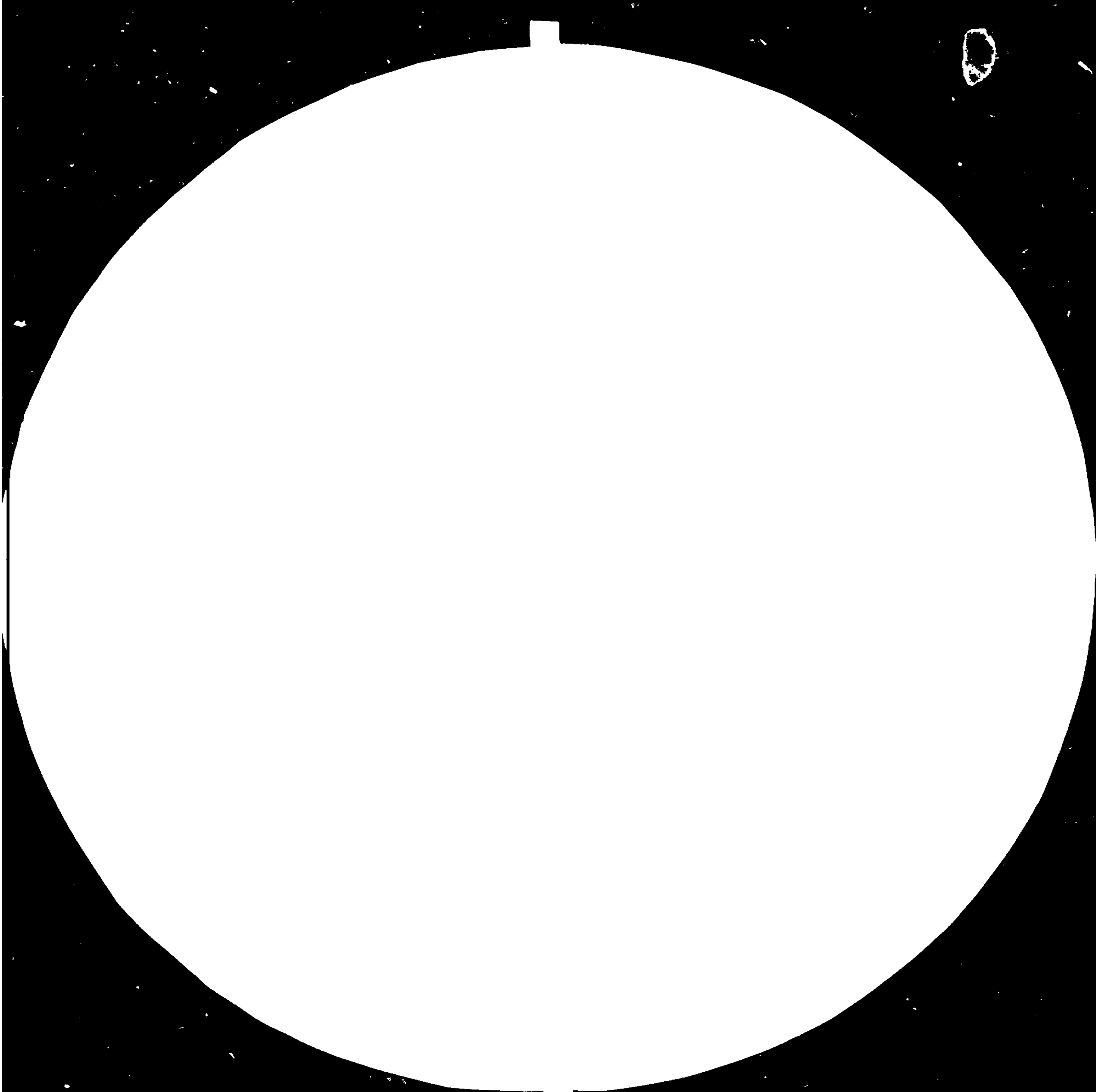
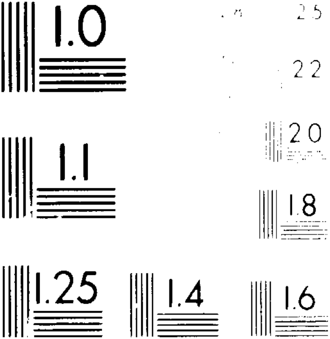
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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ASSISTANCE IN THE DEVELOPMENT
OF CERAMIC INDUSTRY

UC/JAM/83/077

JAMAICA

Technical Report:

Clays of Jamaica and Things Jamaican Ceramic Manufacturing Complex *

Prepared for the Government of Jamaica
by the United Nations Industrial Development Organization,

Based on the work of Jan Knizek
UNIDO Senior Ceramics Consultant

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TABLE OF CONTENTS

SUMMARY OF CONCLUSIONS AND RECOMMENDATION

1. The reserves of light firing clays in Jamaica (2.20.0)
2. Things Jamaican and/or the Ceramic Manufacturing Complex will, in future, produce mainly red-firing bodies (Section 2.20.0)
3. The reserves of clay of Castleton, on which Things Jamaican presently depend, are relatively small but will suffice for some time to meet the requirements of both the above enterprise and the Ceramic Manufacturing Complex.
4. The red clay of the Liguanea formation used by Clays of Jamaica and others will become unavailable possibly within a year (Section 2.30.0)
5. The nearest available substitute for it are the clays from Knollis, Tulloch, and Sydenham. (Section 2.30.0)
6. Since neither the characteristics nor the reserves of these clays are known, these deposits will have to be drilled to ascertain reserve and tested for their brickmaking properties (Section 2.30.0).
7. This will best be done by the Geological survey Department and the Mineral Resources Division's Ceramic Laboratory (Section 2.30.0)
8. A revised Project Document for submission to the E.E.C. Commission has been prepared (Chapter 3.10.0)
9. Based on market estimates (Section 3.21.0., 3.22.0., 3.23.0) equipment specifications were included (Section 3.25.0., 3.30.0., 3.31.0., 3)
10. The additional covered area necessary to accomodate

the new equipment was calculated in Section 3.40.0.

11. The bricks manufactured at Clays of Jamaica will always be face bricks intended for decorative purposes because of the competition of concrete blocks. (In order to compete with it the clay brick would have to sell for less than J$0.20.) (Section 4.10.0)

12. The double-shaft mixer of Clays of Jamaica has to be repaired as soon as possible (Section 4.20.0).

13. Longer-range solutions to this enterprise's problems include:

    - the administration of the enterprise will have to be completely re-organized in the terms of Section 4.30.0.
    - constant equpment maintenance must be available at all times. (Section 4.30.0)
    - a drying shed open to air must be provided to accelerate drying.(Section 4.30.0)
    - the transport to and from sheds should be accomplished by lifters carrying brick-loaded frames.(Section 4.30.0)
    - as soon as possible the brick-making equipment should be complemented by a set of laminating rolls. (Section 4.30.0)

14. The equipment and personnel requirements for the Scientific Research Council's Ceramic laboratory were prepared (Chapter 5.00.0)

15. The qualifications of the R. & D. personnel (Chapter 5.30.0) are of course the maximum recommended and might temporarily be relaxed if sufficiently qualified candidates are not immediately forthcoming. (Section 5.20.0)

16. The specified posts need not be filled all at once and preference will best be given to determinate fields of activities over others as dictated by the needs of the country and its development policy. (Section 5.30.0)

17. It's even feasible that one officer may come to cover more than one field of R. & D. activity in accordance with affinity and volume of work involved in each. (Section 5.30.0)

18. The list of laboratory and pilot plant equipment intends to be inclusive to allow R. & D. work in the field of the most common ceramic products. (Section 5.30.0)

19. Its procurement will best be gradual and perhaps piecemeal, the criterion being the degree of priority given to certain fields over others as dictated by the country's development policy. (Section 5.30.0)

1.00.0 Introduction

The ceramic industry of Jamaica has been receiving special attention of the Government as it has been recognized that it had a potential for growth on a scale commensurate with the size of the country. It is also thought that a properly oriented ceramic industry could contribute considerably to the country's export efforts. Consequently measures are being taken for creating new business options and better employment both for the potters of the island and those workers laboring in the ceramic industries.

In order to assist the national project team in determining the technological and infrastructural requirements with respect to the further development of the ceramic industry in the country the Government of Jamaica requested UNIDO to provide expert. Acceding to this request UNIDO appointed Mr. Ian Knizek, Consultant for the ceramic industry for two months under Job Description UC/JAM/83/077/11-51. His main duties were to be the following:

- Identify the demand and supply situation of ceramic raw materials and set out the necessary measures in order to organize the relevant industries.
- Investigate the export possibilities of other industries in the country which may utilize ceramic products.

- Investigate the technological and economical viability of the establishment of tunnel kiln operation for the production of ceramic containers for the processing industry.
- Investigate the technological requirements of the raw material processing and ceramic products manufacturing industries and identify possible local manufacturing capabilities in Jamaica.

This consultant's frame of reference were further narrowed down by the Scientific Research Council in their letter of May 30 to the Resident Representative of the United Nations Development Programme in Jamaica, in the sense:

- that existing facilities at "Things Jamaican" and "Clays of Jamaica" be assessed with the objective of establishing the ceramic raw materials processing plant at either of these locations to operate as a separate production unit to ongoing production.

In a separate letter to the Consultant of July 11, the Scientific Research Council requested his recommendations

- as to equipment and personnel (qualifications where possible) that would equip the SRC's laboratory and pilot plant to service both the present activities and the potential growth anticipated as Industry develops. The

Consultant was in Jamaica for the first time from June 9 to June 11 and the second time from July 3 to August 15, 1983.

2.00.0 The supply situation of ceramic raw materials in Jamaica

2.10.0 Available Information

A great amount of work on clay appears to have been done, to judge by the available information as may be seen from Annex I. Unfortunately, what these reports lack in precision and trustworthiness is not compensated by the bulk of both published and unpublished reports. The available information is frankly confusing and contradictory and as frequently as not based on dubious hearsay or some older reports themselves of unverifiable trustworthiness. Quite frequently it's not even possible to ascertain from some reports whether the clays under discussion are white, buff or red-firing. One example should be sufficient. In one of the reports (no. 17 in Annex I) "the well known white clay deposit near Castleton" is mentioned. Actually the clay fires to a light brick color.

However, it is not the intention of this consultant to make a critical evaluation of the available literature for which he has neither the time nor the necessary expertise. Nevertheless his experience in the present context indicates the ultimate futility of general clay surveys without any teleological view.

Consequently the present discussions will be confined to the consideration of such clays that might become inportant for Kingston-centered operations, chiefly "Things Jamaican", "Clays of Jamaica" and the planned Central Clay-preparation unit.

2.20.0 White or buff-firing clays

For any operation with the purpose of "Things Jamaican" or for that matter the Central Preparation Plant, the possibility of manufacture of light-colored bodies is of course eminently attractive. Superficially seen such a manufacture might appear viable. Necessarily such light-colored bodies would have to be based on the use of the clays from the Parish of St. Elizabeth which appear to have been intensively studied. The first very optimistic estimates of the available reserves go back to the investigations of the Worcester Royal Porcelain Limited (WRPC) of 1955 of which the reports were unavailable to this consultant. But in an unpublished report to the W.R.P.C., (unavailable to this consultant) Edgar estimated clay reserves at Frenchman at 2½ million tons. Further investigations, conducted in 1959 (no. 7 Annex I), jointly by the Jamaica Industrial Development Corporation and WRPC established the existence

1,144,000 long tons of clay, in four deposits (Bog Walk (2), Holland Estate and Cave Valley).

