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

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CLAY REFINING AND GLAZED TILES MANUFACTURE

SI/MAT/76/801

MALTA

Terminal report

Prepared for the Government of Malta
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Kvotoslav Engelthaler, expert
in ceramic and clay technology

United Nations Industrial Development Organization
Vienna

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Explanatory notes

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Malta is the Malta pound (£M). During the period covered by the report, the value of the £M in relation to the United States dollar was $US 1 = 0.426.

The following abbreviations are used in this report:

CTE	Coefficient of thermal expansion
ISO	International Organization for Standardization

ABSTRACT

The project "Clay Refining and Glazed Tiles Manufacture" (IS/MAT/76/801) originated in a request by the Government of Malta in June 1976 for further UNDP assistance in the establishment of a ceramic pilot plant for the manufacture of glazed tiles and ceramic material for local craftsmen. It was approved in June 1976, with the United Nations Industrial Development Organization (UNIDO) designated as executing agency and the Ministry of Trade, Industry and Tourism as co-operating agency. The six-month mission began in April 1977.

The following are among the main conclusions of the report:

1. The feasibility study prepared by the expert showed that the production of 500,000 flower pots of different diameters, 12,500 m^2 of wall tiles, façade tiles and mosaic, and 52 tons of dressed clay for local craftsmen is very profitable and feasible. To achieve such results the plant would need to be equipped with additional machinery;

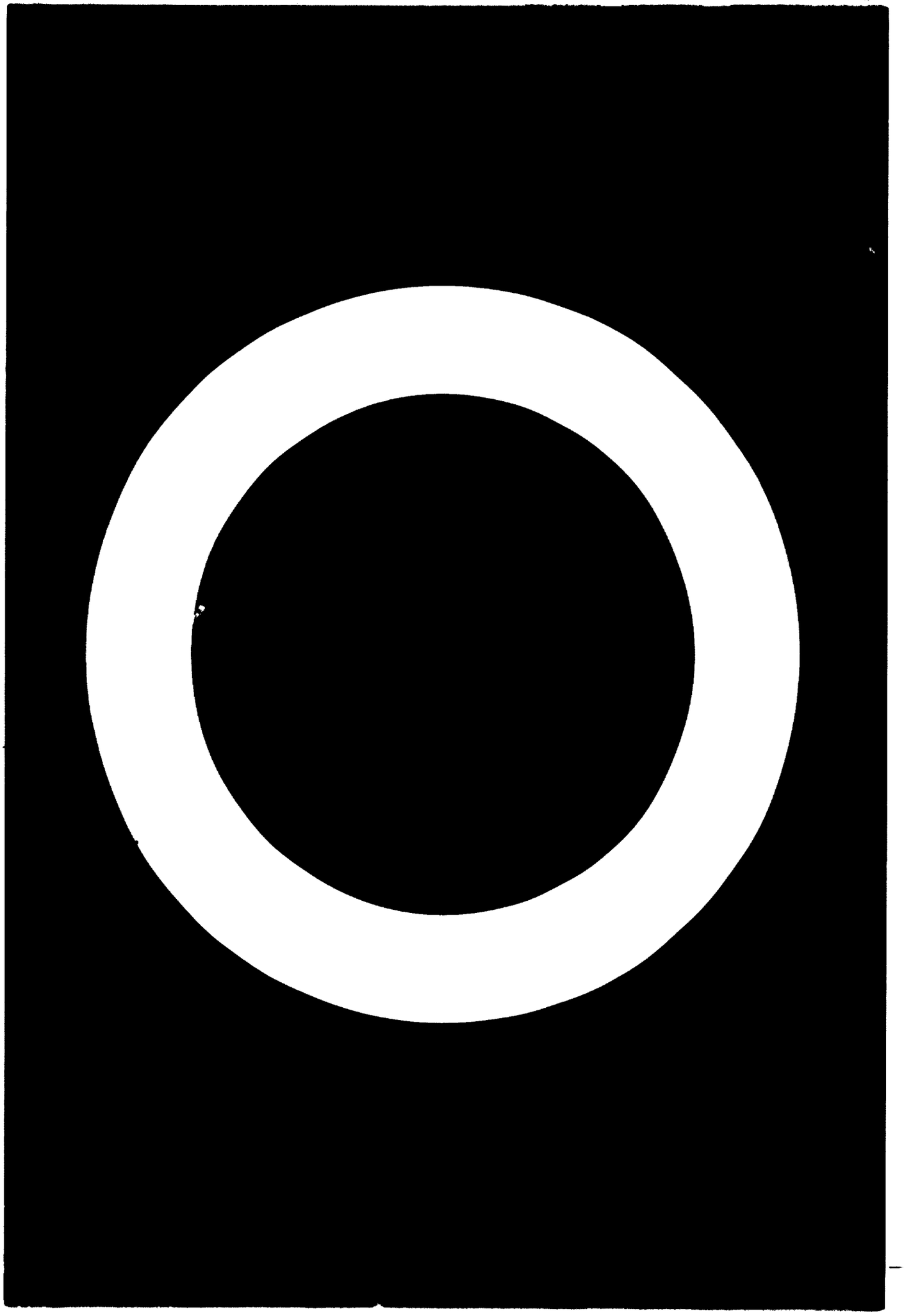
2. The large-scale trials in the production of dressed clay showed that local clay after dressing is suitable for pressing, coiling, throwing and shaping, but not for casting;

3. It would be very useful for the ceramic pilot plant to determine as soon as possible what the intentions of the Government are concerning the future of the plant, since the conditions under which the latter works at present cannot last much longer.

The following recommendations are noteworthy:

1. Core drilling in selected clay deposits and testing of drilled clay samples at the Malta Standard Laboratories should be carried out, with the clay deposit being evaluated by an expert;

2. The production of the following types of dressed clay for local craftsmen should be continued: body 250 - milled green clay (75%), grog fired to 950°C (25%); body 400 - milled green clay (60%), grog fired to 950°C (40%).



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INTRODUCTION

The project "Clay Refining and Glazed Tiles Manufacture" (IS/MAT/76/801) originated in a request by the Government of Malta in June 1976 and was approved during the same month, with the United Nations Industrial Development Organization (UNIDO) designated as executing agency and the Ministry of Trade, Industry and Tourism as co-operating agency. The six month mission began in April 1977 with a budget of $23,700.

So far three short term missions have been undertaken to Malta in connection with the establishment of a ceramic industry. The first was a one-month exploratory mission in October 1974. The result of this mission was not to begin with the production of lime-sand bricks and sewer pipes, as was originally requested by the Government. The former require as basic material quartz sand (about 90%) which is not available on the island, while it would not be profitable to produce the latter in quantities consumable by the local market. However, it was found that the local blue clay which was expected to be the basic material for the production of sewage pipes seemed to be suitable also for the production of fence bricks, façade tiles, wall tiles, glazed floor tiles, decorative ceramics, expanded lightweight aggregates and cement as an addition to the local limestone.

The second mission, in fact the first part of the current project, was intended to obtain further information and took place from April to June 1975. During this three-month mission a clay deposit suitable for mining was selected and its core drilling and clay samples testing was recommended. The establishment of a ceramic plant started. The Government provided a hut at Ta'Qali in which the plant layout had been prepared. The Government had already acquired some ceramic machines (some of them incomplete), including two blungers, a horizontal vacuum press, two filter presses, a glazing machine with silk screening decoration, a stationary kiln and a tunnel kiln.

The project was extended for approximately eight more months (third mission) from November 1975 to July 1976. The purpose of this project was to assist the Government in establishing a pilot plant to produce glazed mosaic tiles, glazed wall tiles, façade tiles and the dressed ready-mixed ceramic bodies for local craftsmen. A few more machines, such as an edge runner mill, wall tiles presses and a ball mill were ordered from abroad and installed in the plant. Locally available machines were assembled and missing parts ordered. In spite of not being fully equipped, the pilot plant was able to start the large-scale trials of the above-mentioned items.

The aim of the current (fourth) six-month mission was to make the large-scale trials and implement the previous recommendations so as to show to the Government that the local raw material is suitable for an industrial production.

