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EVALUATION OF THE FEASIBILITY OF A BRICK MANUFACTURING PLANT

SM/AFG/74/001

AFGHANISTAN,

TERMINAL REPORT,

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

United Nations Industrial Development Organization

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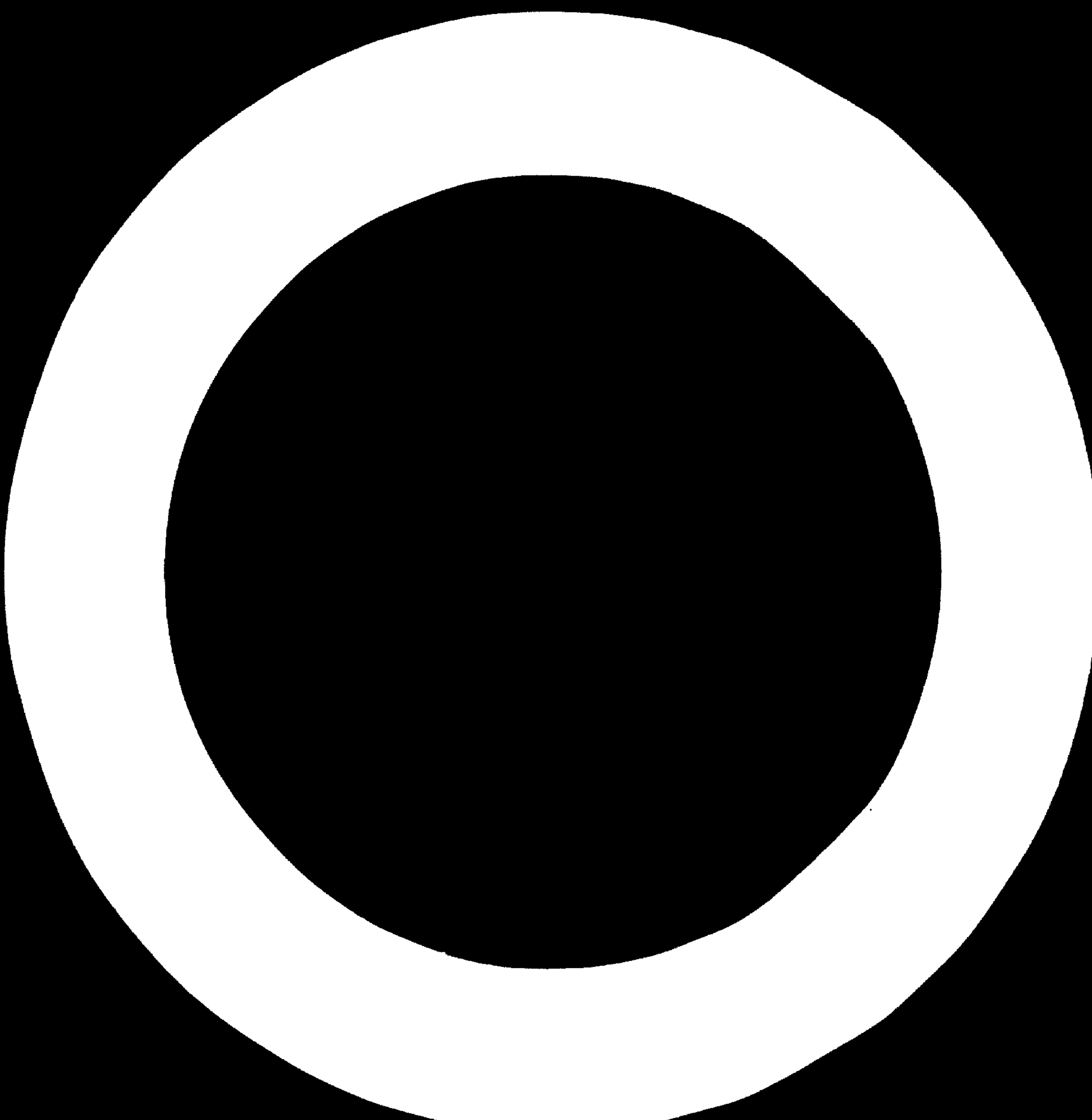

United Nations Development Programme

EVALUATION OF THE FEASIBILITY OF A BRICK MANUFACTURING PLANT

SM/AFG/74/001

AFGHANISTAN

Project findings and recommendations

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

Based on the work of M.F. Selim, expert in brick manufacture

United Nations Industrial Development Organization
Vienna, 1975

Explanatory notes

Reference to "tons" indicates metric tons.

Reference to "dollars" ($) indicates United States dollars.

The following exchange rate is used in the conversion of the country currency to United States dollars:

Currency	Exchange rate per US dollar in 1975
Afghani (Af)	45

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SUMMARY

The project "Evaluation of the feasibility of a brick manufacturing plant", No. SM/AFG/74/001 of the United Nations Development Programme (UNDP), was carried out from May to July 1975 by the United Nations Industrial Development Organization (UNIDO) acting as executing agency for UNDP. The UNDP contribution to the project was $11,000.

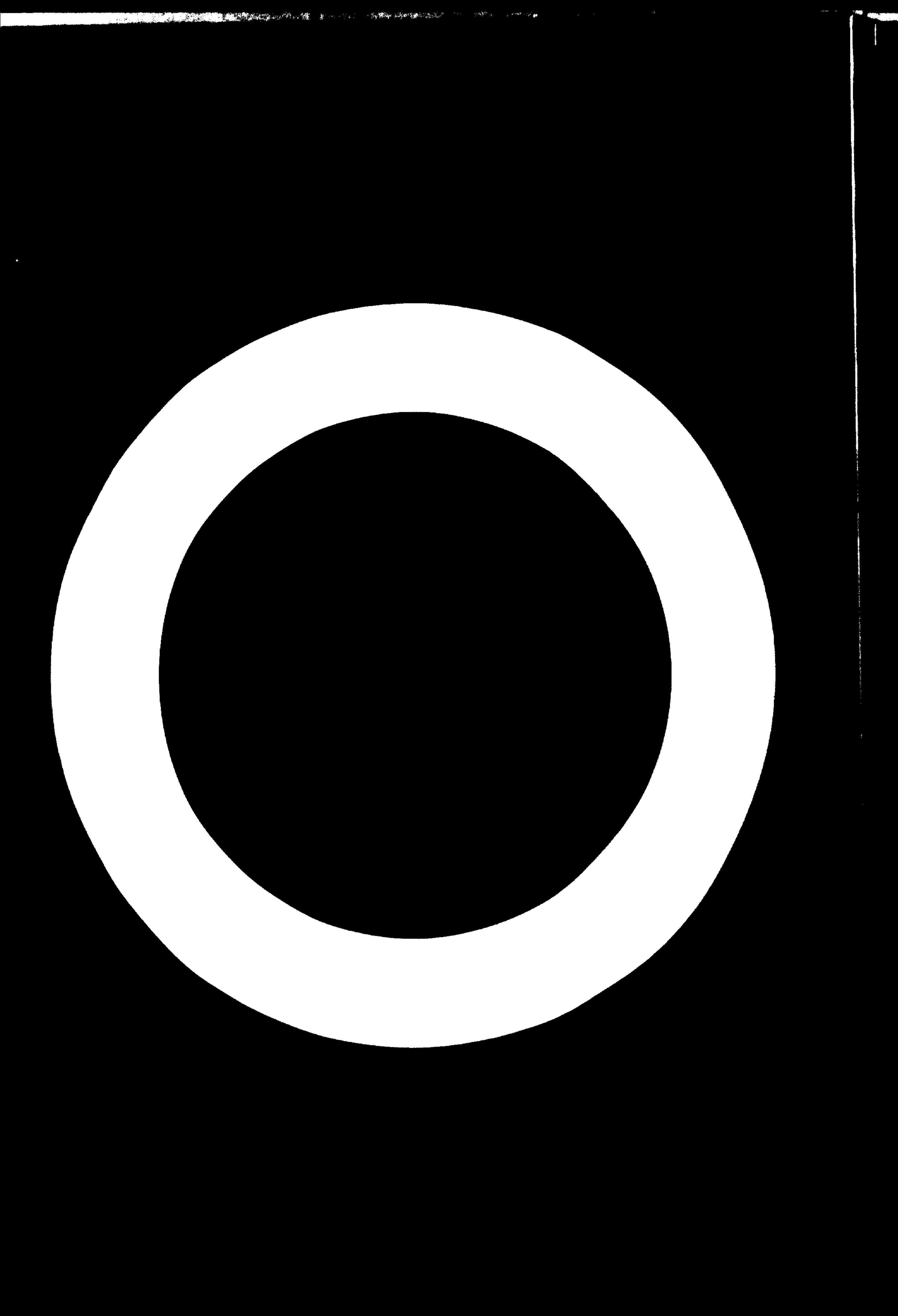
Clay deposits for making burnt building bricks exist in the Kabul area. Three clay deposits were examined where the possibility of establishing a brick plant exists, one near the prefabricated housing plant, the second near the Hochtief factory and the third near the factory of the Ministry of National Defence, about 20 km from Kabul. These clays, which are calcareous and easily disintegrate in water, with average acceptable plasticity and green strength, are not sensitive in drying and in firing. They are suitable for making solid and perforated bricks. Their suitability for making hollow blocks requires further investigation.

A preliminary feasibility study including the technical specification of the machinery and equipment needed is presented for a plant with a capacity of 20 million perforated bricks per year near the prefabricated housing plant. The total cost of this plant is about Af 156,175,000. The production costs per 1,000 bricks (brick size of 25 x 12 x 6.5 cm, weight about 3 kg) is about Af 1,000. The suggested selling price ex factory is about Af 1,200. These bricks are a little more expensive than the equivalent size of bricks manufactured in the private works. But they are better in shape, in compressive strength, in resistance to frost and in heat and sound insulation.

Market demand in the Kabul area for burnt clay bricks is not large. It can be covered by the existing private brickworks, the brickworks of the prefabricated housing plant, the Hochtief plant (when reopened) and the works belonging to the Ministry of National Defence.

Suggestions for the improvement of these works concerning quality, quantity and production costs are given.

However, in the near future the larger industrial brick plant will be a necessity if a higher housing standard is to be achieved within the greater Kabul area, although the required investment seems to be beyond the Government's capacity.



INTRODUCTION

According to available data, the present population of Kabul is about 1.2 million, and it is increasing annually, with the migration to the city included, by more than 2.5%. The total yearly increase is thus about 30,000 persons, or about 5,000 families. Preliminary studies reveal that 90% of the population belongs to the lower- or middle-income groups, which have difficulty in finding a shelter.

To meet the housing needs of the population of Kabul and to make sure that the dwellings are designed according to the general plan of the Authority for Housing and Town Planning and meet the needs of the people, the Authority has found it necessary to introduce the construction of semi-prefabricated houses. A factory of the Authority is able to provide the concrete materials in prefabricated form, and the only supply problem still remaining is to produce a sufficient number of clay bricks. The present output of traditional brick kilns is unable to meet the growing need for more bricks of better quality.

To satisfy an estimated additional annual demand of 20 million bricks of good quality, the Authority is at present evaluating the possibility of financing a brickmaking project from the United Nations Capital Development Fund. In view of the large amount of capital needed for establishing such a factory, the Ministry of Planning requested UNIDO assistance and advice on the feasibility of setting up the plant.

Following a request from the Government of Afghanistan, the United Nations Industrial Development Organization (UNIDO) appointed an expert in brick manufacture for a period of two and a half months, from 6 May to 20 July 1975. The job description in which the duties of the expert are set forth is given in annex I.

In addition to the assigned duties, the expert visited the clay brick factory in Mazar-i-Sharif as well as the glass factory and the fine ceramics factory in Kabul. The observations and recommendations related to these three plants are presented in annex XVIII.

The expert was attached by UNDP Kabul to the Department of Town Planning for the Provinces, under the Ministry of Public Works.

The counterpart officer, the Chief of the Building Laboratory of the Town Planning Department, worked alongside the expert during the assignment. He facilitated the meetings with the various authorities concerned especially through translation. Also he did his best to obtain information the expert needed.

I. FINDINGS

Clay deposits for brickmaking

Clay deposits for making burnt building bricks exist in the Kabul area. The expert examined three clay deposits near which a brick plant might be established, one near the brickworks of the factory for prefabricated housing elements beside the airport; the second near the Hochtief brick factory, closed at present; and the third about 20 km from Kabul where a brick factory of the Ministry of National Defence is located.

These clays, which are mainly light greyish brown and contain weathering products of the old rock, are calcareous, giving effervescence with HCl. Lumps of the clay easily disintegrate in water. Sieving shows that most of the clay passes through a 200-mesh sieve. Grains and stones remaining in the sieve upon visual examination show the presence of quartz, limestone or calcite, mica, gypsum and parts of mother rock. Little soluble sulphate is present as shown by BaCl test after leaching the clay with water. Loss on ignition is about 12%. Tempering water is about 20%, with acceptable plasticity and green strength.

The behaviour of these clays in drying and in firing indicates no sensitivity. Strength is developed at a temperature of about 1,000°C. The linear dry shrinkage is about 3.6%. The total shrinkage after firing is nearly the same as the dry shrinkage, i.e. the firing shrinkage is negligible. By suitably controlling the firing temperature, the time-temperature curve in firing and de-airing during shaping, the cold crushing strength of the fired bricks can be increased and the porosity decreased. The colour of the clay after firing is light brown or buff.

