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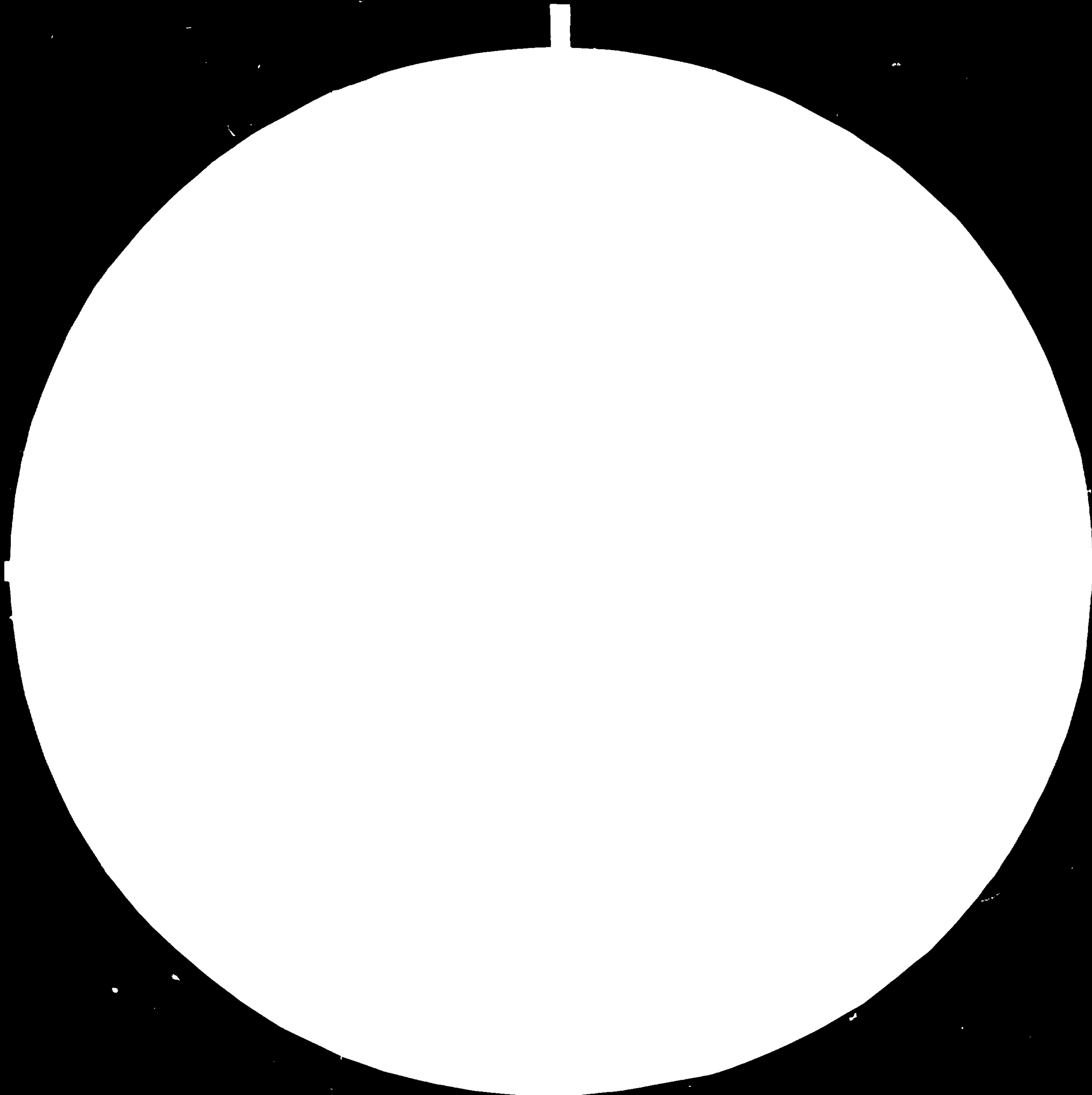

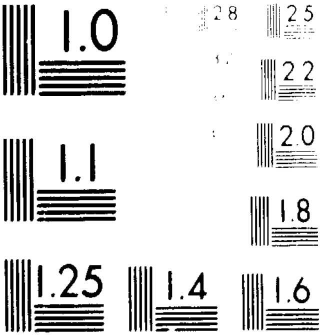
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UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

ASSISTANCE TO THE HIMAL CEMENT COMPANY (PVT) LTD.

AR/RAS/79/135

NEPAL,

Mission report: A technico-economic pre-feasibility study of an expansion of the Chobhar Cement Plant

Based on the work of Harald C. Boeck, cement consultant

V.81-29627

Explanatory notes

A comma (,) is used to distinguish thousanus 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 Nepal is the Nepal rupee (NRs). During the period covered by the report, the value of the Nepal rupee in relation to the United States dollar was $US 1 = NRs 11.90.

The following abbreviations are used in this document:

BEP	break-even point
CCP	Chobhar Cement Plant
HCC	Himal Cement Company (Pvt.) Ltd
KfW	Kreditanstalt für Wiederaufbau
tpd	tons per day
tpy	tons per year

Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

ABSTRACT

The project entitled "Assistance to the Himal Cement Company (Pvt.) Ltd." (AR/RAS/79/135) arose from a request from the Government of Nepal to the United Nations Industrial Development Organization (UNIDO) in June 1981 for assistance in evaluating the technical and economic feasibility of expanding the capacity of the Chobhar Cement Plant (CCP) (see job description in annex I). Funds to the value of $20,000 were made available by United Nations Development Programme (UNDP) to enable the expert and an economist/financial analyst to visit the cement plant at the same time and to prepare a joint report. Due to unforeseen circumstances the two experts visited Nepal separately.

The expert was briefed by the Kreditanstalt für Wiederaufbau (KfW), Frankfurt am Main, which was interested in financing the expansion of the CCP.

After arriving at Kathmandu it was learned that there were no offers from prospective suppliers and an ongoing raw materials investigation needed a further two to three months to be finalized.