The primary duties of the expert for the current six-month mission were specified as follows:

(a) To work out a feasibility study in two variants in accordance with the request of the Ministry of Parastatal and People's Industries;

(b) To participate in discussions about the future of the ceramic plant;

(c) To advise on core drilling and testing of samples;

(d) To advise on ordering the flower pots press and on the establishment of an intermittent oil-heated chamber kiln;

(e) To finish the lining of the ball mill with the silex stones;

(f) To start large-scale trial production of dressed clay for local craftsmen;

(g) To start large-scale trial production of façade tiles and decorative fence items with the existing equipment;

(h) To start large-scale wall tile production on a trial basis with the existing equipment.

All the duties mentioned above were carried out with the exception of the third. The Department of Industry was not able to finalize arrangements with the Public Works Department for core drilling and testing of clay samples throughout the current project, although the expert repeatedly stressed its need and the fact that core drilling and clay samples testing is the basic condition for industrial production. It would seem unwise to continue with the ceramic project until the Department of Industry is able to guarantee that core drilling and clay samples testing will be carried out. It is too risky to start with the production of ceramic items such as façade tiles, wall and floor tiles and clay for craftsmen without any knowledge of the raw material used in the production.

In accordance with the request of the Ministry of Parastatal and People's Industries, a feasibility study of two variants has been prepared. Follow-up discussions showed that variant No. 2 is the right one for Malta, based on the possibility of exporting 300,000 flower pots to the Libyan Arab Jamahiriya. The ball mill was lined with the silex lining and used in the following large scale production: 8,000 façade tiles, decorative fence items, 5,500 wall tiles, and 11 tons of dressed clay for local craftsmen.

Flower pots have not been produced in the pilot plant because of the lack of pressing equipment. However, a private producer who had ordered a flower pots press started the production of flower pots and achieved good results, with the percentage of rejections varying from only 4% to 6%.

I. PROJECT ACTIVITIES

A. Feasibility study

In accordance with the request of the Ministry of Parastatal and People's Industries, the expert prepared a feasibility study on the basis of two variants, with the assistance of Guido Pace, of the Malta Crafts Centre.

Variant No. 1

250,000 flower pots of different diameters per year
12,500 m^2 of wall tiles, façade tiles and mosaic per year
52 tons of dressed clay for craftsmen per year

Variant No. 2

500,000 pcs of flower pots of different diameters per year
12,500 m^2 wall tiles, façade tiles and mosaic per year
52 tons of dressed clay for craftsmen per year

A feasibility study was prepared in such a way that all the figures were over-estimated in order to be sure that the calculated profit will be reached. In reality, the profit should be approximately 20-30% higher.

The feasibility study showed that variant No. 2 is very profitable and more feasible. All the products will be saleable because the dressed clay and wall, façade and mosaic tiles and 200,000 flower pots will cover demand on the island. The remaining 300,000 flower pots could be exported to the Libyan Arab Jamahiriya. Export arrangements have already been cleared through the Maltese Embassy in Libya.

The consumption of dressed clay for local craftsmen will be estimated in the feasibility study. For example one craftsman now consumes 2 tons of dressed clay per week and his consumption is expected to increase to 3 tons per week, which means that the production of dressed clay may increase by 200 tons per year or more. The feasibility study was handed over to the Department of Industry, the Malta Development Corporation and the Ministry of Parastatal and People's Industry for further study.

B. Discussion about the future of the ceramic plant

When the feasibility study had been examined in detail by the above-mentioned Institutions, a discussion was held at the Ministry of Parastatal

and People's Industries. Its aim was not only to determine and discuss the best variant for Malta but also to consider the future of the ceramic plant.

During the discussion it was recommended that provision should be made in Chapter VIII - Furniture and Others - for a van which will be able to arrange transport of labourers and small supplies. In chapter XIII, insurance was added. It was also recommended that chapter XVIII - Capital Requirements - should include £M 10,000 as starting-up expenses, thus reducing the profit calculation by approximately 10%. While the starting-up expenses should not be included in such a feasibility study as that prepared by the expert, they may be covered in dealing with cash flows because they represent a one-time expense.

The future of the ceramic plant was also discussed. It was decided that the ceramic plant should be developed in accordance with variant No. 2. The Department of Industry was recommended to complete the factory as indicated in variant No. 2 and to start production. The factory would be transferred to the Ministry of Parastatal and People's Industry, which implies a merger with the factory producing cement goods. Such a factory is very close to the ceramic plant.

However, time passed and no progress had been reached in this matter when the expert left the island. Further equipment such as an edge runner mill MK 800, a vertical bucket conveyor for filling the ball mill and the blunger, an hydraulic press for flower pots, a kiln for firing flower pots, conveyors etc., have not yet been ordered and it is doubtful whether or not they will be ordered. In that case two labourers working at the factory must fill the ball mill and the blunger with the buckets. It is not an easy job to lift 700-800 kg of material up 2.5 m in buckets every day, when a conveyor can do it in a few minutes.

The same situation exists with regard to the supply of blue clay. There is no stock of raw materials at all in spite of the fact that the mined clay needs approximately three months drying before being milled in the edge runner mill. But before any bulk supply of clay is undertaken, core drilling and clay samples testing should be done to determine whether and how the quality of raw material changes.

It will be very useful for the ceramic plant to find out as soon as possible what the Government's intentions are concerning the future of the plant, because the situation under which it operates at present cannot last long.

C. Core drilling and clay samples testing

In previous reports the expert stressed that good knowledge of the raw material used in production is the basic condition for successful performance of the factory. Although the Government has known about this condition since April 1975, no response has been made. However, the expert wishes to point out once again that the core drilling should be done in the selected deposit at the sites indicated by the expert, and the drills, if possible, should penetrate to the base of the clay deposit.

The clay samples obtained by core drilling (one sample every two metres) should be transferred to the standards laboratories, which are fully equipped to perform the necessary chemical, mechanical and technological testing, and they should undergo chemical analysis and tests for wet-dry shrinkage, dry-fired (1000° C) shrinkage, porosity after firing and residue on the screen (10,000 openings per cm^2). According to the results obtained, the quality of the clay deposit as industrial reserves for a minimum of 20 years should be determined, since the existence of reserves of raw materials is a prerequisite, not only for the establishment of any large-scale ceramic industry in Malta, but also for large-scale tests and production in the pilot plant.

It was also stressed by the expert that the clay has its natural humidity when mined (about 14% water content), and must be dried in the store before being crushed and milled in the edge runner mill. To decrease the moisture of blue clay from 14% to, for example, less than 1% means to store the clay for a minimum of three months, otherwise when the clay is milled with a higher moisture, it will make a jam in the mill and either the milling will not be possible, or the edge runner mill may be completely damaged.

The expert does not think that it is possible to continue with the production of the three tons of dressed clay weekly (orders for two tons per week are already in the hand of the Malta Crafts Centre) when there is not one kilogram of dried clay in the factory.

D. Flower pots press and oil-heated chamber kiln

The production of 500,000 flower pots requires a press and a large kiln of four chambers heated by oil, because to fire pots with electricity will not be economic. A press such as the Fulgor press from Italy would give good results. There are three different sizes of Fulgor presses: Fulgor 150, Fulgor 240 and Fulgor 400, each being used for production of flower pots of different diametres. The one Fulgor 240 allows the production of flower pots from the cactus size (about 5 cm in diameter) up to 25 cm in diameter, which means that such a press covers the most common sizes of flower pots in ordinary use. It is true that in Malta there is a small demand for bigger flower pots. However, the statistics show that demand for bigger pots is limited to approximately 2,000 items per year. The expert considers that 2,000 flower pots of bigger size may be produced by throwing in order to supply the local market. The Fulgor 240 press will be suitable for both the local market and export to the Libyan Arab Jamahiriya. However, though variant No. 2 of the feasibility study was approved, the press has not yet been ordered.

An intermittent kiln with four chambers was recommended for firing flower pots. The refractory material necessary to build such a kiln is available on the island. The kiln will work in such a way that the heat from the fired chamber will be used for preheating the next chamber loaded with the green articles. Simultaneously the hot air from the chamber which should be cooled will be used as primary air for burners firing the next chamber. In such a way, the maximum amount of calories will be used in the production process and firing expenses will be as low as possible. The firing temperature should be 1050°C, although 950°C is enough for firing flower pots. However, the expert thinks that façade tiles and decorative fences may also be fired in this kiln.

