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STRENGTHENING THE NATIONAL COUNCIL FOR CEMENT AND  
BUILDING MATERIALS (NCB) CAPABILITY IN PRODUCTIVITY  
ENHANCEMENT OF CEMENT INDUSTRY (PEP)

DP/IND/84/020

THE REPUBLIC OF INDIA

Report of the Evaluation Mission\*

Prepared in co-operation with The Republic of India,  
United Nations Development Programme and the  
United Nations Industrial Development Organization

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\* This document has not been edited.

LIST OF ABBREVIATIONS, CURRENCY EQUIVALENTS  
AND WEIGHTS AND MEASURES

ACC	Associated Cement Company of India
CAD/CAE	Computer Aided Design/Computer Aided Engineering
CCP-NCB	Centre for Consumer Protection
CEI	Centre for Environmental Improvement
CIS-NCB	Centre for Industrial Information Services
CPE-NCB	Centre for Productivity Advancement
CRI	Cement Research Institute (now NCB)
CTQ-NCB	Centre for Standardization, Calibration, Testing and Quality Control
DANIDA	Danish International Development Assistance Agency
DCCI	Development Commissioner for Cement Industry
DEA	Department of Economic Affairs
DRY	Dry Process Plant
EIA	Environmental Impact Assessment
GOI	Government of India
ICICI	Industrial Credit and Investment Corporation of India
Ind D	Industrial Department
kcal/kg	Kilocalories per kilogram
Kwh/t	Kilowatt Hours per Ton Cement
mg/Nm <sup>3</sup>	Milligram per normal cubic metre
M/M	Man-month
MT	Million tonnes
MTY	Million tonnes per year
NCB	National Council for Cement and Building Materials
NCB-B	NCB Ballabgarh Laboratories
NCB-H	NCB Hyderabad Laboratories
NCB-N	NCB, New Delhi Office
PPER	Project Performance Evaluation Report
SD	Semi-dry Process Plant
SLC	Separate Calciner & Grate Cooler
SPC	Suspension Preheater Kiln & Grate Cooler
SPP	Suspension Preheater Kiln with Planetary Cooler
SVK	Stationary Vertical Kiln
TPD	Tonnes Per Day
TPR	Tripartite Review
TPY	Tonnes Per Year
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
VSK	Vertical Shaft Kiln
WET	Wet Process Plant

CURRENCY EQUIVALENTS - Rs 1 = US\$ 0.054  
Rs 18.5 = US\$ 1.00

WEIGHTS AND MEASURES - Metric System

Fiscal Years - Government of India - April 1 to March 31  
ICICI - April 1 - March 31

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## INTRODUCTION

In 1985, the year the project document was signed, the Cement Industry in India was comprised of 94 cement plants spread all over the country and had an installed capacity of 41 million tonnes. During 1989/90, the effective installed capacity was 57 million tonnes. The capacity is targetted to increase to 82 million tonnes by 1994/95.

In the face of rapid technological change and increasing sophistication in the Cement Industry in India, the level at which technological and other production problems which needed to be addressed in the cement plants and the level the National Council for Cement and Building Materials (NCB) was capable of providing services to industry required upgrading. In particular, the level of sophistication of services provided to industry by NCB needed to be raised.

An institution-building project, it was designed to strengthen the National Council for Cement and Building Materials' (NCB) capability and capacity to provide state-of-the-art services to the Cement Industry in matters connected with productivity enhancement.

The National Council for Cement and Building Materials (NCB), formally the Cement Research Institute of India (CRI), is a multi-disciplinary autonomous body attached to the Ministry of Industry, Government of India (GOI). It is the main national institution for the Cement Industry devoted to research, technology development and transfer, education and industrial services.

This UNDP-financed and UNIDO-implemented technical cooperation project to strengthen the National Council for Cement and Building Materials (NCB) was approved on 4 February 1985 with a total budget of US\$ 1,961,000. As of today, US\$ 2,435,785 has been allocated by UNDP to this project. Approximately US\$ 250,000 of this amount remains uncommitted. It became operational in September 1985 and was planned to be completed during a three-year period. The duration of the project was subsequently extended to September 1990 and on 20 December 1990 was extended to 1 June 1991 to allow the completion of the last of four subcontracts.

During the course of implementation, some difficulties were encountered in locating the right kinds of experts. This problem was overcome by sub-contracting co-ordinated packages of assistance. The sub-contracts were jointly designed by UNIDO and the project staff in the fields of: Optimisation, Simulation and Process Control Systems; CAD/CAE; Energy Audit System; and Process Optimisation in Cement Plants.

The evaluation was carried out to comply with UNDP/UNIDO policy, which requires that all projects having an international budget over US \$ 1 million should be evaluated. The evaluation was requested to analyse the role the project has played in strengthening NCB's capabilities to provide productivity enhancement services to the Indian Cement Industry. The primary purposes of the evaluation were as follows:

- (a) To assess the achievements of the project against its objectives and expected outputs, including a re-examination of the project design.
- (b) To identify and assess the factors that have facilitated the achievement of the project objectives, as well as those factors that have supported the fulfillment of those objectives.

The full Terms of Reference for this evaluation are contained in Annex I. The decision to evaluate this project was taken during the last Tripartite Review (TPR) held on 5 June 1989.

The members of the evaluation team consisted of the following individuals:

- Mr. Ib Worning - Consultant and Representative of UNDP (Team Leader)
- Mr. K. R. Lakhanpal - Development Commissioner for Cement Industry (DCCI)
- Mr. Hans H. Heep - Senior Evaluation Officer representing UNIDO

The mission took place in India from 13 February to 6 March 1991. The Team Leader was briefed at UNIDO Headquarters on 12 February 1991. Team members held meetings with UNDP/UNIDO representatives, contacted Government officials and organisations relevant to the project, had extensive discussions with national project staff and most importantly, met many Cement Industry representatives who are the clients of NCB. The Schedule of Meetings Held and Visits Made is given in Annex II. The List of Persons Met is given in Annex III.

Preliminary findings and recommendations of the evaluation mission were discussed with the Government and UNDP/UNIDO on March 4, 5 and 7.

The mission wishes to thank Dr. A. K. Mullick, Director General, and Mr. Kamal Kumar, Head of the Centre for Productivity Enhancement, NCB, for their excellent professional and administrative support to the evaluation mission.

## I. PROJECT CONCEPT AND DESIGN

### A. Socio-economic and institutional context of the project

#### 1. Changing profile of the Indian cement industry

The Cement Industry is a basic core industry, the growth of which, along with other infrastructure industries, is vital for India's economic growth. The industry has had a chequered history. It had to operate under a strict control for well over forty years. This was a period when the industry suffered from very low capacity utilisation, technological obsolescence and lack of fresh investments. This led to a shortage of cement and the country had to import cement until 1985.

The cement scenario underwent a dramatic change with the introduction of certain positive policy initiatives taken by the Government. These included partial de-control of price/distribution, allowing liberal import of technology and capital goods, as well as financial assistance for new capacities. Starting with partial de-control from the year 1982, the Cement Industry was freed from all price/distribution controls from 1 March 1989. Recently the Central Government also decided to do away with the licensing restrictions for selling and distributing cement, with a view to encouraging availability of cement in the rural and suburban areas.

The foregoing policy initiatives have had a salutary impact on the long-term growth of the Cement Industry. The post-1982 period was characterised by a massive addition to the cement capacity and huge investments aimed at expansion, modernisation and technological upgradation of the existing capacities. As a result, the country not only became fully self-sufficient in respect of its cement requirements, but also acquired the capability and capacity to export. In the following paragraphs, an attempt has been made to spell out the changing profile of the Indian Cement Industry in its various aspects.

#### 2. Growth in capacity/production

Growth in installed capacity and production of cement since the beginning of the Plan Era is indicated below:

S No	Five Year Plans	Year Ending	Capacity MTY	Production MTY	Percentage of capacity utilisation
1	Pre-Plan	1950-51	3.28	2.20	67
2	First Plan	1955-56	5.02	4.80	92
3	Second Plan	1960-61	9.30	7.97	86
4	Third Plan	1965-66	12.00	10.82	90
5	Fourth Plan	1973-74	19.76	14.67	74

(continued)



S No	Five Year Plans	Year Ending	Capacity MTY	Production MTY	Percentage of capacity utilisation
6	Fifth Plan	1978-79	22.55	19.42	86
7	Sixth Plan	1984-85	40.92	30.19	74
8	Seventh Plan	1985-86	44.58	33.13	79
		1986-87	53.73	36.59	79
		1987-88	58.31	39.59	71
		1988-89	60.31	44.29	77
		1989-90	61.91	46.64	79
9	Eighth Plan	1990-91	62.66	39.59*	80

\*On the basis of operating capacity of 491.90 million tonnes for the period April 1990 to January 1991.

It can be observed from the above figures that massive increases in installed capacity and cement production, especially during the last eight years, have taken place. In fact, the installed capacity during the Sixth and Seventh Plans was nearly double that of the entire capacity installed up to the Fifth Five-Year Plan. A quantum jump in cement production has been witnessed during this period.

### 3. Expansion/modernisation

The Industry has embarked upon an ambitious and comprehensive modernisation and expansion programme since the introduction of partial de-control in 1982. This is evident from the expenditure incurred on modernisation and expansion during the period 1982-1990, which is tabulated below:

Years	(rupees in millions)		
	Modernisation	Expansion	Total
1982-83 to 1985-86	5218.70	5618.50	10837.20
1986-87	1468.00	829.40	2297.40
1987-88	1385.80	1220.00	2605.80
1988-89	1172.00	765.00	1937.00
1989-90	1740.00	2110.00	3850.00

The modernisation programmes undertaken by the Cement Industry have mainly focussed on productivity optimisation; conversion from wet process into dry process; installation of captive power generating sets; expansion by installing pre-heaters and precalciners; and pollution control.