Fairley and Halden (no. 3 Annex I) who drilled the Frenchman deposit estimated available reserves of clay here as between 40,000 and 60,000 tons. However, Felbier drilling the same deposit in 1976 (no. 10 Annex I) has been unable to confirm Fairley and Halden's estimate and his figure as to available clay only comes to 10,000 tons of refined material. The clay as mined would have to be refined and the available reserve were found to be insufficient to justify the establishment of a refining plant.

Bailey's report of 1970 (no. 4, Annex I) claims 600,000 long tons of white-firing clay for the Hodges deposit. Again, however, Felbier (no. 9 Annex I) drilling this deposit could not even estimate the tonnage of available clay. The clay seem to occur in lenses some of them not being larger than twenty feet in diameter. He recommended that the so-called Hodges clay deposits be"dropped as a major clay supply area for white or buff-firing clays from the records." He says that the Hodges clay could be used on a small scale, such as hobby operators. More or less this is the situation now. The clay as mined is used by some potters (Rene Piscaer in in Port Antonio) and even the Ceramic Laboratory of the Scientific Research Council employs it to produce limited amounts of wall and floor tiles and Insulating firebricks. In view of these results the light-firing clays of St. Elizabeth cannot be considered for use by the proposed Central Clay Preparation Plant nor for that matter by "Things Jamaican" which will require steady supply of clay of uniform quality.

2.30.0 Red-firing clays

The standard red clay in the Kingston area comes from the so-called Liguanea formation. Same is reported to have been used for the last three centuries; the Kingston Penitentiary is built with bricks manufactured from it.

The Liguanea clay is presently used by the "Clays of Jamaica" brick plant and to a much less extent by "Things Jamaican" as well as by independent potters and colleges.

It appears to be an excellent clay. At the "Clays of Jamaica" plant it is used without any preliminary preparation straight as it comes from the pit. This consultant has not seen any cracking in the extruded bricks and it appears to dry without troubles. There is some dryer scumming, however. It has been reported as early as 1974 by W. de Carish, (no. 8 Annex I) that the entire eastern section of the Liguanea area is extensively built up and it is feared that this clay will soon become unavailable. A visit by this consultant to the Harbour View area confirmed this. A further danger in this sense is that in many places the worked face of the clay seam is presently not much over 20 meters from the beginning of the escarpment a point at which it is likely to disappear under over 10 meters of overburden, the removal of which would be uneconomical. W. de Carish (Ref. 8, Annex I) has suggested the area west of Kingston proper and extending towards the southern St. Catherine plain could provide an alternative to the clay in other parts which will soon become unavailable. Additional exploration and testing will be necessary to establish the feasibility of this course of action.

Otherwise the clays of Tulloch, Knollis and Sydenham. These clays are well known at the Ceramic Laboratory of the Scientific Research Council. MacLeod (Ref. 16, Annex I) estimates the reserve of Knollis and Tulloch clays at about 1,000,000 but warns about the danger to an eventual commercialization particularly in the areas outside the Tulloch estate because of their being owned by small holdings and heavily cultivated.

In order to estimate reserves, the above areas have to be drilled and tested. This could be done by the Geological Survey Department. The clays must then be tested for their suitability for brick making. This could and should be done by the Mineral Resources Division of Scientific Research Council. Here the emphasis should be on extrudability and drying behaviour.

The principal clay employed by "Things Jamaican" comes from the Castleton deposit reported to be "the whitest naturally occuring clay so far known in Jamaica." It is also said that it occurs in a small quantity, "the actual area where pure white clay occurs is less than 100 feet by 100 feet and the thickness of deposit does not exceed 4-5 feet." (Ref. 17, Annex I)

This consultant has been able to test this clay in his own laboratory in Mexico prior to the second part of his mission. The obtained results were disappointing. The clay showed a raw modulus of rupture close to 50 kg. per sq. cm which is within the range of Kentucky-Tennessee Ball clays. Drying shrinkage was 4%, water absorption at cone 2 (1125^{0}C, 2057^{0}F) average 9.5% and 1% at cone 8 (1225^{0}C, 2237^{0}F). All this is good but the color was a salmon red at cone 2 and brownish red at cone 8. Furthermore it would not deflocculate with addition of sodium silicate and did so only with a simultaneous introduction of Baryum Carbonate.

The conclusion of the present chapter is that "Things Jamaican will in the future continue using red-firing bodies, not necessarily based on the Castleton clay. As regards the Central Clay Preparation Plant it too will use red-firing clays. In view of the doubtful supply situation of the Liguanea clay, alternate sources of clay will have to be sought.

As the last resource, one would have to fall back on imports, however unappetizing this may sound. It is this consultant's understanding that this possibility has already been entertained. But rather than importing the whole body one would prefer to import only ball clays and feldspar, local silica being then used to complement the body.

The objections against importing are clearly macroeconomic rather than microeconomic. In most ceramic products the raw material represents only a fraction of the total manufacturing cost. On the other hand the advantages arising out of their employment are momentous, and they entirely outweigh all the microeconomic objections. These advantages arise chiefly from the imported ball clays' uniformity and excellent working properties through which losses due to breakage etc., are greatly reduced. There would be one further advantage to "Things Jamaican" and the whole Ceramic Manufacturing Complex. It would enable them to produce white or near white bodies.

In conclusion, the Consultant does not recommend that clays be imported. He mentions this possibility because the present clay-supply situation does not appear to be entirely satisfactory so that a contingent solution is required. Furthermore, the facts about the advantages accruing from their use must be stated.

3.00.0 The Ceramic Manufacturing Complex

Under the Lome I Convention between Jamaica and E.E.C., 1,000,000 E.U.A.'s were earmarked for the handicraft sector from the E.D.F. These funds were never used. After consultations between the National Planning Agency, the Prime Minister's Office & "Things Jamaican" it was proposed that the funds be used for financing, equipping and installing a Ceramic Manufacturing Complex. Several subsequently revised requests to the E.E.C. were made. When the present consultant arrived in Jamaica he, too, was called in to assist in formulating a new request. Since same was to be based on more or less realistic appreciation of the needs, the market etc., this consultant proceeded to gather the available information and evaluate it in order to prepare both his report and the project document. In view of the fact that the Project Document forms part of this report its details will not be repeated in this place. But in order that same be understandable in terms of market, availability of inputs and certain essential technological facts pertinent to the industry and to its sources certain details omitted in the Project Document will be dealt with here. One further thing must, too, be understood. Even though the view with which the Project Document was prepared was the eventual submission to E.E.C. as a request it was quite consciously drawn along the general lines UNDP Project Documents are expected to follow. In the present case, certain of the usual headings, thought to be meaningless to the E.E.C organization were omitted. It has also been thought that should E.E.C or E.D.F. consider it convenient to have a United Nation's specialized Agency like UNIDO implementing the Project, the basis for a formal UNDP Project Document which might then be necessary, would be more easily put together.

In order to prepare equipment specifications which, naturally, must be grounded in the volumes of clay to be handled, dependent in their turn on the output (and sales) of the finished products, both actual and projected, considerable amount of ancillary information was required. In the absence of any market investigation the latter turned out to be a difficult problem involving much guessing and extrapolation, normally not reliable guides.

3.10.0 Requirement of Clay Bodies

The supply situation of claye raw materials was discussed in Section 2.00.0 and reference should be made to it. Nevertheless, in order to size and specify the clay preparation equipment a carefull investigation of the possible demand has to be made.

The demand for prepared clay or clay bodies will come from three different directions:

Things Jamaican

Clays of Jamaica

Independent Pottery shops over the country.

3.11.0 Things Jamaican

As regards "Things Jamaican" its need of clay will arise fundamentally from:

(1) The manufacture of gift items (probably including a line of dinnerware either to be finished at the plant itself or to be sold as bisquit, to independent glazers or decorators.)

(2) The manufacture of containers either decorative decanters for rum or products for packaging and export of jams, honey, spices, etc.

No estimates as to point (1) were available and of those who were interviewed to ascertain future volumes of production no one would risk even a guess. The "Things Jamaican's" Marketing people were in general unenthusiastic as to the possibility of an increase in the size of the ceramic gift line business and would not venture a guess as regards dinnerware. In the absence of a market study, such an attitude is understandable. Therefore the Consultant decided to fall back on the available production and sales records and concentrated on figures for May 1983 and proceed from there by induction. The production figures provided by Douglas Casebeer indicated that deliveries to "Finished goods" in the above target month were approximately 3,500 pieces while production estimated by him stood at 2,000 pieces per week or over 8,500 pieces per month. Sales figures for the month in question provided by the management were 2,500 pieces, and May was considered a "good month". Considering the cautious estimates by all concerned this Consultant's doubling of the present sales figure, i.e. 5,000 pieces per month might be considered safe, at least for the time being.

Next the possible volume of rum bottles that could be manufactured had to be estimated. Here estimates from the industry were more forthcoming. Wray & Nephew, (claiming 90% of the rum market) who have used ceramic bottles before and could therefore be trusted to possess some experience in their use, estimated the market as between 12,000 and 18,000 per year but possibly as much as 36,000. In consultation with the Marketing Department, the Consultant selected the 18,000 figure.

The second manufacturer and exporter (Dr. Ian Sangster) of rum etc., thought that he could use up to 25,000 decanters per year. At the first sight this figure seemed too high but after further consultation it was accepted when it was pointed out that this manufacturer specialized in a gift market for which ceramic decanters were of course ideal. The yearly figure of 43,000 decanters per year was thus arrived at.

Estimating the possible demand for other containers turned out to be more difficult. Again nobody would venture even a guess. It was the opinion of the Marketing Department that provided "Things Jamaican" could manufacture all that was required in the appropriate quality the figure 500,000 to 1,000,000 containers (other than bottles and Decanters) per year did not appear unreasonable.

Now if such figures were to be used for the purpose of preparing a Feasibility or even a pre-feasibility study it would have to be flatly rejected. Using them, however, for calculating required equipment capacities is another matter. Here the principle must be rather to overestimate than underestimate, more so because price differences between identical equipments of different sizes are generally speaking unremarkable and it usually pays to select a larger size. This was especially true in the case of containers, individual weights of which were small. Thus it was calculated for instance that the production of

500,000 containers per year required the processing of 76 tons of clay and that of 1,000,000 of them , 152 tons per year. The higher figure was therefore preferred.

The total clay consumption on which the sizing of the manufacturing equipment was based was calculated using average piece weights obtained in the case of decanters by weighing of representative example and correcting the as-determined weight by applying to it a factor to compensate for the (1) natural moisture of the as-mined clay, (2) its loss on ignition, (3) losses due to spillage, trimming etc. This correction factor amounted to 1.4.