Industrial tests

The expert carried out industrial tests using the mass preparation unit in the brickworks of the prefabricated housing factory. It consists of a belt conveyer, double-shafted mixer with water spray, double-roller mill, extrusion machine without de-airing, followed by a manual cutting unit. Clays from the area near the airport and the area near the closed Hochtief factory were used for the manufacture of the bricks.[1/] The shaped bricks were fed back to the double-shafted mixer to obtain better homogenization before final shaping. After

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1/ The Ministry of National Defence was not interested in the industrial tests of its clays for building bricks.

drying, they were fired in an electric kiln in the Department of Engineering of Kabul University. These tests showed that elaborate equipment is not needed for making good-quality solid and perforated bricks from these clays. Annex II gives a description of the technology, annex III a general information flow sheet, and annex IV the specifications of the required machinery and equipment. As for hollow blocks, further investigation is needed (see annex V). Information on the clay samples prepared for further testing abroad is given in annex XVII.

In recommmending a manufacturing process, the expert took into consideration local conditions - the scarcity of capital and the availability of cheap labour. The soft-plastic process is preferable to the stiff-plastic process, which is usually used with automation or complete mechanization in developed countries. The stiff-plastic process needs more expensive machinery and equipment and fewer more highly skilled workers than the soft-plastic process. It also consumes more power and more fuel for artificial drying.

Shaping bricks mechanically has certain advantages over shaping them manually in wooden moulds, including the following:

(a) Higher output, more accurate shape and better specifications;

(b) Possibility of producing perforated bricks, which weigh less (less foundation work and lower manufacturing costs) and afford better insulation from heat and noise.

Since the evaporation of water in drying clay bricks consumes energy equal to or even greater than that needed for firing, it is suggested that for half the year natural drying on mobile shelves under sheds be used. During this period there is no rain, the temperature is relatively high and the humidity low, and sometimes the wind blows in the afternoon. The bricks can thus dry in two or three days.

For firing, continuous chamber kilns are suitable. Three Hoffmann chamberless kilns are suggested, for they can be built locally with a low investment. In the future when capital is available, worker skills have been developed and industrialization has advanced, these kilns can be replaced by car tunnel kilns. Also, coal for firing can be replaced by gas or liquid fuel when available.

Market demand

The demand for burnt-clay building bricks is limited mainly to the urban areas, including the Kabul area, with which this report is concerned. In view of the low standard of living and the low average per capita income in the rural areas and in some parts of the urban areas of Afghanistan, where one can easily get stones or unburnt brick, there is no market for fired-clay building bricks. Unburnt bricks cost about one tenth as much as fired ones and are used with clay mortar instead of the much more expensive Portland cement mortar. However, the risks are greater and the annual repairs more extensive for buildings made of raw clay bricks. A change in this situation will depend mainly on an increase in individual income and the availability of fuel, whether solid, liquid or gas, at a reasonable price.

There is no standard size of burnt-clay brick in Kabul, and the shape of the bricks is not exact. The perforated Hochtief brick previously produced had dimensions of about 23.5 x 11.3 x 6.6 cm and weighed about 2.3 kg. Fired bricks from private works at present have average dimensions of about 20-22 x 10-11 x 5-6 cm and weigh about 1.75-2.2 kg. Bricks produced in the factory of the Ministry of National Defence have dimensions of about 25-26 x 12-13 x 6-6.5 cm and weigh about 3.33 kg. Bricks produced in the factory of the prefabricated housing plant have dimensions of 26.5 x 12.5 x 7 cm and weigh about 4 kg.

The designed capacity of the Hochtief plant is reported to be 5 million bricks per year using a car tunnel kiln, top-fired with coal. The output of the plant of the Town Planning Department, according to the information given, was about 321,000 bricks in 1974; the designed capacity is reported to be 1.5 million bricks per year, which takes into consideration that for about half the year, i.e. during the winter and the wet season, this factory is closed (as are the private works).

The firing is in elliptic updraught shaft kilns called Dash, which use timber for fuel (see annex VI). These simple kilns are constructed mainly of raw clay bricks plastered with a mortar of clay and straw. This type of kiln is also used by all private works in Kabul for firing their clay bricks. The private kilns differ in capacity, which ranges from about 13,000 to about 45,000 large bricks. Naturally, if small bricks are used, the capacity (number of bricks) of the kilns will be larger. About 300 licensed kilns exist in the Kabul area, including the kilns used for firing limestone to obtain lime and for firing gypsum to obtain plaster of Paris. As the exact number of kilns firing limestone and gypsum is unknown, their number will be considered equal to that of the unlicensed kilns. The firing cycle in the big kilns lasts about 20 days and in the small kilns about 10 days. Based on an average of a 15-day firing cycle and about 150 days of operations per year, the kilns will be fired 10 times. With an average kiln capacity of about 30,000 standard-sized bricks, the total annual capacity is 30,000 x 300 x 10, or 90,000,000 bricks.

The capacity of these private works depends on the following:

Market demand

Availability of clay pit and water

Area for setting the bricks to dry in the sun after hand moulding in wooden moulds

Number of workers available

Number and capacity of the kilns

Availability of timber for firing

The quality of bricks produced is fairly good. The proper setting of bricks for firing in such kilns to a height of perhaps seven metres is an art. The acceptable workability and green strength and non-sensitivity in drying and in firing of the clays in the Kabul area are the major reasons for the low percentage of rejects no matter how rough the manufacturing process and handling of the bricks. This applies to the private works as well as to the works of the Town Planning Department. The favourable climatic conditions during the working season make it possible to shape and dry these bricks in the open air (see annex VII). Efflorescence is rarely noticed in brickworks in Kabul.

No exact figure is available concerning the present and projected demand for burnt-clay building bricks in Kabul. However, on the basis of an annual increase of about 2.5% (some authorities give it as 4.5%) for the population of Kabul and the Government's policy of removing city slums, about 3,000 new buildings will be required annually if the programme of the Ministry of Planning and the Municipality of Kabul is to be fulfilled. The number of apartments in each building can reach 20, with up to 6 rooms in each apartment. Each room requires 2,000-3,000 burnt-clay building bricks.

On the basis of these figures and of the above-mentioned capacity of the existing brick plants, a new plant with a capacity of 20 million bricks per year is justified as long as the sales price of these bricks is reasonable. Such a factory will produce perforated bricks, accurate in shape, better in compressive strength, lighter in weight, more effective in heat and sound insulation, lower in porosity and more resistant to frost than the bricks produced at present.

It is suggested that this new plant and quarry be located near the existing brickworks of the prefabricated housing factory (see annex VIII). In this area the ground is level, clay is present and there are two high-tension electric lines with excess capacity for the use of the factory. Ground water is available at a depth of less than 15 m. The area is accessible to the main road and is adjacent to Kabul. A drainage system is possible.

The Department of Town Planning started manual auger drilling to estimate the reserves of clay in the suggested quarry area of about 360,000 m^2. Nine holes 300 m apart were drilled to a depth of 6 m each. Samples were taken at every metre in depth. Clay came out in all the samples. However, the work was somewhat unsatisfactory and not completed, so the Department of Geological Survey was asked to bring a specialized crew with a power drill to finish the job. These samples are to be sent abroad, as soon as they are ready, for quick, simple tests to confirm the reserves.

Annex IX shows the suggested layout of the plant. The orientation of the plant has to take into consideration the direction of the prevailing winds during the year. Annex X gives the requirements for the raw material, the buildings and estimated costs.

Other factors covered by the feasibility study

Fuel

Timber

The plants manufacturing clay bricks in Kabul, apart from the closed Hochtief factory, use timber for firing their bricks. This practice is not suitable for a country in which the forests are limited and the rate of consumption of the forests is higher than the rate of reforestation. With the increase of population, the priority will be given to timber for heating dwellings in winter rather than for firing bricks, in the opinion of the expert.

Natural gas

Deposits of natural gas exist in northern Afghanistan, a long distance from Kabul. Natural gas is mainly exported by pipeline to the Union of Soviet Socialist Republics, and no possibility exists for transporting a part of it to Kabul economically. The amount of condensate produced is small and is expensive - Af 3.75/litre.

Crude oil

Despite exploration in the north since 1930, only one relatively small field has been discovered. There is no production at present.

Coal

Proved coal reserves in Afghanistan are estimated at 50 million tons and probable reserves at several hundred million tons. The main deposits are at four locations far to the north and north-west of Kabul. Production has fluctuated between 125,000 and 167,000 t/a in recent years. In the draft of the fourth plan, a modest production target of 180,000 t/a by 1975/76 has been set.

It is suggested that coal for the new brick factory come from the mines near the town of Dara-i-Soof, about 490 km north-west of Kabul. These are the best deposits, with a reported calorific value of about 7,800 kcal/kg. The pithead cost of production per ton is about Af 400-450 at Dara-i-Soof, but after addition of transport costs the selling price in Kabul is about Af 1,100.

The amount of coal needed for firing in the suggested plant is about 4,513 t/a, costing about Af 4,513,000 (see annex X).

Conclusion

The Government should undertake a thorough investigation of different sources of fuel in the country, whether gas, liquid or solid, that could be used for the future industrialisation of the country.

<u>Water</u>

Ground water is available in the Kabul area, including the area suggested for the factory. But an extended deficiency in precipitation in some years may result in severe scarcity. An artesian well with a pumping station and water tower is suggested as a means of providing the plant with water. The annual amount of water needed is about 18,780 tons (see annex X). Tests for the depth of ground water and possible rates of pumping should be carried out. The chemical analysis of this water is also important, especially for the boilers. In case of hard water, a water-treatment unit is suggested.

Electricity

In the area proposed for the factory, there are two high-tension electric lines, one at 110 kV and the other at 15 kV, that have excess capacity to cover the suggested factory's needs. The factory's requirement for electrical power is estimated at 500 kW, with annual consumption of about 1.5 million kWh costing about Af 1.5 million (see annex X). A stepdown transformer with a capacity of 500 kVA is suggested for stepping down from 15 kV to 380/220 V. An emergency source has not been taken into consideration, nor a compensation station for improving the power factor, for reasons of cost.

Drainage

A septic tank and a drainage well or drainage canal must be provided. It is estimated that the plant's 130 workers will each consume 50-100 litres of water daily. Industrial water will have to be drained. The levels at the ground around the factory and of its roads should be such that rain water can drain away easily from the factory.

Labour

Labour is plentiful in Afghanistan, but it is mostly unskilled. This has been taken into account in estimating manpower requirements (see annex XI). Training of capable personnel locally and abroad is essential (see annex XI). Once these technicians have been trained, it is important to retain them in their jobs. In an only partially mechanised factory, an incentive method or piece-rate system should be used and followed strictly to attain the required efficiency in production. It is simple to apply and is succesful in many developing countries.

Annex XI also gives the factory's requirements for expert services.

Project schedule

Annex XII gives a schedule of the project.

Capital outlay and operating expenses

Annex XIII gives data on capital outlay and on operating expenses. A summary is given below (afghanis).

Yearly manufacturing costs	Approx.	20,000,000
Income from sales		24,000,000
Yearly profit		4,000,000
Period of repayment of capital loan	=	$\frac{151,175,000}{4,000,000}$
	=	37.8 years

These figures are given as a guide. Exact figures will be arrived at after tendering and obtaining the offers, whether for the machinery and equipment or for the buildings.

The Government will provide the land and quarry, which are outside the Master Plan of Kabul, free of charge.

Although the rate of depreciation is usually taken as 10% for the machinery and equipment, in this industry it can safely be taken as 7%.

The factory will be exempt from taxes and duties.

The interest on the loan of the fixed capital will be 0.75% and on the circulating capital 8%. However, interest is not considered in calculating the manufacturing costs.

If tests prove that the clay is suitable for making hollow ceiling blocks, production of these blocks can be added as a new line. Hollow clay ceiling blocks will sell at a much higher price than the bricks and will compete with other types of roofing and flooring, e. g. reinforced concrete, timber and galvanized sheet-iron roofing, not only in its price but also in its properties. In these circumstances, the yearly profit of the project can be increased and hence the period for repaying the capital loan reduced.

One has to be careful in comparing prices per 1,000 bricks of different manufacturers. For example, the size of the bricks produced by one of the private works is about 20 x 10 x 5 cm (volume, 1,000 cm^3), with a selling price of about Af 550 ex works, while the size of the bricks of the suggested new plant is 25 x 12 x 6.5 cm (volume, 1,950 cm^3), with a selling price of about

Af 1,200. If the price of the equivalent volume of bricks from the private works is compared, it will be $\frac{550 \times 1,950}{1,000}$ = Af 1,072.5 per 1,000 bricks, i.e. there is not much difference in price, but the small bricks require more joints and more mortar in construction. They also need plastering, whereas bricks of the new plant can be used as facing bricks without plastering.

II. SUGGESTED IMPROVEMENTS IN THE EXISTING BURNT-CLAY BRICKWORKS IN KABUL

The manufacture of clay bricks in Kabul is carried out in:

Private works, where the bricks are shaped manually in wooden moulds

Brick factory that is part of the prefabricated housing plant of the Ministry of Public Works (mass preparation and shaping mechanized)

Brick factory of the Ministry of National Defence located about 20 km from Kabul

Hochtief factory (partially mechanized), which is closed for the time being

General

Standard-size and regular bricks (modular system)

The production of bricks of a standard size could be achieved if the Government established a department responsible for issuing the standard specifications similar to those bearing the reference ASTM, BSS or DIN for various products, including bricks. Legislation would be necessary requiring manufacturers to adhere to these standard specifications.

Fuel economy

The private works and the brickworks of the prefabricated housing plant use updraught shaft kilns in firing, where the consumption of fuel is high. To economize on fuel and to produce bricks of better quality, it is suggested that they use instead chamberless Hoffmann kilns with the following approximate dimensions (m): length, 30; width, 8; and height, 4. The kiln, representing an endless gallery or corridor, has a capacity of about 250,000 bricks (see annex XIV). The cross-section of the corridor is about 3.5 m x 3.5 m with 10 wickets, or doors, and 10 damper-controlled flue inlets that lead to the main flue and then to a chimney. Temporary paper partitions can be placed between each wicket and flue pair to divide the kiln into 10 chambers. Every day 25,000 bricks are loaded for firing, while another 25,000 fired bricks are unloaded. The travelling fire zone advances at the same rate. The kiln is fired with powdered coal through holes in its top. The construction of such a kiln is simple. It requires about 180,000 ordinary building bricks; the stack for one kiln requires about 20,000 bricks.