#### 4. Changing process profile

Though the earlier cement plants were based on wet process and long dry process technologies, the invention of suspension pre-heater and precalciner technology has changed the process scenario in the Indian Cement Industry. Wet process based plants, which constituted nearly 50 per cent of the total installed capacity in the beginning of the Eighties, represent only about 20 per cent of the total capacity as at the end of 1990.

The oldest cement kiln still in operation was set up in 1926 in Shahabad by the Associated Cement Company of India (ACC). There are as many as 125 kilns which are more than ten years old. Ninety-three kilns, representing 25 per cent of the total capacity, are over 20 years old. Older kilns are small in size and sub-optimal and thus need to be replaced.

The trend in the recent past has been to install large kilns of 3000 TPD capacity. There are 12 single-line one million tonne capacity kilns in the country at present. Although no definite conclusion can be drawn in view of the socio-economic scenario and infrastructural developments in the foreseeable future, 3000 TPD single-line kiln systems appear to be the preferred size and the future trend is likely to be based on higher capacity single-line kilns.

#### 5. Cement machinery manufacture

Even though cement is one of the major established industries in the country, complete cement plants were imported up to the early Sixties. It was only during the Sixties that the development of cement machinery was taken up indigenously in an organised manner. The number of cement machinery manufacturing units rose to 16 in the year 1989-90.

Almost all the cement machinery manufacturers cooperate with foreign partners on a selective basis. With appropriate technology transfer, Indian cement machinery manufacturers are now capable of manufacturing cement machinery, including large-sized cement plants. Quite a large number of components and systems, which were earlier imported, are also now being manufactured indigenously; however, some components, including computerised process control/monitoring systems, on-line analysers and advanced instrumentation, etc. are still being imported.

#### 6. Technological developments

The prime mover behind the growth of new cement technologies in the Eighties was the energy crisis, which prompted innovations by producers to contain the spiralling costs. The technological advances that have taken place in recent years resulted in higher efficiencies achieved in the grinding process; innovations in plant computerisation and analytical instrumentation; and utilisation of waste and by-products as fuel alternatives.

With the known advantages of precalciner technology, it could be safely predicted that it will continue to dominate cement production in the Indian Cement Industry. A recent development is an addition of a sixth cyclone stage in the suspension preheater in order to reduce the exit gas temperature by about 40 degree centigrade, with the resultant thermal energy saving of 30-40 kcal/kg clinker, with or without a marginal increase in power consumption. A six-stage preheater system has already been installed in India for the first time at Diamond Cement in Madhya Pradesh.

#### 7. Wastes and fuel alternatives

A growing list of wastes have been examined for possible use as supplementary fuels. These include colliery wastes; oil shale; sewage sludge; graded household refuse and wood chips. Use of wastes such as rice husks, colliery wastes, etc. is being tried in some of the cement plants in India. The Industry is expected to make a breakthrough in this area in the years to come, with a resultant saving in fuel energy.

Poor quality of coal is one of the major reasons leading to low productivity in the India Cement Industry. Blending is a partial solution to the poor quality fuels. The discovery of new reserves of natural gas have raised hopes to free the Cement Industry from the effects of poor quality coal. Some cement plants have been identified for using the natural gas as an alternative fuel; however, issues relating to the cost of natural gas and the fallback period, etc. are required to be sorted out before full utilization of this potential can be realized.

Efforts are being made to use lignite in lieu of coal by cement plants located in the proximity of lignite deposits. A number of plants in Tamil Nadu and Gujarat are using lignite to the extent of 30 to 35 per cent of their total coal requirement. This trend is likely to increase in the future.

#### 8. Future demand projections

Demand projections of cement made by the Industrial Credit and Investment Corporation of India (ICICI) up to the year 2000 are indicated below:

(in million tonnes)

Years	Demand MTY
1989-90 (last year of 7th Plan)	45.60
1990-91	49.79
1991-92	54.02
1992-93	58.61
1993-94	63.60

(continued)

(in million tonnes)

Years	Demand MTY
1994-95	69.00
1999-2000	101.00

9. Addition to the installed capacity

To fully meet the demand for cement, the addition of 25 million tonnes of capacity has been planned during the eighth Five-Year Plan. An additional capacity of 32.00 million tonnes has already been sanctioned by the setting up of new green-field projects and by the expansion of the existing projects. These schemes are in various stages of implementation. The current growth trends in the Cement Industry indicate that the Industry will not only be able to fully meet the national demand for cement, but will also be able to generate surplus for exports.

10. Price/distribution control

The Cement Industry operated under a strict Government controls for over four decades. Price/distribution control over cement was partially lifted in 1982; controls were fully phased out from the 1st of March 1989. With the removal of price/distribution controls, the system of freight equalisation/ freight pooling in cement has also been abolished. Recently, the Government also decided to remove restrictions on the sale/distribution of cement, with a view to ensuring increased availability of cement to the rural and suburban areas.

From the foregoing account of the changing profile of the Indian Cement Industry, it can be observed that the Industry has undergone a radical transformation in some important aspects. It is difficult to isolate the role played by a single institution or policy instrument in the process of this transformation; however, there is no doubt that certain positive policy initiatives taken by the Government have helped the Industry to enter into an period of sustained growth. The role of NCB, as well as the UNDP Project: Strengthening the National Council for Cement and Building Materials (NCB) Capability in Productivity Enhancement of Cement Industry (PEP) needs to be viewed in this context.

Undoubtedly NCB is the prime institution in India rendering assistance to the Cement Industry. Its main fields of operation are in the areas of research, training and rendering technical advisory services to the Cement Industry. NCB not only has a group of highly qualified and capable scientists and engineers but is also equipped with the most modern equipment for carrying out its various activities. The Project under evaluation has gone a long way in equipping NCB to render effective services to the Cement Industry. It has been found, however, that NCB can surely improve their delivery system and should reach out to the Industry more aggressively than it has in the past.

B. Project document

1. Objectives, Outputs; an analysis

The Project document appropriately identifies the immediate objective, which is stated as follows:

"To strengthen the existing capabilities of the NCB (formerly CRI) in:

- (a) Effectively diagnosing technological problems and productivity constraints in cement industry;
- (b) Formulating programmes and methodologies for solving technological problems and improving productivity; and
- (c) Implementing solutions as arrived at in (b) above to enable it, in cooperation with the industry, to achieve the following:
  - 1.1 increase the present capacity utilisation of the cement industry from 77 per cent by at least 5 per cent;
  - 1.2 stable capacity utilisation figures;
  - 1.3 introduce energy conservation schemes in 10 to 15 cement plants so that:
    - 1.3.1 power consumption figures are decreased by at least 5 per cent;
    - 1.3.2 heat consumption figures are reduced by at least 5 per cent
  - 1.4 reduce dust emission in 20 to 25 cement plants in India by at least 10 per cent
  - 1.5 assist in the conversion of as much as possible of the cement plants presently run on wet process into dry process ones;
  - 1.6 decrease kiln downtime in 10 cement plants by at least 10 per cent.

Establishment of central data base at NCB for monitoring indicators of cement plants".

Although the immediate objective statement is at the appropriate level, the end-of-project indicators listed under 1.1 to 1.6 above are mostly at the development objective level and are consequently impact measures. While the performance of the Cement Industry is useful to monitor, it is difficult to precisely determine the extent to which this project can take credit for the industry improvement targets listed above, especially in view of the impact of the Cement Industry liberalisation programme discussed in Chapter I.A.

With respect to the objective statement itself under (a), (b) and (c) overleaf, a more appropriate statement would have set out that the project will strengthen NCB to be able to provide a specific quantity and quality of trouble-shooting and consulting services to the Cement Industry in the fields of Process Optimisation; Energy Conservation; Systems Engineering; Maintenance Systems; Process Simulation Training and Environmental Services.

End of project status indicators should have been developed which describe the nature, quantity and quality of services routinely provided to industry under the subject areas listed above.

The project document under the output section says that the basic output of the project is to be a considerably improved expertise in efficiently diagnosing technological problems and formulating and implementing various programmes of trouble-shooting; productivity optimisation and enhancement; and expansion and modernisation in the cement industry, with particular emphasis on a strengthened capability within NCB to formulate the following programmes, methodology of studies and implement these in industry.

This statement is at the project objective level, since it only provides a summary description of what capability will be established at NCB by the end of the project. As a case in point, it more or less repeats the first part of the existing objective statement.

The project document output section listed the following subject areas where service capabilities were to be strengthened. They were:

1. Optimisation and process control systems and programmes;
2. Energy conservation programmes;
3. Programmes in system design and plant engineering;
4. Plant maintenance programmes;
5. Programmes for control electronics and instrument repair and maintenance;
6. Instrumental engineering programmes;
7. Quality control programmes;
8. Programmes in areas such as improved kiln utilisation, improved refractors lining practices and conversion of high energy consuming wet process plants into energy efficient new systems.

When discussing these capabilities or service functions with NCB, it was decided that the functions listed under 1, 2, 3 and 4 would be retained for evaluation purposes and that 5, 6, 7 and 8 would be replaced by two functions in the field of cement plant simulation training and environmental advisory services. This was agreed to since the project inputs and activities served to strengthen NCB in these areas. These six areas more accurately reflect the

service capabilities which were either created or strengthened by the project. Elements of subject areas 7 and 8 fall under output 1 in any case.

The project document output statement suffers from a major deficiency by not providing a detailed specification of the capabilities to be strengthened or established by the project. This problem was brought to the attention of UNDP when the UNIDO Evaluation Staff, during late 1984, appraised the draft project document in response to a special request from the UNDP Resident Representative. UNIDO's Evaluation Staff had sent to UNDP a more detailed statement of outputs with the request that UNDP and UNIDO field representatives discuss and agree on the revised output statement. This was never done.