Up to now the erection of such a kiln has not yet been started. The production of flower pots from local clay is without any risk, as far as production technology is concerned, and will be very profitable. It should also be noted that one of the local craftsmen has already successfully started the production of flower pots using a Fulgor 240 press, electric firing, local clay and technology recommended for the pilot plant by the expert. However, the craftsman producing flower pots (200 per day) is able to cover the local market and cannot meet the demand of the Ministry of Agriculture and the Libyan Arab Jamahiriya export market. But a three-month performance has shown that local clay is suitable for the production of flower pots, as predicted by the expert more than two years ago.

E. Lining of ball mill with silex stones

During the expert's absence between the previous mission and that covered by this report, a new ball mill was installed as recommended by the expert. Its lining was done by a local firm under the supervision of the expert. Cement with a strength of 425 kg/cm^2 was used for the lining of silex stones which were selected according to the size of the ball mill. The work was finished in 10 days and the ball mill was left for another 14 days for hardening before being used. When it was hard enough, the ball mill was charged with pebbles, cleaned twice with water to remove excess cement, and put into industrial operation.

The ball mill is charged by hand using buckets. Such a method is adequate enough for the large-scale trials which have already been carried out and described, but it is not acceptable for industrial production. There must be a platform above the ball mill and a vertical bucket conveyor to charge the ball mill with the materials. It is very dangerous for people to stay on the frame or on the top of the ball mill because they may slip and fall down from a height of 2.5 m. To avoid exposing the workers to danger, the expert wishes to stress that something must be done about the charging of the ball mill, namely finishing the platform and installing the vertical bucket conveyor. It was decided nevertheless to continue with the production of a minimum of two tons of dressed clay weekly because there is a continuous order for it.

F. Large-scale trial production of dressed clay

Two different bodies were produced in the large-scale trial for local craftsmen:

Body 250

75% of green clay

25% of grog (green clay fired to 950°-1000°C)

Charge to the ball mill: 25% grog, 10% green clay, water (twice the weight of the grog)

Charge to the blunger: 65% green clay, water (1.5 times the weight of the clay)

Ball milling was continued for 8 hours while blunging continued for only one hour. After milling and blunging the slurry was discharged to the second

blunger and both components were blunged together for another 30 minutes. The slurry obtained was filter-pressed. The pressing time was 3½ hours. By this means cakes with a moisture of 24%-28% were obtained.

Body 400

60% of green clay

40% of grog (green clay fired to 950°-1000°C)

Charge to the ball mill: 40% grog, 10% green clay, water (twice the weight of the grog)

Charge to the blunger: 50% clay, water (1.5 times the weight of the clay)

Body preparation was done in the same way as described for body 250. The pressing time was also 3½ hours, and cakes with a moisture of 24%-26% were obtained.

The first batch of each dressed clay was distributed among the local craftsmen free of cost for tests using their products. Some of them realized quickly that the clay is very good and placed orders for a bulk supply. One craftsman has placed an order with the Malta Crafts Centre for two tons of clay each week. On the other hand, another craftsman has thus far purchased only one ton of clay, and one firm refuses to take more dressed clay because it is not white burned clay. Such order probably depend on the size of their production.

In any case, the demand for local dressed clay seems to be higher than that estimated in the feasibility study and will probably reach the figure of 150 tons per year. Production on such a scale requires daily filter-pressing (700 kg of dressed clay per cycle), although only 20-25 tons of dressed clay will be left for the production of other items such as wall tiles and glazed or unglazed façade tiles and floor tiles. The expert therefore prepared the time schedule given below for the clay preparation cycle, which should be followed in order to achieve the above-mentioned capacity.

Time (h)	Operation	Number of workers required
700-800	Discharge of filter press	2
800-900	Preparation of filter press for next pressing	2

Time (hr)	Operation	Number of workers required
900-915	Break	
915-1000	Discharge of blunger and ball mill	2
1000-1300	Filter-pressing	0
1000-1100	Charging of blunger and ball mill	2
1100-1900	Ball milling	0
1100-1300 (summer time)	Milling of raw materials and pugging of clay for grog firing	2
1100-1200	Milling of raw materials and pugging of clay for grog firing	2
1200-1300	Break for lunch	
1300-1600	Milling of raw materials and pugging of clay for grog firing	2

However, for such large-scale production it is not possible daily to charge the ball mill and the blunger by hand with buckets. It is therefore recommended to buy a vertical bucket conveyor for this purpose. The milling capacity should also be increased with another edge runner mill, and transport through the factory should be arranged by use of belt conveyors.

On the basis of current findings, it may be said that local craftsmen prefer body No. 250, which is plastic enough for throwing and not too pasty for pressing and coiling. The industrial production of dressed clay should continue in the absence of the expert. Eleven tons of dressed clay were produced on an industrial scale before the expert's departure. Annex I shows the prices for local dressed clays.

G. Large-scale trial production of façade tiles and decorative fence items

In the production of façade tiles three different trials have been carried out.

Body composition: blue clay only

The clay was mixed with water by hand and charged in the pug mill with plastic buckets (no conveyors for transport are available as yet in the plant). About 4,000 façade tiles of two different sizes were pugged. Many problems of

pugging were solved, and it took the expert almost three weeks to adjust the moulds with filing, after which the pugging continued without urther problems. After drying the tiles were fired to the temperature of 950°C, which resulted in considerable cracking and damage due to substantial shrinkage of the clay. It was therefore decided to grind the products for grog and henceforth to use this method for the grog preparation only.

Body composition: dressed clay No. 250

The cakes produced by filter-pressing were taken from the filter press (moisture 24%-28%) and fed into the pugmill. About 3,600 façade tiles of two different sizes were pugged without any problems. After drying, the tiles were fired to the temperature of 950°C. After firing there was no damage at all, except that a few tiles were bent or had hard lumps in the body. Some of them were given an attractive green glaze (the only glaze available in the factory).

Body composition: dressed clay 400

Production continued as mentioned above, with the cakes from the filter press being fed straight into the pug mill. About 2,800 façade tiles of two different sizes were pugged without any problem. After drying, the tiles were fired to the temperature of 950°C. No damage occurred except for a few tiles which were bent or had hard lumps in the body (clay lumps which remained in the pug mill from the previous trial and became dry). Glazing a few of them was also successful when fired to the temperature of 950°C.

The following results were obtained.

	Blue clay only	Body 250	Body 400
Green length	109.4 mm	109.4 mm	109.4 mm
Dry length	100.5 mm	100.3 mm	100.8 mm
Fired length	95.8 mm	95.8 mm	96.6 mm
Wet-dry shrinkage	8.14%	8.15%	7.86%
Dry-fired shrinkage	4.70%	4.60%	4.10%

From the technological and economical point of view, it is evident that the best results are obtained with body 250, which may be used for industrial production. Façade tiles may be used as floor tiles and produced either with

a plain glaze, or decorated with silk screening or in marble design, or without glazing for use in industrial flooring. The industrial production of façade tiles may continue during the absence of the expert. The façade tiles produced by the expert may be used as samples for advertisements, and it will be very useful to find a suitable place where the tiles may be shown to the public as a new product available on the market.

The expert also made a number of unsuccessful trials to produce decorative fence items using the same three bodies as mentioned in the production of façade tiles. The mould seems to be too big (20 cm x 20 cm), and the speed of the body on the outside walls was very high in comparison with the speed of the body in the very centre, which resulted in cracks and empty places in the products. This suggests that the mould must be adjusted to give better results, but there was no time to do it. The expert believes that another shape will be easier to pug, whereas the shape of a Maltese cross needs a perfectly adjusted mould.

H. Large-scale trial production of wall tiles

The body for wall tiles was composed as follows in accordance with recommendations made by the expert in previous reports.