Essentially the same procedure was employed for calculating clay requirements for the production of gift items. The piece-weight was obtained by weighing samples of 61 pieces and averaging the weight. In this case the resulting average turned out to be 1 kg. To this the compensating factor was applied as above. The following table shows the obtained figures:

Output per year	Clay required, Kg	
	Per year	Per day
43,000 decanters	40,248	155
60,000 assorted gift ware	109,200	420
1,000,000 containers	152,000	584
TOTAL Things Jamaican	301,448	1,159

3.12.0 Clays of Jamaica

The estimate as to the consumption of clay for pottery at Clays of Jamaica are based entirely on information provided by the enterprise's manager, Miss Vidal and could not be checked by the consultant. It said to amount to about 100 tons per year. This estimate leaves out the clay required for bricks and other structural clay products. The processes of clay preparation for fine-ceramics are, generally speaking incompatible with those fit for structural clay products. They are generally too expensive for the latter. For best results (unless dry preparation is employed) comminuting equipment must be integrated with the actual making process (as happens for instance with the laminating roller which delivers the clay directly to the pug mill.) This is the process which should (and hopefully will) be used at Clays of Jamaica.

3.13.0 Independent Potters and Colleges

Actually the precision of consumption of independent potters and Colleges is questionable as it has been obtained through interviews conducted by this consultant. But the veracity of the obtained data is impossible to check. So for instance Mico College consumes 1.5 tons per year and Shortwood Teachers' College up to 3,000 kg per year. One informant (Burchell Duhaney) claims that 6 colleges, (excluding Shortwood) consume about as much in an average year as Mico does, i.e. about 1,500 Kg. But Jamaica School of Art uses 40 tons per year. That would make a total for schools and Colleges approximately 50 tons per year.

Estimates for potters are even more at variance. It was not even possible to obtain a more or less dependable estimate of the number of small potteries but the most frequently mentioned number is 100. Estimates as to their consumption vary from a low of 250 Kg. per month (Cecil Baugh) to 1,000 Kg per month for Rene Piscaer. In accordance with the general tenor of the interviews, the non-industrial use of clay (that is excluding Things Jamaican and Clays of Jamaica) was 200 tons per year.

3.14.0 Summary

With the projected consumption for Things Jamaican of roughly 300 tons per year, 100 tons for Clays of Jamaica and 200 for all the remaining consumers, the total comes to 600 tons. In order to be on the sure side this figure has been increased by 50% to take care of the unforeseen consumption. The grand total then comes to 900 tons per year or 3,500 Kg to be processed per day.

3.2o.0 Kiln Space

In order to estimate the required kiln space, the volume occupied by the to-be-fired ware had to be calculated, based on the geometry of the individual pieces. Several factors were then applied to allow for the shrinkage and the necessary separation of the pieces in the process of firing. The results are shown below:

	Kiln Space required, m^3		
Yearly Output	Yearly	Daily (TK)	Daily (SK)
43,000 decanters	309	0.87	1.20
60,000 assorted gift ware	468	1.32	1.80
1,000,000 containers	1,530	4.31	5.90
	2,307	6.50	8.90
Plus 30% allowed for kiln furnitures	2,999	8.60	11.50

Note: TK = Tunnel Kiln operation 355 days per year
SK = Shuttle kiln operation, 260 days per yr.

A minimum size tunnel kiln compatible with firing not over cone 2, this consultant is familiar with, would be 18 meters long delivering on the average 20-21 m^3 of Kiln space at a speed of 2 hours 25 min. per meter. Allowing for kiln furniture such a kiln will deliver 14 - 15 m^3 of disposable firing space. It appears, therefore that for the contemplated output periodic kilns, either of the shuttle or truck type are to be preferred. Especially so because the 1,000,000 containers considered in the above calculation (which are still a somewhat dubious supposition) account for full 66% of the calculated Kiln space requirement. The periodic kiln size that suggest itself here will be about 5 m^3. Two of them are required to fire bisque and gloss respectively.

3.30.0 Description of Processes and Equipment

3.31.0 Body Preparation

As may be seen in Fig. 1, the process consists essentially of proportioning, blunging, mixing, homogenizing, screening, dehydration and pugging. The main pieces of equipment are 1 blunger (Unit No. 15) and a series of storage arks with agitators (Unit Nos. 16, 23).All of them are subterranean and made of concrete. The blunging respectively agitating mechanisms are self-containing and will be mounted on top of the tanks. The weighed clays are dumped into the blunger. Water is metered in to achieve a slurry with a specific gravity of 1.3. Non-plastics (Feldspar & Silica) are weighed and wet-ground in two ball mills (Unit No. 22) situated on eitherside of the blunger. The slurries are discharged by gravity into the respective underground storage arks (Unit No. 23) The concentration of solids in the slurries will be kept constant and proportioning will be by volume using two measuring vessels situated on top of the blunger. (Their size can not be indicated because the proportions of silica and feldspar in the body are not known yet.) The metered slurry drops into the blunger by gravity. No feldspar being available in the country, same will have to be imported in form of a 200 mesh product. Nevertheless a ball mill is being provided anyway just for the case that domestic feldspar-containing volcanics could be used instead of feldspar in red-firing bodies.

When homogeneity of the slurry has been achieved same is first transferred into a storage ark wherefrom it is pumped over a vibro-energy separator (Unit No. 18) for screening through 120 mesh. From the separator the screened slurry is pumped to the further storage arks where it stays until a high pressure diaphragm pump (Unit no. 19) takes it out for dehydration in the filter press (Unit No. 20). The cakes are then fed into the de-airing pug mill and the extruded slugs stored either for use in the factory or delivery to customers.

Casting slip is prepared by blunging and deflocculating in a blunger (Unit No. 24). to obtain a 1.7 spec. gravity casting slip. Same is stored in its own ark with agitation(Unit No. 25).

This is the only storage ark that is not underground. Its bottom will be, in fact at least 1 m above the floor level to enable 200 liter containers to be filled with the slip by gravity for delivery to the casters. To facilitate the transport of the containers they will rest on skids which will be picked-up by hand-pulled lifters and taken wherever necessary. The individual pieces of equipment are shown in the accompanying Project Document.

3.32.0 Frit Department

The Frit ingredients are weighed and mixed. The fritting will be done in a large crucible kiln. Same will be manufactured in the factory by lining with Grade 28 Insulating Firebrick wedges, a 200 liters oil drum (Unit No. 6). It will also be provided with two LP Gas burners entering the kiln space tangentially. The crucibles are filled by the powdered glaze batch and heated until melted. The crucibles are then lifted from the furnace by means of special tongs (Fig. 3), tilted and the content poured into water.

The quenched frit is dried and ground in a ball mill to 200 mesh fineness. It is then ready for use or sale after preliminary checking.

3.40.0 Required Areas

3.41.0 Manufacturing

The ceramic activities at Things Jamaican occupy presently roughly 550 m^3, excluding the plaster shop and the clay preparation area. At the present the available area is not well used. Furthermore additional working space could be gained by moving the kilns to a more convenient place. Still the large increase in the contemplated manufacture will require the addition of 600 m^2 to the present production area.

3.42.0 Clay and Body Preparation

The Clay and Body preparation unit as outlined in Section 3.30.0 and in Figures 1 and 2 requires approximately 350 m^2. Fifty more square meters are needed for raw clay storage.

3.43.0 Recapitulation

All in all the following areas are required for the Ceramic Manufacturing Complex:

Addition to the present manufacturing area	600 m^2
Kiln and Fritting area	200 m^2
Testing and Development Laboratory	100 m^2
Clay & body preparation (with day storage	400 m^2
TOTAL	1,300 m^2

Fortunately over 1,800 square meters of land are available at the site of Things Jamaican.

4.00.0 Clays of Jamaica

This enterprise manufactures a line of attractive pottery in addition to bricks and some roofing and floor tiles. Sponsored by the British Executive Service Overseas, acting on behalf of the Scientific Research Council of Jamaica, one J. P. Clift inspected the plant in December 1979. Same was then owned by Mr. W. Aiken (Ref. 20, Annex IO.) According to his report, the factory has at no time produced any product in reasonably large quantities, having specialized in making items asked for by the customer. The mixer and extruder was then reported to be 6 years old. The original supplier, Bradley & Craven gave the output of this equipment as 5.25 tons per hour or 50,000 solid bricks 9" x 4½" x 2½", per 40 hour week. This estimate sounds low. J. P. Clift observes that the profit record in recent years did not appear to be good. He also reported that the Works has a large financial commitment to the bank(s) which was causing some embarassment.

Nevertheless, just about the same year (the Project Appraisal is undated) J. N. Clift as a conclusion of a well-documented Feasibility study (Ref. 27, Annex I), proposed to the board of J.D.B., to approve the sum of $364,132 for investment in the Aiken enterprise. The date of the acquisition of Aiken's Clay Works by the Government is not known to this consultant.

It appears, however, that the factory, now renamed Clays of Jamaica has not been doing particularly well. Its problems have been investigated twice as far as this consultant is aware, first by H. Piper from S.R.C. (15) and then by Leonard Gillen (16) Annex I.

4.10.0 The Brick Market

In any developing country the feasibility and prospects of a brick making operation may be usually quite quickly gauged by the price/volume ratio of sand-cement or concrete blocks (if manufactured in the country) and fired clay bricks. In and around Kingston this ratio is 1:4 meaning that the clay brick is on a volumetric basis approximately four times more expensive than cement blocks.

Consequently, the bricks manufactured by Clays of Jamaica can not be a masonry brick. It will always be a face brick used for decoration for the higher class market. There will, consequently, always be a market for the products of Clays of Jamaica, the size of which cannot, however be estimated without some further investigation. The enterprise's manager estimates the market at 200,000 per month but this estimate is nothing more than a guess, probably based on the present backlog of orders and reactions of customers that are not being supplied regularly.

The present consultant visited Clays of Jamaica several times. By the time of his first visit, the hammer mill and the ball mill were standing idle and the double-shaft pug mill-extruder combination was operating at a rate of 4 thousand bricks per day. That is less than half of what it should have been according to Bradley & Craven. The reason was that the pug mill was being operated as an intermittent piece of equipment. That is, it was filled with clay while at stillstand, then it was started and operated until empty. Then it was stopped again, filled with clay etc. Inquiries as to the reason of proceeding in this unusual fashion brought the answer that in continuous operation the pug mill stops. This did not make much sense. Nevertheless it seemed that there would have to be something wrong with the drive mechanism.

4.20.0 Short Term Approach

Now a pug mill is not a very sophisticated piece of equipment. Though specialized in its application, it is composed apart from such *sui generis* parts as knives of rather simple elements as shafts, pillow boxes, bearings, cog-wheels, clutch, pulleys or speed reducer that are well known to every mechanical engineer or even master mechanic. It seemed to the consultant that the best way to proceed would be to take apart the pug mill, check every one of its elements in order to trace the source of the trouble and replace those that were worn out or otherwise damaged. If the pug mill could be thus overhauled and the production of bricks restored to its normal level, the added revenue would contribute considerably toward improving the cashflow of the enterprise.

The consultant presented this proposition to Dr. Hamilton, Executive Director of the Scientific Research Council. As a result of this the Community Economic Organization which administers the plant on behalf of the Ministry of Youth and Community Development agreed to cover the cost of the preliminary operation, i.e. expert examination of the equipment but asked for an estimate.

At the writing, this has not been submitted yet but S.R.C.'s engineers were working on it.

The rest of the idling equipment would then be overhauled piecemeal. It has been established that the ball mill and pulverizer were not used for the manufacture of bricks being apparently unnecessary for the operation of the extrusion equipment, but only to provide clay for pottery. The clay required for it was at the present prepared by sieving of the as-mined clay, a much more labor-intensive operation than simple grinding. Consequently the artware department has been operating on the basis of an out put of 2000kg per month whereas three times that amount could allegedly be disposed of.