Hoffmann kilns are successfully used in Egypt and other developing countries for firing building bricks and, if properly lined, even some fire-clay refractories. Continuous chamber kilns are used and will continue to be used in most countries whenever feasible. Their fuel efficiency is nearly that of car tunnel kilns, and they are used where capital is limited, where labour is abundant and where high skill is not necessary.

Specific

The brickworks of the prefabricated housing factory began operations in 1965 under the supervision of the Central Authority for Housing and Town Planning. It is now under the direct supervision of the Ministry of Public Works. The manufacturing process in this factory is described below.

The clay is excavated from the clay area beside the factory. It is then fed manually to a belt conveyer that feeds a double-shafted mixer with a water spray. From the mixer it falls through a coarse double-roller mill and then through the extrusion machine without de-airing. The extruded column of clay is cut into bricks by a hand-operated cutting machine. These machines were acquired from the USSR. There are two units, only one of which is working. The output of each unit is about 1,000 solid bricks per hour. The bricks are set manually on rail cars and pushed to the open sheds, where they are set manually on wooden pallets for drying. After drying, which takes two or three days, they are set manually in a lorry and transported to the five updraught shaft kilns. The bricks are set manually in the kilns, or sometimes with the help of a crane in the case of the two larger kilns. Six days are required for setting, three for firing, four for cooling and six for discharging the big kiln with a capacity of 45,000 bricks. Two of these kilns are fired from two sides.

The output of the factory in 1974 was about 321,000 bricks, although the capacity of the plant is 1.5 million bricks per year. The general director pointed out to the expert that the figures represented the actual number of bricks needed for the prefabricated units that year. The output for 1975 will be about 200,000 bricks, i.e. an idle capacity of almost 1.3 million bricks per year.

The factory employs approximately 30 workers. The average monthly wage is Af 900. After the working season the workers are dismissed, and in the following season new workers are hired.

To increase efficiency and output, to improve quality, and to reduce production costs so that the selling price will be competitive with that of the private works, the following measures should be taken:

(a) The mouth of the two extrusion machines should be modified to produce perforated bricks as shown in annex XV. The weight of the brick will be 3 kg instead of 4 kg, which means reduced consumption of raw materials and fuel and higher output of the extrusion machines. The brick will also have better heat-insulation properties;

(b) The two shaping units should work on two shifts. Then the daily output would be 2 x 1,000 x 14 = 28,000 bricks, annual output, 28,000 x 300 = 8,400,000 bricks. If about 5% of the total is assumed to be rejects, annual output would be about 8 million bricks;

(c) The area of the open sheds for drying the bricks should be increased;

(d) One chamberless, Hoffmann kiln should be installed to replace the five updraught shaft kilns;

(e) The number of workers should be increased to about 50 and they should be employed all the year round. An incentive or piece-rate system should be introduced to ensure the quantity and quality of the output;

(f) A heating system should be arranged inside the works to be used in the winter for drying the bricks in chamber driers and warming the place of work;

(g) The capacity of the water tank and pumps should be increased;

(h) Manually pushed platform trucks should be used for transferring the dried bricks to the Hoffmann kiln.

Clay brick factory of the Ministry of National Defence

In the brick factory of the Ministry of National Defence, the clay is mixed with water manually in the clay pit to bring it to a soft plastic state. It is then shaped manually in sanded wooden moulds on the ground and left to dry in the open air, as is done in the private works. But firing is done mainly mainly in a sort of chamberless, roofless continuous kiln, the approximate dimensions of which are (m): length, 100; width, 6; and height, 3. The top of the kiln is level with the ground, i.e. the kiln is a corridor dug in the ground; a sheet-iron chimney a few metres long is used to create the draught in the kiln. The kiln is fired through holes in the top using pulverized coal as fuel. The reported capacity of the kiln is about 1 million bricks. The fire proceeds about four metres daily through 4 x 9 = 36 holes. The complete firing cycle takes about 52 days. Water needed for brickmaking is taken from an artesian well about 15 m deep by means of a pumping unit. The work is don[illegible] and. The brickworks operates from March to the end of July. The quality of the bricks is poor, with a high percentage of rejects.

To improve operation, it is proposed that continuous chamber kilns be used above the ground, specifically, four chamberless, roofed Hoffmann kilns each with a capacity of 250,000 bricks with a common brick or concrete chimney about 35 m high to ensure the correct natural draught for proper firing and hence better products with fewer rejects.

The Hochtief factory

Arrangements were made for the expert to visit the Hochtief factory on 3 July 1975. This factory is at present closed. It is to be turned over to the Government as a grant from the Hochtief company, but the formalities for the transfer have not been completed. Annex XVI shows the location of the factory in Kabul. The plant was opened by a committee and then closed again after the visit. Operations are described below.

The clay is brought by cars on rails (dumpers) and dumped into a circular tempering mixer, which also acts as a feeder. By a rubber belt conveyer the raw material is fed into a double-roller mill. The clay passing the roller mill is then taken by another belt conveyer to the single-shafted mixer of the de-airing auger machine. The extruded perforated column of clay is then wire-cut into bricks. The bricks are set manually on wooden pallets. The loaded pallets are taken by a manual finger-car on rails to the drying sheds. After drying, the pallets with the dried bricks are taken again by the finger-car to the tunnel kiln hall. The bricks are set manually on the tunnel kiln cars. The tunnel kiln is top-fired, using coal as a fuel and a forced-draught chimney. There is a well, a pumping unit and pressure tanks for supplying the plant with the needed water. Electric energy is supplied by a step-down transformer with a capacity of 250 kVA stepping down from the near-by 15 kV line to 380/220 V. The expert was unable to see the factory's small mechanical workshop or the department for mass preparation and shaping and was thus unable to see and evaluate the machines there.

The reported capacity of this plant is about 5 million perforated bricks per year. The plant operated for about half the year, i.e. the dry season, two shifts for the mass preparation and shaping and three shifts for the driers and the kiln. The quality of the bricks the factory produced was good. The plant was in operation for about 4 years; it has been closed for about 10. However, the machinery and equipment are in good condition and the expert believed it could start operating again easily. The expert was unable to determine the exact reason for closing the factory.

It would be easy for an expert assigned for a year to bring operations again to full capacity and train the personnel needed. The capacity of the plant could be doubled if arrangements for working the whole year instead of half the year were made. It would be necessary to add another unit for mass preparation and shaping, chamber driers with the necessary generators for heat for drying in the winter and wet season, and another car tunnel kiln. Space is available for the new buildings needed; the clay quarry seems adequate for this extension. However, reserves of clay should be confirmed by auger drilling.

III. RECOMMENDATIONS

1. The Government should investigate intensively the various sources of fuel in the country, whether gas, liquid or solid. It should discourage the use of timber for firing clay bricks. Timber is needed for more essential purposes.

2. Brick factories in the private and public sectors should use simple, continuous kilns to save on fuel instead of the updraught shaft kilns (Dash) used now. Drawings and instruction in building and operating such kilns should be provided free of charge.

3. The existing brickworks of the prefabricated housing factory should produce perforated bricks, and its capacity should be increased to about 8 million bricks. These bricks will not only be lighter in weight than those it produces at present, but also give better heat and sound insulation. Manufacturing costs will be lower and hence the selling price will be low enough so that the bricks will be competitive with those of the private works. The production goal is not only to satisfy the needs of the housing factory, but also to meet partially the needs of Kabul.

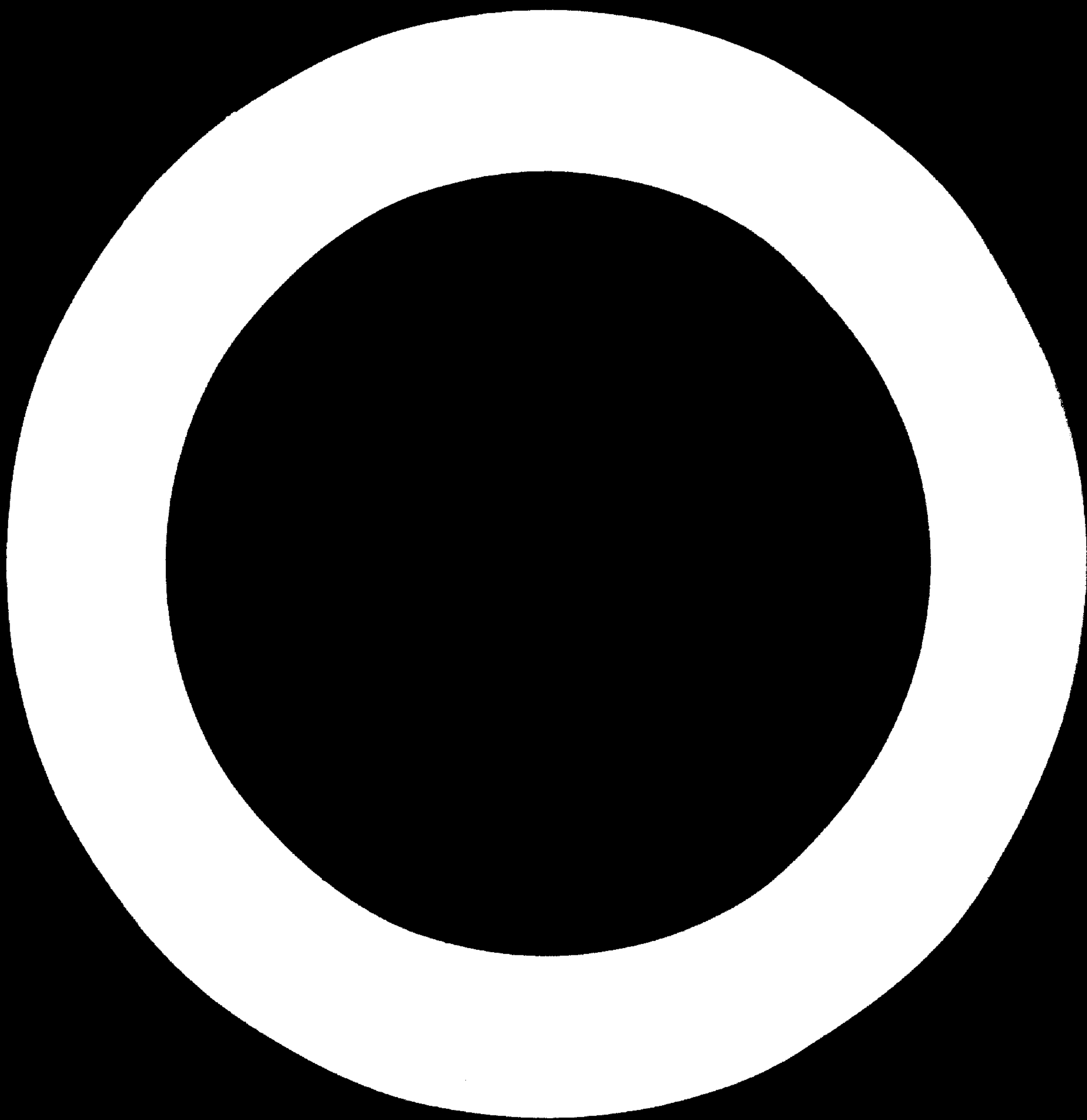
4. The Hochtief factory should be started up again. It uses superior technology (car tunnel kiln top-fired with coal, also the drying sheds and finger-cars).

5. The system of firing in the brickworks of the Ministry of National Defence should be changed. A continuous kiln above ground with a fixed chimney at least 30 m high to give a proper natural draught should be used. This change would ensure better quality of bricks and fewer rejects.

6. A proper incentive system or a piece-rate system for the workers in the government brickworks should be introduced.

7. The workers in the brickworks of the prefabricated housing plant, which should operate throughout the year, should be trained and be employed the whole year.

8. A new clay brick factory should be established, although the authorities might consider the terms of financing the project onerous. Such a factory is essential if the standard of living of the population of Kabul is to be raised.



Annex I

JOB DESCRIPTION

The expert will be attached to the Central Authority for Housing and Town Planning to assist in an evaluation of possibilities for establishing a brick plant. Specifically, the expert will be expected to:

1. Study all available reports on brick clay deposits and make a field assessment of the ones that seem to be most promising in respect of quality, quantity and location;

2. Plan and supervise a series of industrial performance tests (including shaping, drying, firing and quality control) on collected representative samples of clays to determine their suitability;

3. Evaluate the present and projected market for quality bricks on the basis of the existing housing and construction programme, giving special attention to the possible sales price of such bricks;

4. Prepare a technical specification for a brick plant (or a combination of plants) corresponding to the observed market and the availability of raw material, fuel, labour etc.;

5. Estimate the required capital investment and operating costs and perform a profitability analysis for the proposed plant;

6. Combine all the information gathered into a techno-economic feasibility study for the establishment of a brick plant, sufficiently detailed to allow the Government to take a realistic decision on the future development of the brick industry.

Annex II

DESCRIPTION OF TECHNOLOGY FOR THE PROPOSED BRICK PLANT

An excavator piles up in horizontal layers a three months' supply of clay. The clay is then dumped by dumpers or tilting box trucks into the box feeder, which feeds continuously the raw material to the preparation line and also chops up large lumps of clay. Since the clay contains impurities harmful to production - quartz, limestone or calcite and other parts of mother rook - they are removed in a stone-separating roller mill. Two differential roller mills follow, one coarse with a gap between the rollers of 4-2 mm, the second fine with a gap of 1-0.5 mm between the rollers for grinding impurities present in the raw material. To ensure a flat surface on the fine roller mill, a grinding machine is provided. The material then passes into a double-shafted mixer, where it is moistened with water, mixed, kneaded and homogenised. (An alternative is an edge runner mill (wet pan mill) followed by a circular tempering mixer instead of the coarse roller mill and the double-shafted mixer.)