The output section lacks a description in specific terms of the various capabilities (expertise) which were expected to be built up or strengthened; the methodologies, guidelines and procedures which were to be developed and used on a regular basis to provide them; the staff skills required; the equipment to be used in performing the described functions (delivered as part of the project); and how these services were to be marketed, managed and financed.

Confronted with an unspecified output section, the evaluation mission had difficulty in evaluating project performance. Discussions with NCB concerning the unspecific output section of the project were held to define the institution-building outputs of the project using the "service module" concept as recommended by UNDP in its Programme Advisory Note on Industrial Research and Service Institutions (UNDP/PPM/TL/20). NCB re-designed the output section on this basis and provided information on the capacities and capabilities strengthened by the project. This placed the evaluation mission in a position to assess what was accomplished at NCB.

This approach requires that the service capabilities/capacities to be strengthened or established by the project be specified as follows:

- (a) The different kinds and quality of services which will be provided by the NCB unit (programme) and how much each year (i.e. planned level of services);
- (b) How many of each type (skill classification) of staff are required for the volume, quality and diversity of services specified under (a);
- (c) Which technical or scientific methodologies testing and other procedures, guidelines, etc. are required for the full functioning of the module;
- (d) What premises or facilities are needed, specified by type (workshops, office, laboratory, etc.);
- (e) What equipment and supplies are needed for full operation (summarised by major categories);

- (f) For which end-users or clients are the services meant; how large is the market/demand; how will the demand be stimulated; and how will the feedback information on the quality and utilisation of the services provided be obtained and used;
- (g) How will the services be financed and managed?

It should be apparent that with this information essentially missing from the project document output section, the project document design was seriously deficient.

The original project document's output section continues on to list that technical reports will be prepared to report on the impact the strengthened capabilities at NCB had on industry-wide performance. These include:

- 1.1 The actual increase in capacity utilisation figures achieved;
- 1.2 Achievements in the field of energy in cement plants in terms of:
  - 1.2.1 Actual reduction in power consumption;
  - 1.2.2 Actual reduction in heat consumption;
- 1.3 Reduction in dust emission from cement plants;
- 1.4 Number of cement plants converted from wet to dry process;
- 1.5 Actual decrease in kiln down-time achieved in cement plants.

The provision of such reports are not direct outputs of an institution-building project. At best, they represent a documentation of the project impact, i.e. on what a strengthened NCB was able to do to increase Cement Industry performance as a result of the project, whereas institution-building project outputs are results produced by using project inputs to carry out activities to strengthen or establish specified service capabilities and capacities. Once these capacities and capabilities are established or strengthened and are successfully provided to industry in the form of services, one can report on the results of the provision of such services to industry. Such reports could then be used to substantiate that the project has achieved its objective and is significantly contributing to the country's development objectives.

The final output listed in the project document was the establishment of a central data base at NCB for monitoring various productivity indicators of cement plants. Again, this output lacks the specification required by UNDP's service module concept discussed above.



## II. PROJECT IMPLEMENTATION

### A. Delivery of inputs

#### 1. UNDP/UNIDO inputs

In the original budget, the UNDP contribution was planned at US\$ 1,961,000. The total budget, in accordance with the latest budget revision "N", now totals US\$ 2,445,190. Table 1 below shows the comparison between the original and latest budgets. Significant differences are noted under the project personnel, equipment and sub-contract components. The project personnel component decreased by 69 per cent from US\$ 1,414,000 to US\$ 433,241. This component was significantly reduced to purchase modern equipment not originally foreseen in the budget and to shift money to sub-contracts which provided 'packages' of equipment, training and expertise. The training component only increased by 12.6 per cent; however, a part of the originally unforeseen training was actually provided under the sub-contracts. The equipment component was increased by 56 per cent to purchase the latest measuring and testing equipment. Moreover, major pieces of equipment were also purchased under the sub-contracts. These included, for example, sophisticated computers and software for a cement process training simulator, measuring equipment and a computer and other equipment for a mobile energy audit facility.

The results of the above changes will be discussed in more detail under Chapter III. A. and B. Changes in project inputs and activity, particularly the shift to the sub-contracting modality were conceived during the course of project implementation in order to improve project input delivery, efficiency and effectiveness. The changes in project input requirements and implementation modality reflected in the budget were discussed and agreed upon during the project tripartite review meetings. It must be stated, however, that what these additional inputs would produce in terms of increased capabilities and capacities was not fully discussed during these meetings.

Project Budget Revision "N" has allocated US\$ 550,000 for a sub-contract to be implemented during 1991. According to UNIDO records, a sub-contract for process optimisation assistance was signed during December 1990 for US\$ 294,000. This leaves approximately US\$ 256,000 in uncommitted funds. The possible utilisation of these funds is discussed in Chapter V. Recommendations.

Details of fellowship training, study tours, experts, equipment and subcontractural inputs are given in Annexes V to IX. Further reference will be made to these inputs in Chapter II. B. Implementation of Activities and in Chapter III.

TABLE 1 ON FOLLOWING PAGE

Table 1

Comparison between original and latest UNDP/UNIDO budget  
and indication of funds remaining in 1991

Budget Line	ORIGINAL BUDGET	TOTAL REVISION	% increase/ (decrease)
	US\$	(Rev. "N", 20.12.90) US\$	
10 Project Personnel	1,414,000	443,241	(69%)
039 Training	221,000	248,898	12.6%
049 Equipment	306,000	746,675	56%
021 Subcontracts	-	988,057	
050 Miscellaneous	20,000	18,323	(8.3%)
	US\$ 1,961,000	US\$ 2,445,190	

2. Government inputs

During the implementation of the project, it was envisaged that the total resources of NCB would be placed at the disposal of the project since it was stated that productivity enhancement and modernisation is a multi-disciplinary activity which will draw support from the total resources of the institute. Suffice to say that the required counterpart staff for all the experts fielded were provided. The items of equipment supplied under the project are adequately housed in the Ballabgarh and Hyderabad facilities. Staff trained by the project, with a few exceptions, are on the job and providing enhanced services, as planned.

The project document specified that 80 professional engineering and scientific staff were to be assigned to the project at least part-time and 60 technical and other staff for the laboratories, etc. Although it is nearly impossible to pinpoint the exact number of staff actually provided to the project, the analysis contained in Chapter III. A. Outputs includes listings of staff who have participated in and benefitted from the project. These, along with the facilities provided, clearly indicate that NCB has fully lived up to its commitments even if they were not fully specified in the original project document.

The NCB also provided adequate office facilities, secretarial support and transport arrangements to the many experts and sub-contractors working on the project to the best of their ability.

Presently NCB has around 400 staff, with a little more than 200 professionals. In 1985, the total staff was approximately 380, with about 185 professionals. As can be seen, there has been only a slight increase in staff since the project started.

#### B. Implementation of activities

The mission was provided with a useful summary of project implementation figures which provided a good indication of the nature of assistance provided and activities carried out under this project.

Under the Personnel component, 24 experts were fielded in 20 subject areas. They visited and provided technical advice to 55 cement plants and 125 studies in various fields and subjects were carried out.

Under the training component, seven officials completed study tours and 29 officials received fellowship training. In connection with the sub-contracts, ten officials completed training and three staff are undergoing training under the fourth sub-contract.

Equipment pieces received totalled twenty, as was planned during the implementation phase of the project.

Four sub-contracts were finalised in the areas of:

- (a) Productivity improvement through application and development of simulation, optimisation and process control systems;
- (b) Productivity improvement through development of modern methodologies for system design and engineering in cement industry;
- (c) Energy audit system;
- (d) Process optimisation in cement plants.

The fourth sub-contract will be implemented during 1991, while the other three were successfully implemented during the life of the project.

Details of fellowship training, study tours, experts, equipment and sub-contracts delivered are contained in Annexes V to IX.

The project was originally scheduled to start during April 1985 and actually commenced operation during September 1985, when five officials began their study tours. The original completion date was targetted for September 1988; the actual completion is now forecasted for June 1991. The delay in completing the project is attributed to the tremendous initial difficulties in identifying high-level experts willing to work in the project for the span of time required (split missions and for an average of two months) and with the remuneration the United Nations is able to provide. Moreover, NCB was very meticulous in screening the qualifications of the expert nominees submitted by UNIDO. It was subsequently decided that to find experts in highly

sophisticated technical areas the most efficient and effective approach would be to sub-contract for such services. This proved to be an excellent decision since under a sub-contract, an integrated technology transfer package can be provided in a timely fashion and with the quality specified, since the contractor is legally committed to provide the services in accordance with the requirements specified by NCB.

Moreover, the technologies envisaged to be transferred to NCB, i.e. simulator systems, are available with only a few companies who are not willing to provide their expertise unless it is sub-contracted.

One could question why this was not envisaged during the project design and formulation stage. The explanation given was that the needs in the areas sub-contracted were refined during the project's implementation phase and it was also only subsequently realised that sub-contracting would be the most efficient and effective means to obtain the technologies required. The heretofore good results achieved under the sub-contracts confirms the validity of this approach. It is to the credit of UNDP, GOI and UNIDO that they were flexible enough to agree to this modality.

Despite the initial expert recruitment delays, NCB has expressed their satisfaction with the implementation performance of UNIDO in supplying experts, equipment and arranging the training and sub-contracts.

The training component delivery was also substantially behind schedule, which was largely caused by the delay in the delivery of experts. The NCB rightfully wanted to use the knowledge and advice of the experts in specifying training requirements and locating suitable training opportunities. Basically the trainees were able to receive training in a large number of cement plants and from cement machinery manufacturers.

No major problems were experienced with the implementation of the project's equipment component. The equipment was delivered more or less as planned and with the quality required.