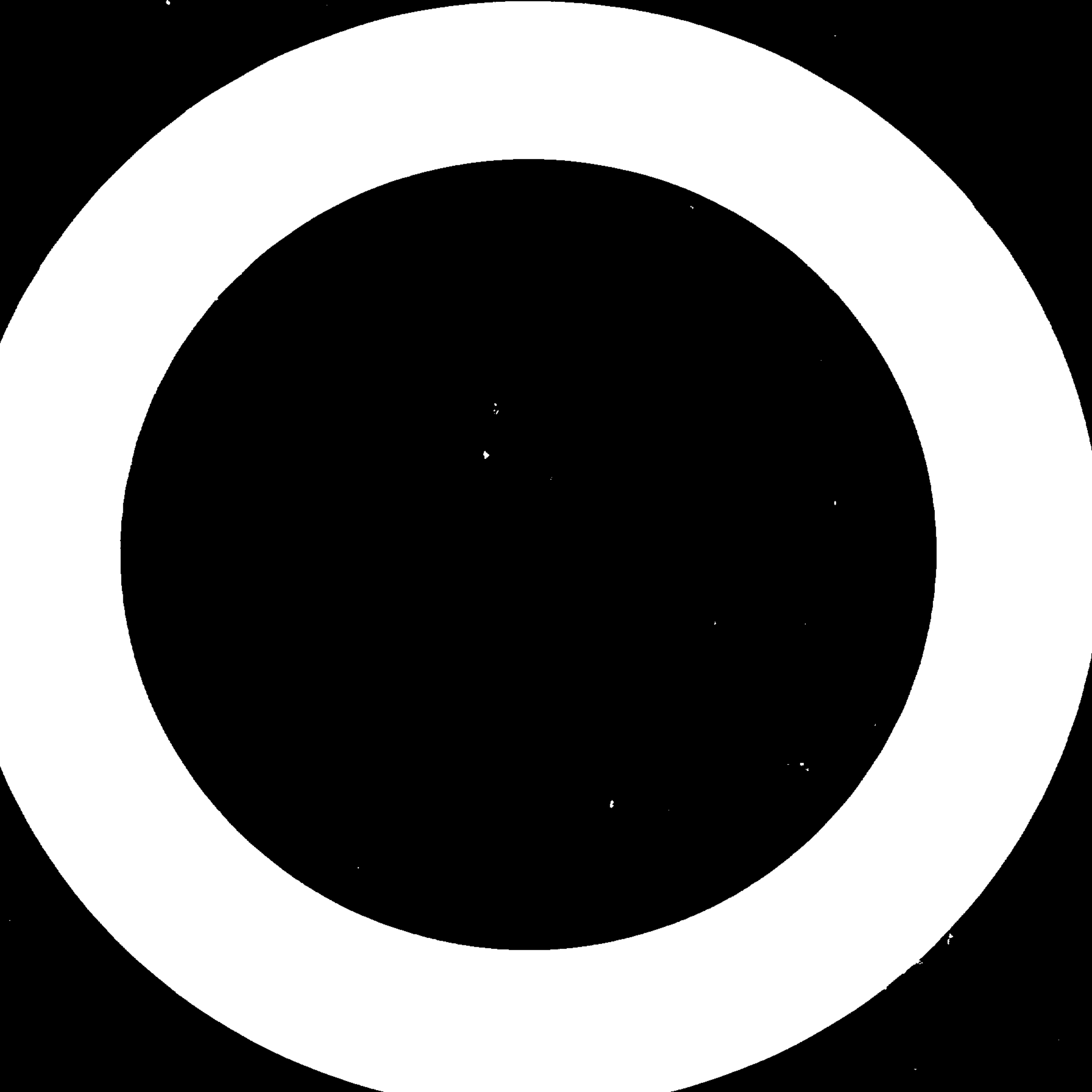
The plant suffered from bad conditions, with declining production due to unsuitable raw materials for the semi-dry shaft kiln process. Furthermore it lacked a satisfactory power supply.

A serious accident in late June in the kiln department killed three workers when hot air escaped from the kiln.

After the return of the General Manager from travel in Europe, the kiln re-started on half capacity, 80 tpd.

It is not recommended to expand production by constructing another shaft kiln. Reputable companies have been asked to submit prices on a turnkey basis for a 500 tpd pre-heater kiln cement plant.

A technico-economic pre-feasibility study was carried out on the assumption that a suitable supply of raw materials was available.



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INTRODUCTION

The production of cement clinker by means of a semi-dry process shaft kiln has been known for more than a century, and since 1976 UNIDO has paid special attention to this process. It is simple and calls for lower investment than other processes up to a capacity of about 180,000 tpy, i.e. about four kilns of the same size as the kiln at the Chobhar Cement Plant (CCP).

The expert visited the CCP in June 1976 and recommended that the plant should be expanded, provided enough raw materials were available.

The reason for this proviso was that the plant contained a number of bottle-necks and the raw materials handling system was poor.

The expert returned to the CCP in 1979 and again proposed to expand and modify the plant. He then recommended that another process would have to be considered if the conditions for a shaft kiln could not be fulfilled. In case raw materials well suited for the available installations could not be secured, the shaft kiln process at the CCP would have to be abandoned.

The aim of the mission entitled "Assistance to the Himal Cement Company (Pvt.) Ltd" (AR/RAS/79/135), from June to August 1981, was to prepare a pre-feasibility study for expanding the CCP. UNDP funds to a value of $20,000 were allocated for the expert and an economist/financial analyst together to visit the CCP and to prepare a joint report. However, this was not possible, and the two experts visited Nepal separately.

During his visit the expert met with and gave assistance to a number of organizations etc. (see annex II).

The technical department of the CCP asked eight companies to quote for an expansion of the plant to 200 tpd, without any positive replies.

It was difficult to locate suppliers of preheater kilns with a capacity of less than 500 tpd. Fourteen prospective suppliers were asked by telex for their price for the supply on a turnkey basis of a standard 500 tpd cement plant (see annex III). So far, replies have been received from 7 of the 14 approached; 6 of them positively (see annex IV).

The future of cement production capacity in Nepal seems to indicate that it will be years before the country can be self-sufficient. It should be borne in mind that expanding the existing cement plant is less costly and much quicker than building a new plant.

This report aims at assisting the Government in making the most appropriate decision regarding selection of priorities for the expansion of the cement industry.

RECOMMENDATIONS

An immediate general overhaul of the entire CCP is needed, specifically in the kiln department. This will ensure the security of the operations and avoid future accidents.

New equipment and spare parts for the overhaul should be ordered now and should be sent to Kathmandu by air. Air-freight and formalities from Europe take about three months.

The present 160 tpd shaft kiln should be kept in operation at its maximum capacity after being overhauled. By careful selection of raw materials and fuel it might be possible to reach a production of 35,000 tpy, equal to a run factor of 0.60.

Provided there are sufficient raw materials and enough market demand, the feasibility of a 500 tpd preheater kiln should be investigated. With a run factor of 0.82 (300 days per year operation), the annual production would be 150,000 tons of clinker.