Component	Percentage
Green clay	45
Grog (clay fired to 950°C)	27
Quartz sand	28
Amount charged into the ball mill:	27 grog, 28 quartzsand, 5 green clay, and water (ratio of 1:1 with the raw materials)
Amount charged into the blunger:	40 green clay, water (1.5 times the weight of the clay)

Sand used for production was supplied by Malta Decorative Glass. Ball milling continued for eight hours while blunging continued for only one hour. After milling and blunging the slurry was discharged to the second blunger and all components blunged there together for another 30 minutes. The slurry obtained was filter-pressed. The pressing time was 3½ hours. In such a way cakes with a moisture of 22%-26% were obtained.

The cakes were dryed in the open air on rugs for 14 days in order to decrease their moisture to 3.8%-4.8%. When dry enough they were milled on the edge runner mill to the pressing powder. The pressing powder was screened through a 2 mm screen before used for pressing.

A total of 5,400 wall tiles was pressed (150 mm x 150 mm) successfully. About 2,500 of them were fired to the temperature of 950°C, and a few were given a green-blue glaze.

It should be noted that a number of tiles were rejected during production because of handling damage and cracks in the green stage. It was actually the first large-scale production of wall tiles in the factory, and the workers (the expert was serving as press operator) have not been sufficiently trained to handle the green tiles without breaking the corners and damaging the edges. The permanent staff should therefore be selected for the production of wall tiles in order to decrease handling damages.

However, the production was successful and has shown that it is possible to produce wall tiles from local blue clay when quartz is added. The expert also made a small-scale trial in the production of wall tiles with body No. 400. About 400 wall tiles were pressed and fired. Few of them were glazed and perfectly executed, except for the fact that they were short in size (146 mm only). This indicates that the local glaze has a very low coefficient of thermal expansion (CTE), and when such a glaze is used, quartz need not be added to the body composition and only local raw materials may be used for production. After more tests, this possibility will be certified. The moulds should of course be adjusted for size 150 mm x 150 mm. There was not time for the expert to carry out more tests, but it seems that there is a way to decrease manufacturing costs and increase the plant's profitability.

I. Other activities

Further activities of the expert are described below.

The tunnel kiln was tested without heating. The kiln was properly cleaned, newly laid with underlayer tiles, and operated by pushing the slabs without any load for about 30 hours. A test was then successfully carried out which involved the pushing of slabs loaded with saggers. After about eight hours a jam appeared in the kiln and further pushing was not possible. The expert checked

each slab taken from the kiln and found that the guide edges in the kiln were so worn out that there is a possibility for loaded saggers to touch the kiln walls. This causes the saggers to turn and stack in the kiln and to stop pushing.

To put the kiln in perfect operating condition means to repair the guide edges with some suitable castables. The expert is not sure if such a repair will give a fully successful result because the addition of castables in some places in the kiln might be only 5 mm, and it is not known whether such a thin layer will withstand the conditions of the kiln when goods are pushed on the slabs.

Another possibility is to dismantle the kiln completely and to replace the guides with new bricks having a higher cold crushing strength. This would definitely give a successful result and the kiln will then operate without any problem for another 4-5 years.

As requested by UNIDO, the expert prepared a draft project document for follow-up assistance in the ceramic project.

The draft project document was prepared in such a way that not only the expert assistance was included, but also the training of counterparts, basic laboratory equipment, and the pilot plant equipment required to bring the project to a successful conclusion. The draft project document is attached to this report as annex II. However, it should be noted that the Government of Malta was not ready to discuss the prepared draft project document with the expert. The figures and views given in the draft project document are therefore those of the expert only, and do not necessarily correspond with the views and future plans of the Government of Malta.

II. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. The core drilling has not yet been done, although the expert has frequently stressed the necessity of core drilling and of a good knowledge of the raw materials used in production. The Department of Industry has not been able to persuade the Public Works Department, which owns the drilling machine, to lend it for approximately three weeks to carry out the core drilling.

2. Tests of drilled samples and the evaluation of the clay deposit could not be carried out. The Standard Laboratories are fully equipped to make all the necessary tests according to International Organization for Standardization (ISO) Standards. Final evaluation of the deposit should be done by an expert.

3. The feasibility study prepared by the expert showed that variant No. 2, involving the production of 500,000 flower pots of different diameters, 12,500 m^2 of wall tiles, façade tiles and mosaic, and 52 tons of dressed clay for local craftsmen, is very profitable and feasible. To achieve such results the plant would need to be completed with edge runner mill MK800, a vertical bucket conveyor, a semi-automatic mosaic press, an hydraulic press for flower pots, a kiln for firing flower pots, conveyors etc. In this connection, however, no progress has been achieved to date.

4. It would be very useful for the ceramic pilot plant to determine as soon as possible what the intentions of the Government are about the future of the ceramic plant, since the conditions under which the plant works presently cannot last long.

5. The ball mill supplied and erected during the expert's absence was lined with silex stones under the expert's supervision. The work was very well done by a local mason. The ball mill was then put in the production process and produced all the dressed clay for the craftsmen.

6. The large-scale trials in the production of dressed clay showed that the local clay after dressing is suitable for pressing, coiling, throwing and shaping but not for casting. Two different qualities are now produced industrially and available on the market although charging of the ball mill and the blunger is done by hand. An edge runner mill and a vertical bucket conveyor are necessary to complete the production line for dressed clay.

7. The consumption of dressed clay is practically three times higher than estimated in the feasibility study. If the consumption of dressed clay remains at such a high level, it will be necessary to obtain another blunger and to complete a second filterpress in order to double the production of dressed clay and to satisfy both local craftsmen and plant demand for the production of façade and wall tiles.

8. The large scale trials in the production of façade tiles were successful when body 250 (composed of 75% green clay and 25% grog, milled in the ball mill and filter-pressed) was used. When the moulds were adjusted, pugging of façade tiles was very smooth,and there were practically no rejections after firing, except for a few tiles which were slightly bent. A few façade tiles which were given the only available glaze have shown that the CTE of the body corresponds with the CTE of the glaze.

9. The pugging of decorated fence items did not give a successful result because the speed of the body when pugged was not uniform, and this caused cracks and holes in the products. In the expert's view, the pugging of decorative fence items (Maltese cross) will be possible when the mould is properly adjusted. However, there was no time to do this.

10. The results achieved with the glaze and corresponding CTE brought the expert to the idea of making a trial in the production of wall tiles with body 400 (composed of 60% green clay and 40% grog, milled in the ball mill and filter-pressed). The production was successful except that the tiles were smaller in size (146 mm x 146 mm).

11. The large-scale trial in the production of wall tiles was carried out with a body containing 28% of sand. The pressing powder was prepared by ball milling, filter-pressing, cake drying and cake milling. After a proper adjustment of the press, pressing was done, and after a few days drying, the tiles were fired in the stationary kiln. There were handling damages because the workers are not yet sufficiently trained to handle the green tiles properly.

12. The tunnel kiln was tested without heating and it was found that the guide edges leading the pushed slabs need to be repaired. Two methods are possible: using suitable refractory castables or rebuilding the kiln. The latter may seem to be better.

13. Water is still leaking through the roof of the huts when it rains. The machines will be spoilt by rust if the water falls on them.

B. Recommendations

1. Steps should be taken to carry out the core drilling in the selected clay deposit and to arrange the testing of drilled clay samples at the Standard Laboratories. Evaluation of the clay deposit should be done by an expert.

2. The production of dressed clay for local craftsmen should be continued as follows:

Component	Body 250	Body 400
Milled green clay	75%	60%
Grog fired to 950°C	25%	40%

3. The production of glazed and unglazed façade tiles should be continued using body 250 for pugging. Advertisement of these products should be started and the public should be shown how they can be used in practice.

4. The following equipment should be ordered immediately:

Item	Approximate cost (£M)
Hydraulic Fulgor press for the production of flower pots	6,100
Raisman friction press for mosaics	1,400
Edge runner mill MKS 800	1,053
Vertical bucket conveyor	1,075
Vibrating sorters	921
Two moulds for mosaics	600
Conveyors (5)	3,000
Material for kiln firing flower pots	8,000

5. The roofs of the huts should be repaired in order to prevent rain-water leaking on the machines.

6. The draft project document for follow-up action prepared by the expert should be approved and submitted to UNDP through the office of the resident representative in Geneva for further consideration.

7. The plant should be supplied with blue clay (about 100 tons) before the rainy season begins. The clay requires three to four months of drying before being used in production.