From there the material falls into the mixing unit of the de-airing extrusion machine. The steam heating used increases the workability of the clay and aids in bringing water from the inside to the surface of the extruded bricks during the initial stage of drying. The mass is de-aired and extruded by the worm through the orifice (die with fingers) of the extrusion machine. The extruded, perforated column is automatically cut to the required lengths. The individual perforated bricks are put on wooden frames and then into a multicolumn loader. The wooden pallets with the bricks on them are then taken off by a finger-car on rails and pushed manually to the drying sheds, where the wooden frames with the bricks are reset on supports. During half the year, i.e. the dry season and the summer, natural drying is used. During the other half of the year, i.e. the winter and the wet season, drying in drying chambers using steam for heating is suggested. The finger-car on rails feeds these chambers with the bricks on pallets for drying. Beneath the track in every chamber ribbed heating pipes are installed through which steam from the boiler plant flows. The hot air, temperature about 60°C, rises in the ribbed heating pipes, flows around the moulded bricks and takes out the pore water. The resulting water-vapour-air mixture is conducted into the open air via slide valves provided in the ceiling of the chamber and an exhaust air vent. The air flow is supported by ventilators.

The drying process takes place in 3 phases:

(a) Heating up the bricks with closed slide valves;

(b) Preliminary drying with slide valves partially open;

(c) Drying out the residual moisture with the slide valves fully open. Drying takes about 48 hours, with the time of these three phases adjusted to suit the raw material.

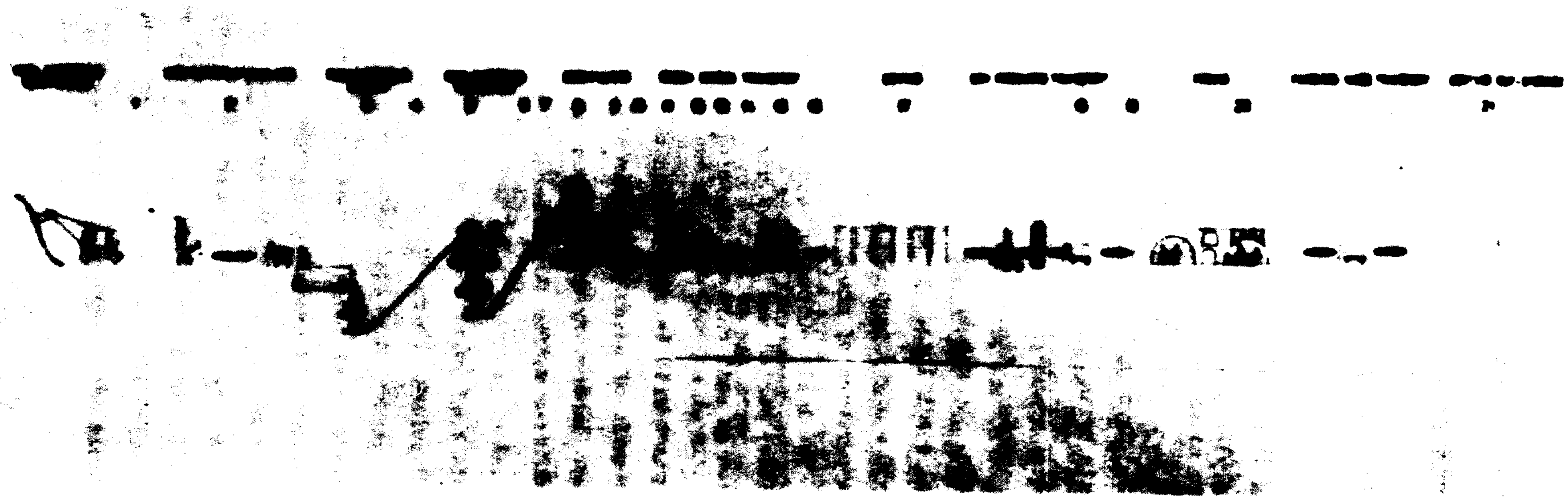
This system of steam drying is suggested because of easy maintenance and no operating troubles, i.e. no drying problems for the product. However, hot-air drying can also be used.

After drying, which takes 2-3 days under sheds, the wooden frames with the bricks on them are taken again by the finger-car to the frame collector. Here the bricks are placed manually on platform trucks and taken direct to the empty chamber of the continuous chamber kiln, e.g. Hoffmann kiln. The Hoffmann kiln is easy and cheap to maintain. It can be operated by workers who are not highly skilled, which suits local conditions. Three Hoffmann chamberless kilns (with a common chimney about 35-50 m high) each with a capacity of 250,000 bricks are suggested for firing at a temperature of about 1,000°C by using pulverized coal from the top of the kilns. The daily output of each kiln is about 25,000 bricks. The fired bricks are either sorted and loaded directly into trucks or lorries for the consumer, or taken on rail cars to the product stores.

The proposed manufacturing plant will be operated on the basis of a standard six-day work week, a single work shift of seven hours for administration, excavation, auxiliary departments, i.e. laboratory and workshops; two shifts for mass preparation and shaping; and three shifts for driers, kilns and boiler house.

Annex III

INFORMATION FLOW SHEET FOR BRICKMAKING PLANT, KABUL



1. Bucket excavator
2. Dumper
3. Box feeder
4. Stone-separating roller mill
5. Belt conveyer
6. Edge runner mill
7. Circular feeder
8. Slat conveyer
9. Fine roller mill
10. De-airing extruder
11. Automatic cutter
12. Belt conveyer
13. Pallet loader
14. Heap trans-car
15. Transfer platform
16. Electric transfer car
17. Drying chamber
18. Frame collector
19. Three-wheel platform trucks
20. Circular kiln
21. Burnt bricks pile

Annex IV

SPECIFICATIONS OF THE MACHINERY AND EQUIPMENT

Item No.	No. of pieces	
Quarrying		
1	1	Universal power shovel excavator with diesel engine for the exploitation and loading of loose raw material (clay). Shovel capacity 1 m^3 Diesel engine output 120 hp
Mass preparation		
2	3	Dumper or tilting box trucks for the transport of clay to the box feeder, capacity 6 t each
3	1	Box feeder, capacity 8 m^3 with electric motor 7.5 kW for uniform feeding of raw material. Output infinitely variable up to 20 m^3/h fitted with a chopping-up device at the outlet of the feeder
4	1	Stone-separating roller mill consisting of one smooth roller and one with grooves (worm), the rollers rotating in opposite directions at different speeds, output about 15 m^3/h with electric motor about 14 kW
5		Slat belt conveyer, width 600 mm, length 8,500 mm, complete with motor 2.2 kW, capacity about 15 m^3/h
6 ✓		Edge runner mill (wet pan mill), capacity about 15 m^3/h, runner diameter about 1,800 mm, width about 500 mm, power requirement about 40 kW
10 ✓		Circular tempering mixer collector, plate diameter about 3,000 mm, discharge worm diameter about 600 mm, capacity about 15 m^3/h, power consumption about 3 kW
6		Differential roller mill for coarse crushing, opening between rolls about 4 mm, output about 15 m^3/h complete with electric motor
7	1	Slat belt conveyer or through conveyer, width 600 mm, length 10,000 mm, electric motor 3 kW
8	1	Differential fine roller mill, roller diameter about 1,000 mm and width about 630 mm. Different roller speeds by using separate drive gap between the rollers can be adjusted to 0.5 mm, output about 15 m^3/h, electric motors 22 and 30 kW

✓ Alternative items 6✓ and 10✓ can replace items 6 and 10.

Item No.	No. of pieces	
9	1	Grinding apparatus for above roller, grinding width about 1,000 mm, grinding wheel drive about 4 kW, feed drive about 0.4 kW, feed rate about 0.0035 m/sec, max. cutting depth 0.1 mm
10		Grinding wheel speed 35 m/sec
Shaping		
11	1	Combined horisontal de-airing extruder machine comprising double-shafted mixer with steam heating from top and bottom for somewhat soft plastic extrusion (about 22% water), barrel diameter of extruder 500 mm. The worms are made of a special wear-resistant alloy steel and have replaceable segments. Electrio motor for mixer 40 kW and for extruder 75 kW vacuum produced by water-ring vacuum pump complete with motor about 10 kW, output of the machine 5,000-8,000 standard bricks per hour, two dies for standard solid and perforated bricks
12	1	Automatic cutting machine for bricks 25 x 12 x 6.5 cm complete with motorised cutting, tilting, collecting, loading and heaping on pallet. Loader is preferably mechanized
13	1	Finger-car on rails
14	1	Turn-table
15	1	Electric transfer car
Drying		
16	1	Chamber drier, local delivery of the buildings according to the drawings, to be heated by steam. Supplier delivery includes rails, beneath track ribbed steam pipes (and along the walls of the factory for heating in winter), slide valves in the ceiling, exhaust air vent and ventilators
17	1	Frame collector
18	12	Three-wheel platform trucks
Firing		
19	3	Continuous kilns (Hoffmann kilns) each of a daily maximum output of 25,000 standard bricks 25 x 12 x 6.5 cm These kilns to be built locally according to drawing using natural draught by a chimney (35-[illegible] m high) and fired by coal (calorific value about 7,000 kcal/kg) to a temperature of about 1,000 °C. Supplier has to supply automatic stoking equipment for firing through holes in the roof

Item No.	No. of pieces	
20	1	High-lift truck/diesel engine, carrying capacity 2.5 tons
21	10	Platform or rail trucks
22 1/	3	Lorries with trailer capacity of 20 tons each for transfer of coal from pit 490 km from Kabul and sometimes for transporting fired bricks to customers

Boiler house

23	2	Tubular medium-pressure boiler fired with coal, steam generation 2,500 kg/h each, working pressure 8 atm. steam temperature 174°C, feedwater temperature 60°C, heating area about 87 m^3 each. Complete with accessories, pumps for feeding boilers, fitting, piping, insulation, condensate repumping equipment. Distribution of steam and condensate for drying chambers including spiral ribbed pipes. Water-treatment unit may be needed

Transformer station

24	1	Step-down transformer, output about 500 kVA with high-tension switchboard 15 kV and low-tension switchboard 380/220 V complete with distribution cables, all electrical equipment for motors, lighting and power points. (Compensation unit for improving the power factor to be offered in a later stage.)

Maintenance shops

25-1	1	Universal turning lathe
25-2	1	Metal frame saw
25-3	1	Shaping machine
25-4	1	Piller drilling machine
25-5	1	Bench drilling machine
25-6	1	Anvil
25-7	1	Stationary forge hearth
25-8	1	Smith's vice
25-9	1	Welding table

1/ Separate offer in case the factory finds it cheaper to transport the coal from the mines.

Maintenance shops (continued)

25-10	2	Oxyacetylene and arc welding units
25-11	1	Workshop table
25-12	1	Universal machine shears
25-13	1	Full set tools
25-14	1	Voltage tester
25-15	1	Ampere tester
25-16	1	Resistance measuring bridge
25-17	1	Avometer
25-18	3	Full set tools
25-19	1	Electric hand drilling machine
25-20	1	Grinding machine
25-21	1	Universal handsaw
25-22	1	Double planer
25-23	1	Band sharpener
25-24	1	Band brazing machine
25-25	1	Full set tools

Total installed input about 50 kW

Laboratory

26-1	1	Laboratory vacuum worm press with electric motor
26-2	1	Vibrating screen apparatus
26-3	1	Weighing machine, capacity 100 kg
26-4	1	Technical balance
26-5	1	Analytical balance
26-6	1	Optical pyrometer, portable type
26-7	1	Andersen apparatus for particle-size determination
26-8	1	Regulated hot air drier (electric)

Laboratory (continued)

26-9	1	Muffle resistance electric kiln up to 1,150°C, automatic thermal regulation
26-10	1	Set, laboratory glassware and tools
26-11	1	Set, laboratory chemicals
26-12	1	Double-sized laboratory table
26-13	1	Laboratory fume cupboard
26-14	1	Infra bath for evaporation
26-15	1	Orsat apparatus
26-16	1	Small hydraulic press for compressive strength
26-17	1	Portable appliance for quick testing of moisture in clay mass

Total price of machinery and equipment, including spare parts, is approximately Af 68,750,000.