An engineering study should be carried out by a reputable consultant or UNIDO to replace the existing shaft kiln by a 500 tpd preheater kiln. However, provision should be made for keeping the existing shaft kiln operational by considering changing from the black meal process to the more commonly used white meal process. It would theoretically be possible, if there were enough good raw materials, to reach an annual clinker production of 150,000-185,000 tpy with a low investment cost.

The companies which are interested in supplying a 500 tpd preheater kiln should be contacted. They should be given 300 kg of representative samples of the raw materials and fuel for testing purposes.

It is not recommended that CCP engineers carry out the engineering study. The technical staff at the CCP should concentrate their efforts on keeping the existing plant in shape with appropriate maintenance and operate it at maximum capacity.

When the engineering study has been completed, suppliers should be invited to provide prices or bids, so that up to date and realistic feasibility calculations can help the authorities in comparing the possibilities and in making the right deicision.

I. GENERAL

A. The "run factor"

The rated capacity of a cement plant is normally expressed in the daily kiln capacity of its production of burned cement clinker. Clinker is a semi-product consisting of calcined and sintered material appearing as small and hard balls, 8-20 mm in diameter. The Portland clinker is ground together with about 4-5% gypsum in order to form Portland cement.

Many additives other than gypsum can be added, up to 70%, if suitable pozzolanic materials are available.

When a new cement plant is commissioned the production capacity is based on the daily output of the kiln. Depending on different parameters the kiln can operate for a certain number of days per year. The life of the refractory lining limits the number of operating days per year. The resulting production compared with the rated kiln capacity is usually called the run factor.

$$\text{Run factor} = \frac{\text{yearly clinker production (in tons)}}{\text{daily rated kiln capacity (in tons)}}$$

If the run factor was 1.00, which is possible for a shaft kiln, this means the kiln is operating 365 days per year at its full rated capacity. If the kiln operates 300 days per year of its rated capacity, the run factor is $\frac{300}{365} = 0.82$. The following run factors have been made by CCP since it came onstream in 1975:

1975/76 = 0.49
1976/77 = 0.67
1977/78 = 0.62
1978/79 = 0.36
1979/80 = 0.50
1980/81 = 0.51

B. The reasons for abandoning the CCP shaft kiln process

When the CCP was established in 1975 the Himal Cement Company (Pvt.) Ltd (HCC) was warned not to apply the semi-dry shaft kiln process. In spite of the warning the process was applied, and the result was an extremely low output, declining each year from when the plant came onstream.

All possibilities of improving the plant's capacity should be tried, but it appears that after six years of operation, which includes UNIDO technical assistance at the end of 1979, everything seems to have failed.

In June 1981, an accident occurred which killed three persons. This was a result of using unsuitable raw materials, the poor raw materials handling system and the poor condition of the kiln itself.

The shaft kiln is marvellous if excellent raw materials and fuel are available, but it is a dangerous kiln when the raw materials are unsuitable as is the case at the CCP.

The local limestone, clay and fuel are at the minimum limits of the desired quality; thus any changes make the process unsuccessful. To expand the plant by constructing another shaft kiln is therefore unreasonable.

However, if it were decided not to abandon the shaft kiln it should still be possible to operate it with a low capacity by carefully selecting suitable raw **materials and** on condition that a general overhaul of the entire plant is made.

The maintenance of the plant will also have to be improved considerably. **However, this is not an easy matter as it is a single-unit plant without stand-by machinery.**

C. The preheater kiln

A preheater kiln is normally a rotary kiln with a four-stage cyclone preheater. A kiln of this type would undoubtedly solve all the clinker production problems at the CCP. However, a final decision cannot be taken before the ongoing raw materials investigation has been completed.

The preheater kiln process is so well-known that nearly all the problems with raw materials can be overcome, including the high contents of alkalis and chlorides. The normal technique for eliminating the alkalies etc.. is to provide a preheater kiln with by-pass. Equipment suppliers will, upon receiving a representative sample of the raw materials, be able to advise on process details and equipment requirements. For more than [illegible]% Cl^- in the raw mix a by-pass is necessary.

With a preheater kiln it should be possible for the CCP to use limestone and clay from a nearby quarry as special clay is not necessary. The need to transport the clay 50 km could therefore be avoided.

The preheater kiln process is simpler than the present shaft kiln's black-meal process. In the latter, limestone, plastic clay and special fuel are interground in a roller mill and dried. The dried black meal, after homogenizing, is then fed to a nodulizer and, in order to produce nodules, about 16% of water is added. This sounds strange; first, the raw materials are dried, and then water is added.

For use in the preheater kiln the raw materials are dried and ground to a powder with a maximum moisture content of 1%. After homogenizing, the powder is fed to the preheater. The nodulizer is avoided which means one major problem less.

Furthermore, the hot gases which leave the preheater at about 350°C, can be used in the raw mill for drying the raw material. Up to 6-7% moisture can be dried out by means of exit gases from the preheater. This means a saving in fuel costs.

The existing shaft kiln uses 5.36 GJ/t clinker (1,280 kcal/kg clinker) plus 0.47 GJ/t clinker (112 kcal/kg clinker) for drying the raw materials, i.e. a total of 5.83 GJ/t clinker (1,392 kcal/kg clinker).

The 500 tpd preheater kiln is expected to use about 3.50 GJ/t clinker (835 kcal/kg clinker) with raw materials at a 6% moisture content level. If a higher moisture content in the raw materials is present, extra fuel will have to be used in an auxiliary furnace attached to the raw mill. Fuel consumption will be about 35-40% less than for the existing shaft kiln process.

The main difficulty for the CCP is to find a company which will supply a 500 tpd preheater kiln. This is the smallest size available today from reputable manufacturers.

In July 1981 the expert in co-operation with UNDP contacted 14 suppliers of preheater kilns. Only 7 replied positively.

Before the expert arrived at Kathmandu, CCP asked eight companies for quotations to expand the present plant to 200 tpd. Not one replied positively.