With regard to the implementation of the expert component of the project, all experts were thoroughly briefed upon arrival. Their terms of reference were discussed and agreed upon in detail. The experts were always accompanied by NCB staff during their plant visits to ensure on-the-job training for these officials. Moreover, most of the experts were requested to give a seminar in their area of expertise. The evaluation mission has received a representative sample of the reports prepared by the experts and the vast majority were found to be good to excellent. Only one expert had language problems, despite claims to the contrary in his Resumé. His report was unacceptable.

NCB also prepared their own expert appraisal report summarizing their assignment, listing recommendations made and their status. The evaluation found this procedure to be very useful and worthy of emulation by other UNDP projects.

Returning trainees all prepared comprehensive reports on their experiences. In reviewing them, they were generally judged to be of high

quality. The trainees also made presentations of their overseas training experiences to their fellow NCB staff.

The study tours were also implemented to the general satisfaction of the staff participating. Detailed reports were prepared by the participants. The study tours were intended to acquaint senior staff with the latest developments in the Cement Industry and to help NCB locate sources for consultants, training offers and equipment. This was found to have been useful to NCB for fine-tuning project inputs and activities to meet the rapidly developing technological needs of industry.

There seems to be a unanimous opinion among all parties concerned that training - both in the form of fellowships and study tours - has contributed significantly to the capability of NCB.

The three completed sub-contracts were implemented successfully and the results which the evaluation mission were able to observe in action, namely the energy bus and the simulator, were impressive. Especially with respect to the simulator, the mission was impressed with the way the NCB officials responsible were able to get the maximum benefit from this particular sub-contract. NCB was able to establish a state-of-the-art simulator training centre in Hyderabad, which in the end exceeded the performance capabilities originally envisaged.

#### 1. Project management and monitoring

In terms of managing the project, making full use of the inputs and carrying out project activities, no serious problems were detected. Record keeping in UNIDO, UNDP and at the project site were satisfactory. No critique of UNIDO's backstopping performance was noted and NCB was generally pleased with the support provided by UNIDO. Although this project had a duration of five years, only three tripartite reviews were held and three Project Performance Evaluation Reports (PPERs) were prepared. Only two reached UNIDO, however, which meant that UNIDO was able to comment on two reports before the tripartite reviews took place.

It should be noted that because the project document failed to properly specify the output section as discussed in Chapter I.B. of this report, the PPERs and the Tripartite Review Meetings (TPRs) did not fully assess the project performance in developing the Cement Industry productivity enhancement service capabilities at NCB. In the absence of an adequately designed output section, the TPRs and also NCB's own Programme Committee meetings focussed on project input delivery. At the other end of the spectrum, figures concerning Cement Industry productivity improvement, i.e. capacity utilisation, were presented to these meetings as indicators of project success, without attributing the role the project, let alone NCB, played in these industry-wide improvements, whereas project objective achievement and the contribution that project results were making towards this end were never meaningfully discussed. Luckily, NCB had a clear idea of what capabilities they needed to have strengthened and what, albeit with many modifications, was required to achieve it.

III. PROJECT RESULTS AND ACHIEVEMENTS OF OBJECTIVES

A. Outputs

As discussed in Chapter I. B. 1. Objectives, Outputs: an analysis, NCB staff and the evaluation mission agreed that in the absence of a properly specified project document Output section and in view of the fact that the project strengthened six functional (service capability/capacities) areas instead of the eight listed, the evaluation would report on what was achieved in this respect by using institution-building "service modules". This enabled the evaluation to report on the capacities and capabilities created as against those which were there at the beginning of the project. Six modules were developed.

1. Expertise in Process Optimisation;
2. Expertise in Energy Conservation;
3. Expertise in CAD/CAE Systems;
4. Expertise in Maintenance Practices;
5. Simulator Training Facility at Hyderabad; and
6. Expertise in Environmental Improvement.

The results achieved are summarized below:

Output Module 1: Expertise in Process Optimisation

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
1. Functional service(s)	Basic expertise for providing services in improving the productivity of cement plants through process optimisation in mills and kilns, trouble-shooting and guide norms	An expert group conversant with latest techniques in providing services related to plant productivity improvement through:  * optimisation of process parameters and operation * trouble-shooting * guide norms
2. Staff composition	4 engineers-3 chemical -1 electrical instru- mentation	8 engineers-7 chemical -1 electrical instru- mentation  Expertise strengthened by training and exposure to latest techniques abroad.

(continued)

Output Module 1: Expertise in Process Optimisation

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
-----		
3. Methodologies/ work routines	Studying the process, operation and design parameters, survey of the plant with data format and plant visits for measurement inspections, data collection/discussion	Analysis of data, diagnosis of problems/bottleneck based on field measurements using sophisticated equipment, as well as data discussions following recommendations for improved productivity, including output rates/production/consumption targets
-----		
4. Premises and facilities	Ballabgarh Unit of NCB	Ballabgarh Unit of NCB Hyderabad Unit of NCB
-----		
5. Equipment and supplies	<ul style="list-style-type: none"> <li>- Radiation pyrometer</li> <li>- Pitot tubes</li> <li>- Thermo couples</li> </ul>	<ul style="list-style-type: none"> <li>- Two colour radiation pyrometers</li> <li>- Portable CO and O<sub>2</sub> gas analyser</li> <li>- Microprocessor controlled K-type thermometer and service parameters</li> </ul>
-----		
6. Market for and services provided	Indian Cement Industry	<ul style="list-style-type: none"> <li>- Indian Cement Industry Detailed process optimisation studies carried out in 17 cement plants</li> <li>- Exploring the potentials in neighbouring countries on a regional basis</li> </ul>
-----		
7. Management/ Financing	- Process optimisation was one of the missions of the Productivity Enhancement Programme of NCB	- Team leaders and senior members of process optimisation programme report to the programme leader and head, Centre for Productivity Enhancement

(continued)

Output Module 1: Expertise in Process Optimisation

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
	- Financing of R&D funds and partly by R&D contributions by plants/organizations availing the services	- Financing by R&D fund allocations and partly by R&D contributions by the plants availing the services

Process optimisation - detailed description of service capability

With the expertise gained from the experts' visits, the training of the NCB staff abroad and the equipment supplied under this programme, NCB is capable of rendering the following process optimisation services to the Indian Cement Industry.

Raw materials

(a) Mining and Quarrying:

Planning new mines and restructuring old quarries. Using advanced computer-aided techniques in quarry planning, monitoring, quarry performance and establish information systems.

(b) Raw Materials Technology:

Evaluate raw materials by optical microscopy, electron microscopy, x-ray diffraction and x-ray flourescent analysis. Study raw mix design and burnability.

(c) Size Reduction:

Survey the state-of-the-art grinding operations using classifying techniques; and study grindability of raw materials.

Kiln utilisation

(a) Optimise operation of wet plants, dry process kilns and precalciner kilns.

(b) Guidelines for improving dry process blending and homogenisation.

(c) Study suitability of various types of coal.

(d) Material balances and heat balances.



When the fourth sub-contract on process optimisation has been completed, the service will be extended to cover process optimisation by computer-aided mining, raw grinding, pyroprocessing and cement grinding. The computer will be equipped with programme development environment expert systems.

Output Module 2: Expertise in Energy Conservation

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
-----		
1. Functional service(s)	Basic expertise in providing energy conservation and energy auditing services to the cement plants	An expert group conversant with the latest technologies in providing services related to energy conservation and audit by effectively diagnosing the potential areas through surveys and by recommending appropriate remedial measures for implementation by cement plants
-----		
2. Staff composition	6 engineers-3 chemical -2 mechanical -1 electrical	12 engineers-5 chemical -2 mechanical -4 electrical -1 industrial  Expertise strengthened by training and exposure to latest techniques abroad
-----		
3. Methodologies/ work routines	Studying the energy consumption survey of plants through data formats and plant visits for data collection/discussion	Carrying out detailed and systematic energy audit studies in plants, including on-site measurements for energy balance and giving recommendations for energy conservation by operational control and by energy efficient equipment/systems
-----		
4. Premises and facilities	Ballabgarh Unit of NCB Hyderabad Unit of NCB	Ballabgarh Unit of NCB Hyderabad Unit of NCB
-----		

(continued)

Output Module 2: Expertise in Energy Conservation

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
5. Equipment and supplies	<ul style="list-style-type: none"><li>- Portable gas analyser for O<sub>2</sub>, CO</li><li>- Thermocouples</li><li>- Pitot tubes</li><li>- Radiation pyrometer</li></ul>	<ul style="list-style-type: none"><li>- Portable gas analyser, fuel efficiency monitor, thermovision, hygrometer, infrared thermometer, thermocouples, etc.</li><li>- Mobile energy diagnostic unit, including on-board computer and on-line measurement and recording facilities for process and electrical parameters</li></ul>
6. Market for and services provided	<ul style="list-style-type: none"><li>- Indian Cement Industry</li><li>- Energy survey of 46 cement plants</li></ul>	<ul style="list-style-type: none"><li>- Indian Cement Industry</li><li>- Detail energy audit studies in 29 cement plants, including 4 plant studies with Mobile Energy Diagnostic Unit</li></ul>
7. Management/financing	<ul style="list-style-type: none"><li>- Energy conservation was one of missions of Productivity Enhancement Programme</li><li>- Financing by R&amp;D funds and partly by R&amp;D contributions by the plants/organizations availing the services</li></ul>	<ul style="list-style-type: none"><li>- Programme leader of Energy Conservation Programme reports to to the head, Centre for</li><li>- Financing by R&amp;D fund allocations and partly by R&amp;D contributions by the plants availing the</li><li>- Providing services to neighbouring countries on regional basis</li></ul>

Energy conservation - detailed description of service capability

With the expertise gained mainly from Sub-contract III in Energy Audit System, NCB is capable of offering the following services to industry:

- (a) Identifying the quantity and costs of various energy inputs:

- (b) Evaluating energy consumption pattern in different process centres;
- (c) Relating energy inputs and production outputs;
- (d) Highlighting wastages in major areas;
- (e) Identifying potential areas of energy economy; and
- (f) Fixing of energy targets for individual cost centres.