It must be observed in this context that slotted ball mills and in fact no ball mill is suited for grinding raw clay as due to its inherent plasticity it tends to pack hard on the bars and blinds the slots. Nevertheless until foreign exchange becomes available, all the available equipment will have to do.

It will be appreciated that the proposed course of action constitutes what may be termed a short-range approach to some of the enterprise's problems.

4.30.0 Longer Term Approach

A longer term approach would mean in the first place a complete reorganization of the enterprise on strict business lines. An administration headed by a competent manager and supervised by a Board of Directors must be set up.

While details of such an organization are outside of this consultant's frame of reference it must be stressed that there must be at least two production supervisors, one for the pottery production and another for Building materials. And what is more important, there should be a maintenance engineer. Alternatively the enterprise might contract its maintenance to an outside organization or engineer bound to it contractually and obliging it or him to take over the responsibility for the maintenance of the equipment.

4.31.0 <u>Further Improvements</u>

At the present, bricks are dried in an enclosed space with little or no air movement, which, however, is essential for drying. It is recommended that outside sheds be built to house and protect the brick during drying. These sheds must have a concrete floor. The bricks from the extruder would be set on frames as is being done at the present, but they will be picked-up and carried to the sheds by hand-operated lifters, a quite inexpensive piece of equipment.

Apart from natural deterioration through overuse, there is nothing basically wrong with the kilns now in use. Up-draft brick kilns are used all over the developing countries and are just about the cheapest kind of kilns. One might, of course, prefer a rectangular up-draft kiln which facilitates setting or perhaps even go over to a modified scove kiln which is not a permanent structure as it has no walls except a thin shell to cover the to-be fired bricks erected ad hoc for every firing.

The next step toward a more sophisticated kiln would be a moving-fire continuous kiln of the Hofmann type which while saving fuel requires an investment of considerable magnitude, geared, too, as it is to high outputs;there is some question whether the available market for bricks would justify the construction of such a kiln.

As soon as the foreign exchange situation allows it and provided that the enterprise's sales improve, the available brick making equipment should be complemented by a set of laminating rolls which would facilitate clay preparation. Same would be set above the receiving end of the present belt-conveyor. Its feeding will be facilitated by an inclined slat-conveyor in turn charged manually by shovelling.

4.32.0 The Clay Supply

In view of the precarious situation of the Liguanea clay deposit (as discussed in 2.30.0) a long range solution to assure clay supply must be found. The problem should, however, be solved in the context of the Ceramic Manufacturing Complex. This complex will mine the clay for "Clays of Jamaica's" brick making making operation and will test it but will not further process it. It is important that the property rights to any clay land be vested in the Government which will grant the Ceramic Manufacturing Complex exploitation rights to the underlaying clay.

5.00.0 Ceramic Research and Development Activities of the Scientific Research Council

5.10.0 Definition of Terms

Before approaching the problems of equipping and staffing a Ceramic Research and Development Laboratory, a clarification and definition of some key terms is required. It is the conviction of this consultant that Developing countries should not engage in research for research's sake. Therefore the very term Research and Development is in a sense a misnomer because the basic aims should always be development. And research activities should be confined to providing the information required for efficient products development. It is with the above qualification in mind that the proposals that follow are formulated.

The present laboratory of the Mineral Resources Division at the Scientific Research Council possesses a certain amount of equipment for both Research and Development. Most of it is, however, out of order, so that either repairs or replacement are necessary. The list of recommended equipment that follows has been compiled without considering what is actually available. It is, furthermore, sometimes difficult to distinguish clearly between Research and Development equipment and tools. There is, then, rather a continum. A PCE furnace is, for instance, a good example. It provides, first of all the information necessary for the selection of certain clays to develop a certain product. But same is also necessary to test the development product.

5.20.0 Personnel Requirement

1 Director of Research and Development

Qualification: Doctorate in Chemistry, Physics or Physical Chemistry.

Duties: In close collaboration with the Executive Director of the Scientific Research Council, the Director of R. & D. initiates, inspires, directs, supervises all R. & D. projects. He reports directly to the Executive Director to whom he is responsible.

1 Research and Development Officer for fine Ceramic Products.

Qualifications: Ceramic or Chemical Engineering degree with experience in the manufacture of fine ceramic products.

Duties: In close collaboration with the R. & D. Director, engages in R. & D. activities as required. He is directly responsible to the R.D. Director to whom he reports and advises.

1 Research & Development officer for refractories.

Qualification: Degree in Ceramic or chemical engineering with practical experience in the field.

Duties: In close collaboration with the R. & D. Director, engages in R. & D. activities in his sector as required. He is directly responsible to the R. & D. Director to whom he reports and whom he backstops.

1 Research & Development Officer for Structural Clay Products.

Qualifications: Degree in Ceramic Engineering with practical experience in the field of structural clay products or Refractories.

Duties: In close collaboration with the R. & D. Director, engages in R. & D. activities in his sector. He is directly responsible to the R. & D. Director to whom he reports and whom he backstops.

1 Mineralogy & Geology Officer

Qualifications: A University degree in Geology or Mineralogy.

Duties: In close collaboration with the R. & D. Director he advises and backstops the R. & D. development Officers in the field of raw materials and final products constitution. He examines under petrographics microscope powder preparation and thin sections of the materials submitted to him by the officer and advises them on matters of geology related to raw materials.

1 Frit and Glaze Development Officer.

Qualifications: A university degree in chemistry or ceramics. Some practical experience in glazes or the manufacture of fine ceramic products desirable.

Duties: In close collaboration with the R. & D. Director engages in R. & D. activities in his sector. He also collaborates with the Officer in charge of fine ceramic products to supply his needs. Otherwise he is responsible to the R. & D. Director to whom he reports and assists.

The above specifications of personnel to operate the R. & D. ceramic laboratory comprise personnel necessary to cover most ceramic activities that might become interesting for a developing country. Some positions might be suppressed should the activity in question be considered unimportant or two sectors might be covered by a single officer, like structural clay products and refractories for instance. Sometimes even the position of Director of Research and Development may be left unoccupied because some Executive Directors prefer to act as their own Directors of R. & D.

The qualifications, too, might become a problem of sorts. As regards the academic qualifications, the requirements reflect the normal usage and the Government might opt for relaxing them occassionally and temporarily. As to the requirement of practical experience, this, too might be difficult to come by in Jamaica. The only solution to this problem will be fellowships abroad. To be effective they must be sufficiently long and one year is considered a minimum. British Ceramic Research Association of Stoke-on-Trent probably offers the best conditions for a successful specialization in all the fields considered.

5.30.0 Research and Development Equipment

1 Electric Laboratory Centrifuge, speed range 0 - 600 RPM

1 pH - meter, ranges 0 - 700 m V. Accuracy: pH better than 0.02 or better than 1 mV

3 Sets Hydrometers acc. to ASTM D - 422

1 Binocular Magnifying Glass, magnification 30x, 60x, 100x.

1 Sample divider for particles up to 10 mm with 3 collecting bins

1 Hydraulic Press, Laboratory model 20 tons, hand-operated with double action hydraulic pump and pressure gauge. Max. distance between plattens 230 mm. max. passage between columns 220 mm.

1 High speed Blunger 15 - 20 gal. with motor and accessories.

1 Filter press, Lab. type, with diaphragm pump, 15 x 15 cm frames.

3 Spray guns, with abrasion resistant nozzles and hoses.

1 PCE Furnace, gas fired. Either Bickley Model BV or American Refractories Institute type.

1 Thin Section Preparation Equipment.

1 Grinding & Polishing machine for thin sections

1 Universal Cutting Saw

1 Leeds & Northrup Potentiometer

(for calibrating thermo couples.
0.3^0C precision.

1 RVF Model Synchro-lectic
Viscometer with complete range of
spindles. Brookfield.

1 Gallen Kamp Torsional Viscometer
modified for thixothropy determinations

4 Sets of torsion wires for the above

1 Moisture Expansion Apparatus
BCRA Model.

1 Tyler Sieving Machine
with 200mm diam. sieve
mesh 3, 4, 6, 8, 10, 12, 14, 16, 20, 25,
30, 35, 40, 50, 60, 80, 100, 200.

2 Shrinkage-measuring gauges

2 Glaze thickness measuring micrometers (Malkin)

1 Orsat apparatus for CO, CO_2, H_2, N_2, O_2.

1 Crucible furnace, gas fired up to 1300^0C
(for experimental frit melting).

1 Drying oven, about 50x50x50 cm range 40 -250^0C,
automatic temp. control, precision 1^0C,
Temp. selector.

2 Thermostats for control of water temperature
range 18 - 25^0C

1 Multiple-sample thermal Grandient furnace from
Kilns & Furnaces Ltd. Stoke-on-Trent.
Range up to 1250^0C.

1 Multiple-jar laboratory Mill for nine units, motor driven.

9 Porcelain jars, 1 lt. capacity with balls or pebbles.

2 Double-jar lab. mills for 4 liter jars.

2 Porcelain jars, 4 liters capacity with balls or pebbles.

1 Laboratory balance, OHAUS, 2 kg capacity 0.1 g precision.

1 Precision Optical Pyrometer disappearing filament type, battery operated. Leeds & Northrup.

4 Pt & Rh Thermocouple complete with protecting tube. 18" long.

1 4 points recording potenhometer

1 Super-Kanthal Electric Kiln with program controller, chamber size 350 x 350 x 700 mm up to 1600^{0}C.

1 Large size Electric Kiln, effective chamber size 850x1090x970 mm up to 1300^{0}C including switching and regulating equipment.

1 Laboratory Balance, top loading, single pan, capacity 8 Kg. accuracy 0.19

1 Permeability Meter, BCRA TYPE - Malkin.

1 Universal Testing Machine for fired

materials.

1 Vacuum pump, up to 10^{-5}cm Hg
Sliding - Vane Rotary type

1 Green Strength testing machine

2 Andreasen - Pipettes

1 Autoclave (for crazing tests)
with gas burner, pressure gauge 0-25 Kg/sq.cm.
and safety valve.

1 Simultaneous Thermal analyzer 25^0C - 1300^0C
for weight loss and differential temperature recording apparatus

1 Thermal Expansion App.
20^0 - 1000^0C BCRA or Orton type.

1 Adiabatic Bomb Calorimeter for solid and liquid fuels; Calorimeter Combustion Bomb.

1 Apparatus for thermal conductivity.

1 Whiteness Reflectometer for measuring luminous reflectance of white and near-white materials.

1 Hunter Multipurpose color-measuring apparatus.

1 Polarizing Petrographic Microscope, Leitz.

1 Set of refractive Index liquids

5.40.0 <u>The Pilot Plant</u>

5.41.0 <u>Preliminary Considerations</u>

Pilot plants are best assembled ad hoc, i.e. for pilot scale testing of a determined product.

What must be taken into consideration is that some ceramic products are unamenable to be produced under pilot plant conditions. A good example here are large size hollow clay tiles which require production-size extruders.

On the other hand, refractories, wall tiles, dinnerware are relatively easy to produce on a pilot plant scale even though the results are sometimes difficult to extrapolate to full factory conditions. The proposed pilot plant equipment will include facilities for grinding and sizing raw materials either to the size required for both fine ceramic goods as earthenware, vitreous china, stoneware and rather coarse-grained products like refractories or structural building materials. There are then being provided ample facilities for comminution, sizing, mixing and shaping, as well as for drying and firing.