II. GENERAL PLANT OVERHAUL INCLUDING ADDITION OF A CLAY DRYER

A. Estimated cost

	Thousands of dollars
Limestone crusher	
Repair of hopper and apron feeder Gearbox for apron feeder (lower speed) 110 kW motor for crusher Set of new hammers	50
Clay crusher	
Clay dryer complete with filter and feeder, 10 t/h, 30-10% moisture	500
Raw materials including clinker storage	
Repair of 6 t x 16 m overhead crane New rails, wheels, cables etc.	40
Raw mill department	
1 weigh feeder for limestone, 2.0-20 t/h	25
1 weigh feeder for clay, 0.2-2.0 t/h	25
Repair of triple-gate feeder Exchange of louvre ring in the mill Repair of control panel	20
Homogenizing silo	
Complete exchange of the air intake system (polyester)	10
Kiln department	
Exchange or repair of: Stepped "Spohn" grate Sealing main shaft Hydraulic gears and pump for triple-gate sluice New blower with 30% more capacity Dedusting system (larger fan)	85

Cement mill department

Three weigh feeders	75
Sub-total	830
Interest during construction	170
Civil works, erection and supervision	170
Contingencies	125
Total	1,295

B. Implementation time

Delivery time for equipment ordered from overseas (Europe) is in the region of 12-18 months.

The overhaul of the plant including the erection of a clay dryer is estimated to take two to three months, depending on the availability of skilled labour.

The limestone crusher poses a bottle-neck problem, as it takes quite a long time to repair the hopper and the apron feeder. However, a large stock of crushed limestone could be built up before the hopper and feeder are overhauled.

The clay dryer can be installed independently, but should be done before the kiln is stopped.

III. PRE-FEASIBILITY STUDY FOR PLANT EXPANSION

A. Raw materials

Limestone

A core-drilling campaign in the existing limestone quarry has just been completed and about 1,200 metres of cores have been performed. Chemical analyses are in progress together with log sheets for each drilling.

The total investigation will probably be completed within two to three months.

In order to have sufficient limestone for a 500 tpd kiln for the next 30 years, 6.28 million tons will be needed (500 x 365 x 0.82 x 1.6 x 30 x 0.875).

Clay

No investigation has yet been undertaken at the new clay pit at Panchkhat, about 50 km from Chobhar. Auger drilling is urgently required as the CCP depends on this supply for at least the next four years, and perhaps for the rest of its life.

Limestone/clay mix is actually 87.5/12.5%. The annual consumption of clay for the 160 tpd shaft kiln only, operating with a run factor of 0.82, would be 12,500 tpy with a 30% moisture content, i.e. about 50 tpd (250 days per year) which will have to be transported from Panchkhat to Chobhar provided the kiln can reach a run factor of 0.82.

Local clay can be used for the preheater kiln. This is a great advantage.

Gypsum

The consumption of gypsum amounts to 4-5% of the clinker production, and it will have to be imported either from India or other countries.

According to figures made available by the CCP in reply to a questionnaire, if 5% gypsum were added to the clinker, the landed cost at Chobhar would be $91/t (see annex V, A).

B. Fuel

Fuel for the shaft kiln

The shaft kiln is still using coke breeze imported from India. Unfortunately, declining quality causes serious problems in making nodules of sufficient quality.

Calorific value has fallen from 20.9-21.8 GJ/t (5,000-5,200 kcal/kg) to 20.0-20.9 GJ/t (800-5.000 kcal/kg), thus more coke and less clay will have to be used in the black meal. The ash content is now over 31%.

The present price for coke breeze landed at the CCP is NRs 750/t ($63/t), an increase of 50% since December 1979.

Fuel consumption	5.36 GJ/t of clinker
Net calorific value	20.4 GJ/t of coke breeze
Fuel price, $\$63 \times 20.4^{-1}$	\$3.09/GJ
Fuel cost, \$3.09 x 5.36	\$16.56/t of clinker

The CCP is attempting to obtain better fuel from India; this is a must factor if it wishes to operate its shaft kiln with a reasonable run factor.

Fuel for the preheater kiln

Almost any kind of fuel can be used in a preheater kiln. In the case of the CCP it is preferable to use high-calorific coal due to the heavy transport costs.

Suppliers elsewhere than in India should be sought. It might be possible to obtain coal from China or the United States with a net calorific value of 26.4 GJ/t (6,300 kcal/kg) and an ash content of 12-15% landed in Calcutta at a price of $75/t to $85/t. India itself suffers from a shortage of coal and it would be too risky to depend on this source only for a supply.

In a preheater kiln system it is possible to make a secondary firing in the riser pipe which connects the kiln with the preheater. About 20-25% of the fuel could be used at this point, and as the combustion is flameless a low-calorific fuel could be used, even with a high ash content. This would reduce the fuel costs considerably.

Estimated fuel consumption	3.50 GJ/t of clinker
Net calorific value (preferable)	26.4 GJ/t of coal
Estimated fuel price, c.i.f. Chobhar, about $150/t	$5.68/GJ
Fuel cost, $5.68 x 3.50	$19.88/t of clinker

These fuel costs are conservative and could probably fall as low as $8.35/t of clinker using todays fuel price, $63/t, c.i.f. CCP. A 20-25% secondary firing would drop the cost further.

Fuel for the raw mill

In the shaft kiln process the exit gases at about 90°C cannot be used for drying purposes as they contain a high degree of moisture. The raw mill will thus have to be equipped with a hot-gas generator for drying the raw materials and the coke breeze.

According to information given by the CCP (see annex V, A and B) NRs. 1.94 million was spent in the financial year 1979/80 on fuel for the raw mill for the production of 30,000 tons of clinker. This amounted to 400,000 litres of diesel fuel at 4.85 NRs/litre, which is equivalent to about 0.47 GJ/t of clinker (112 kcal/kg clinker).

In the preheater kiln, where the exit gases have temperatures of these gases can be used in the raw mill for drying the raw materials to a 6-7% moisture content.

Extra fuel may only be needed at the time of the monsoon when the moisture content of the raw materials could exceed 6-7%. Consumption may reach 0.21 GJ/t of clinker (50 kcal/kg clinker) at this time.

However, to reduce the moisture content of coal from 20% to 1% the fuel consumption would be about 0.13 GJ/t of clinker (32 kcal/kg clinker). This will again depend on the type of cooler applied. If a grate cooler were used there would be no need for extra fuel. If a planetary cooler were used extra fuel would be necessary.

Fuel for quarry equipment

From the information given by the CCP (see annex V, B), the consumption of diesel fuel for the quarry in the financial year 1979/80 was 45,000 litres at NRs 5.65/litre which is equal to NRs 254,250 ($21,366) for the production of 30,000 tons of clinker.

This amounts to NRs 8.48/t of clinker ($0.71/t clinker) or 1.5 litre/t clinker.

This figure is low and can be explained by the fact that the quarry is operated by a subcontractor. Moreover, the main compressor is driven by an electric motor. The quarry is located about 500-600 metres from the crusher at the plant.

C. Electricity supply

Future supply

At present the supply of electricity is a severe problem; flooding has disrupted the local hydro power station, resulting in a number of stoppages at the CCP.