Annex V

TESTS TO BE CARRIED OUT ABROAD ON KABUL CLAYS

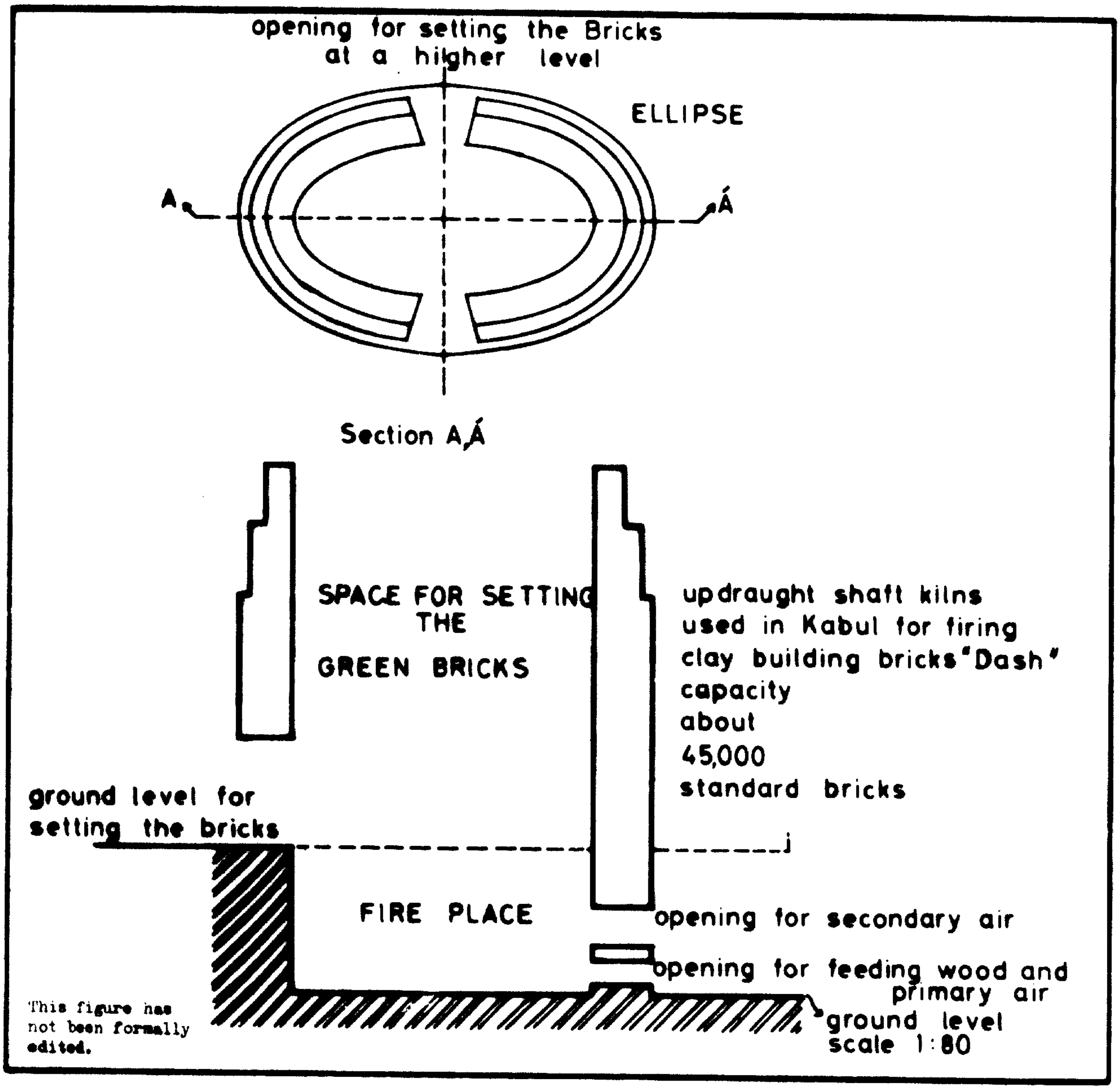
Sources: clay quarry near the airport, quarry near Hochtief factory.

Aim: to confirm properties of these clays and to investigate the possibility of using them in making hollow blocks.

1. Particle-size distribution and Winkler diagram i.e. $> 20\mu$, $20-2\mu$, $< 2\mu$
2. Plasticity according to Pfefferkorn
3. DTA diagram
4. Dilatometric diagram
5. Drying behaviour, Bigot-Diagram
6. Extrudability, water content during forming and pressure in kg/cm^2 for solid, perforated and hollow bricks with and without vacuum
7. Green strength
8. Firing behaviour and the determination of total linear shrinkage, compressive strength, water absorption, frost-resisting power in samples fired at 950°, 1,000°, 1,050°, 1,100°C
9. Sintering temperature and PCE
10. Mineralogical and X-ray examination
11. Chemical analysis including determination of soluble salts

All are simple, quick tests to be made on drilled samples from the suggested quarry to confirm the reserves.

Annex VI SKETCH OF UPDRAUGHT KILNS FOR FIRING BRICKS



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Annex VII

CLIMATIC CONDITIONS IN KABUL AREA AND EARTHQUAKES

Precipitation occurs mainly from November to May, sometimes partly as snow, sometimes as hail. The average yearly precipitation (1959-1970) is 329 mm with a maximum 451.5 mm and minimum 176.2 mm.

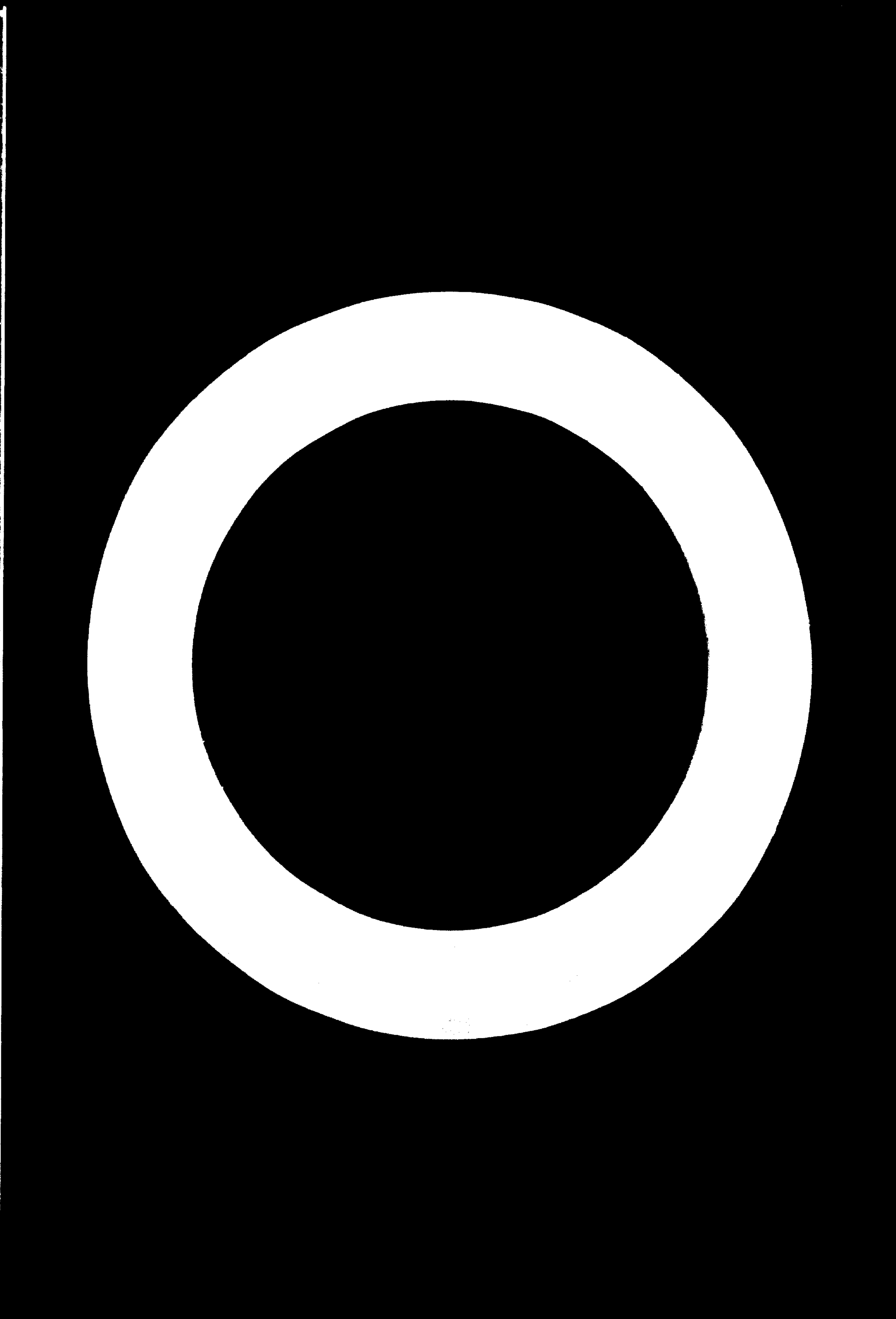
The average daily air temperature in summer is usually 20°-25°C, in spring and autumn 10°-20°C; maximum absolute temperature in summer is 36.8°C; minimum absolute temperature in winter is -25°C.

The yearly average relative humidity (1959-1970) is 55%. The average monthly relative humidity 1959-1964 is given below.

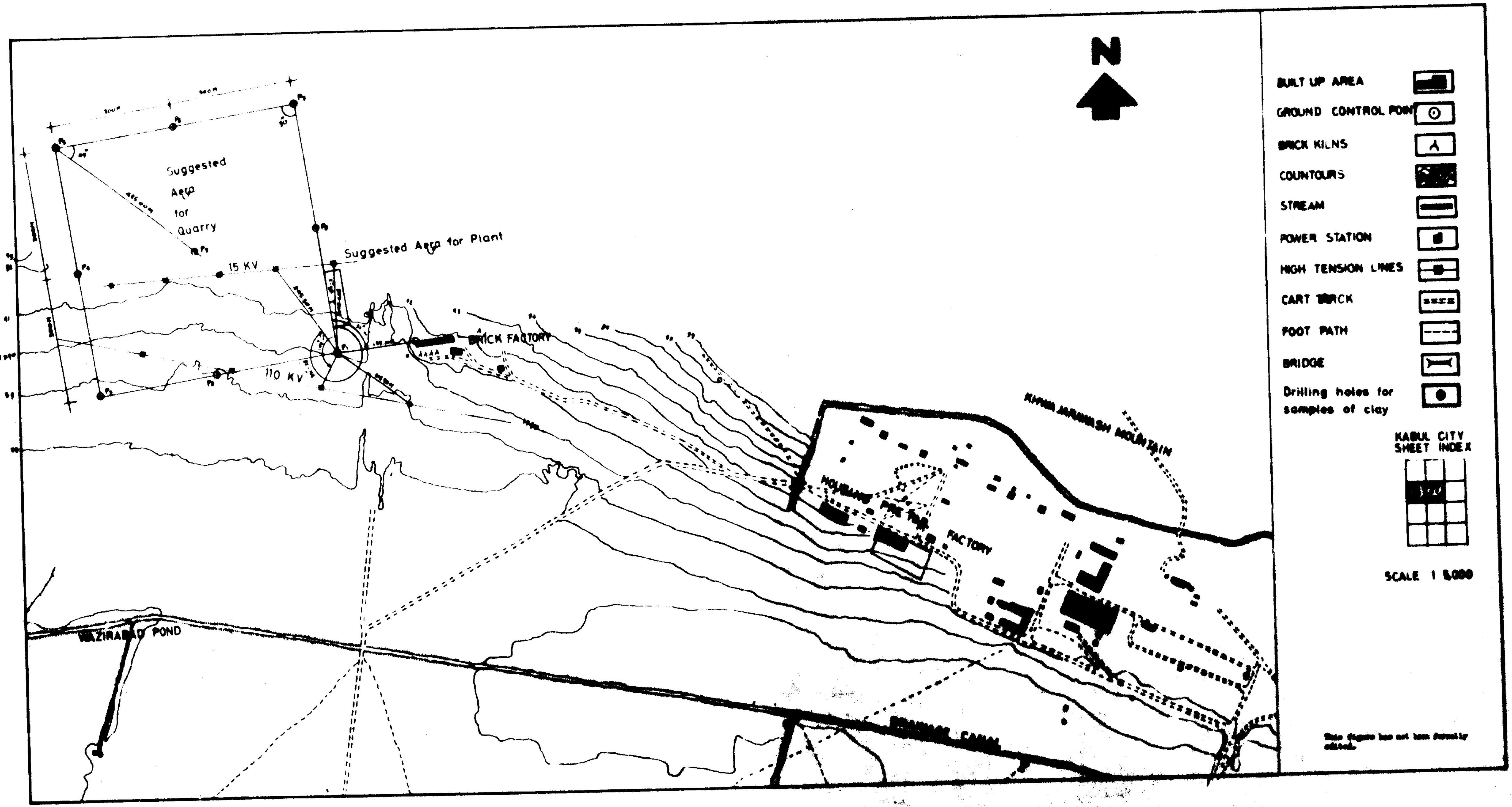
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
71	71	69	65	51	38	40	40	43	48	61	68

The prevailing wind comes from the north-west, north and west.

