

Measuring of temperatures in a factory kiln, per man hour + travelling costs	150 Rs
Orsat analysis of flue gas	200
Calibration of temperature measuring equipment	400
Check of kiln temperatures by seger cones or bullers rings	200
Use of gradient kiln up to 1200°	300
- " - including making samples	500
- " - including measurement of CEC colour shade, LoI, shrinkage and water absorption for each temperature section	900
Use of Super Kanthal Kiln (7.11 kW, 12 dm^3) for firing up to 1200°	200
1400	300
per dm^3 at 1200°	25 Rs
1400°	40 Rs.
Firing in gas kiln (50 dm^3) up to 1200°	750
per dm^3	25 Rs
Firing in large Naber kiln (69 kW, 634 dm^3) 1200°	1200
per dm^3	30 Rs
Determination of Pyrometrical Cone Equivalent (PCE)	800
Autoclave test per filling (to be divided between the amount of samples of different orders) at 3,5 kp/cm^2 (=50 psi) for 2 hours	500
Determination of caloric values of fuel	x)

General Investigation of a Clay

at 8 different temperatures	
Colour, water absorption, shrinkage, loss on ignition	900
Sieve analysis, particle size analysis, bending strength at best temper.	2050
Mineral analysis (DTA, XRD and SEM)	2000
Plasticity (Pfefferkorn)	200
Pugmill plasticity	600

Orders

Orders have to be given with all details of inducement and about the real interest of customer. CRL can only by such information select the most reasonable method for investigation and give the full information. Customer should tell us in the order what kind of information he needs.

Plese take advantage of the fact that we like to discuss your order before and after our analysis. We like to advise you about the easiest way to get your question answered.

Please take into consideration that the selection of samples should be representative. Samples should be collected according to standards.

Samples

Samples should be collected according to standards about sampling. We can send you with our Laboratory Method Specification No 0 the most important rules. Samples have to be signed by a specific number or name and the date of sampling.

Methods

Analytical methods (physical and chemical) are performed according to our Laboratory Method Specifications. If you are interested we can provide you with a copy of specification of the methods used for your order.

Acceptance of Orders

Customer will get an acceptance of order if the order cannot be settled within 2 weeks. Otherweise acceptance of order is sent together with the result.

Reports

The results will be summarized by a report for each order.
For this very essential work we are asking for 100 Rs/order.
If the report includes more than one page we bill 50 Rs/additional page.

Billing

We send the bill after submitting the report by seperate mail.
We are billing in accordance with a price list. If there are asked for very many analysis of same kind, we are ready for negotiation of the fixed prices for such series.

Conditions of Payment

We expect payment by cheque to Ceylon Ceramics Corporation for CRA within 30 days after date of the bill.

ANNEX Q

INVENTORY CRL

Equipment No.:

Room No.:

Name and Address of Supplier :

Name and Address of Manufacturer :

Servicing Company / Agent in Colombo :

Designation of Equipment :

Parts belonging to this Equipment :

Description of Equipment in File ? YES / NO

Instructions for Operation in File ? YES / NO

List of Spare Parts in File ? YES / NO

Year (and month) of Delivery:

Remarks :

Value in foreign currency : . . .

Value in Sri Lankan Ruppees : . . . Rs.

CERAMIC RESEARCH LABORATORY

ANNEX R

established by
United Nations Industrial Development Organization (UNIDO)
and Ceylon Ceramics Corporation

REQUEST for SUPPLY (purchase or repair) Piliyandala

Room No. and responsible Officer (Originator) :

Equipment concerned (no. and designeation)

Recommended Supplier / Workshop

Exact description of Spare Part / Material / Chemical / Function to be repaired

Spare Part No.: Catalogue No.:

Quality :

Size : Price :

For Purpose :

Supplement to stock ? YES / NO

If yes, when the stock is expected to expire :

New Article ? YES / NO

Electrical Equipmenmt ? YES / NO (if yes, order for 220 V)

Gas using equipment ? YES / NO (if yes, order for butane)

Quantity : (do not forget unit !)

Further Remarks :

Date : Signature :

This request has to be given to SRO who informs originator about actions he has taken.

A copy of the request has to be given to Administrative Secretary.

ESTIMATED BUDGET for CRL

At full work with 1 Head of Laboratory, 14 Research Officers, 2 Technical Officers, 2 Administrative Officers, 2 Workmen and 1 Driver

CRL will need the following estimated budget anually.

The money for such budget has to be provided by CCC which also takes advantage of the income of CRL by billing services to others.

Personnel		700,000 Rs.
Purchase		
Raw material, pigments, glazes, plaster, pebbles	50,000	
Chemicals and glassware (20 % of stock 150,000 Rs.)	30,000	
1 Argon-Methane gas cylinder/year	10,000	
Photo material for SEM	15,000	
Recording paper	75,000	
Photocopy paper, Stationary, Printing	25,000	
Sum Purchase	190,000	190,000 Rs.
Energy		
Electrical Current	160,000	
Butane Gas and Oxigen	20,000	
Diesel for Project Vehicle (25,000 miles/year)	25,000	
Sum Energy	205,000	205,000 Rs.
Services of CCC		
Maintenance of building, electrical and water supply)		50,000 Rs.

Service Agreements and Spare Parts

5 % of value of inventory :

31.12.1984 : 13,440,000 Rs.

31.12.1985, when complete 15,000,000 Rs.

750,000 Rs.

Depreciation

So far maintenance and exchange of rotten parts by spare parts is done in time, the equipment is expected to have a life span of 20 years. Therefore, 5 % depreciation is justified.

5 % of inventory value of 15,000,000 Rs.	750,000 Rs.
Total annual Costs of CRL	2,645,000 Rs.

CALCULATION of PRICE of LABORATORY WORK

The CRL has 12 productive working places.
The Head of the CRL, the Senior Research Officer, the designer, the TO of Workshop and the office personnel are regarded as central functions.

The annual working hours of CRL are estimated at		
50 weeks with 35 hours	=	1,750 h
reduction by 20 % leave and illness	=	350 h
effective annual working time at working place	=	1,400 h
i.e. for 12 working places (12 Research Officers)	=	16,800 h

Deviding the annual cost of	2,645,000 Rs
by	16,800 h
the costs per hour are calculated at	= 157.44 Rs/h.

All sections of the CRL have 2 RO in one section.
Consequently, to cover the costs, each section has to earn in average 2 x 35 x 157.44 = approximately 11,000 Rs. each week.

This consideration was base for the evaluation of the prices of all services as shown in Annex P (Price List) :
If in one section the performance of 11 tests (analyses, preparations) is possible for each of the RO, a price of
11,000 : (2x11) = 500 Rs. was calculated.

If the CRL can perform so many orders as possible, all costs including a depreciation of 5 % will be covered. If the capacity is used by 72 % only, no cent can be used for depreciation cash flow.

Attention has to be paid to the development of costs.
In the years 1985 and 1986 perhaps no costs for spare parts will occur. However the budget should nevertheless grant the money for it.