Annex I

PRICE CALCULATIONS FOR CLAY TYPES

A. Clay no. 250L

Direct labour	Time required (hours)		
Clay milling (750 kg)	4		
Grog milling (250 kg)	2		
Ball mill charging	1		
Ball mill discharging	1		
Blunger charging	1		
Blunger discharging	1		
Filter press preparation	2		
Filter press discharging	2		
Extra reserve	2		
Total	16	hours = 2 work days 2 (days) x £M 4.00	£M 8.00

Direct materials	£M	
750 kg of clay	1.50	
250 kg of grog	6.00	
	7.50	£M 7.50

Power requirements

Edge runner mill	7.5 kWh x 6 = 45 kWh	
Ball mill	5.5 kWh x 8 = 44 kWh	
Blungers	2.5 kWh x 3 = 7.5 kWh	
Filter press	2.5 kWh x 3 = 7.5 kWh	
Extra reserve	11.0 kWh	
	115.0 kWh	
Cost	115.0 kWh x 0.02	£M 2.30

Water

2 (tons) x £M 0.03 — £M 0.06

Depreciation

For the edge runner mill, ball mill, blungers and filter press, the depreciation was estimated at £M 5.00 per ton — 5.00

Total — £M 22.86

Gross profit

25% of total — £M 5.72

per ton Total — £M 28.58

B. Clay No. 250P

Direct labour	Time required (hours)	
Clay milling (750 kgs)	4	
Grog milling (250 kgs)	2	
Ball mill charging	1	
Ball mill discharging	1	
Blunger charging	1	
Blunger discharging	1	
Filterpress preparation	2	
Filterpress discharging	2	
Pugging and de-airing	4	
Wrapping	2	
Extra reserve	2	
Total	22 hours = 2.75 work days 2.75 (days) x £M 4.00	£M 11.00

Direct materials

	£M	
750 kg of clay	1.50	
250 kg of grog	6.00	
Polythene covers	0.40	
	7.90	£M 7.90

Power requirements

Edge runner mill	7.5 kW x 6 =	45 kWh
Ball mill	5.5 kW x 8 =	44 kWh
Blungers	2.5 kW x 3 =	7.5 kWh
Filter press	2.5 kW x 3 =	7.5 kWh
Pug mill	20 kW x 1.5 =	30.0 kWh
Extra reserve		11.0 kWh
		145.0 kWh

145.0 x 0.02 £M 2.90

Water

2 (tons) x £M 0.03 £M 0.06

Depreciation

For the part of the equipment used, the depreciation was estimated at £M 5.00 £M 5.00

Total £M 26.86

Gross profit

25% of total £M 6.72

per ton Total £M 33.58

C. Clay No. 400L

Direct labour	Time required (hours)	
Clay milling (600 kgs)	3	
Grog milling (400 kgs)	3	
Ball mill charging	1	
Ball mill discharging	1	
Blunger charging	1	
Blunger discharging	1	
Filter press preparation	2	
Filter press discharging	2	
Extra reserve	2	
Total	16 = 2 work days 2 (days) x £M 4.00	£M 8.00

Direct materials

	£M	
600 kg of clay	1.20	
400 kg of grog	9.60	
	10.80	£M 10.80.

Power requirements

Edge runner mill	7.5 kWh x 6	= 45 kWh
Ball mill	5.5 kWh x 8	= 44 kWh
Blungers	2.5 kWh x 3	= 7.5 kWh
Filter press	2.5 kWh x 3	= 7.5 kWh
Extra reserve		11.0 kWh
		115.0 kWh

115.0 kWh x 0.02 £M 2.30

Water

2 (tons) x £M 0.03 £M 0.06

Depreciation

For the part of the production equipment, used the depreciation was estimated at £M 5.00 £M 5.00

Total £M 26.16

Gross profit

25% of total £M 6.54

Total per ton £M 32.70

D. Clay No. 400P

Direct labour	Time required (hours)	
Clay milling (600 kgs)	3	
Grog milling (400 kgs)	3	
Ball mill charging	1	
Ball mill discharging	1	
Blunger charging	1	
Blunger discharging	1	
Filter press preparation	2	
Filter press discharging	2	
Pugging and de-airing	4	
Wrapping	2	
Extra reserve	2	
Total	22 = 2.75 days	
	2.75 days x £M 4.00	£M 11.00

Direct materials

	£M	
600 kg of clay	1.20	
400 kg of grog	9.60	
Polythene covers	0.40	
	11.20	£M 11.20

Power requirements

Edge runner mill	7.5 kW x 6 = 45 kWh	
Ball mill	5.5 kW x 8 = 44 kWh	
Blungers	2.5 kW x 3 = 7.5 kWh	
Filter press	2.5 kW x 3 = 7.5 kWh	
Pug mill	20 kW x 1.5 = 30.0 kWh	
Extra reserve	11.0 kWh	
	145.0	
	145.0 kWh x 0.02	£M 2.90

Water

2 tons x £M 0.03	£M 0.06

Depreciation

For the part of the equipment used, the depreciation was estimated at £M 5.00	£M 5.00
Total	£M 30.16

Gross profit

25% of total	£M 7.54
Total per ton	£M 37.70

II. DRAFT PROJECT DOCUMENT ON INDUSTRIAL PRODUCTION OF CLAY AND CERAMICS

A. Background and supporting information

Justification for the project

The "blue clay formation" found in the northwestern part of Malta and on Gozo has attracted the interest of the Government as a possible basis for industrial manufacture.

So far four short-term missions have been undertaken in connection with the establishment of a ceramic industry in Malta. The first mission was actually a one-month exploratory mission to decide if the local blue clay which was expected to be the basic material is suitable for any building material and ceramic production. The second mission (three months) was intended to obtain further information. Clay deposits suitable for mining were selected and core drilling and clay samples testing recommended. A beginning was made with the establishment of a ceramic pilot plant. A hut at Ta'Qali was provided by the Government to serve as a building. The plant layout has been prepared. The project was extended for approximately eight more months. By this time (third mission) the locally available machines as well as newly ordered machines were set up and assembled. The pilot plant, although not fully equipped, was able to start the large-scale trials. During the fourth mission, the large-scale trials were made and it was proved that production of dressed clay for local craftsmen, of glazed and unglazed façade tiles, of glazed interior tiles and of flower pots, is possible on an industrial scale if a few more machines and an oil fired kiln are supplied to the plant.

Institutional framework

The Government co-operating agency for the project is the Department of Industry of the Ministry of Industry, Agriculture and Fisheries. Adequate provision has been made by this Department for premises, counterpart staff, administrative support, personnel, expendable and non-expendable equipment, and operation and maintenance of equipment. Details are given in the project budget covering Government inputs.

The project will be carried out in close co-operation with the Malta Development Corporation, which is responsible for assistance to aided industries - large and medium size - and for export promotion measures.

Provisions for Government follow-up

The project will start with the setting up of a four-chamber kiln for firing flower pots and with the repair of the existing tunnel kiln. The production of dressed clay for craftsmen and flower pots should start as soon as the flower pot press is set up. The production of mosaic may also start on an industrial scale immediately when the moulds are available. The production of glazed and unglazed façade tiles and of wall tiles should increase slowly together with the training of labourers.

In view of the Government's interest in establishing a ceramic industry, it can be expected to give its full support in the implementation of the project.

Other related activities

The project is also expected to support the position of local ceramic craftsmen through the supply of a correct body composition and in this way to reduce or stop the import of clay from abroad.

Future UNDP assistance

Probably no further follow-up project will be necessary since the factory will be transferred to the Government in full running condition. Only a simple project will be useful to help the local management to run the factory when this project ends.

B. Objectives of the project

Long-range objectives

The project is intended to provide all the necessary assistance for the full-scale annual production of 500,000 flower pots of different diametres, 12,500 m^2 of wall and façade tiles and mosaic per year, and 52 tons of clay for craftmen per year, which in turn will create about 30 new employment possibilities, make optimum use of local natural resources and lead to a substitution of imported flower pots and glazed wall tiles and partly also floor tiles, thereby saving foreign exchange for the country. It is also expected that new ceramic products such as glazed, decorated and unglazed façade tiles will enrich the local market.