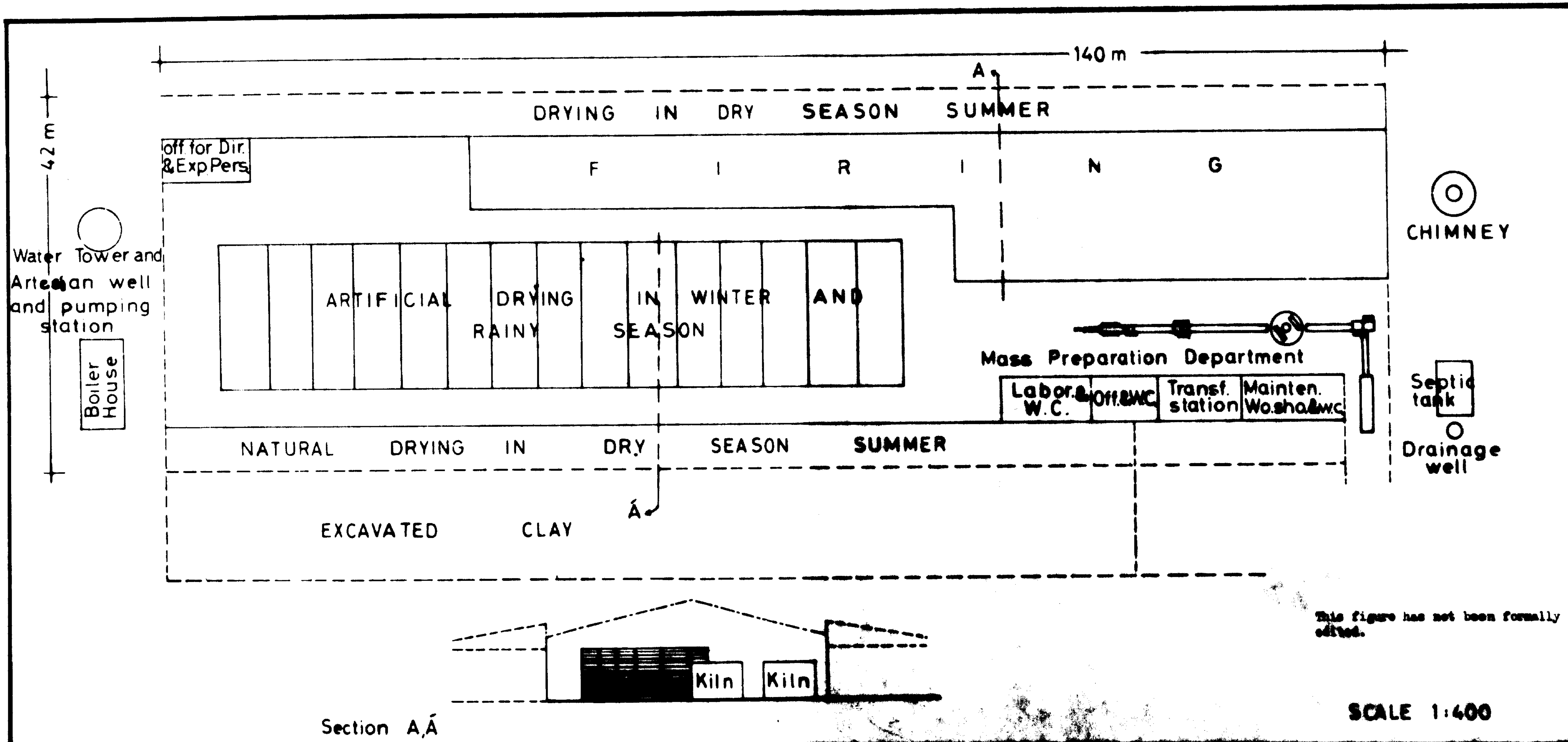
Deep-focus earthquakes occur under the Hindu Kush mountain range, at about 36.5°N and 70.5°E and at depths of about 230 km. Magnitude m_b up to 8. Shallow-focus earthquakes also can cause damage if they occur with sufficient magnitude close to the area.



Annex VIII LOCATION OF PROPOSED BRICK FACTORY AND QUARRY



Annex IX SUGGESTED LAYOUT FOR BRICK FACTORY



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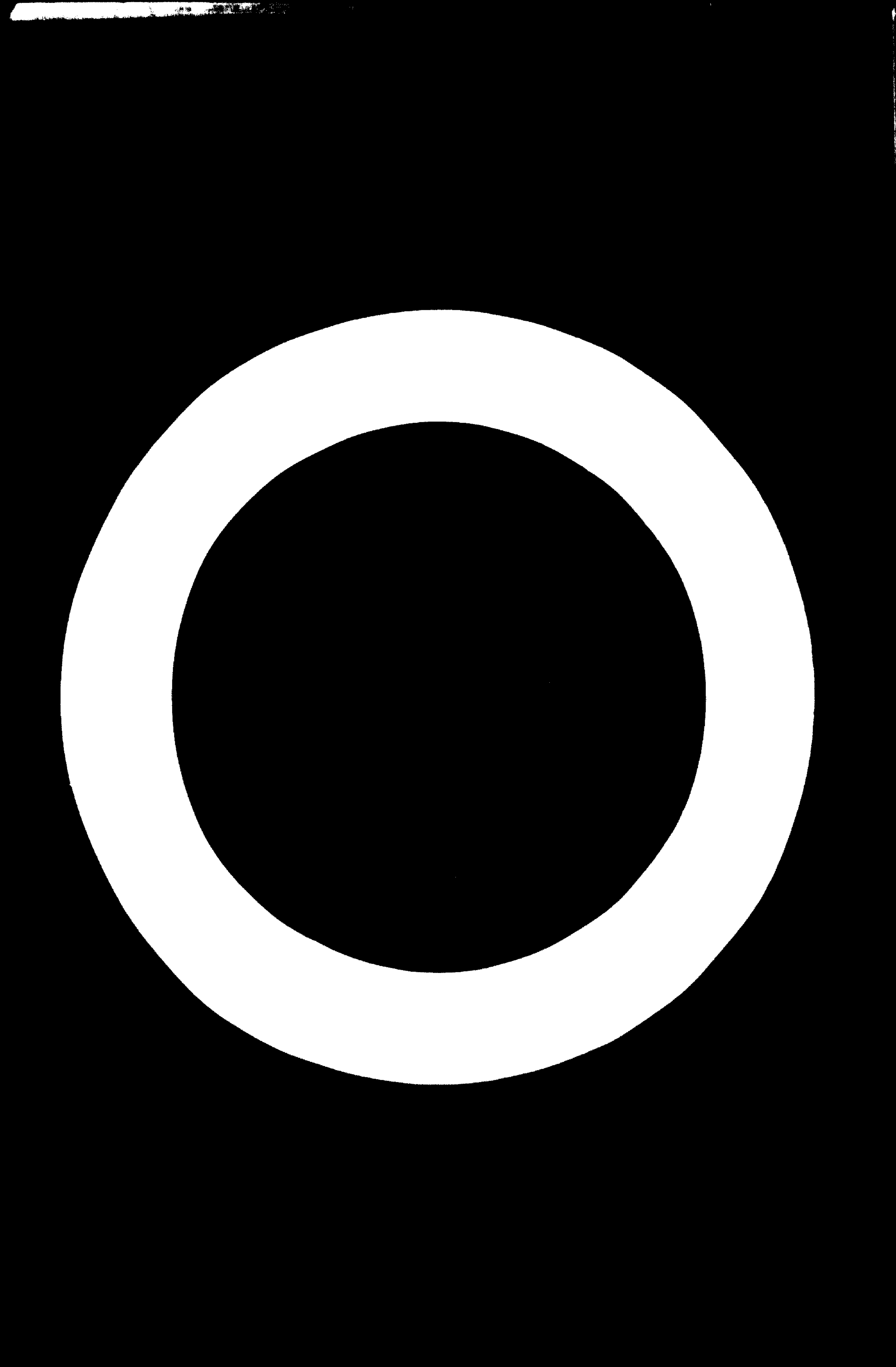


Annex X

REQUIREMENTS FOR RAW MATERIAL, BUILDINGS, FUEL, WATER AND POWER

Raw material (clay)

The annual production of the proposed plant will be 20 million perforated bricks, each weighing about 3 kg. Assuming about 12% loss on ignition owing to clay dehydration and decomposition of the carbonate, also about 3% losses in firing and raw material preparation, the requirements will be:

Annual: 70,000 tons

Daily: 233 tons, 300 working days/year

If the lifetime of the factory is assumed to be 30 years, 2.1 million tons of clay will be required. It is suggested that the reserves of clay be confirmed in an area of the quarry beside the factory measuring 600 m x 600 m, to a depth of about 6 m.

Buildings

Main factory building
Mass preparation section
Chamber driers
Hoffmann kilns and natural draught chimney (about 35 m high)
Dispatch section
Raw material stores
Store for fuel (coal)
Maintenance workshop
Laboratory
Transformer station
Boiler house
Water tower, artesian well and pumping station
Septic tank and drainage well
Offices
Welfare building etc. to be built at a later stage

The total cost of the buildings, including internal water supply, sanitary and electrical installations, a ribbed steam pipe along the side wall of the whole building for heating during winter, is estimated at Af 51.8 million.

Fuel

Calorific value of fuel (Dara-i-Soof coal): about 7,800 kcal/kg

Heat consumption: 400 kcal/kg of fired product

Total annual production: 20 million bricks weighing about 3 kg each, i.e. 60,000 t/a

Assuming about 2% loss in firing, the total product from kilns will be 60,000 ÷ 0.98 = 61,224 t/a. Therefore, the amount of coal needed for firing the bricks will be:

$$\frac{61,224 \times 400}{7,800} = 3.140 \text{ t/a}$$

Steam will be needed in the chamber driers during winter and the rainy season for drying the bricks, i.e. for about six months, natural drying under sheds being assumed for the rest of the year. Assuming a heat consumption to generate the steam of 1,500 kcal/kg of evaporated water, which amounts to 14,280 t/a (see below), the amount of coal needed for winter drying will be:

$$\frac{14,280 \times 1,500}{2 \times 7,800} = 1,373 \text{ t/a}$$

The total amount of coal needed will therefore be about 4,500 t/a. Assuming the price of coal in Kabul to be about Af 1,000 per ton, the annual cost for fuel will be about Af 4.5 million.

Water

For brick factory with an annual capacity about 21 million bricks (about 5% rejects - 3% in drying and 2% in firing)

Moisture in bricks before drying: 22%

Moisture in bricks after drying: 2%

(basis: 100 g dry material)

Weight of fired brick: about 3 kg

Loss on ignition: about 12%

Thus, weight of brick before firing is 3.4 kg, total weight of dry bricks before firing per year is 71,400 t, and weight of water evaporated in drying is 14,280 t. This figure was taken as the basis for calculating the heat requirements for drying (see above). It can also be taken as a basis for the tempering water requirement for manufacture, although the actual figure will be less, since the moisture in the clay used for manufacture varies with the season.

Since the yearly water requirement for sanitary purposes will be 3,000 t and for garden and garages 1,500 t, the total yearly requirement of water comes to 18,780 t. (The water needed in the boilers, whose condensate will be used again, is not considered.) This figure can be used a basis for calculating the capacity of the water tower and pumping station.

Electric power

Total installed capacity (kW):

Electric motors	400
Lighting	50
Total	450

Total consumption per year on the basis of departments working 2 and 3 shifts: 1.5 million kWh.

Yearly costs of electric energy: Af 1.5 million, assuming that 1 kWh costs Af 1.

Annex XI

REQUIREMENTS FOR MANPOWER, PERSONNEL TRAINED ABROAD AND EXPERT SERVICES

Manpower

Direct	No. of persons
Raw material excavation	2
Dumper transportation	6
Clay processing	4
Shaping or moulding	7
Drivers for finger-cars	2
Driers	12
Setting the continuous chamber kilns	24
Firing	9
Driver for transfer platform	6
Unloading of fired products	24
Workshops and transformer station, water tower and pump station	10
Laboratory and inspection	4
Boiler house	6
Indirect	
Administrative, stores, accounts, typist, guards, chauffeur etc.	14
Total	130

Salary and wages per year	Afghanis
Director of the factory	48,000
100 workers at an average wage per month of Af 1,000	1,200,000
29 workers and employees, average salary	672,000
Total	1,920,000

Personnel to be trained abroad for about 6 months each

Category	Function in factory	No. of persons
Technologist	Director	1
Mechanical engineer	Workshops and maintenance	1
Technician	Workshops and maintenance	1
Chemist	Laboratory	1
Technician	Mass preparation	2
Technician	Shaping	2
Technician	Finger-cars and chamber driers	2
Technician	Firing continuous kilns	3
	Total	13

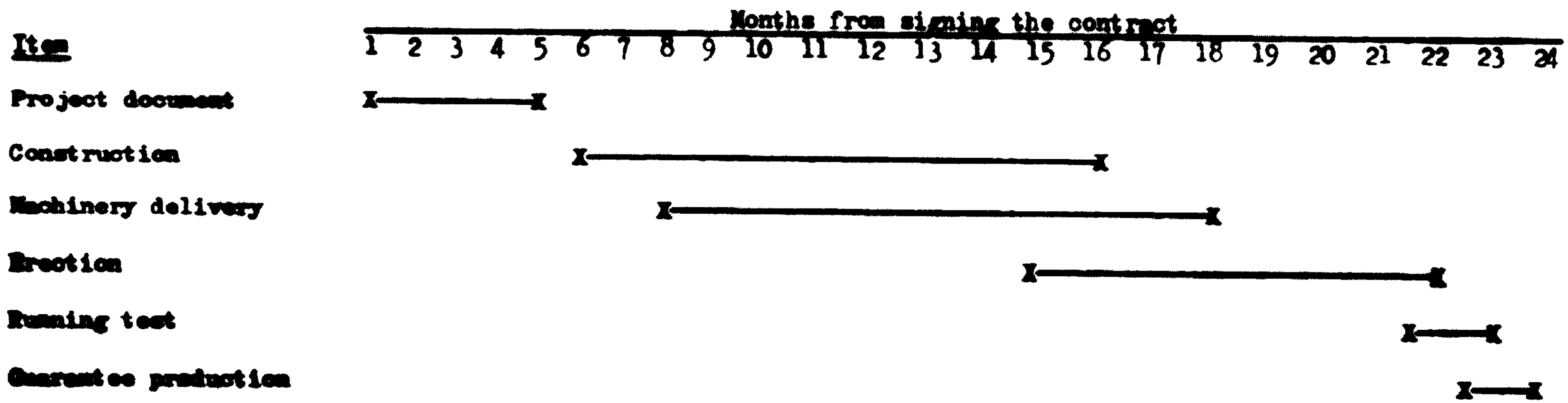
Expert services

Civil engineering and building works	Period (months)	No. of persons
Civil engineer for supervision	8	1

Erection of machinery and equipment, start-up and taking over tests	Period (months)	No. of persons
Chief of supervision	10	1
Special fitters for machinery and equipment	8	2
Special electrician for electricity of machinery and equipment	8	1
Specialist for drie	8	1
Specialist for kilns	8	1
Total		7

Annex XII

SCHEDULE FOR PROJECT FOR BRICK FACTORY



Annex XIII

CAPITAL OUTLAY AND OPERATING EXPENSES
(Af)