NCB has a computerised programme for:

- (a) Electrical energy audit;
- (b) Thermal energy audit; and
- (c) Peak load demand control.

NCB can also give guidelines on different methods of co-generation.

Output Module 3: Expertise in CAD/CAE Systems

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity*
1. Functional services(s)	0	<ul style="list-style-type: none"><li>- A CAD work station was used for geological studies. Software developed for a mineable block grade and bench maps</li><li>- Various softwares used for equipment component design and reparation of drawings</li><li>- Development of interactive design of reinforced concrete elements and stress analysis of bridges</li><li>- Training courses conducted on use of CAD for civil structure</li></ul>

(continued)

Output Module 3: Expertise in CAD/CAE Systems

-----		
Specifications		
Module Components	Baseline: Status at beginning of project	Present status/capacity*
-----		
2. Staff composition	0	- 1 Head of Centre (civil) - 1 Activity in-charge (mechanical) - 1 Engineer (structural) - 2 Engineers (mechanical) Officials have been trained under the project
-----		
3. Methodologies/ work routines	0	Utilisation of CAD services for programmed R&D projects, sponsored projects, equipment design activities and training courses
-----		
4. Premises and facilities	0	Separate room (80m <sup>2</sup> ) fully equipped with air conditioners and a 3 KVA uninterrupted power supply (UPS) system
-----		
5. Equipment and supplies	0	Detailed configuration enclosed Annexure
-----		
6. Market for and services provided	0	Indian Cement Industry - Completed 3 sponsored projects for cement plant, Gov't/Public undertakings - 2 training courses organised involving 35 participants representing cement plants, public undertakings and private consultants - Development of various CAD softwares
-----		

(continued)

Output Module 3: Expertise in CAD/CAE Systems

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity*
7. Management/ financing		Staff member in charge reports to Head of Centre on all technical matters

\*This is the combination of rudimentary baseline capacity plus the additional capacity produced as a result of project activities. Together they are intended to meet the projected demand for services at the end of the project.

Output Module 4: Expertise in Maintenance Practices

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
1. Functional service(s)	- Basic expertise for providing specialized services to cement plants in the field of plant maintenance	- An expert group which can provide services related to plant maintenance covering the following areas:  *Preventive and productive maintenance techniques *Inventory control and spare parts management
2. Staff composition	3 scientists-2 mechanical engineers -1 electrical engineer	9 scientists-7 mechanical engineers -2 electrical engineers  Expertise strengthened through training and exposure to latest techniques abroad

(continued)

Output Module 4: Expertise in Maintenance Practices

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
-----		
3. Methodologies/ work routines	- Studying the status and prevailing maintenance practices in cement plants by plant visits	- Visiting cement plants on request; appraising maintenance staff about the equipment condition; suggesting remedial/corrective actions to prevent catastrophic failure of equipment - Preparing PM schedules after studying the existing plant condition and providing improved maintenance system
-----		
4. Premises and facilities	- Ballabgarh Unit of NCB	- Ballabgarh Unit of NCB
-----		
5. Equipment and supplies	Nil	- Modern equipment for condition-monitoring of cement plant machinery like laser-based kiln aligner; shelltest operators; thermovision; vibration analyser/balancer; shock pulse meter; bearing analyser; ultrasonic thickness gauge and flow detector, etc.
-----		
6. Market for services provided	- Indian Cement Industry	- Indian Cement Industry - Extensive utilisation of condition monitoring techniques/equipment in cement plants through productivity enhancement project - Kiln alignment studies on 14 kilns in 12 plants - Shell ovality studies on 13 kilns in 13 plants

(continued)

Output Module 4: Expertise in Maintenance Practices

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity
-----		
	- Indian Cement Industry	- Preventive maintenance schedule in 7 plants and complete maintenance scheme for one plant - Evaluation of maintenance system in one large modern plant
-----		
7. Management/financing	- Programme leader of plant maintenance programme reporting to the Head of the Centre for Productivity Enhancement - Financing through R&D funds	- Programme leader of plant maintenance programme reporting to the Head of the Centre for Productivity Enhancement - Financing by R&D fund allocations and partly by R&D contribution of the plants availing the services
-----		

Maintenance - detailed description of service capability

With the expertise gained from the experts' visits (one expert visited 19 plants), the training of the NCB staff abroad and the comprehensive items of equipment required for mechanical maintenance, NCB is now capable of undertaking the following services:

- (a) Preventive maintenance for various units of a cement plant;
- (b) Advanced maintenance schedule for machinery units in cement plants;
- (c) Scheme for spare part management and inventory control; and
- (d) Evaluating operating conditions of mechanical and electrical equipment.

Output Module 2: Simulator Training at Hyderabad Facility

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity*
-----		
1. Functional service(s)	0	Conducting regular simulator-based training courses for cement plant personnel working at various levels. There are simulations for three types of kilns (SPP, SPC and SLC kilns) and five different capacities ranging between 300 to 4000 TPD) for each kiln type. Two types of training courses are offered, e.g., (a) Operation of preheater/precalciner kilns; (b) Computerised control of kiln operation
-----		
2. Staff composition	0	1 Activity Manager-in-charge (Chemical) 2 Engineers (Computers) 1 Engineer (Chemical) These officials have been trained abroad under the project
-----		
3. Methodologies/ work routines	0	Training courses comprised of audio-visual lectures on process technologies, automation principles and simulation techniques, followed by hands-on sessions at trainees' workstations, taking any particular plant/process situation as desired (duration 6-8 days)
-----		

(continued)



Output Module 5: Simulator Training at Hyderabad Facility

----- Specifications -----		
Module Components	Baseline: Status at beginning of project	Present status/capacity*
-----		
4. Premises and facilities	0	Separate building (200m <sup>2</sup> ) fully equipped with air conditioner, fire protecting cabinets and a 4.0 KVA uninterrupted power supply (UPS) system
-----		
5. Equipment and supplies	0	See annexure for details and configuration
-----		
6. Market for and services provided	0	<ul style="list-style-type: none"> <li>- Indian Cement Industry</li> <li>- The installation can cater to the training needs of all the 120 rotary kiln-based cement plants in the country. Twenty-three training courses organized so far involving 111 participants representing 38 cement plants.</li> <li>- Trainee profile:                Burners - 56.3%                Process Engineers - 31.1% and Instrumentation/Control System Personnel - 12.6%</li> </ul>
-----		
7. Management/financing	0	The officer in charge reports to the Head of the Centre and the Director in charge (CCE) on all technical and administrative matters. Training fees.
-----		

\*This is the combination of baseline capacity plus the additional capability produced as a result of project activities. Together they are intended to meet the projected demand for services at the end of the project.

Annexure Module 5

Detailed Description of Simulator Configuration

HP 1000 A 900 mini-computer Hewlett-Packard with:

- 6 Megabyte RAM
- 81 Megabyte Winchester drive with built-in tape drive
- 3 ASEA make colour workstations as trainees' op-stations
- 2 Supervisor consoles
- 1 Hard copy colour printer (FACIT)
- 1 Dot matrix report printer
- ACIS control panel 40 analog I/O  
and 32 digital I/O
- RTE-A real time, multi-user operating system

Simulation software for:

- (a) 300, 600, 900, 1200 and 1500 tpd preheater kilns with planetary and grate coolers;
- (b) 1500, 2000, 2500, 3000 and 4000 tpd double string precalcinator kiln with 4-stage preheater;
- (c) 140 and 280 tph vertical roller mills for raw grinding; and
- (d) 80 and 120 tph ball mills for clinker grinding.

Output Module 6: Expertise in Environment Improvement

-----		
Specifications		
Module Components	Baseline: Status at beginning of project	Present status/capacity
-----		
1. Functional service(s)	Monitoring of stack emissions in different cement plants as and when required	Air Pollution: Monitoring of stack emissions, ambient air quality, continuous dust monitoring, system design and optimisation of dust collector equipment  Noise Pollution: Measurement and abatement
2. Staff composition	4 chemical engineers	1 programme leader 6 chemical engineers 1 electrical engineer Some of these officials have been trained abroad under the project
-----		

(continued)

Output Module 6: Expertise in Environment Improvement

Specifications		
Module Components	Baseline: Status at beginning of project	Present status/capacity
3. Methodologies/ work routines	Estimation of stack emission in different cement plants	Estimation of emissions; analysis of problem; trouble-shooting; recommendation for improving the performance of dust collector equipment
4. Premises and facilities	No laboratory	Environmental laboratory has been set up
5. Equipment and supplies	PM-100 Stack Sampler -1 Sound Level Meter -1 Noise Dosemeter -1	See Annexure for details
6. Market for and services provided	Indian Cement Industry	- Indian Cement Industry - An active market for environmental improvement impact assessment (ETA) studies for both new and old plants - Studies dust emission pattern in about 70 cement plants and out of these in 21 cement plants the emissions were brought down within the prescribed emission limits of 250 mg/nm <sup>3</sup>
7. Management/ financing	Nil	The programme leader reports to the Centre head and the Centre reports to the Director in charge of the Centre

Annexure Module 6

List of Equipment for Environmental Improvement Services

S No	Name of Equipment	Make and (Number)	Year of Purchase
1	Stack Sampler	Anderson, USA (4) Envirotech, India (1)	1986 1986

(continued)

Annexure Module 6

List of Equipment for Environmental Improvement Services

S No	Name of Equipment	Make and (Number)	Year of Purchase
2	High Volume Air Sampler	Anderson, USA (2) Envirotech, USA (1)	1986 1986)
3	Respirable Dust Monitor	Rotheroe Mitchell, UK (1)	1986
4	Air Velocity Meter	Kurz Instruments, Inc., USA (1)	1986
5.	Micro Manometer	Furness Controls, Ltd., USA (1)	1986
6.	Opacity Monitor	Dynatron, Inc., USA (1)	1988
7.	Wind Velocity and Director	M/s Lawrence and Mayo, India (1)	1989

B. Utilisation of project results\*

NCB Centre for Productivity Enhancement has conducted forty-one productivity enhancement studies during the project's lifetime.