Immediate objectives

The project's immediate objectives are as follows:

(1) To establish a plant laboratory for the basic testing of ceramic raw materials and products, such as water absorption, porosity, shrinkage, screen analysis, Harkort test etc.;

(2) To start with the production of flower pots on industrial scale using only local raw material. The production should be about 500,000 flower pots per year;

(3) To build a four-chamber kiln oil-fired up to a firing temperature of 1100°C and of such a size as to be able to fire 550,000 flower pots (with an average diametre of 15 cm) per year;

(4) To rebuild the tunnel kiln in order to give a smooth performance when wall tiles are fired in it. The guide edges are worn out, and this causes the kiln to jam during operation and the wall tiles are damaged;

(5) To start with the production of glazed and unglazed façade tiles, with the production of mosaic and of glazed decorated wall tiles on an industrial scale using the body tested in large-scale trials. Production should be about 12,500 m^2 per year;

(6) To train local staff in ceramic technology and production, thus enabling them to operate the plant efficiently when the Government takes over after completion of the UNIDO project.

This project has a direct investment potential.

C. Work plan

Description of project activities

Project activities	Location	Proposed duration and starting date
Establishment of a technological laboratory for testing of drilled clay samples and clay products, including equipment procurement through UNDP/UNIDO	Vienna and Valletta	6 months April - September 1979

Project activities	Location	Proposed duration and starting date
Chemical and technological testing of drilled clay samples in the locally established laboratory and in the Standard Laboratories	Msida and Ta'Qali	3 months June - August 1979
Evaluation of the clay deposit according to results obtained for the production of flower pots, façade tiles, mosaic and glazed wall tiles	Msida and Ta'Qali	2 months September-October 1979
Specification of additional equipment and other facilities required for the ceramic pilot plant and procurement of equipment through the Malta Government and UNDP/UNIDO	Vienna and Valleta	6 months including April 1979
Installation of the newly procurred equipment supplied through the Malta Government and UNDP/UNIDO	Ta'Qali	3 months April - June 1979
Installation of a four-chamber kiln oil-fired for the industrial production of flower pots and façade tiles, including a few initial firing trials	Ta'Qali	6 months April - September 1979
Re-building of the electric tunnel kiln in order to replace the worn-out guide bricks necessary for proper pushing of slabs, including a few initial firing trials	Ta'Qali	6 months April - September 1979
Full-scale industrial production of flower pots of different diametres or façade tiles according to market demand	Ta'Qali	24 months September 1979 - September 1981
Full-scale industrial production of glazed mosaic (different designs)	Ta'Qali	22 months November 1979 September 1981
Full-scale industrial production of glazed and decorated wall tiles	Ta'Qali	18 months April 1980 - September 1981

Project activities	Location	Proposed duration and starting date
Theoretical and practical training of local staff in the plant in ceramic technology	Ta'Qali	30 months April 1979 September 1981
Practical training of a local fitter who will be responsible for the maintenance and greasing of all machines and equipment	Ta'Qali	12 months June 1979 - June 1980
Mid-term review of the project with the assistance of UNDP and/or UNIDO staff members	Valletta Ta'Qali	2 weeks October 1979
Post-graduate course of one chemical engineer (BSc) in ceramic and heavy clay technology	British or American University	22 months October 1979 - August 1981
Assistance in a follow-up UNDP/UNIDO project if necessary	Valletta	1 months January 1980

Description of UNDP inputs

(a) Assignment of international staff

(i) Expert in ceramic technology (team-leader)

The expert should be a chemical or ceramic engineer with considerable practical experience in research and development as well as manufacture of a wide range of ceramic products such as flower pots, façade tiles, mosaic, glazed wall tiles etc. He should also have some experience in preparation of feasibility studies.

The expert will begin his mission on 1 April 1979 for a period of $2\frac{1}{2}$ years. The duty station will be the plant at Ta'Qali;

(ii) Expert in maintenance of ceramic machines

The expert should be a skilled fitter with a broad experience in maintenance and greasing of different ceramic machines. He should be specially trained in maintenance of wall tiles presses (mechanical-hydraulic with nitrogen filling) and pug mills, glazing machines etc;

The expert will arrive on or about 1 September 1979 for a period of 12 months. The duty station will be the plant at Ta'Qali;

(iii) Associate expert in ceramics

The associate expert should be a chemical or ceramic engineer with some practical experience in ceramic laboratory work and/or production technology. He will assist the team-leader in day-to-day work in the laboratory and the plant, with emphasis on close collaboration with the local staff for the purpose of on-the-spot training.

The expert will arrive on or about 1 April 1979 for a period of $2\frac{1}{2}$ years. The duty station will be the plant at Ta'Qali;

(iv) Unspecified consultancy

A provision for six man/months of unspecified consultancy is made in anticipation of requirements for specialized assistance in such fields as moulds preparation, silk screens production etc., to be determined later depending on the problems which may appear during the project;

(v) Staff member travel

A provision for a total of $1\frac{1}{2}$ man/months is made to allow for the participation of UNDP and UNIDO staff members in a mid-term review as well as assistance in preparing follow-up activities, if necessary;

(b) Provision for subcontractual services

A subcontract at an estimated cost of $US 25,000 for supervising the installation of a four-chamber oil-heated kiln (plans and drawing of the kiln in section D below) as well as reconstruction (ro-building) of the electrically heated tunnel kiln should be covered by UNDP;

(c) Training provisions

To fill the present gap caused by the absence of local staff trained in ceramics, the following fellowships will be provided:

(i) One fellowship of 22 months duration starting as soon as possible (probably in September-October 1979) for studies at post-graduate level in ceramic engineering to be taken at an institution of international repute where the instruction is in English;

(ii) One fellowship of six months in ceramics testing, quality control and silk screen techniques;

(iii) A provision for two man/months is made to allow the Government of Malta to participate and become acquainted with the basic ideas about the production and the machinery as well as the organization of a ceramic plant;

(d) UNDP inputs of supplies and equipment

Non-expendable equipment

	Cost ($)	Delivery date
Project car	5,000	April 1979
Laboratory equipment (see table 1)	13,790	
Pilot plant equipment (see table 2)	7,877	
Office and training equipment	1,000	April/June 1979

Expendable equipment

Various imported glazes, gummed paper, silk screens, chemicals, saggers etc.	5,000	As required

Description of Government inputs

(a) Assignment of national staff

(i) Suitable host-country staff will be provided to take responsibility for the plant and laboratory. Initially, however, this staff will be partly away from Malta on fellowship training.

(ii) A skilled fitter will be provided for maintenance and greasing of production machines and equipment.

(iii) Skilled labour and technicians will be provided to the laboratory and plant as required.

(iv) The necessary secretarial and other services will be made available at the time of arrival of the team-leader for use as required.

(b) Government inputs of supplies and equipment

(i) For the raw material survey a suitable core drilling machine with necessary accessories will be provided.

(ii) The project laboratory will be accomodated in suitable premises to be provided by the Ministry of Industry.

(iii) A suitable building with neccssary service facilities is provided (two huts at Ta'Qali) to house the ceramic plant. However, it is still necessary to repair the roofs of the huts and stop any leakage of water when it rains.

(iv) Any laboratory and production equipment presently available in the plant as well as newly procured machinery and equipment will be at the disposal of the project. This equipment is listed in tables 3 and 4 below.

(v) The project will have the full support of the Government of Malta. For this reason the Government will nominate its representative who will have full responsibility for clearing problems which may appear during implementation of the project.

(vi) The raw-materials will be supplied (namely local clay which requires a long time for drying) in time.