The CCP claims that the lack of an adequate power supply was responsible for the low productivity in the financial year 1979/80, when the run factor was only 0.51.

A new hydro power station is under construction and it is expected that it will be able to supply sufficient electricity within two years. It will have a peak capacity of 60 MW, and about 18 MW in the dry season.

If the CCP expands the plant by installing a 500 tpd preheater kiln and allowing the existing shaft kiln to continue working at 50% capacity, the power supply needed would be about 6-7 MW.

Consumption is expected to be in the region of 100-110 kWh/t of cement.

Price

The CCP is currently paying NRs 0.30/kWh ($0.025/kWh).

D. Water

Water supply and consumption

The supply should not be any problem as the Manohara river passes close to the plant site.

Water consumption for the existing shaft kiln process is estimated to be about 16% higher per ton of cement than for the proposed preheater kiln process. For the latter, the consumption is estimated at about 200-300 litres per ton of cement.

E. Transportation costs

Bulk transport from Calcutta

From information provided by the UNCTAD/ESCAP office which is located at Pulchowk, in Patan, near Kathmandu, bulk transport of coal from Calcutta to Chobhar or Kathmandu will have to be done first by railway, a distance of about 737 km to Narayanpur Anant, near Muzaffarpur. The rate is Rs[1/] 72.70/t, which is equal to NRs 105.42/t.

The coal must then be re-loaded on to trucks and carried for a distance of 320 km to Chobhar. The truck rate is NRs 500/t.

Total transport costs for bulk coal or cement from Calcutta to Chobhar is NRs 605.42/t ($50.88/t) exclusive of port and other charges, loading and unloading.

An example of the cost of bulk transport from Calcutta to Kathmandu is the import of cement in bags from the Republic of Korea. The cost of the cement landed in Calcutta is $84/t (20 bags). The selling price in Kathmandu is about NRs 2,200/t ($185/t). Thus the transport cost from Calcutta to Kathmandu, plus the profit, is $101. If the profit were 20% this would amount to $37/t, and the transport costs plus other charges would be $64/t.

The rate for bulk transport by truck from Hetanda to Kathmandu, a distance of 140 km, where a new 225,000 tpy (750 tpd) cement plant is under study is NRs 268/t.

Summary

Bulk transport rates:

	NRs/(t km)
Calcutta - Narayanpur Anant Railway transport, 737 km, NRs 105.42/t	0.1430
Narayanpur Anant - Chobhar Truck transport, 320 km, NRs 500/t	1.5625

1/ Rs 1 = NRs 1.45.

Calcutta - Kathmandu Truck transport, 1,050 km, NRs 846/t	0.8057
Hetaida - Kathmandu Truck transport, 140 km, NRs 268/t (highly mountainous road)	1.9143

Clay transport for the shaft kiln

Special clay is needed to operate the shaft kiln. This is available from a new clay pit at Panchkhat, about 50 km from the plant site.

If one were to assume that the shaft kiln could operate with a run factor of 0.65, equal to 38,000 tpy of clinker, clay consumption would be 38,000 x 1.6 x 0.125 x 1.3 = 9,880 tpy of clay, with a maximum moisture content of 30%.

Transport costs including digging, loading and unloading would be NRs 2/(t km). Thus clay costs, delivered to the crusher at the plant, per ton of cement would be:

$$\frac{9,880 \times 2 \times 50}{38,000 \times 1.05} = 24.76 \text{ NRS/t cement}$$

The actual cost of clay from the nearby pit is about NRs/t 13.30 cement (see annex V, A).

F. Personnel

Staff

As shown in annex V, C, the total number of administrative staff at the CCP is 151. The number should not exceed 20-30 for this size of plant, and it is obvious that the plant is overstaffed.

Labour

Annex V, C shows the total number of labourers as amounting to 349. As with the administrative staffing situation, the CCP is largely overmanned. For most developing countries, the labour required per unit of cement is normally kept within the range of 2-5 man-hours per ton.

Each worker is employed for 2,000 hours per year, and the plant capacity is 48,000 tpy, therefore, the number of labourers should total a maximum of 5 x 48,000/2,000 = 120.

If the plant were expanded, no more labourers should be engaged. The amount of labour would be about 349 x 2,000/185,000 = 3.8 m-h per ton of cement, which is an acceptable figure.

G. Updating and expanding the plant by installation of another 200 tpd shaft kiln

Cost of equipment

The costs which follow are for a recommended general overhaul and include the installation of one more shaft kiln, a clay dryer and the associated mechanical and electrical equipment.

	Millions of dollars
Quarry equipment	1.5
Primary crusher	0.3
Pre-blending bed	0.6
Clay dryer	0.4
Raw mill	0.9
Homogenizing silo	0.3
Shaft kiln	1.6
Electrostatic precipitator	0.8
Cement mill	0.9
Packing machine	0.2
Conveyors and interconnections	0.4
f.o.b. European port	7.9
Transport, from $800-$1,000/t	0.8
c.i.f. price Chobhar	8.7

Capital expenditure

	Millions of dollars
(a) Mechanical and electrical equipment	8.7
(b) Civil works	3.0
(c) Erection and commissioning (30% of (a))	2.6

(d)	Contingencies (10% of (a), (b) and (c))	1.4
(e)	Working capital, 2 months production, $50 x 10,000	0.5
(f)	Interest during construction (20% of (a), (b), (c) and (e))	3.0
	Total	19.2

Investment cost per ton per year = $\frac{19,200,000}{60,000}$ = \$320/tpy

However, if the existing kiln improves its production from 30,000 to 48,000 tpy, the figure will be: $\frac{19,200,000}{78,000}$ = \$246/tpy

Production costs

The figures are taken mainly from annex V, A, as well as annex V, D and E. Cement production = clinker production x 1.05.

Fixed costs		Thousands of NRs per year
(a)	Salaries	1,703
(b)	Wages	1,833
(c)	Overheads	1,885
(d)	Depreciation, old	6,600
	15,700,000 x 0.07 x 11.9, new	13,080
(e)	Interest charges, old	1,000
	19,200,000 x 0.15 x 11.9, new	34,272
	Total	60,373

Variable costs		NRs/t cement
(f)	Limestone	81.90
(g)	Special clay	25.00
(h)	Gypsum	51.59
(i)	Fuel for the kiln	190.48
(j)	Fuel for the raw mill	61.59
(k)	Electric power, NRs 0.30/kWh	31.20
(l)	Consumables	63.49
(m)	Maintenance, excluding manpower	47.05
(n)	Bags, 3,444,000 x $(31,500 \times 21)^{-1}$	5.21
	Total	557.51

Sale price ex-factory, August 1981 ($134.45/t cement) NRs/t cement 1,600

Feasibility

The break-even point (BEP) = $\frac{60,373,000}{1,600 - 558}$ = 57,940 tpy of cement, which is equal to a run factor of 0.44.