1. Process optimisation - 15 studies. Problems identified include:

- Low output rate;
- Low refractory life;
- Back spillage of slurry;
- High heat and power consumption;
- Poor plant operation;
- Poor maintenance;
- Poor kiln operation;
- Frequent cyclone jamming;
- Kiln misalignment and shell ovality;
- Foundation problems;
- Poor fuel planning;
- Vibration problems;
- Lack of knowledge of raw material availability;
- Improper raw mix design;
- Unstable operating conditions.

\*Based on information provided by NCB.

Achievements in resolving these problems in the 15 plants include:

- Increased clinker production;
- Increased kiln output;
- Increased raw mill output;
- Increased life span of refractory lining;
- Overloading of kiln main motor prevented;
- Reduction of power consumption;
- Ring formation eliminated;
- Cyclone jamming eliminated;
- Supply of coal under control;
- Improved raw mix;
- Reduction in the need for additives;
- Stabilised operations.

2. Energy conservation - 6 studies. (One of these studies included a six-plant study for the Advisory Board on Energy and another study included five plants for the National Industrial Development Corporation.)

Problems identified include:

- High thermal energy use;
- High electrical energy use;
- Poor fuel use;
- Inefficient machinery;
- Poor load factor;
- Poor energy monitoring equipment;
- Poor air balance;
- Inefficient fans;
- Leakages.

Achievements in identifying potential savings include:

- Identification of potential thermal energy saving up to 11 per cent and electrical energy of up to 18 per cent;
- Major reductions in the use of fuel;
- Improved air separation;
- Improved heat utilisation;
- Improved power factor efficiency;
- Need for capacitor banks.

3. Plant maintenance - 20 studies.

Problems identified include:

- Shell ovality;
- Kiln misalignment;
- Poor maintenance practices.

Achievements in resolving these problems include:

- Correcting kiln ovality problems:
- Correcting kiln alignment problems:
- Increased awareness for better maintenance practices:
- Roller problems solved.
- Preventive maintenance system developed for one plant;
- Recommendation for improved maintenance system provided.

In addition, 15 cement plants were specifically monitored for heat consumption over a four-year period, 1986-87 to 1989-90. Needs for improvement were found resulting in an average reduction of thermal energy use of 6.4 per cent.

Thirteen plants were monitored for energy consumption over the same period; ten of these plants are the same as were monitored for thermal energy consumption. For these plants, an average of 10% in electrical energy consumption was achieved.

Five cement plants have been converted from wet to dry process. No more efforts are being made in this direction in view of the age of the remaining wet process plants, making these conversions uneconomical.

C. Achievement of the immediate objective

1. Critical assumption

The immediate objective stated in Chapter 1. B. says that the NCB's capability to provide productivity enhancement services to the Cement Industry will be strengthened in specified areas. The assumption implicit in this statement is that the Cement Industry requires such services and would be willing to use the services strengthened by the project. These services are being used by industry but only to a limited degree. Several of NCB's service capabilities are new and are not yet known to all the cement plants and nor to all the key managers working in individual plants. Those who were able to avail the services of NCB were satisfied with the results; however, even these managers felt that NCB should be more aggressive in marketing its services.

The evaluation mission is, therefore, of the opinion that once NCB tackles this problem with the assistance of the Ministry of Industry and the Cement Manufacturers Association, the industry will greatly increase its demand for NCB services. This view is based on the findings that:

- 1) The kinds of services that NCB can provide in the field of productivity enhancement meet the needs of the industry.
- 2) The level and quality of services that NCB can now provide will provide cement plant management with sufficient analysis and advice on how to achieve improved plant performance.

## 2. Industry confidence

Those industries which were assisted by NCB were satisfied with the services and a fair amount of confidence was established; however, the mission was also told that it would be desirable for the more senior staff to have practical cement industry experience. NCB itself recognizes this shortcoming, which stems partially from its previous emphasis on research. With the hands-on experience the staff gained while working with the project's international experts and with their new ability to provide state-of-the-art services to industry and the experience gained in carrying out recent assignments, this shortcoming should be overcome soon.

## 3. Sustainability

The evaluation mission found no evidence that the capabilities and capacities developed by the project will be diminished or deteriorate after the project is completed. The staff trained are on the job and are eager to provide services to industry. Staff turnover up to now does not seem to be a problem; however, with the planned expansion of the Cement Industry, the increased demand for qualified staff and the ability of industry to pay higher salaries could change this situation.

Sustainability issues outside the control of the project could effect the sustainability of project results. NCB is going through a financial crisis and a solution which provides NCB with an assured income, whether it be through fees or industry dues or Government-financed support needs to be found soon.

Another issue which could affect sustainability is whether NCB will find a way to be more outgoing in selling the services it is now able to provide. The mission, however, is confident that with the combined efforts of NCB's new Director-General, its reconstituted Board of Governors (chaired by the President of the Cement Manufacturers Association) and the support of the Ministry of Industry, this problem will be resolved in the near future.

## 4. Effectiveness

Effectiveness is defined as the degree of success in achieving the project's purpose. The evaluation mission assesses the effectiveness of the project as "satisfactory" and if the problems of under utilisation of results of NCB's capacity discussed above are resolved, as is expected, the project in a short time may even be assessed as "excellent", since capabilities and capacities developed were appropriate to the needs of industry and the capacity to significantly benefit them will have been realized.

## D. Contribution to the achievement of the development objective

NCB's contribution to the achievement of higher-level objectives, improved productivity of the Cement Industry is difficult to causally link with the industry-wide improvements experienced recently. The evidence provided in Chapter III. A. on some of the savings and efficiencies achieved in selected cement plants, one can say that NCB is contributing to the Cement Industry's development objective. When the provision of services of NCB is further expanded, its contribution promises to be significant.

#### IV. CONCLUSIONS

The project sponsors correctly perceived the need for sophisticated yet practical consulting services to the Cement Industry. With the liberalization of the industry described in Chapter I. A., these services are required more than ever and the industry has become more receptive to introducing productivity enhancement measures if they are to remain competitive.

The staff of NCB are also very much aware of the need for their institution to be not only in a position to provide industry-oriented productivity services but also of the need to be more aggressive in marketing their newly acquired service capability. This is important since Cement Industry representatives repeatedly told the mission that they were not fully aware of the broad range of services that NCB is able to provide and that there is a need for NCB to be more forthcoming in offering them.

Despite some project design shortcomings with respect to fully specifying project outputs, the project has produced very good results in six areas. Maximum use was made of project-supplied inputs to strengthen NCB capabilities. Experts were fully utilized to provide consultancy services to industry, which helped many plants to improve their operations but most importantly, they provided the staff of NCB with very important on-the-job consultancy training. Additionally, the experts had the effect of making the industry more aware of NCB's potentially beneficial role within the industry. The experts were all required to provide interim and final reports, which were generally well prepared and considered useful to the Cement Industry. Many of the experts' suggestions have been implemented with good results.

The training component was successfully carried out in pertinent areas. Staff trained by the project are on the job and are better able to provide more sophisticated services to industry.

The equipment supplied by the project was considered appropriate to the needs of NCB and enables them to provide the services envisaged with the speed, depth and accuracy demanded by industry. In particular, the simulator hardware and software can be considered to be the state of the art and of great potential use to the country.

Initial project input delivery delays were flexibly addressed by the decision to sub-contract important technology transfer elements of the project. This has enabled the delivery of a coordinated package of expertise, training and hardware/software in key areas which would probably otherwise not have been possible if individual experts, training opportunities and separately supplied hardware had been sought.

The cooperation between the national project management and UNIDO was satisfactory; each relied on the other to identify project inputs which ultimately produced expected results, a good partnership to implement the project involved. Seeing how each had something to offer whether it was at the substantive or at the administrative level, one could question the need



for Government-executed projects. NCB had full say in the project's implementation and was at the same time able to receive advice from UNIDO and was able to utilize the infrastructure of UNIDO to place fellows, organize study tours, field experts and purchase equipment.

The results achieved in building up the six areas of expertise were assessed to be very good. Fully useful capabilities have been created and the staff interviewed appeared to be enthusiastic and competent in applying the technologies transferred in the fields of:

- Process Optimisation;
- Energy Conservation;
- CAD/CAE Systems;
- Maintenance Practices;
- Simulator Training; and
- Environmental Improvement

The capabilities established are documented in Chapter III. A. Outputs.

Although NCB has commenced providing the newly enhanced or established services to industry with good results in improving productivity, much more can be done to fully use the capacity of NCB. NCB's management, its Board of Governors and the Ministry of Industry are fully aware of this issue and plans are already being discussed amongst them to resolve this problem. The mission is confident that this problem will be resolved in the near future.

The project objective has, therefore, been basically achieved in that the expected capabilities and capacities to provide services to industry have been established and are being regularly provided to industry. The main shortfall, as already mentioned, is the need for NCB to provide a greater volume of services in a more integrated fashion.

Due to external factors: the liberalization of the Cement Industry from Government controls and lack of awareness of the industry of NCB's willingness and capability to provide useful services, the sustainability of the project's achievements will very much depend on NCB's success in marketing its new service capability and on it being able to secure adequate financial resources.

The training and consulting capability of NCB could also be made available to other developing countries. Some success in this direction has already been realized and is worthy of expansion.