Table 1. Non-expendable laboratory equipment supplied by UNDP

Item	Quantity	Description	Estimated price ($US)
1	1	Laboratory steel mould for 10 cm x 4 cm x 2 cm briquettes	20
2	1	Laboratory steel mould for cylinders 60 mm in diameter	20
3	2	Set of standard sieves with vibrator	1,100
4	2	Andreasen apparatus for particle size testing	50
5	1	Electric kiln heating up to 1350°C, Sillite elements, 30 cm x 25 cm x 40 cm	5,000
6	3	Set of spare Sillite elements for item 5	1,200
7	1	Cutting saw for sample preparation with 50 spare cutting discs	2,500
8	1	Laboratory dryer heating up to 250°C (50 cm x 30 cm x 30 cm minimum)	1,500
9	1	Automatic laboratory balance, sensitivity from 0.01 g up to 0.5 kg	800
10	1	Automatic laboratory balance, sensitivity from 0.1 g up to 3 kgs	600
11		Laboratory glass, chemicals etc.	1,000
		Total	13,790

Table 2. Non-expendable production plant equipment supplied by UNDP

Item	Quantity	Description	Estimated price ($US)
1	1	Hand-operated friction press for mosaic pressing, Raisman type (available second-hand after overhaul from Pragoinvest, Czechoslovakia)	3 272
2	3	Different mould for item 1	2 145
3	1	Edge runner mill type MKS 800, dry process with 3 mm screen (available second-hand after overhaul from Pragoinvest, Czechoslovakia)	2 460
		Total	7 877

Table 3. Non-expendable laboratory equipment supplied by the Government

Item	Quantity	Description	Estimated price ($US)
1	3	Laboratory tables	600
2		Glass and chemicals available locally	2 000
3	1	Equipment for silk-screens production	3 000
		Total	5 600

Table 4. Non-expendable production plant equipment supplied by the Government

Item	Quantity	Description	Estimated price ($US)
1	1	Edge runner mill MK 600	1 500
2	1	Ball mill 'Constanze', Dorst	10 200
3	2	Tanks with propeller for mixing	3 252
4	2	Filter press with 70 discs (one not yet completed - 40 discs missing) and slurry pump	27 100
5	1	Horizontal vacuum press with mixer and spare parts	48 780

Item	Quantity	Description	Estimated price ($US)
6	2	Wall tile press, 610B Thuringia	12 000
7	1	Vibratory sieve	600
8	1	Cutting machine, Riwani	2 710
9	1	Stationary kiln	9 485
10	1	Tunnel kiln heating up to 1000°C (needs re-building) with pusher (see item 18)	40 650
11	1	Glazing machine complete with silk screening decoration equipment	27 100
12	1	Vertical bucket conveyor (not yet ordered)	2 511
13	1	Vibrating sorter for screening of wall tiles pressing powder (not yet ordered)	1 580
14	1	Feeder for constant feeding of pugmill (not ordered)	1 580
15	1	Hydraulic press 'Fulgor' for pressing flower pots, set of moulds included (not yet ordered)	14 000
16	5	Conveyors (2 m x 8 m, 2 m x 10 m, 1 m x 5 m) (not yet ordered)	8 000
17		Installation costs for newly purchased UNIDO and Government machines (10% of the value)	2 285
18		Refractory bricks, manpower costs, steel frames and burners for newly installed four-chamber kiln and rebuilding of existing tunnel kiln	14 000
		Total	$US 227 333

D. Guidelines for contract specifications

The project "Ceramic and Clay Technology" was requested by the Government of Malta in June 1976 to follow-up a one month exploratory mission undertaken in November 1974.

A beginning has been made with basic testing of the local blue clay, and this has shown that the clay seems to be suitable for the production of flower pots, glazed and unglazed façade tiles, decorative fence items, and glazed floor and wall tiles when quartz is added to the body. The blue clay was also recommended after dressing as a replacement for imported clay for local craftsmen.

Progress has been made with the establishment of a pilot plant in a hangar provided by the Government at Ta'Qali. Machinery and other equipment valued at more than $US 250,000 have already been installed. With the existing equipment the following items have been produced in large-scale trials: 8,000 façade tiles, decorative fence items, 5,500 wall tiles, 11 tons of dressed clay for local craftsmen.

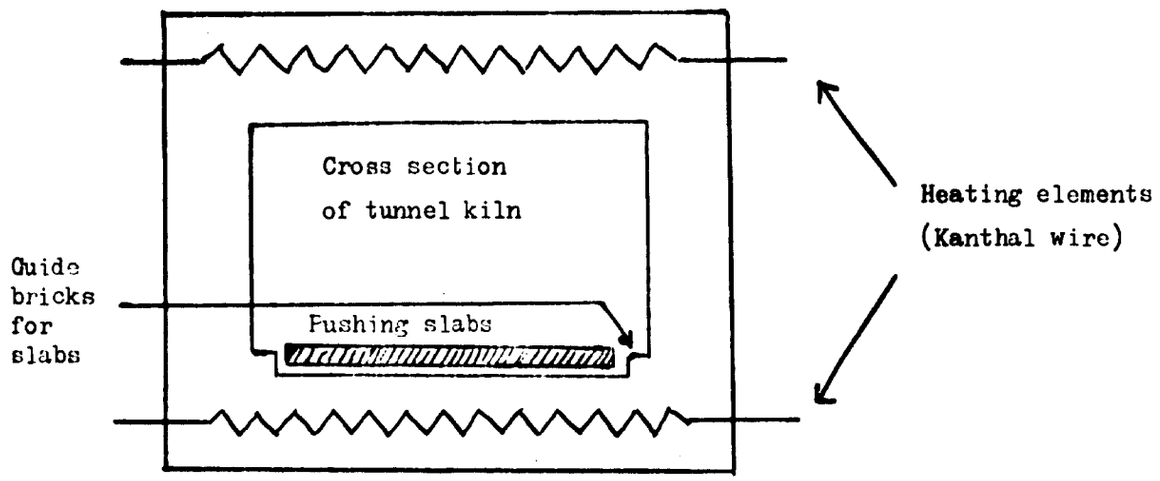
Flower pots have not been produced in the pilot plant because of the lack of pressing equipment and firing in an oil-heated kiln.

The existing equipment includes a tunnel kiln which has been found, during the no-load run test, to be so much worn out that it needs repair. However, all other machines and equipment gave a satisfactory performance.

Aim of the contract

The aim of the contract is to prepare the necessary drawings for a four-chamber oil-heated kiln (light oil, 950 sec Redwood 1), to supervise its installation and to start its operation. The capacity of the kiln should be 550,000 flower pots with a diameter of 15 cm.

The re-building of the existing tunnel kiln is also covered by this contract. The guide bricks for the pushed slabs are worn out and need to be replaced (see diagram below).



Description of activities

The supplier is expected to prepare the necessary drawings for a four-chamber kiln (chimney included) with a capacity of 550,000 flower pots 15 cm in diameter, to supervise its installation and start its operation. The maximum firing temperature is 1100°C. The supplier is also expected to rebuild the existing tunnel kiln, which means to replace the worn guide bricks for slabs with new ones, and, in particular, to perform the following tasks:

1. To calculate the size of the four-chamber kiln corresponding to the above-mentioned capacity and to prepare the necessary drawings, which should be done in such a way as to allow the use of locally available firebricks in the installation of the kiln. Channels and chimney should be included. The kiln should work in such a way that the waste heat will be transferred to the newly fired chamber (round firing).

2. To supervise the installation of the kiln by local masons. All the materials necessary for the installation will be available. Any necessary digging will be done before the superviser arrives. Drawings of the foundations and channels should therefore be sent to the Government of Malta in advance.

3. To organize the drying of the chamber kiln before industrial operations start.

4. To start industrial operation of the kiln and fire a minimum of five chambers to show that the kiln is able to achieve the planned capacity. Dry green products will be available for kiln loading in sufficient quantity.

5. To re-build the tunnel kiln in such a way that the worn-out guide bricks for the pushed slabs will be replaced by new ones.

During the erection of the chamber kiln and the re-building of the tunnel kiln co-operation with the UNIDO expert (team leader) is highly recommended because it is expected that many technical problems may arise and should be solved on the spot.

Tentative time schedule

1. The necessary drawings for the four-chamber kiln are expected to be supplied through UNIDO to the Government of Malta by 31 March 1979 at the latest.

2. The installation of the chamber kiln should be carried out in three months starting from 1 May 1979.

3. Drying of the kiln should be carried out during the month of August.

4. Industrial operations under the supplier's supervision are expected to be undertaken in September.

5. Re-building of the tunnel kiln should also be carried out during the supplier's period of supervision, which means from May to October 1979.

6. The supplier is expected to prepare in October 1979 a final report on his work in Malta. The final report should contain the drawings of the kiln and all the necessary information about firing performance, temperature curve etc.