5.42.0 <u>Pilot Plant Equipment</u>

1 Jaw crusher 2" x 4".

1 Bottom discharge
grinding pan, 5 ft. size

1 Hammer mill with air-separator and
collector of fines.

2 Porcelain-lined Ball-mills
48" x 48" with balls.

2 Porcelain-lined Ball mills
60"x 60" with balls

1 Multiple jars mill assembly for
6 - 1 qt. jars.

1 Multiple jars mill assembly for
6 - 1 gal. jars.

2 Vibro-energy separators
2 ft. diam.

1 Filterpress, pilot plant size
22" x 22" cakes with ram pump
100 p.s.i.

2 Jiggering and batting machine.

1 Friction tile press, 100 tons cap.

1 Hydraulic press for 1 cavity
9" x 4½" mold and 200 tons pressure

1 4 Cu. meters dryer with humidity
control

1 2 cu. meters LP gas fired Kiln
up to 1350^{0}C

1 0.5 cu. meter LP gas fired Kiln
up to 1600^{0}C

1 Fritting kiln for 5Kg. crucibles.

1 Fritting kiln for 4-50 g. crucibles.

1 Muller-mixer (Simpson or Clearfield)
4 ft. diameter size.

1 Blunger-dissolver - mixer
1.5 m diameter x 1.8 m high, 600RPM

2 Storage arks 1.5 m diam. x 1.8 m high,

with agitator 120 RPM

1 Scale, 500 Kg capacity.

2 Diaphragm pumps, compressed air operated, capacity 40 m^3 per hour.

1 Variable speed agitator for bench operation, 0.75 HP.

1 Roll-crusher, 10 cm diam. rolls x 80 cm long.

4 Spray guns with connectors, material and air hoses.

2 Pressure tanks with air-motor agitator, air pressure controller for glaze slip. 2 gal. cap.

6.00.0 Other Ceramic Products

Among the remaining ceramic products, three might, in due course acquire some importance. They will be mentioned here briefly because the Scientific Research Council has expressed some interest in them. At present their economic importance seems to be slight even though need for them might from time be acutely felt.

6.10.0 Refractories

There is no question but that for instance boiler installations such as are used in the sugar industry require firebricks. Refractory Insulating Firebrick of sort are sporadically produced by the Mineral Resources Division of the Scientific Research Council. The Hodges clay is the only one used and saw dust is added to produce a light-weight brick by extrusion. The extruded and cut-off bricks are fired at a relatively low temperature and sold unsized. Thus this manufacture satisfies a certain need.

It seems that the clay from Job's Hill, identified as Dickite (Ref. 4 Annex I) might offer better possiblities as refractory raw material. Its high bulk density indicates that it would produce a low-porosity body at normal firing temperatures of cone 13 - 14 or $1350^0 - 1390^0$C($2462^0 - 2534^0$F) a very desirable property in refractories. It could most probably also be used without pre-firing (the way some Flint clays are used)

The only problem will be the plastic clay that would have to be used as bond. Because the only plastic clay presently available is the one from Hodges. Its high free silica content might impart the final product certain undesirable properties.

Furthermore, the deposit cannot be large. Being most probably of hydrothermal origin it would be expected to be deep rather than superficially extensive. The clay will probably have an Al_2O_3 content over 40% and exhibit a Pyrometric Cone Equivalent of 34 - 35, i.e. $1760^0 - 1785^0$C ($3200^0 - 3245^0$F), both valuable refractory properties.

6.20.0 Electrical Porcelain

High-tension electrical porcelain is unlikely to be manufactured in Jamaica in a more or less near future. The unique electrical properties and close size tolerances required of it makes it necessary that it be manufactured in rather large amounts and in technically quite sophisticated factories. It is not believed that Jamaica's consumption would justify the required investment.

Nor is there at present much of a raw material basis. The only clay that could be considered here is Hodges, of which, as has been mentioned in 2.20.0 not enough is available. Furthermore potassium feldspar required to bring about vitrification is not available in Jamaica. Another problem arising from the use of Hodges-type clays is that in view of their over-high quartz content, very high proportions of feldspar will have to be added to accomplish vitrification. In fact these additions might become so high that the workability of the body would be seriously impaired thus making the introduction of a ball clay (at present unavailable in Jamaica) imperative.

The manufacture of low tension electrical porcelain appears to be more viable. It is certainly possible to manufacture it on a comparatively limited size by jiggering or dry-pressing. Of course the indispensable use of Hodges-type clay is open to the same limitations as discussed in the context of high-tension insulators, namely the danger of a reduced workability due to possibly excessive additions of feldspar.

6.30.0 Sanitary Ware

These products, too, can be produced on a reduced scale. Nevertheless the manufacture offers many problems. To begin with the preparation of mold requires both constant quality plaster and high expertise. Secondly, close control and maintenance of certain rheological characteristics of the casting slip, i.e. viscosity, thixotropy and filterability are indispensable. They can only be obtained through the use of constant, uniform raw materials and much experience. Otherwise losses mount and the venture becomes unprofitable. Hodges-type clay are therefore precluded here and all the ingredients except silica will have to be imported.

ANNEX I

LISTING OF CONSULTED DOCUMENTS AND REPORTS

1. Anon., Report on Reserves of Pottery Clays in in Jamaica, W.I. Jamaica Industrial Development Corporation, October 26, 1959

2. Freeman, T. L., Report on a visit to Jamaica 8th May to 20th May 1967. Ministry of Technology, Building Research Station, Note No. 10, I. C. 15/67

3. Fairley, E. P. and Halden, F. A., Exploitation of Jamaican Clay Resources (Frenchman's Ball Clay) Stanford Research Institute, August 1969.

4. Bailey, B. V., Jamaican Economic Geology Report No. 3, Geological Survey Department, January 1970

5. Holdridge, D. A., Summary of Work on Clays and ancillary Ceramic Materials, 1968 - 1977. Interim Report No. I - 71 - 2, Projects 1002, 1009, 1018, with Appendices:

   5. 1. Thomson, B. E., Mineralogy of Jamaican Clays

   5. 2. Taylor, W. A., Holland Clay Deposits.

   5. 3. Machin, R. J., A feasibility

study into the Production of Wall Tiles.

5. 4. Machin, R. J., Production of Ceramic Floor Tiles.

6. Holdridge, D. A. The Development of Ceramic Wares from Jamaican Raw Materials. The Journal of the Scientific Research Council of Jamaica 3 (1) 1 -18 (1972)

7. Chong, C. M. and Thompson, B. E. Mineralogy of Jamaican Clays; A Report on the Investigation of Hodges Clay. Final Report No. F. 73 - 3, Project No. 1002, October, 1973.

8. De Carish, W. Jamaican Clays: A Review

9. Felbier, H. G. Exploitation of Jamaican Clay Deposits; Hodges Deposit; Parish of St. Elizabeth (1975)

10. Felbier, H. G. Exploitation of Jamaican Clay Deposits; Frenchman Deposit, Parish of St. Elizabeth (1976)

11. Felbier, H. G. , Aspects on the fine Ceramic Industry based on local Raw Materials, April 12, 1976.

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13.	Clift, J.P. & E.M.,	Study and Report on the Clay Industry in Jamaica, November/ December, 1969
14.	MacLeod, D.	The Economically Important Clays of Jamaica, August 19, 1982
15.	Piper, H.	Preliminary Report - Inspection of Facility at Clays of Jamaica, January 24, 1983.
16.	Gillen, L.	Mission Report "Clays of Jamaica" March 1983
17.	Anon.,	The Clay Resources of Jamaica; A Preliminary Survey (Undated)
18.	Anon.,	The Clay Resources of Jamaica (Undated)
19.	Anon.,	Tableware Production , Scientific Research Council (Undated)
20.	Clift, J.P. & E.M.,	Study and Report on the Clay Industry in Jamaica, British Executive Service Overseas (1979)
21	Anon.,	Project Appraisal (of the Aiken's Clay Works) (Undated).

ANNEX II

CONTACTS AND INTERVIEWEES

Hon. Errol Anderson,	Minister of Youth and Community Development
M. O. Hamilton, Ph.D.,	Executive Director, Scientific Research Council, Kingston, Jamaica
John A. Wright, Ph.D.,	Director, Scientific Research Council, Kingston, Jamaica
Dr. Roger Booth,	Delegate, Delegation of the Commission of the European Communities, Kingston, Jamaica
David G. Tipping,	Economic Adviser, Delegation of the Commission of the European Communities, Kingston, Jamaica
David E. F. Smith,	Plant & Production Manager, Wray & Nephew Group Limited, Kingston, Jamaica
Dr. Ian Sangster,	Dr. Ian Sangster & Co., Kingston, Jamaica.
Keith Gilfillian,	Director, Building Research Institute, Kingston, Jamaica
Cecil Baugh,	Artist Ceramist, 17 Leitrim Ave., Kingston 3, Jamaica
Dr. A. W. Sangster,	Principal, College of Arts, Science & Technology, Kingston, Jamaica.
George A. Roper,	Head, Science Department, College of Arts, Science & Technology, Kingston, Jamaica