Plant with a capacity of 20 million perforated burnt-clay building bricks per year, i.e. 60,000 t/a, brick size 25 x 12 x 6.5 cm, weight about 3 kg

Capital outlay

Item	Cost
Land and buildings	
Land	-
Buildings, including driers and kilns with all civil work	51,800,000
Machinery and equipment with project documentation	68,750,000
Spare parts	13,750,000
Freight and insurance	
Internal transportation	
Installation costs, including expenses of experts supervising erection	9,625,000
Other fixed assets	
Furniture and office equipment	750,000
Transport vehicles	1,000,000
Other assets	1,000,000
Pre-production costs	1,500,000
Contingencies and price escalation	3,000,000
Total fixed capital cost	151,175,000
Working capital	5,000,000
Total capital outlay	156,175,000

Operating expenses

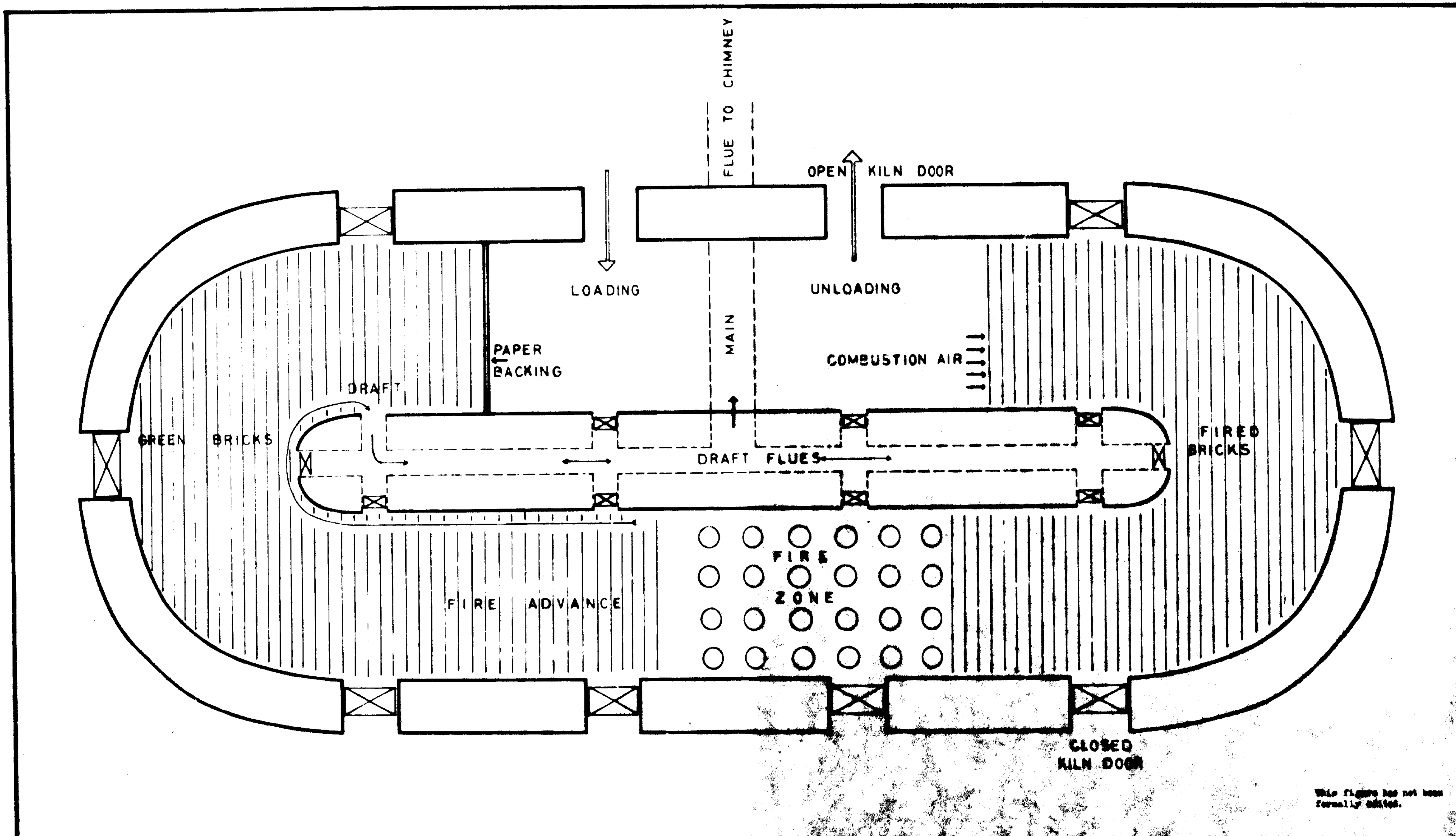
Item	Yearly costs	Cost per 1,000 bricks
Raw material (clay)	- -	-
Fuel (coal)	4,513,000	225.65
Electric power	1,500,000	75
Water	-	-
Wages and salaries (direct and indirect)	1,920,000	96
Depreciation, buildings 40%	2,072,000	103.6
Depreciation, machinery and equipment 7%	6,448,750	322.4
Repair and spare parts 2%	3,103,500	155.2
Taxes and duties	-	-
Interest on fixed capital 0.75%	1,133,812	56.7
Interest on circulating capital 8%	400,000	20
Diverse expenditure	500,000	25

Yearly manufacturing costs = 20,057,250

Approximately = 20,000,000

Income from sales 1,200 x 20,000 = 24,000,000

Annex XIV DIAGRAM OF CHAMBERLESS HOFFMANN KILN FOR FIRING CLAY BUILDING BRICKS



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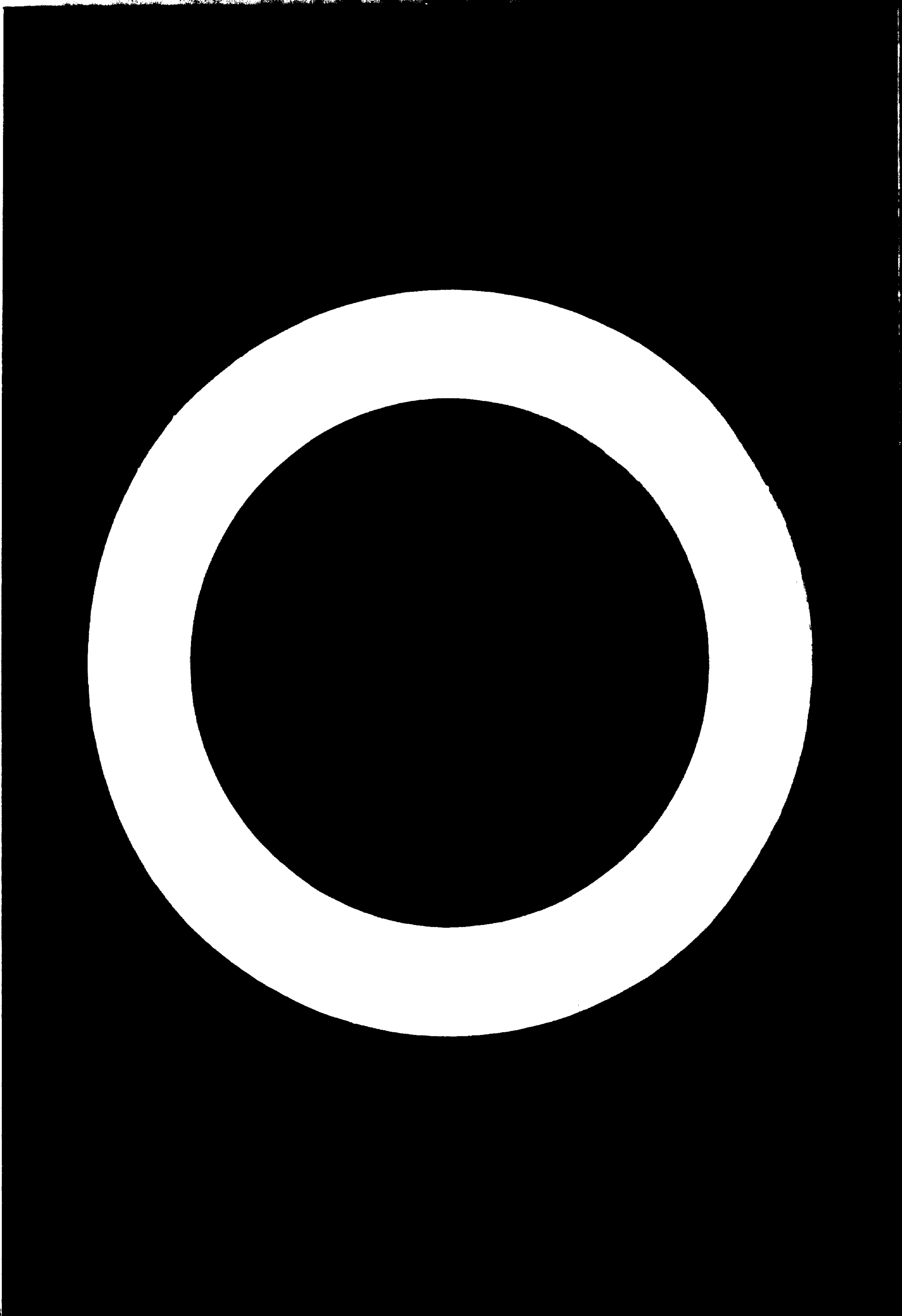
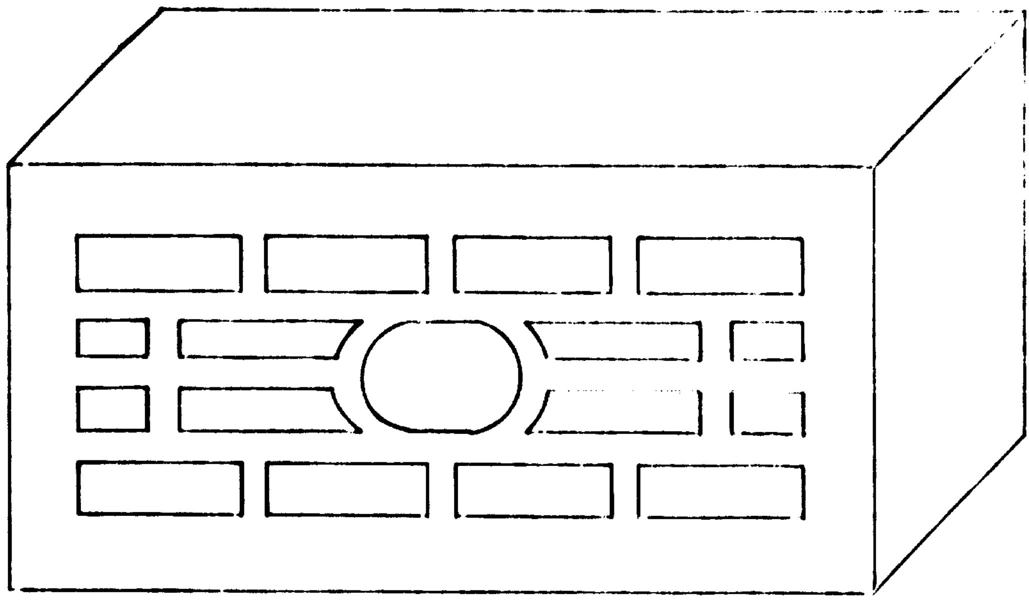