It is assumed that the two kilns together will have a nominal rated capacity of 360 tons of clinker per day, and a peak capacity of 400 tpd.

Run factor	tpy	Profit NRs/year	Profit $/year
0.44	57,816	-	-
0.50	65,700	8,118,549	682,231
0.60	78,840	21,816,605	1,833,328
0.70	91,980	35,515,318	2,984,481
0.80	105,120	49,214,030	4,135,633

The project should prove feasible provided enough and suitable raw materials for the semi-dry process shaft kiln are available.

Expansion by installation of another shaft kiln should not be undertaken before the existing kiln has proved a run factor of at least 0.80 (46,720 tpy clinker) for one full year of operation.

If this could be done, expansion might be considered a possibility.

However, such a trial could not be completed before 1984; the plant must be certain of an adequate supply of electric power, which is planned to be operational in 1982-1983.

H. Expansion by installation of a 500 tpd preheater kiln

Plant description

To solve the severe production problems at the CCP it was suggested that the existing semi-dry process, which neither the supplier of the plant nor the management of the CCP have been able to run satisfactorily be abandoned, and a modern fuel-economic preheater kiln be installed.

The expert, in co-operation with UNDP has asked a number of reputable companies for budget proposals for a complete 500 tpd preheater kiln supplied on a turnkey basis.

Seven companies have replied positively, and based on this information it is possible to make a pre-feasibility study. However, the final results will largely depend on how well the old and the new plants can be matched together.

The new dry-process preheater kiln will have the following features:

(a) Any kind of fuel can be used; an advantage in future fuel negotiations;

(b) Fuel consumption is about 30-40% less than for the shaft kiln;

(c) Probably all raw materials except gypsum can be supplied from the nearby quarry. Long-distance tranrport of clay is unnecessary;

(d) Clinker produced in a rotary kiln can be stored for years, and could be sent to any site in Nepal, however remote, for local grinding. Cement in bags loses 10-20% of its strength after three months and 20-30% after six months. It is therefore not good to import bagged cement and store it for a long time. The losses of clinker which is stored outdoors amount to only 15% per year. Shaft kiln clinker has to be ground as soon as possible because of its porosity;

(e) A great advantage is that the nodulizer is eliminated in the dry process;

(f) It is also an advantage to have a rotary kiln alongside a shaft kiln as unburned shaft-kiln clinker can be saved by mixing it with well-burned rotary-kiln clinker. In this way the CCP can save money by making good use of all burned raw materials.

The project should aim at keeping the existing shaft kiln operating, even at half capacity, by careful selection of raw materials and fuel. If possible, the black meal process should be changed to the white meal process.

Capital expenditure		Millions of dollars
(a)	Mechanical and electrical equipment including quarry equipment, c.i.f. price Chobhar, about 1,700 tons	20.2
(b)	Civil works by local contractors	9.0
(c)	Erection and commissioning (30% of (a))	6.0
(d)	Contingencies (10% of (a), (b) and (c)	3.5
(e)	Working capital, 2 months production, $50 x 25,000	1.3
(f)	Interest during construction (20% of (a), (b), (c), (d) and (e))	8.0
	Total	48.0

Investment cost per ton per year = $\frac{48,000,000}{150,000}$ = \$320/tpy

150,000 tpy clinker production is equal to a run factor of 0.82 (300 days per year kiln operation).

Production costs

This estimate covers only the preheater kiln. It should be noted that the shaft kiln might produce about 35,000 tpy at the same time as the 150,000 tpy produced by the preheater kiln.

Fixed costs	NRs in millions per year
(a) Salaries	1.7
(b) Wages	1.8
(c) Overheads	2.5
(d) Depreciation, 38,700,000 x 0.07 x 11.9	32.2
(e) Interest charges, 48,000,000 x 0.15 x 11.9	85.7
Total	123.9

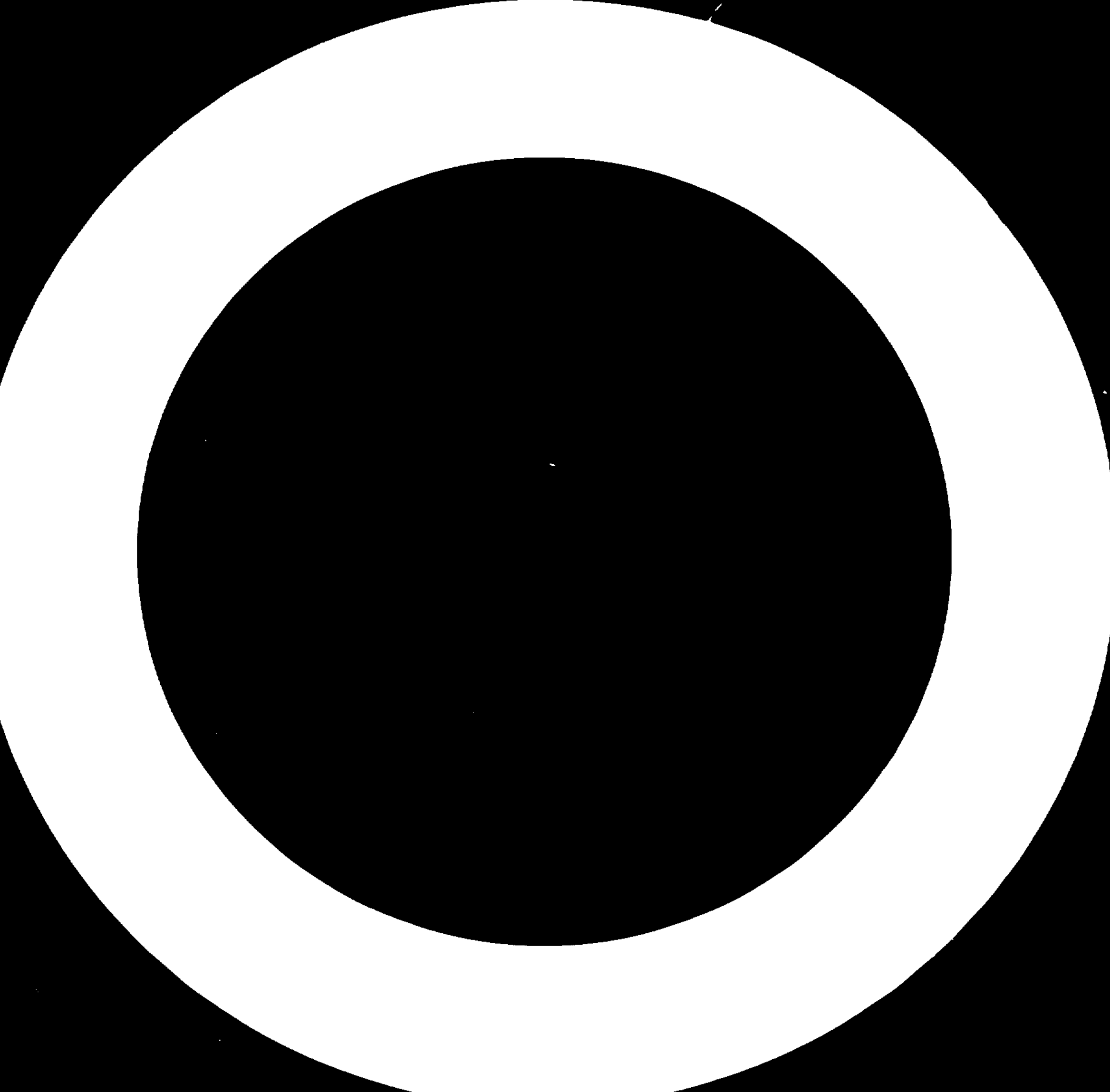
Variable costs	NRs/t cement
(f) Limestone	70.0
(g) Clay	13.4
(h) Gypsum	51.6
(i) Fuel for the kiln	160.0
(j) Fuel for the raw mill	30.0
(k) Electric power, NRs 0.30/110 kWh/t	33.0
(l) Consumables	70.0
(m) Maintenance, excluding manpower	47.0
(n) Bags, 21/t	5.2
Total	480.2
Sale price ex-factory, unchanged	1,600.00