FIGURE I

CLAY PREPARATION FLOW SHEET

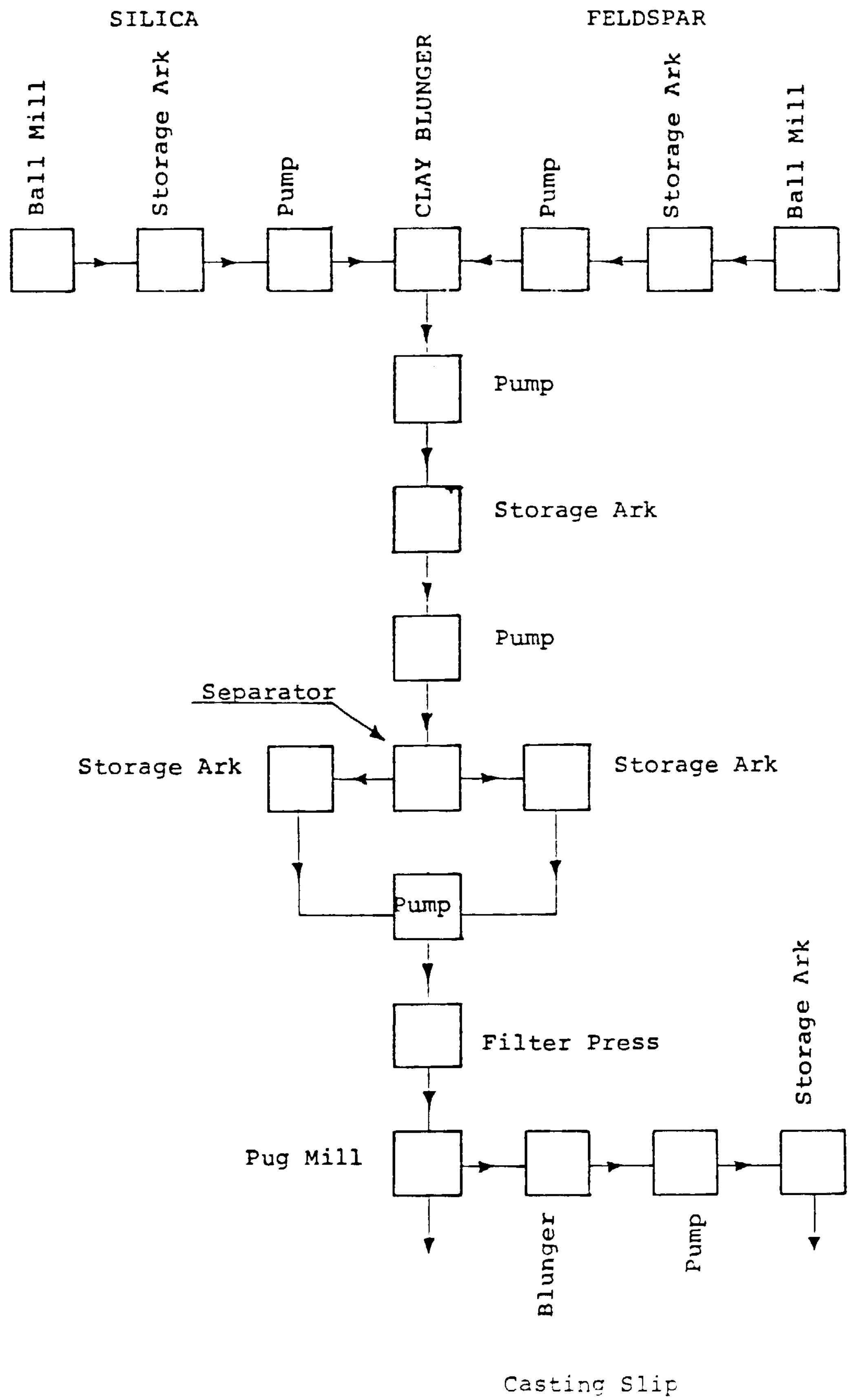
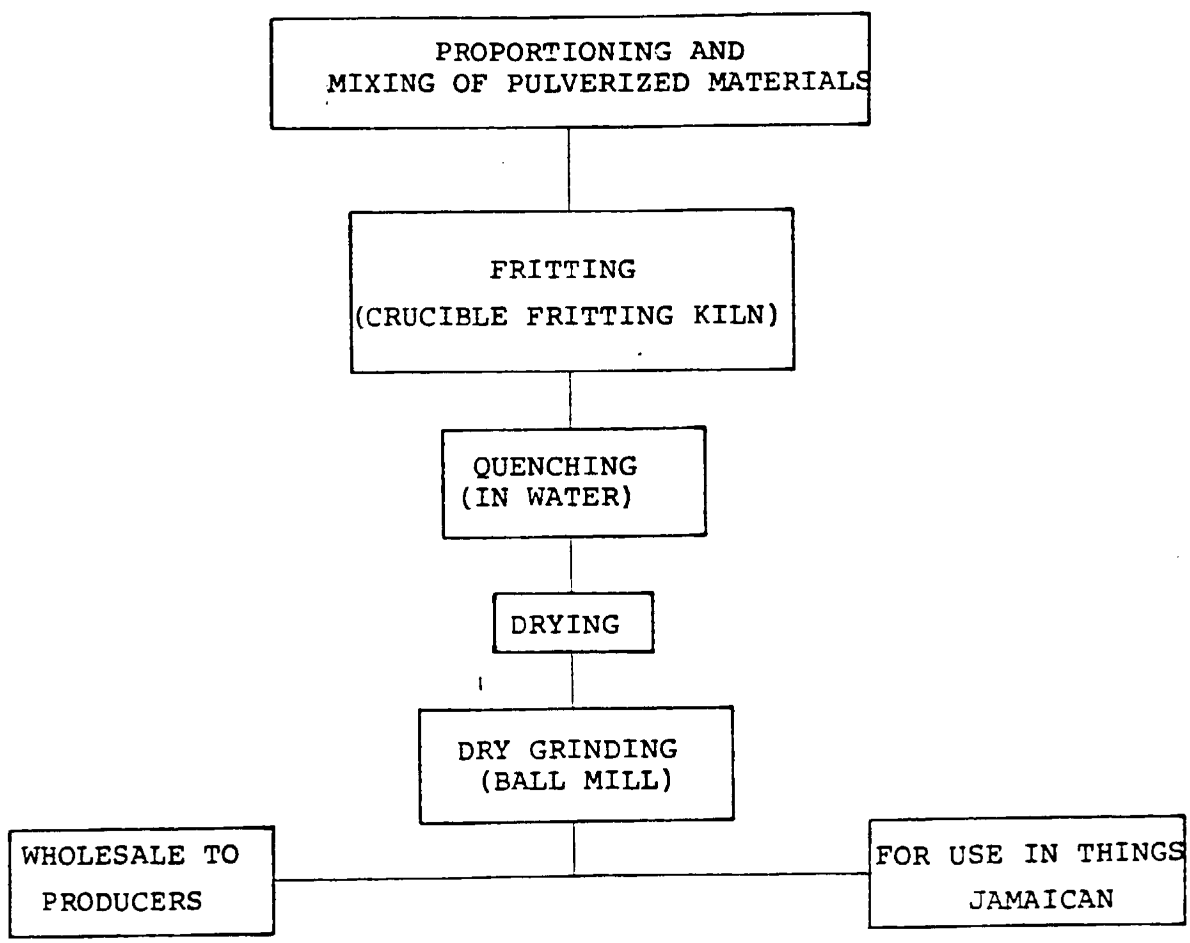


FIGURE 2

FLOW SHEET OF THE FRITTING OPERATION



THE CERAMIC MANUFACTURING COMPLEX

PROJECT DOCUMENT

DEVELOPMENT OBJECTIVES

The Project will

- strengthen the economy of the country by enabling it to make efficient use of its natural resources such as clay.
- create new business options in the ceramic industry.
- improve employment conditions for both the potters of the island and workers laboring in the ceramic industries.
- enhance earning of foreign exchange through the promotion of exports either direct or indirect.
- improve the condition of the ceramic craft sector by enhancing skills.

IMMEDIATE OBJECTIVES

- mine and test clays suitable for the ceramic trade.
- manufacture uniform ceramic bodies and supply them to Things Jamaican, Clays of Jamaica, Ceramic Schools and Colleges, and independent potters over the island.
- manufacture frits, glazes and colors required for the ceramic industry.
- develop or design new products and improve the quality and aesthetic appeal of the presently manufactured ones.
- qualify the technical staff necessary to carry on the work at the two industries, i.e. Things Jamaican and Clays of Jamaica.
- train potters for establishment in economically depressed regions of the island.

BACKGROUND AND JUSTIFICATION

Since 1960 the Government of the Prime Minister, Hon. Edward Seaga, has been promoting the handicraft activity mainly through Things Jamaican which having been established in the mid - 1960, developed into a large handicraft complex which manufactured and marketed among 10 handicraft products such as wood, weaving, embroidery, alabaster, leather, pewter, straw etc., and also ceramics in the form of hollow-ware, statuary, cast ware, hand-thrown ware, earthenware and stoneware.

Clays of Jamaica, the second ceramic enterprise in the country has been in operation for many years. It produces a line of attractive and highly appreciated pottery (in addition to bricks and tiles an activity which does not concern the trend of the present presentation). Though then, also being active in the craft-production field, Clays of Jamaica does not compete with Things Jamaican. Rather their activities complement each other the first mentioned enterprise specializing in the production of larger-size unglazed or slip-decorated terra cotta ware whereas the other producing generally smaller and glazed products.

Clays of Jamaica is, too, hampered by shortage of prepared clay. It is being presently estimated that it could produce and sell three times as much than is being turned out now.

During the mid - 1970's, Things Jamaican went into decline. With the new Government administration in 1981 things began to change and the role of Things Jamaican for job creation and product development for tourism and export, indigenous talent, skill, manpower and basic materials for craft industrial ceramic activities on a national level was once more recognized.

The Government has early realized that a certain pattern began to emerge in the craft sector and that one sector has been increasingly domirant and continues to enlarge in both the private and public sector. This is the sector of Ceramics. This area utilizes a great percentage of ready available materials in Jamaica such as clays and an increasing work force. The Government of Jamaica also realized that the handicraft ceramic industry was not developing in accordance with its potential. This was due to several important factors, which boil down to the lack of several essential imputs. So "Things Jamaican", finding itself unable to process the required amount of clay was forced to refuse substantial orders for ceramic rum gift decanters for the country's main distilleries. Nor was the enterprise able to enter the field of packaging for luxury and food lines, coffee and others. All these articles indirectly foster valuable exports.

In the very important field of independent potters and ceramic goods outlets, the situation was not better. They too were unable to fulfil the demands put on them. Two main reasons may be singled out to account for that. In the first place, there was the case of high cost of importing glazes and colors and the usual difficulties involved in their acquisition and imports. There were also the difficulties connected with processing their raw materials and "Things Jamaican" inability to supply them with bisquitted ware for their subsequent glazing and decoration.

Conscious of this situation the Government concluded that the scope of the remedies to be applied, their complexety and the anticipated outlay much of it in foreign currency require some kind of outside assistance.

Under Lome I. Convention of 1975 - 1980 between Jamaica and E.E.C. 1,000,000 EUA'S were earmarked for the handicraft sector out of the

E.D.F. These funds were not used. After consultation between the National Planning Agency, the Prime Minister's Office and "Things Jamaican", it was proposed that the funds be used to finance, equip and install a Ceramic Manufacturing Complex.

In accordance with the needs exposed above the present project has been conceived to achieve the following aims:-

- enable the Ceramic Craft Sector to develop in accordance with its potential;
- make the Ceramic Industries comprising it more self reliant and to reduce its dependence on certain imports (glazes, colors);
- develop amd make more efficient use of the available human resources;
- benefit about 100 workers directly employed in all operations from collection of clay, grinding, refining and in manufacturing;
- benefit indirectly approximately 300 independent ceramic workers who are working for privately owned independent ceramic productions;
- stimulate the exploitation and use of the country's resources of ceramic raw materials;
- contribute toward increasing exports both directly and indirectl

These aims justify the Project as well as the very fact that the future Ceramic Manufacturing Complex responding to the real needs of "Things Jamaican", "Clays of Jamaica" and the many independent potters, decorators and artists will act as a spark plug generating the impulse required for their more intesive development and providing some of the needed backstopping.

Outputs

The Project is expected to produce the following:-

1. Steady and dependable supply of clay bodies to "Clays of Jamaica", "Things Jamaican" and the fledgling ceramic producers in different ranges for specialized purposes such as: slip casting, jiggering and hand throwing.
2. Custom grinding of local or imported ceramic materials such as Flint, Fluxes, Opacifiers, Coloring Oxides etc.
3. A body of glaze and color formulations.
4. Steady and dependable supply of frits, glazes and colors for approximately four temperature ranges suitable for Jamaican Ceramic Industries.
5. Availability to local producers of holloware, flatware, saucers, butter plates to sell in bisque to local producers who would decorate them in their own glazing kilns.
6. Ready availability to the local producers of cast vases large and small required by local producers.
7. Glazed Production (in house) of some of the above items in co-ordinated lines ofJamaican Glazed Dinnerware decorated and plain for both traditional and modern market styling trends.
8. Adequate supply of ceramic containers for local food producers of rum, jams, honey and spices.
9. Silk-screened under- and overglaze transfers.
10. A body of technically trained operators for the most important positions in the ceramic manufacturing industry.