## V. RECOMMENDATIONS

With the complete lifting of price/distribution controls over cement, the financial contribution made by the units in the Cement Industry towards NCB are no longer fixed and can no longer be reckoned with. As a result, quite a number of units in the Industry stopped making their contribution to the NCB from March 1989. This has obviously plunged the NCB into a financial crisis. Thus, there is a need for working out some arrangement for funding the NCB so that this institution can provide services to the Industry on a sustained basis. As the Cement Industry is quite well represented on the Governing Council of NCB, it should play a very positive role in this direction.

NCB should evolve a suitable fee policy for its long-term sustainability.

The Mini Cement Sector was not looked into by this evaluation team. NCB, however, has played an important role in designing machinery for VSKs and have also acted as consultants for many of the mini plants. It is, therefore, important that NCB plays an important role in the World Bank Mini Cement Plant Strategy.

A new training scheme is being launched with assistance from the World Bank and DANIDA in the order of US\$ 10 million through the setting up of Regional Training Centres at the premises of selected cement plants. Since NCB, through this project, has been well-equipped for undertaking training programmes, it should be made use of as a source by the Regional Training Centres to the extent feasible and possible.

Since NCB was originally set up as a research institute for the Cement Industry, its main emphasis has been on basic research. In future, NCB should focus more on applied research and on rendering technical assistance services to the Cement Industry. It is also noted that NCB's staff, except for a few, are all scientists and engineers without any practical cement plant experience. Frequent and intimate interaction between NCB's staff and plant engineers and operators will help improving NCB services to the Cement Industry.

During visits to the cement plants, the evaluation team learned that cement plant line managers and engineers were not adequately aware of NCB's capabilities. NCB should, therefore, embark upon aggressive marketing for dissemination of their capabilities amongst various cement plants.

Noise, gaseous emissions and emissions of dust into the atmosphere are three of the major problems of cement plants in India. Limits for the various emissions have been prescribed. NCB has adequate equipment and has carried out numerous tests at plants to measure these emissions. DANIDA is financing a study for general environmental status and pollution control measures for the Cement Industry. NCB should take an active part in this study.

There is a world-wide trend towards more stringent customer's expectations with regard to quality. With the failure of concrete structures,

total quality systems has now been established in the cement and concrete industry abroad. As an example, the British cement factories and concrete manufacturers are now fulfilling international standards for quality systems in accordance with the series of ISO Standards 9000 to 9004. NCB should address itself to this task in the future.

Under the project being evaluated, NCB has acquired state-of-the-art expertise in certain fields such as raw material planning, maintenance and energy audit. In the interest of sustainability of the project benefits in the future, it is important that NCB, in consultation with the Cement Industry, devise suitable modalities for better utilisation of this expertise.

UNIDO should investigate the possibility of using the NCB training facilities for interregional Cement Industry group training programmes. NCB facilities could also be used to meet technical co-operation training needs of other countries. Moreover, NCB has the capacity to provide consulting services to the Cement Industry in other developing countries. UNIDO should make use of these capabilities in the interest of promoting technical co-operation amongst developing countries.

The remaining unutilised project funds could be usefully employed to develop additional software required to expand the simulator training facility.

## VI. LESSONS LEARNED

- The importance of having a well balanced evaluation team composed of members possessing a combination of technical, evaluation and country experience.
- The necessity of having a well-defined project document output section to ease management, monitoring and evaluation activities.
- The significance of critical factors external to the immediate project which can influence the degree to which industrial end-users will make use of the services strengthened by the project. This relates to the need for aggressive marketing of such services in the industry, including the creation of awareness of the potential benefits such services can provide.
- The urgent need to find a solution to the long-term financing of an industrial service institution.
- The desirability of establishing flexible, cooperative and mutually supportive project implementation working arrangements amongst the beneficiary institution, Government, UNDP and UNIDO.
- The need for complete industry involvement in the functioning of an industrial service institution if it is to fully benefit the end-users as intended.

Annex I

TERMS OF REFERENCE  
IN-DEPTH EVALUATION MISSION

IND/84/020 - STRENGTHENING THE NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS (NCB) CAPABILITY IN PRODUCTIVITY ENHANCEMENT OF CEMENT INDUSTRY (PEP)

1.0 Background

The cement industry in India comprised of 94 cement plants in 1985 (the year the project was signed) spread all over the country with an annual installed capacity of about 36.5 million tonnes and a production of 27 million tonnes. The capacity was planned to be raised to about 81 million tonnes by 1994-95. By the year 2000 A.D., the capacity is expected to reach about 100 million tonnes and a production figure of 85 million tonnes.

It was experienced in the perspective of world-wide technological development in cement industry, that in India, the level at which the technological problems of the plants were being diagnosed, the levels at which remedial as well as suggested measures were being recommended, and - most importantly the methodologies being adopted in formulating and implementing recommendations needed to be raised.

The Cement Research Institute of India, now known as National Council for Cement and Building Materials (NCB), is a multidisciplinary autonomous body attached to the Ministry of Industry, Govt. of India. It is the national centre for the cement industry devoted to research, technology development and transfer, education and industrial services. It provides the necessary technological services to the cement industry at national level.

The UNDP assisted project was approved on 4 January 1985 with a total UNDP input of \$1,961,000. It became operational in September 1985 and was planned to be completed during a three year period. The duration of the project was subsequently extended up to September 1990. This Institution Building has as its objective strengthening the existing capabilities of NCB in the area of productivity enhancement. During the course of implementation, difficulties were experienced by UNIDO in locating the right type of experts for the project. Keeping in view the difficulties and to help achieve the objectives of the project, TPRs held from time to time, recommended inter-component transfers and accordingly a total of four sub-contracts were designed. As on date the total UNDP inputs to the project is \$2,109,695. The scheduled date of completion of the project is September 1990.

The indepth evaluation is considered necessary in accordance with the UNDP policy of evaluating projects having UNDP funding of more than US\$ 1 million; the present project total amounting to US\$ 2,109,785. It has also been agreed to by the Government of India. The evaluation will contribute significantly in analysing the role this project has played in strengthening the NCB's capabilities in productivity enhancement of Indian Cement Industry.

## 2.0 Purpose

- a) To ascertain the extent of strengthening of NCB capabilities in:

effectively diagnosing technological problems and productivity constraints in cement industry;

formulating programmes and methodologies for solving them and improving productivity;

implementing the solutions arrived at.

- b) To pay special attention and comment on the design of the project in relation to the immediate objectives, activities and outputs of the project.

- c) To ascertain contribution this project has made in achieving the development objective of the project.

## 3.0 Issues to be covered

The evaluation mission is to address the following major issues paying particular attention to the specific questions indicated but not confining itself to these questions.

### 3.1 Project Concept and Design

The mission is to consider whether -

- a) The problems the project was supposed to solve were clear and the approach to be used was sound. There had been certain gaps, essentially in the availability of expertise, in areas of methodology of studies, in the conversion and modernization of old high energy consuming plants into energy efficient new systems and in the areas of plant design operation and maintenance.
- b) A proper personnel cadre has been set up.
- c) The strengthening of NCB has resulted in the cement industry having been benefited.
- d) The objective and outputs were stated explicitly, precisely and in terms that are verifiable.
- e) The objectives are achievable, and whether the relationship between the objectives, the outputs, the activities and the inputs was clear, logical and commensurate, given the time and resources available.

### 3.2 Implementation

The PRODOC provided 185 m/m of expertise, 29 fellowships and \$306,000 worth of equipment. As UNIDO could not provide expertise, four sub-contracts

were designed as per the recommendations of the tripartite review meetings held from time to time. Three sub-contracts and 25 fellowships have been implemented so far; and all the equipment valued at \$846,693 has been delivered.

The project activities were to cover studies through surveys and recommended remedial measures. The areas included studies in geology and mining, raw material technology, size reduction, improving kiln utilization maintenance, energy conservation, modernization, system design and engineering, industrial engineering practices, refractory practices, dust and noise reduction techniques, coal combustion technology, optimization, simulation, and process control system, and advanced electronic control and instrumentation.

There should be specific queries about:

- a) The quality and timeliness of the inputs;
- b) The quality and timeliness of the activities;
- c) The quality and timeliness of the responsiveness of project management to changes in the environment of the project;
- d) The quality and timeliness of monitoring and backstopping by all parties to the project.

To examine if the following have been achieved:

- capacity utilization raised from 77 to 82%;
- stable capacity utilization;
- energy conservation schemes in 10 to 15 cement plants;
- power consumption figures decreased by 5 per cent (compared to the 1985 figures);
- heat consumption figures reduced by at least 5 per cent (compared to 1985 figures);
- to assess the number of cement plants converted from wet to dry process;
- decrease kiln downtime in 10 cement plants by at least 10 per cent;
- establishment of a data base at NCB for monitoring various productivity indicators of cement plants;
- to ascertain if a microprocessor based simulator and process control system installed and operational NCB;
- to ascertain if 29 national officials trained;
- in how far comments on project design made by UNIDO ODG/EVAL have been taken into account and on basis of which design project operated;
- whether the chosen counterpart institution was/is adequately established within the sector with requisite links to private and public industries and/or whether these links needed to have been built up through the project;
- whether the chosen approach was adequate and most effective;
- whether success criteria quantified in the project document are reasonable and attainable;
- whether improvements made in industries were actually attained through services provided by NCB and/or what are other supporting/adverse factors;

- whether latest technological developments in the sector, particularly environment related, can be responded by NCB.

### 3.3 Results

The evaluation mission is required to record the following:

- a) The results of the project: whether the project is producing or has produced its outputs effectively and efficiently; their quality and how they are being utilized and whether the project has achieved or is likely to achieve, its objectives and when.
- b) The effect on target group(s) or institutions the project is aimed at. Any unintended effects should be enumerated.
- c) The significance of the results achieved for the country or region.