Annex XV

TYPE OF PRODUCT



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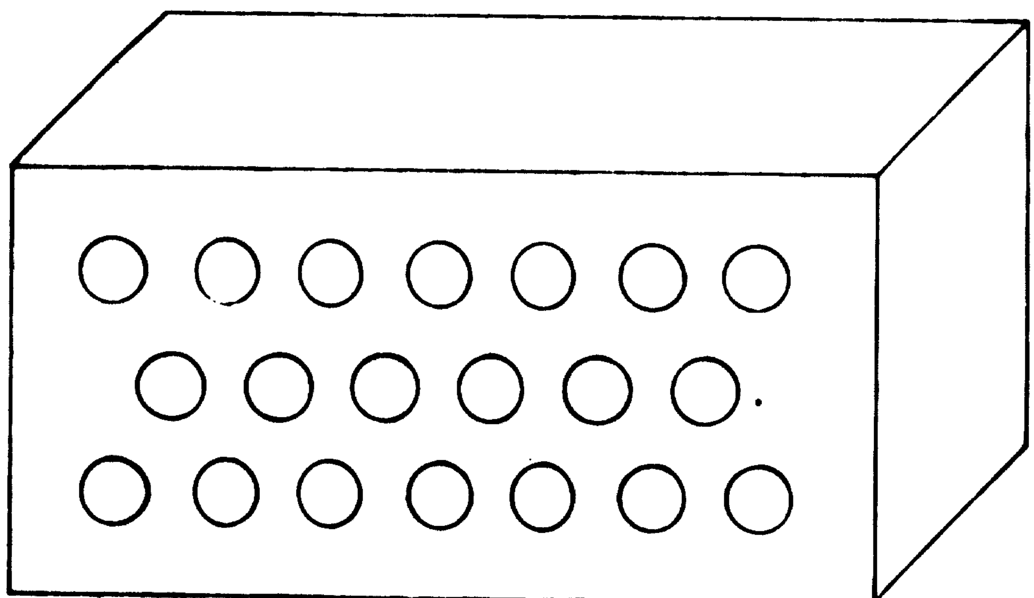
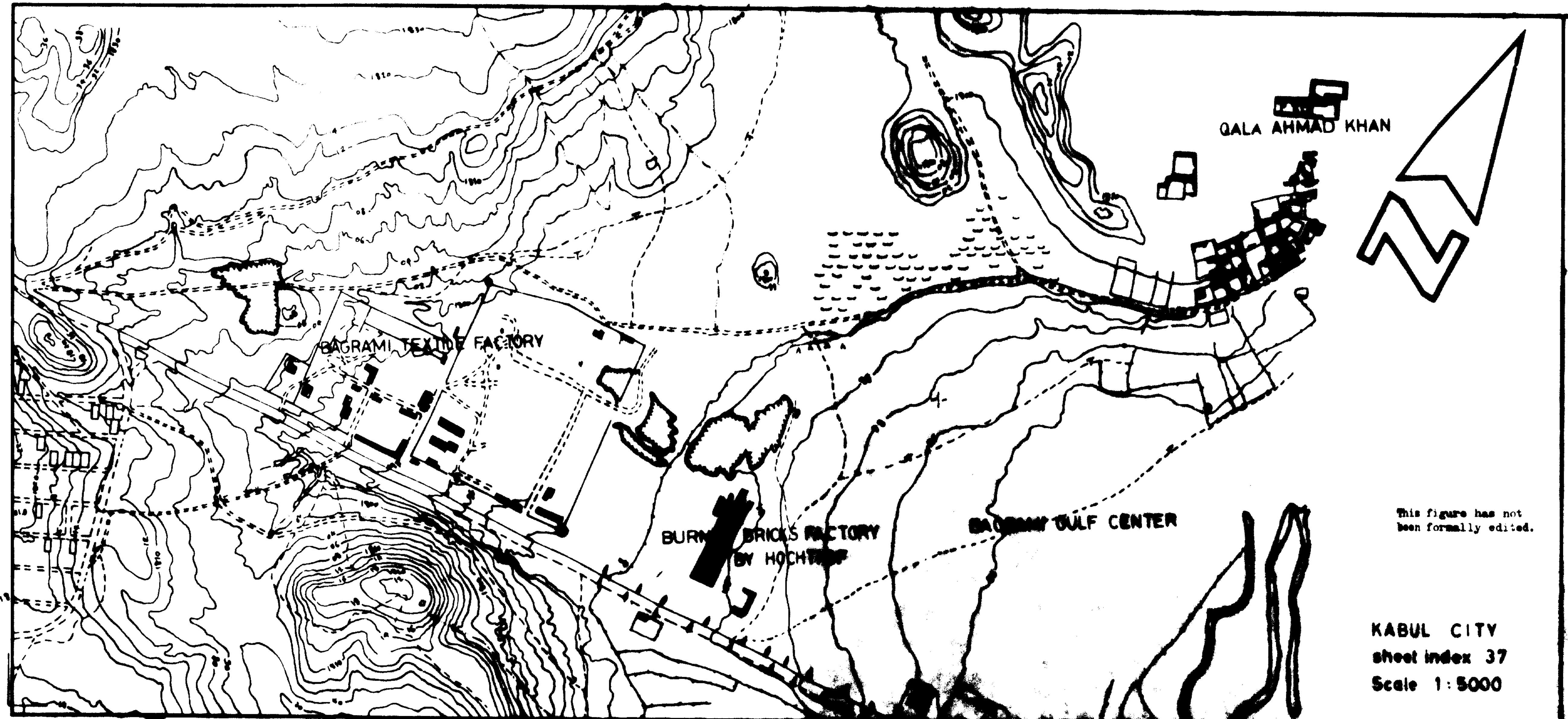
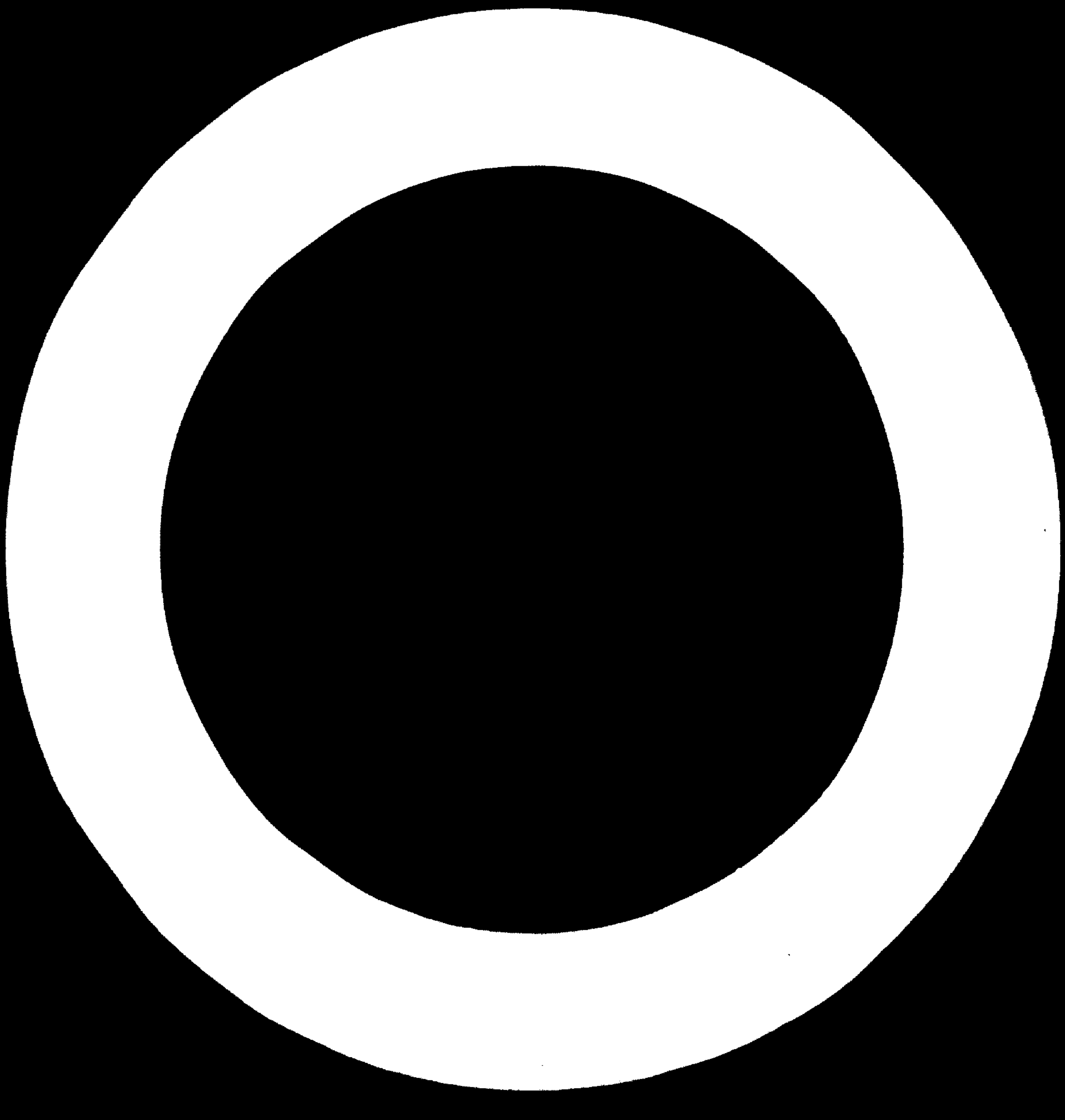


B

Perforated burnt-clay building bricks - size, 25 x 12 x 6.5 cm; weight, 3 kg; compressive strength, about 200 kg/cm^2; water absorption < 15%

Annex XVI LOCATION OF HOCHTIEF BRICK FACTORY IN KABUL





Annex XVII

CLAY SAMPLES FOR TESTING ABROAD

The expert collected two average samples of clays weighing about 50 kg each to be tested abroad, one from the suggested clay quarry near the airport and the second from the clay area near the closed Hochtief plant. The two samples are stored in the UNDP stores in Kabul, ready for shipment when the contractor has been selected.

As for the samples of clay from the area near the airport, which were to be obtained for the purpose of estimating reserves, i.e. 6 x 9 = 54 samples of less than one kg each, it was agreed that as soon as the crew and power drilling machine belonging to the Geological Survey Department were ready, samples would be taken under the supervision of the expert's counterpart, who had already been instructed how to collect the samples and mark them. However, the chief of the crew of the drilling machine is also trained for this work, which is done in connexion with soil mechanics for foundation and building construction. The start of this work was delayed because of routine problems. The possibility that UNDP would cover the expenses for the power drilling was mentioned.

Annex XVIII

VISITS TO ADDITIONAL FACTORIES

Clay brick factory, Mazar-i-Sharif

On 12 July 1975 the expert visited the clay brickworks of the fertiliser factory at Mazar-i-Sharif in order to explore brickmaking in one of the provinces.

The output of this factory will reach 6.5 million bricks/year. All the production is taken by the fertiliser factory, first for the construction of the buildings of the factory and now for the construction of dwellings for the workers. In future it will be used for the extension of the factory. The product, together with the system of manufacture and machinery, is similar to that of the brick factory of the prefabricated unit near the Kabul airport. However, in firing the bricks, in addition to the Dash kilns, a circular underground corridor similar to the one used in the factory of the Ministry of National Defence near Kabul is used. Condensed oil from a nearby natural gas source is used for firing. The bricks are of a better quality than those produced at the factory of the Ministry of National Defence.

The private works for burnt-clay building bricks (there are said to be about 50 Dash kilns) are similar to those in Kabul. The only difference is that the abundant dry bushes and straw in the area are used for fuel. The bushes and straw are fed from the upper opening of the fireplace, which is wider in cross-section.

There appears to be no urgent need for a new clay brick factory. This is also the view of the city officials. However, in future, with greater industrialisation and a demand for better housing, the establishment of a new burnt-clay brick factory may be considered.

Fine ceramics factory, Kabul

On 10 July 1975, the expert visited a small ceramic factory near Kabul, 70% of whose production consists of small low-tension pin insulators and 30% table-ware, mainly teapots and cups, in faience. The annual output is about 250 tons.

The body mass used is based on local raw materials. It contains 50% plastic clay, 20% siliceous clay and 30% soda feldspar (Albite) as a flux.

The clay is concentrated in precipitation tanks. The other ingredients are wet-ground in ball mills. The body slurry from the plungers and mixers is pumped for dewatering by filter presses. The cakes from the filter press are kneaded by a pug machine. The plastic mass is then taken for shaping by jiggering machines into pin-type, low-tension electric insulators.

The table-ware, teapots etc. are formed by slip casting in plaster moulds. The products are fired twice, biscuit firing at about 780°C and glost firing at about 1,200°C, using direct oil-fired, downdraught kilns. The articles are put in saggars for glost firing. The glazing of the articles is done by dipping.

The following improvements for the manufacture of faience products are suggested:

(a) For longer life of the saggars, about 15% powdered local steatite should be added to their body composition;

(b) For low-tension electric insulators, instead of biscuit and glost firing, only one firing is necessary, which reduces the cost of manufacture. This was demonstrated at the factory by glazing a green article by dipping and asking the plant staff to fire it to see the result. According to the result of the experiment, a slight change may be needed either in the glaze or body composition;

(c) As the fuel being used for firing is expensive (2-3.75 Af/litre) and electricity is available, an alternative method of firing should be studied. It may be better to glost fire the table-ware directly in a fast electric push slab tunnel kiln with an internal cross-section of about 30 x 30 cm, length about 10 m heated by 4-mm Kanthal A wire. This procedure may not only be more economic but also produce better-quality products. The elimination of saggars and the cost of fuel to heat them up may exceed the difference in price between electricity and condensate oil. Such electric kilns are not difficult to design and construct. The expert has, in fact, designed and constructed some in Egypt that are running successfully.

The factory also makes fire-clay bricks and, on a trial basis, silica bricks made from massive quartz (about 99% SiO_2). The silica bricks, although coming out of the kiln nicely shaped, lack strength and are high in porosity. Possibly there is no inversion of quartz into cristobalite and tridymite, since firing is at a low temperature (cone 6-7), and mineraliser is not added to the batch.

The following measures to improve production are suggested:

(a) Using milk of lime in a proportion about 2% in the batch instead of adding limestone directly;

(b) Adding a mineraliser to aid inversion, say, iron oxide powder in a proportion of about 1%;

(c) Using a binder for the bricks in the green state, say, molasses, and firing at a temperature of about 1,450°-1,500°C;

(d) Heating the quartz above the temperature of α - β quartz inversion and then quenching it by water, which weakens the hard material and makes it easy to crush and grind to the grain sizes needed for manufacture.

Glass factory, Kabul

On 10 July 1975 the expert visited a small glass factory producing about 2,000 soda glass containers per day weighing about 400 g each. One problem is that the refractory pots, with a capacity of 50 kg and 100 kg that they make from local raw material, crack during firing. During his very short visit, the expert examined the problem. His findings are reported below.

The batch composition of these refractory pots for smelting glass is of a local refractory clay of a good workability and green strength mixed with grog from broken refractory pots. The batch varies in composition. The percentage of grog in the batch is too low, and the grain-size distribution of the grog is not the best obtainable. Properly fired refractory clay should mainly be used for grog. Broken refractory pots should not be used as grog, since they are probably contaminated with glass. However, a small amount can be used.

Mixing the refractory clay and water can be done more efficiently in a mixer than manually. Before it is used, the mixture should be left overnight, covered, so that the moisture content will be even throughout the batch.

The pots are shaped manually, but the wall thickness is not regular, as was evident from the broken pots. Regular thickness is important.

The green pots must be dried before they are heated up; the heating-up must be gradual and according to a stipulated time-temperature curve. One of the manufactured pots was chipped owing to entrapped moisture and rapid heating up. Also, cracks may develop owing to improper firing, which causes stresses and strains from firing shrinkage.

The complete properties of this local refractory clay should be determined in order to select the best composition and manufacturing process.

In answer to a question regarding the use of a small smelting tank instead of the glass pots now being used for smelting, the expert suggested that special specialised firms abroad be contacted.

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