Feasibility

The BEP = $\frac{123,953,100}{1,600 - 480}$ = 100,672 tpy cement, which is equal to a run factor of 0.60 (219 days per year kiln operation).

Run factor	tpy	Profit NRs/year	Profit $/year
0.60	109,500	-	-
0.66	118,625	8,882,640	746,440
0.70	127,750	19,101,180	1,605,141
0.75	136,875	29,319,994	2,463,865
0.80	146,000	39,338,260	3,305,736
0.85	155,125	49,756,344	4,181,205

The project is feasible provided enough and suitable raw materials for the dry-process preheater kiln are available.



Annex I

JOB DESCRIPTION

RAS/79/135

Post title:	Cement expert
Duration:	As soon as possible
Duty station:	Kathmandu, with travel in the country, visit to Frankfurt am Main, Federal Republic of Germany
Purpose of project:	To assist the Nepalese authorities and experts in evaluating and reporting on the technical and economic feasibility of expanding the capacity of the Himal Cement Plant

Duties:

The expert will be attached to the Government of Nepal to assist and support the Himal Cement Company (Pvt.) Ltd., in examining the techno-economic feasibility of expanding the capacity of the cement plant at Chobhar. The expert will be part of a team of two, in co-ordination with an economist/financial analyst. Specifically the expert will be expected to:

1. Assist in compiling and presenting the information already available.
2. Participate in an evaluation of the information available and help in the planning of further work necessary for proving the availability of sufficient raw materials in quantity and quality.
3. Examine the existing cement plant and make recommendations for its rehabilitation.
4. Assist in identifying the optimum expansion programme and technology, and in estimating the capital and operating costs of any expansion.
5. With the economist/financial analyst, assist and support Nepalese experts in finalizing and presenting a complete and comprehensive techno-economic feasibility report.
6. Based upon the findings from the raw material survey, advise on the elaboration of an exploitation plan as well as quarrying methods and raw material preparation including technique and equipment for quarrying, crushing, preblending, grinding, storing and controlling the production of a suitable raw mix.
7. The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government of Nepal on further action which might be taken.

Qualifications:	Industrial engineer with relevant experience in the cement industry
Language:	English

Annex II

NAMES OF ORGANIZATIONS, AGENCIES, PLANTS, PERSONS ETC. WITH WHOM THE EXPERT HAS HAD CONTACT

His Majesty's Government
Ministry of Industry and Commerce

Mr. J.L. Satyal
Director General
Department of Industries
Bagh Bazar, Kathmandu

Mr. Durga Bahadur Shrestha
Department of Industries

Mr. Stalin Man Pradhan
Industrial engineer
Department of Industry

Mr. Mahendra N. Rana
Director General
Department of Mines and Geology
Lainchour, Kathmandu

Himal Cement Company (Pvt.) Ltd.
Chobhar Cement Plant
Kathmandu

Mr. I.B. Shahi
General manager

Mr. Dibya Bilas Bajracharya
Business manager

Mr. Hira Ratna Sthapit
Mines manager

Mr. U. Jha
Mining chief

Mr. C.D. Rajbhandari
Production manager

Mr. A.S. Bania
Laboratory manager

Mr. Shankar Raj Aryal
Maintenance chief

Mr. Binaya Kumar Kushle
Production engineer

Mr. Bijon Kumar Banerjee
Civil engineer

Ms. Ambika Rajbhandari
Procurement officer

Industrial Services Centre (ISC)
Kathmandu

Mr. G.D. Pandey
Division chief

Assistance to least developed land-locked countries
UNCTAD/ESCAP
Pulchowk, Patan

Dr. Charles E. Stonier
Project manager

Mr. Girish Pokhrel
Professional on transit facilitation

Kreditanstalt für Wiederaufbau
Palmengartenstrasse 5-9
D-6000 Frankfurt am Main 1

Mr. Jörg Harmsen
Section director

Dr. Wolfgang Voss
Economist

Mr. Heinz Hoppen
Engineer and cement expert

Annex III

TELEX SENT TO PROSPECTIVE SUPPLIERS

You are kindly requested to inform us whether you in principle are interested in the supply of a 100,000 mtpy expansion of Chobhar Cement Plant replacing existing 160 mtpd shaft kiln with a 500 mtpd preheater kiln.

New raw materials investigation ongoing and report may be available after three months.