Activities:

In order to produce the above outputs the following activities will be carried out during the project.

1. Production of a blueprint for the installation of the processing, manufacturing and laboratory equipment.
2. Installation of the processing manufacturing and laboratory testing equipment.
3. Preparation of operation manuals.
4. Elaboration and establishment of uniform clay testing procedures.
5. Development, manufacture and introduction of the required clay bodies for the manufacture of earthenware, stoneware, etc.
6. Development and manufacture of frits, glazes, colors.
7. Organizing the production flow.
8. Reduction and gradual elimination of losses due to lack of quality or breakage at different levels of manufacture.
9. Training of local personnel in all aspects of the manufacture.
10. Development and design of adequate decoration patterns.
11. Promoting and more effective advertising of the "sophisticated uniqueness" of Jamaican producers in the ceramic craft sector.
12. Securing and employing professional services for marketing and industrial design.

<u>Imputs</u>

To be provided by the Government (i.e. Things Jamaican & Clays of Jamaica, etc.) -

- the cost of prospecting and exploration of clay deposits.
- 1300 m^2 of additional covered areas at "Things Jamaican".
- the cost of acquisition of an adequate area of clay land.

- the cost of operation of "Things Jamaican" and "Clays of Jamaica", the former including:-

    20 workers in the Jiggering, pressing Departments

    16 workers for trimming and finishing

    20 workers for the slip-costing department.

    6 glaze-preparing operators

    12 glazing (dippling and spraying)

    4 Kiln operators

    8 Stackers

- local salaries of 5 trainees while on 3 months fellowship abroad.
- salaries of 5 technicians - managing, directing and training a ceramic decoration department.
- salaries of 5 technicians - on-the-job-training, in firing techniques,fritting and intermittent gas operated shuttle kilns.
- to be provided by EDF:-

1	Senior Ceramic Engineer	
	Duration 24 mm	US$100,000
1	Ceramic Raw material Processing Technician	
	Duration 24 mm	80,000
1	Glaze and Clay Senior research Technician	
	Duration 24 mm	80,000

- Fellowships for 5 Nationals for three months each

1	production management of ceramic factory	US$ 10,000
1	mining collector, management of clay preparation and frits.	10,000
1	body and glaze calculation and development	

	of new glazes	10,000
1	managing/directing, training ceramic decoration department	10,000
1	on the job training of firing techniques, fired furnaces and intermittent gas operated shuttle kilns	10,000
1	up-grading fellowship for "Things Jamaican" Senior Master Craftsman in plaster mould making	8,000
1	1½ month on-the-job training for "Things Jamaican Kiln-firing Technician in Kiln-firing methods	4,000

- Equipment for the clay processing plant, laboratory according to the list that follows:

Unit	No.		
1	1	Front loader tractor 1 cu. m. bucket	50,000
2	1	Large Truck, 5 ton capacity	50,000
3	2	Small pick-up trucks 1 ton capacity each	20,000
4	2	Station wagon automobiles	20,000
5	4	Ball mills, 400 liters capacity approx. 30" x 30" (75 cm x 75 cm)	20,000
6		Material and equipment to build a fritting furnace	10,000
		1200 Insulating Firebrick Wedges	

		Grade 28, 9" x 4½" x (2½" x 1½")	
		200 Kg Heat setting mortar	
		200 Kg Light weight Refractory Castable, Super-Duty quality	
		20 Clay Refractory Crucible 70 Liters Capacity	
		3 L.P. Gas burners for use with compressed air	
		2 Tongs for handling above crucibles	
7	10 m	Sieving screens, 60 & 120 mesh stainless steel	600
8	1	Ram Press - 50 tons capacity	50,000
9	3	Jiggers with bat-forming turntables	24,000
10	15	Banding wheels, 25 cm diam. hand-operated	1,500
11	2	Shuttle or Truck kilns 5 m^3 capacity with 2 extra trucks each, one transfer car	150,000
12		Mullite-cordierite slabs and parts for the above	10,000
13	3	Carbon dioxide meters	300
14	1	Set of clay-laminating rollers 0.9 m diam. with attached surface grinder	US$10.000
15	1	Self-containing blunging mechanism with shaft and impeller for	

		tank 2 m in diam. 1.8 m high, filling height 1.35m. useful volume 3.7 m^3, spec. gravity of slurry 1.3	US$ 5,000
16	3	Self-containing mechanisms with shafts and impellers for storage arks, diam. 2.6 m filling height 2.0m, useful volume 10 m^3, spec. gravity of slurry 1.3	US$18,000
17	5	Compressed air diaphragm pumps for transfers, capacity 20 m^3/hour	US$10,000
18	1	Vibro-energy separator, 80 cm diam., 120 mesh screen, capacity 6-7 m^3/hour of slip, spec. gravity 1.3	10,000
19	1	High pressure diaphragm pump working pressure 25 Kp/cm^2 capacity 5 m^3/ hour	18,000
20	1	Filter press, 91 x 91 cm cakes (36" x 36") 40 trays, cast iron	30,000
21	1	Auger extruder, max diam. of slugs 20cm (8"), output capacity 4000 Kg/hour	70,000
22	3	Porcelain-lined ball mills, 110cm diam. x 90cm length, 530 lt. capacity, in lined state, 250-350 kg.	

		with lining and balls	30,000
23	2	Self-containing agitating mechanisms with shafts and impellers for storage arks 1.2m diam., max. filling height 0.75m. max. useful volume 0.8 m^3 speed 200 RPM (Feldspar & Silica)	6,000
24	1	Self-containing blunging mechanism with shaft and impeller for tank, diam. 1.6m, height 1.5m, max. filling height 1.15m max. useful volume 2 m^3 propeller speed 360 RPM spec. gravity deflocculated slip 1.7	6,000
25	1	Self-containing agitating mechanism with shaft and impeller for storage tank 2.0m in diam. height 2.0m, max. filling height 1.5m, impeller speed 180 RPM	7,000
26	2	Skid lifters and transporters	2,000
27	1	Air compressor, $20m^3$/min 10 Kp/cm^2	5,000
28	1	Water meter, circular dial 25cm diam., or similar, capacity 100 liters per round, total capacity 500 liters, 1 liter divisions	1,000

29	1	Raw material scale, 500 kg capacity, precision 500gm	6,000
30	3	Gram scales, 2 Kg capacity tripple beams	1,500
31		Hand tools; shovels, picks etc.	1,000
32	1	Modulus of Rupture tester for raw clays, 0 - 50kg capacity complete with transverse test fictures	1,500
33	1	Portable, variable speed Blunger, 0.75 HP	1,000
34	1	Laboratory Filter press 15 x 15 cm frames	800
35	1	Electric drying stove, for temperatures up to 300^0C 2 cu. ft.	1,000
36	1	Electric Kiln, 0.25 m^3 capacity for temperatures up to $1,300^0C$ Kanthal resistance	2,000
37	2	Full sets of coils for the above	500
		TOTAL	US$971,700