Tentative budget

Item	Estimated cost ($US)
Preparation of necessary documentation for the four-chamber kiln	10,000
Six-month service (supervision of installation and re-building) on the spot	15,000
Total	25,000

E. Draft project budgets

Project budget covering Government inputs in kind

(Malta pounds)

Country: Malta

Title: Industrial production of clay and ceramics

Item	Total		1979		1980		1981	
	m/m	£M	m/m	£M	m/m	£M	m/m	£M
10. Project personnel								
Technical manager (shift engineer)	30	3 750	9	1 125	12	1 500	9	1 125
Secretary and typist	30	2 340	9	702	12	936	9	702
Technicians and laboratory and glaze preparation	30	2 340	9	702	12	936	9	702
Factory maintenance	30	2 580	9	774	12	1 032	9	774
23 labourers	690	59 340	207	17 802	276	23 736	207	17 802
Driver	30	2 580	9	774	12	1 032	9	774
19. Component total:	840	72 930	252	21 879	336	29 172	252	21 879
20. Subcontracts								
20-01 Subcontracting of drills (core drilling) for evaluation of technological reserves of the blue clay deposit	-	1 500	-	1 500	-	-	-	-
29. Component total:	-	1 500	-	1 500	-	-	-	-
30. Training								
33 in service training	-	300	-	100	-	100	-	100
39 Component total:	-	300	-	100	-	100	-	100

Item	Total		1979		1980		1981	
	m/m	£M	m/m	£M	m/m	£M	m/m	£M
40. Equipment and raw materials								
Raw materials	-	18 883	-	5 665	-	7 553	-	5 665
Supplies	-	10 263	-	3 079	-	4 105	-	3 079
Non-expendable equipment (see III and IV)	-	98 284	-	98 284	-	-	-	-
Expendable equipment (Power and fuel)	-	44 250	-	13 275	-	17 700	-	13 275
Premises	-	4 000	-	4 000	-		-	-
Rent for premises	-	2 000	-	600	-	800	-	600
49 Component total	-	177 680	-	124 903	-	30 158	-	22 619
Total		252 410		148 382		59 430		44 598

Because the factory will work for some time during implementation of the project in full industrial production, the following amounts (in £M) are expected to be recovered by the Government of Malta:

Full industrial production of flower pots during the period September 1979 -September 1981 2 x 62,500	125,000
Full industrial production of glazed wall tiles during the period April 1980 September 1981 1.5 x 28,800	43,000
Full industrial production of two tons of dressed clay per week (already in production)	7,800
Total (£M)	175,800
This means that real Government inputs will be: £M 252,410 - £M 175,800 =	76,610

Project budget covering UNDP contribution
(US dollars)

Country: Malta
Title: Industrial production of clay and ceramics

Item			Total		1979		1980		1981	
			m/m	$US	m/m	$US	m/m	$US	m/m	$US
10.	Project personnel									
	11	Experts								
	11-01	Expert in ceramic technology (Team leader)	30	132 000	9	39 600	12	52 800	9	39 600
	11-02	Expert in maintenance of ceramic machines	12	53 800	4	17 600	8	35 200		
	11-05	Consultancy	6	26 400	3	13 200	3	13 200		
	11-04	Associate expert	30		9		12		9	
	16-12	Staff travel		4 000		4 000				
	19	Component total	78	216 200	25	74 400	35	101 200	18	39 600
20.	Subcontracts									
	21-01	Kiln installation and tunnel kiln repair		25 000		25 000				
	29	Component total		25 000		25 000				
30.	Training									
	31	Fellowships								
	31-01	Ceramic engineering study	22	26 400	4	4 800	12	14 400	6	7 200

Item			Total		1979		1980		1981	
			m/m	$US	m/m	$US	m/m	$US	m/m	$US
	31-02	Testing and quality control	6	7 200	6	7 200				
	31 03	Government staff participation abroad	2	2 400	2	2 400				
	33	In-service training		3 000		1 000		1 000		1 000
	39	Component total	30	39 000	12	15 400	12	15 400	6	8 200
40.	Equipment									
	41	Expendable equipment		5 000		2 000		3 000		
	42	Non-expendable equipment (see tables 1 and 2)		21 667		21 667				
	49	Component total		26 667		23 667		3 000		
	99	Total		305 867		138 467		119 600		47 800

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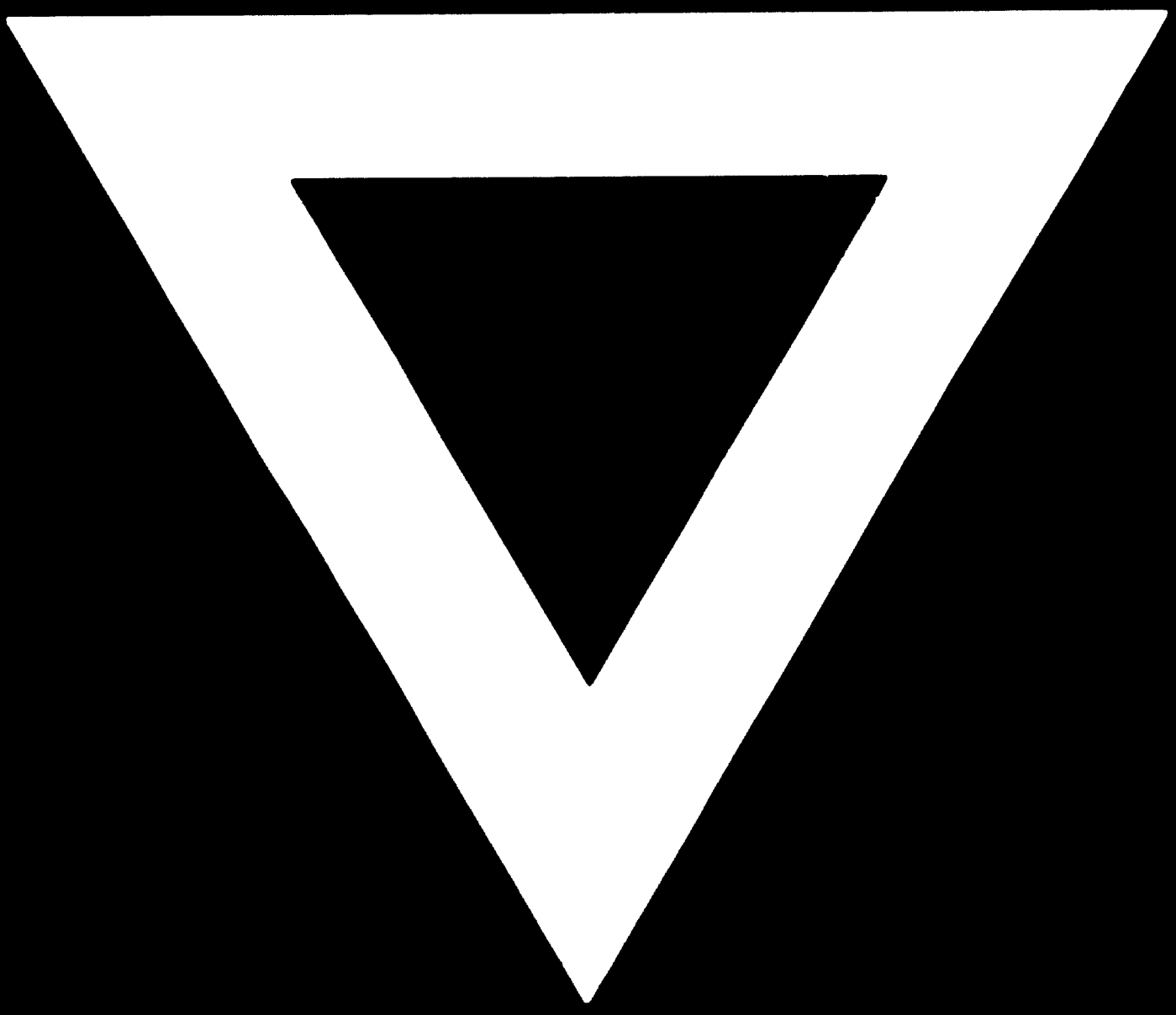

79.01.15