For the pre-feasibility study your budget proposal for a standard 500 mtpd plant would be appreciated and should be telexed to UNDP in Kathmandu for the attention of Harald Boeck UNIDO cement consultant as mission expires first week August. Regards

Annex IV

LIST OF PROSPECTIVE SUPPLIERS

	Response
ALC Ateliers Louis Carton S.A. Chaussée d'Antoing, 55 B-7500 Tournai Belgium	Positive
Cimprogetti Costruzione Impianti per Cemento e Calce S.p.A. Via Broseta 70 Bergamo Italy	Positive
Creusot-Loire Entreprises S.A. Tour Gan Cedex 13 F-92082 Paris-La Défense France	
Fives-Cail Babcock 7, rue Montalivet F-75383 Paris Cedex 08 France	
Fuller Company A Gatx Company World Headquarters P.O. Box 2040 Bethlehem, Pennsylvania 18001 United States of America	
Hyundai P.O. Box 8943 Seoul Republic of Korea	
IHI Ishikawajima-Harima Heavy Industries Co., Ltd. Shin Ohtemachi Bldg., 2-chome 2-1 Ohtemachi, Chiyoda-ku Tokyo 100 Japan	
KHD Humboldt Wedag AG P.O. Box 91 04 04 D-5000 Köln 91 Federal Republic of Germany	Positive

	Response
Kobe Steel Machinery and Engineering Division Tokko Bldg., 1-chome Marunouchi, Chiyoda-ku Tokyo Japan	
Krupp Posysius AG Graf-Galan-Strasse 17 P.O. Box 2340 D-4720 Beckum Federal Republic of Germany	Positive
O and K Orenstein and Koppel Aktiengesellschaft Werk Ennigerloh P.O. Box 1025 D-4722 Ennigerloh Federal Republic of Germany	Positive
F.L. Smidth and Company, A/S 77, Vigerslev Alle DK-2500 Valby, Copenhagen Denmark	Positive
UBE Industries, Ltd. Plant Engineering Division 7-2, Kasumigaseki 3-chome Chiyoda-ku, Tokyo Japan	
Voest-Alpine AG Engineering and Contracting Div. P.O. Box 2 A-4010 Linz Austria	

Annex V

REPLIES TO QUESTIONNAIRES FROM HIMAL CEMENT COMPANY (PVT.) LTD

A. Breakdown of production costs in the financial year 1980

Variable costs	Variable costs NRs/t of cement	Fixed costs NRs
Limestone landed at the crusher	2,579,000	
Clay landed at the crusher	420,000	
Coke breeze	6,000,000	
Gypsum	1,625,000	
Diesel fuel for the raw mill	1,940,000	
Consumables (refractoreis, wearing plates, bolts, hammers, balls, lubrication oil etc.)	2,000,000	
Maintenance, excluding manpower	1,482,000	
Paper or jute bags	3,444,000	
Government tax	9,600,000	
	5,040,000	
Fixed costs		
Salaries		1,703,000
Wages		1,833,000
Overheads		1,885,000
Depreciation		6,600,000
Interest		1,000,000
Other		800,000

Ex-factory price NRs/bag of 50 kg = Rs. 80.00

B. Fuel costs and consumption in the financial year 1980/1981

	Consumption	C.i.f. price Chobhar
Coke breeze for the kiln	8,000 t	NRs 750.00/t
Diesel fuel for the raw mill	4,000,000 litres	NRs 4.85/litre

Diesel fuel for quarry equipment	45,000 litres	NRs 5.65/litre
Diesel fuel for personnel transport	30,000 litres	NRs 5.65/litre
Gasoline for personnel transport	15,000 litres	NRs 9.30/litre

C. Personnel

Administrative staff

Title	Duty	Basic 1980 annual salary (in NRs)
General manager	Chief of organization	25,200
Business manager	Business administration	15,300
Mines manager	Mining administration	15,300
Senior chief of production	Production administration	15,300
Senior chief of maintenance	Repair and maintenance administration	15,300
Senior chief of laboratory	Laboratory administration	15,300
Second class officer (Admin.)	Chief of division	10,560
Third class officer (Admin.)	In charge of section	8,400
Fourth class assistant (Admin.)	Assistant to above officers	5,400
Fifth class assistant (Admin.)	Assistant to nearest above posts	3,960
Sixth class assistant (Admin.)	Record-keeping	3,060
Seventh peon, guard etc.	Guarding	2,400
Second class officer (Technical)	Chief of division	11,400
Third class officer (technical)	In charge of section	9,000

Total number of administrative staff: 151

Total salary for (1980) including surcharges: NRs 1,703,000

Staff costs per tonne of cement (1980/81): NRs/t 64.93

Labourers

Area	Number of workers
Limestone quarry	30
Clay quarry	15
Limestone crusher and transport to store	10
Clay and gypsum crusher and transport to store	10

Raw mill department } Homogenizing silo } 1	23
Kiln department	32
Raw materials and clinker store	6
Cement mill department	16
Packing plant	15
Laboratory	35
Mechanical workshop	52
Electrical workshop	27
Auto workshop, including quarry equipment	22
Spare-parts store	11
General services, carpenter, cleaning etc.	45
Total	349

Total wages per year (1980) including surcharges: NRs 1,833,000

Labour costs per tonne of cement 1980/81: NRs 69/88/t

D. Electricity cost and consumption in the financial year 1980/81

Terms of payment for electricity: NRs 0.30 per unit monthly

Total consumption of electricity from quarry to packing plant, including workshops and offices: 3,485,800 units

Average consumption in kWh/t of cement: 104 kWh/t

Break-down of consumption, department by department in kWh:

Raw mill department } Homogenizing silo }	978,864
Kiln department	586,498
Cement mill department	783,481
Packing plant	47,551

E. Clinker production at the Chobhar Cement Plant from its 160 tpd shaft kiln in tons

Month	1975/76	1976/77	1977/78	1978/79	1979/80	Estimate 1980/81
July/August	2 359	2 965	3 169	2 069	2 313	
August/September	1 942	3 353	3 877		2 943	
September/October	1 061	3 717	3 830	1 134	3 170	
October/November	2 334	3 161	4 124	3 037	1 266	
November/December	2 118	3 730	1 669	2 397	[illegible] 404	
December/January	2 228	905	2 546	1 723	2 720	
January/February	2 692	3 435	3 476	384	2 684	
February/March	2 623	3 457	2 626		2 464	
March/April	1 963	3 837	3 385	1 403	2 236	
April/May	3 110	3 551	2 150	3 424	2 650	
May/June	2 905	3 825	2 406	2 459	2 655	
June/July	2 108	3 314	2 632	2 989	2 658	
Total	27 443	39 250	35 890	21 019	29 163	30 000