FIGURE I

CLAY PREPARATION FLOW SHEET

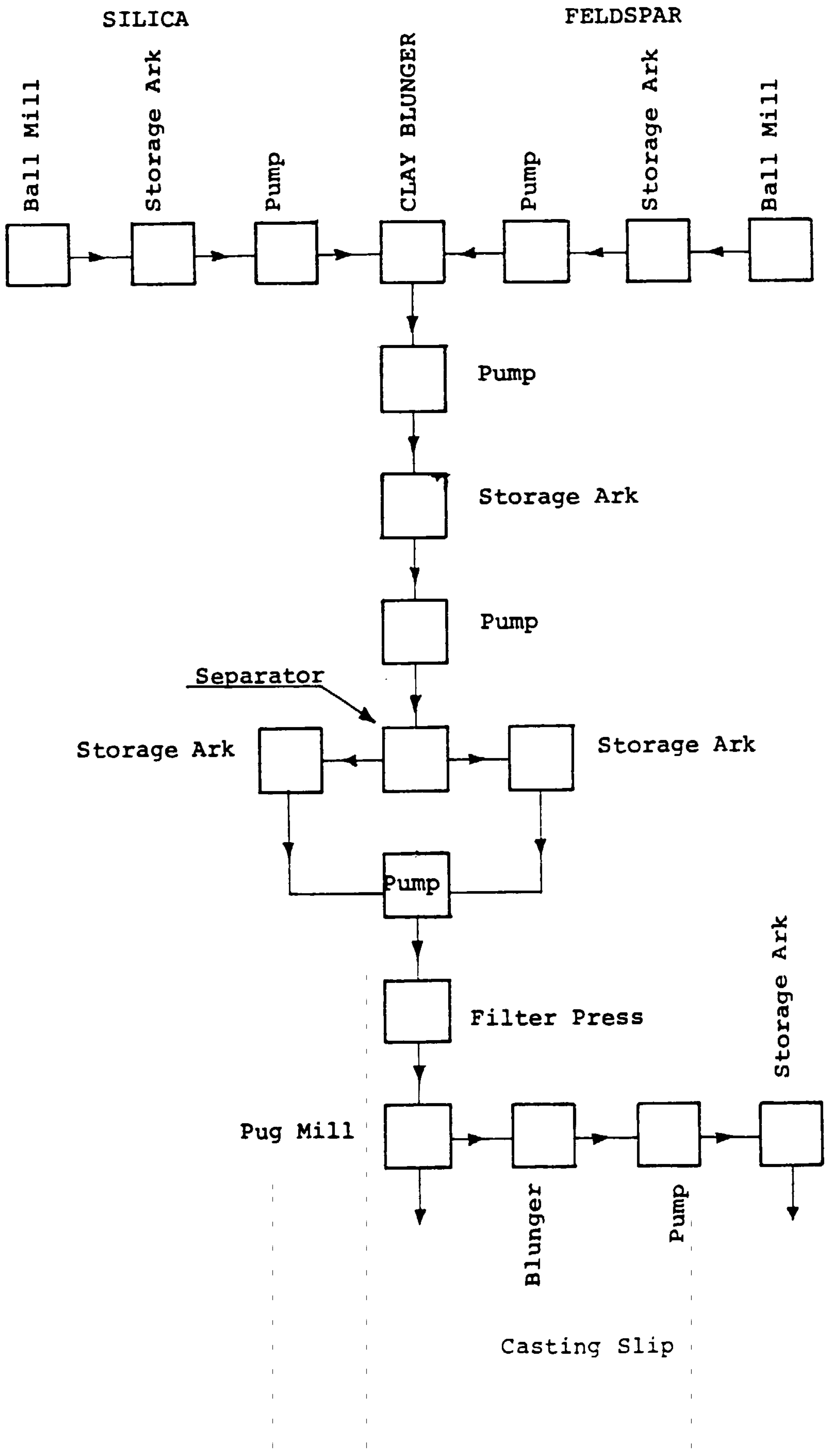


FIGURE 2

FLOW SHEET OF THE FRITTING OPERATION

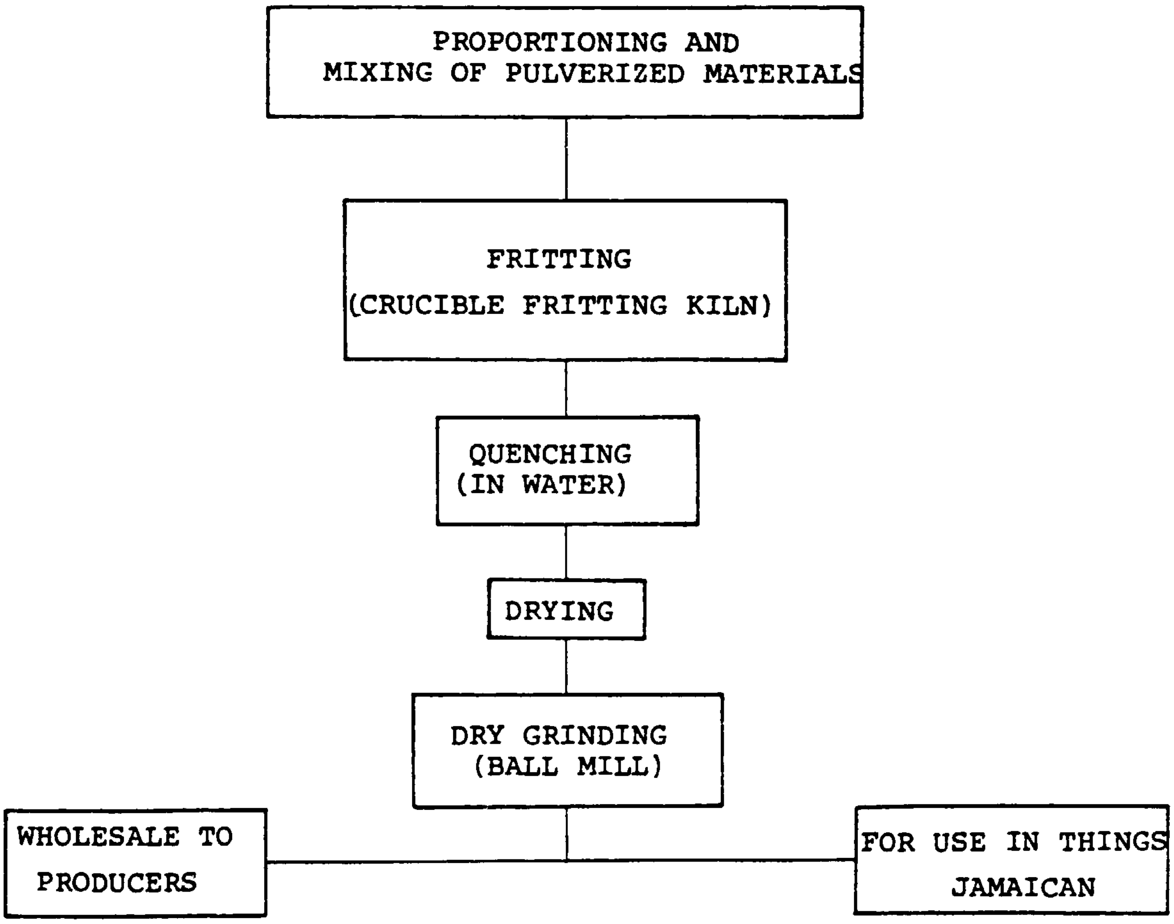
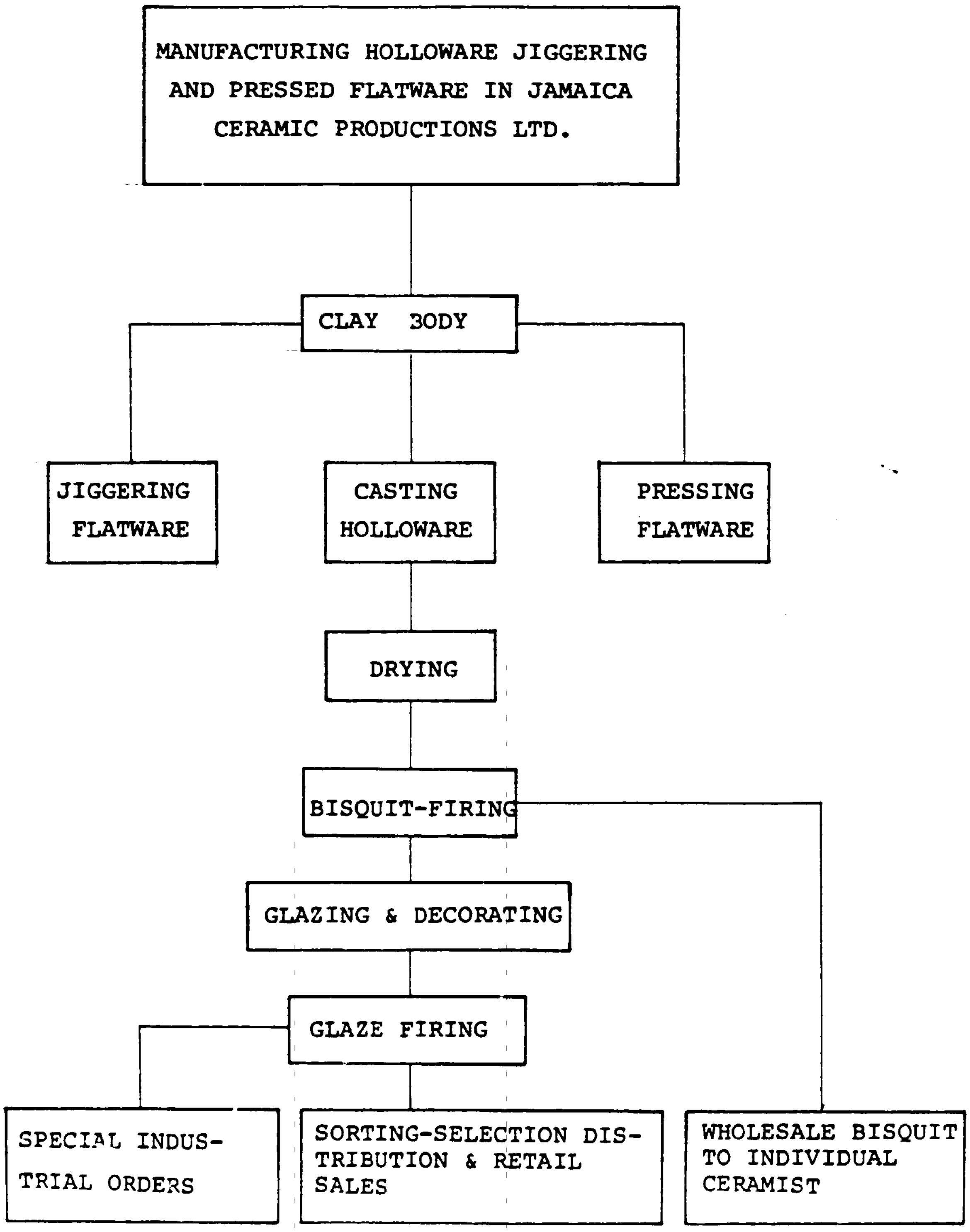


FIGURE 3

FLOW SHEET: FORM-GIVING



The equipment will be used in "Things Jamaican" to manufacture the following wares using the indicated volumes of clays:

Output per year, pieces	Clay Requirements, Kg	
	Per year	Per day
43,000 decanters	40,000	155
60,000 assorted giftware	109,000	420
1,000,000 containers	152,000	584
TOTALS	301,000	1,159

The output figures have been arrived at through a series of informal interviews and much extrapolation and guessing. They would not be fit to serve as a basis for a Feasibility study but are suitable for estimating maximum equirement requirements.

The total amounts of clay handled in the Ceramic Manufacturing Complex were calculated as follows:

	Tons per year
Things Jamaican	300
Clays of Jamaica	100
Others (Independent manufacturers)	200
	600
Plus 50% for unforseen demand	300
Total of Clays handled	900

DESCRIPTION OF THE MANUFACTURING PROCESS AND EQUIPMENT

As may be seen in Figure 1, the process consists essentially of proportioning, blunging, mixing, homogenizing, screening, dehydration and pugging. The main pieces of equipment are 1 blunger (Unit No. 15) and a series of storage arks with agitatiors (Unit Nos. 16, 23). All of them are subterranean and made of concrete. The blunging respectively agitating mechanisms are self-containing and will be mounted on top of the tanks. The weighed clays are dumped into the blunger. Water is metered in to achieve a slurry with a specific gravity of 1.3. Non-plastics (feldspar & silica) are weighed and wet-ground in two ball mills (Unit No. 22) situated on either side of the blunger. The slurries are discharged by gravity into the respective underground storage arks (Unit No. 23). The concentration of solids in the slurries will be kept constant and proportioning will be by volume using two measuring vessels situated on top of the blunger. (Their size can not be indicated because the proportions of silica and feldspar in the body are not known yet.) The metered slurry drops into the blunger by gravity. No feldspar being available in the country same will have to be imported in the form of a 200 mesh product. Nevertheless a ball mill is being provided anyway just for the case that domestic feldspar-containing volcanics could be used instead of feldspar in red-firing bodies.

When homogeneity of the slurry has been achieved same is first transferred into a storage ark wherefrom it's pumped over a vibro-energy separator (Unit No. 18) for screening through 120 mesh. From the separator the screened slurry is pumped to two further storage arks where it stays until a high-pressure diaphragm pump (Unit No. 19) takes it out for dehydration in the filter press(Unit No. 20). The cakes are then fed into the de-airing pug mill and the extruded slugs stored either for use in the factory or delivery to customers.

Casting slip is prepared by blunging and deflocculating in a blunger (Unit No. 24) to obtain a 1.7 spec. gravity casting slip. Same is stored in its own ark with agitation. (Unit No. 25) This is the only storage ark that is not underground. Its bottom will be, in fact at least 1 m above the floor level to enable 200 liter containers to be filled with the slip by gravity, for delivery to the casters. To facilitate the transport of the containers they will rest on skids which will be picked-up by hand-pulled lifters (Unit No. 26) and taken wherever necessary. The individual pieces of equipment are shown in the accompanying Project Document.

Frit Department

The Frit ingredients are weighed and mixed. The fritting will be done in a large crucible Kiln. Same will be manufactured in the factory by lining with Grade 28 Insulating Firebrick wedges a 200 liters oil drum (Unit No. 6)

It will also be provided with two LP gas burners entering the kiln space tangentially. The crucibles are filled by the powdered glaze batch and heated until melted. The crucibles are then lifted from the furnace by means of special tongs (Fig. 4) tilted and the content poured into water.

The quenched frit is dried and ground in a ball mill to 200 mesh fineness. It is then ready for use or sale after preliminary checking.

DESTINATION OF ANCILLARY EQUIPMENT

Unit 1	Loading and transporting clays
Units 2,3	Transport of clays and prepared bodies
Unit 4	Personal Transport
Unit 5	Grinding frits and glazes
Unit 7	Replacement for Unit 18
Unit 8	Pressing special items between plaster dies
Unit 9	Jiggering - forming of flatware
Unit 10	Banding-decoration of flatware
Unit 11	Bisque and gloss firing of general goods
Unit 12	Self-explanatory
Unit 13	Controlling firing of kilns
Unit 14	Disintegrating clays
Unit 22	Grinding Silica, feldspar and frits
Unit 27	Self explanatory, provides air for spray guns and pumps (Unit 17)
Unit 28	Metering water to blungers and mills
Unit 29	Weighing clays, silica and other ingredients
Unit 30	Weighing of colors as glaze additions
Unit 31	Self Explanatory
Unit 32 - 37	Testing Laboratory