### 4.0 Lessons Learned

The mission should record any significant lessons that can be drawn from the experience of the project and its results, in particular anything that worked well and that can be applied to other projects and anything that has worked badly and should be avoided in future.

### 5.0 Composition of the Mission

The mission will consist of ...

### 6.0 Tentative Schedule and Itinerary of the Evaluation Mission

The evaluation is scheduled for October 1990. The following is the proposed time-table:

New York	1 day briefing
Vienna	1 day briefing
New Delhi	1 day for initial briefing and discussions in UNDP
Ballabgarh	5 days discussions and visit to two cement plants
Hyderabad	5 days discussions at NCB Hyderabad and visit to two cement plants
New Delhi	3 days report writing and final round of discussions with UNDP and concerned Govt. of India departments

### 7.0 Consultations in the Field

The mission will maintain close liaison with the Resident Representative in India, the concerned agencies of the Government, the counterpart staff assigned to the project as well as the UNIDO Country Director.



Although the mission should feel free to discuss with the authorities concerned anything relevant to its assignment, it is not authorised to make any commitments on behalf of the UNDP or UNIDO.

#### 8.0 Reporting

The mission will prepare a report on the findings and recommendations in draft along the lines indicated in the attached format. The report will be presented to the Government of India in draft form in the field so that there is an opportunity to discuss it. The report be submitted in final form to UNDP.

Annex II

SCHEDULE FOR IN-DEPTH EVALUATION

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13.2.1991	Wednesday	Arrival India and briefing about Project
14.2.1991	Thursday	Discussions with National Project Director NCB-N Briefing and Discussions at UNDP
15.2.1991	Friday	Visit to NCB-B Laboratories
16.2.1991	Saturday	Weekend
17.2.1991	Sunday	
18.2.1991	Monday	Discussions with NCB Project Team and Departure to Kota
19.2.1991	Tuesday	Visit to Cement Plant (M/s Shriram Cement Works, Kota)
20.2.1991	Wednesday	Visit to Cement Plant (M/s J K Cement, Nimbahera)
21.2.1991	Thursday	Arrival Delhi
22.2.1991	Friday	Meeting Danida Report writing - 1st part
23.2.1991	Saturday	Weekend
24.2.1991	Sunday	
25.2.1991	Monday	Meeting World Bank Departure to Hyderabad
26.2.1991	Tuesday	Visit and Discussions at NCB-H
27.2.1991	Wednesday	Meetings in Madras Tamilnadu Cements Cement Manufacturers Association
28.2.1991	Thursday	Visit to Cement Plant (M/s Madras Cement, RR Nagar)
01.3.1991	Friday	Visit to Cement Plant (India Cements, Sankarnagar)
02.3.1991	Saturday	Return to Delhi
03.3.1991	Sunday	Report writing
04.3.1991	Monday	Meeting Ministry of Finance Report writing

(continued)

Annex II

SCHEDULE FOR IN-DEPTH EVALUATION (cont'd)

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05.3.1991	Tuesday	Meeting Ministry of Industry (Debriefing) Report writing
06.3.1991	Wednesday	Report writing
07.3.1991	Thursday	Meeting UNDP & UNIDO (Debriefing) Mission completed

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Annex III

LIST OF PERSONS MET

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Government of India

Ministry of Industry

Mr. L. M. Singh, Joint Secretary, Industrial Development

Ministry of Finance

Mr. S. Varadachari, Joint Secretary, Department of Economic Affairs  
Mr. Rajiv Sharma, Director

UNDP

Mr. Erling Dessau, Resident Representative  
Mr. David H. Jenkins, UNDP Senior Deputy Resident Representative  
Mr. M. Ramachandran, Chief Prog I (Ind & Trade)  
Ms. Sushila Nayar, Programme Assistant

UNIDO

Mr. M. Matiul Islam, UNIDO Country Director

UCE-D

Dr. A. K. Mullick, Director General, NCB

NCB-B

Dr. J. P. Saxena, Joint Director, CPE  
Mr. S. K. Khanna, General Manager, CIS  
Mr. V. B. Dutta, Manager, Administration  
Mr. K. C. Sachdeva, Secretary  
Mr. Kamal Kumar, Head, CPE & CCP  
Mr. S. Chatterjee, Head, CRI & CEI  
Mr. S. C. Ahluwalia, Head, CTQ

NCB-H

Dr. N. Raghavendra, Director  
Dr. M. Vasudeva, Scientist

World Bank

Mr. R. J. Robinson, Senior Economist

Annex III

LIST OF PERSONS MET (cont'd)

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DANIDA

Mr. Bent Dahl-Olsen, Danida Representative, India

Industry:

Cement Manufacturers Association:

Mr. N. Srinivasan, Chairman

Shriram Cement Works:

Mr. Nitish Brahma, Director  
Mr. B. S. Dua, Joint General Manager  
Mr. D. K. Dak, Joint Chief Engineer  
Mr. B. R. Sahu  
Mr. H. K. Ahluwalia

J K Industries:

Mr. G. H. Singhania, Chairman  
Col. S. P. Wadi (Consultant to J K)  
Mr. P. S. Bajpai, Deputy General Manager  
Mr. D. Ravishanker, General Manager, Works  
Mr. K. K. Jalori, Senior Manager, Production  
Mr. R. K. Gupta, Manager, Planning

Tamil Nadu Cements:

Mr. Arun Ramanathan, IAS, Managing Director

Madras Cement:

Mr. S. N. Rama Raju, General Manager  
Mr. H. V. Sethu Ram, General Manager, Mines  
Mr. A. Velayutham, Works Manager  
Mr. K. S. Anandan, Mines Superintendent  
Mr. G. Madana Gopal, Manager (Productivity)  
Mr. S. Natrajan, Superintendent (Production & Quality)  
Mr. S. Shanmugam, Chief Geologist  
Mr. R. Natarajan, Geologist  
Mr. R. Saravana Perumal, Administrative Manager  
Mr. A. Ramakrishnan, Chief Burner

Annex III

LIST OF PERSONS MET (cont'd)

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India Cements:

Mr. K. S. Narayanan, Past Chairman  
Mr. S. Narayanan, Chairman  
Mr. N. Srinivasan, Managing Director  
Mr. T. S. Raghupathy, Vice President, Marketing  
Mr. P. L. Subramanyan, General Manager  
Mr. V. S. Santhnam, Manager, Marketing  
Mr. E. Venkataramanan, Manager, Quality Control

KCP:

Dr. H.C. V. L. Dutt, Managing Director

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Annex IV

FELLOWSHIP TRAINING

SI No	Name of Fellow	Post No. & Title	Period of Training	Place of Training
1	Mr. Kamal Kumar	11.09 Large Precal Kiln	28.09-03.11.'86	Onoda Engineering Co., Ltd.
2	Mr. J.P. Saxena	11.10 Preventive Maintenance	21.01-20.02.'87	St. Lawrence Cement, Inc., CAN
3	Dr. S.N. Yadav	11.08 Dry Process Kiln	17.05-20.06.'87	Nihon Cement Company, JAPAN
4	Dr. L.K. Janakiraman	11.18 System Design & Engineering (Electrical)	17.05-20.06.'87	Nihon Cement Company, JAPAN
5	Mr. H.C. Hans	11.18 System Design & Engineering (Electrical)	17.05-20.06.'87	Nihon Cement Company, JAPAN
6	Mr. R.A. Ramanujam	11.21 Dust Reduction Techniques	20.07-21.09.'87	Fuller Company, USA
7	Mr. S.J. Raina	11.20 Refractory Practices	01.09-30.09.'87	Institut fur Gesteinbodenkunde FRG
8	Mr. V.K. Arora	11.23 Coal Combustion Techniques	01.11-30.11.'87	University of Leeds, UK
9	Mr. S.C. Rastogi	Post No.? Data Base	15.01-14.02.'88	CDS International, Inc., USA
10	Mr. A.D. Agnihotri	11.02 Geology and Mining	28.02-31.03.'88	Nihon Cement and Kawasaki, JAPAN
11	Mr. S.C. Sharma	11.20 Refractory Practices	29.02-31.03.'88	Mitsubishi Mining & Cement Co., Ltd.
12	Mr. S. Aggarwal	11.20 Refractory Practices	29.02-31.03.'88	Mitsubishi Mining & Cement Co., Ltd.
13	Mr. Y.P. Sethi	11.09 Large Precal Kiln	09.05-11.06.'88	Mitsubishi Mining & Cement Co., Ltd.
14	Mr. C.D. Elkunchwar	11.09 Large Precal Kiln	09.05-11.06.'88	Nihon Cement Company, JAPAN

Annex IV

FELLOWSHIP TRAINING (cont'd)

SI No	Name of Fellow	Post No. & Title	Period of Training	Place of Training
15	Mr. A.V.S. Rao	11.05 Large Precal Kiln	09.05-11.06.'88	Mitsubishi Mining & Cement Co., Ltd.
16	Mr. S. Sinha	11.17 System Design & Engineering (Mechanical)	09.05-11.06.'88	Mitsubishi Mining & Cement Co., Ltd.
17	Dr. M.M. Ali	11.03 Raw Materials Technology	01.06-30.06.'88	Continental Cement USA
18	Mr. A.K. Ailawadi	11.03 Raw Materials Technology	01.06-30.06.'88	Continental Cement USA
19	Mr. N.R. Subramanyam	11.09 Large Precal Kiln	03.07-02.08.'88	Nihon Cement Company, JAPAN
20	Mr. D.B. Rao	11.05 Optimisation of Roller Mill Operation	12.08-10.09.'88	FLS, DENMARK
21	Mr. S. Giridhar Kumar	11.05 Optimisation of Roller Mill Operation	12.08-10.09.'88	FLS, DENMARK
22	Mr. P.S. Sasturkar	11.05 Optimisation of Roller Mill Operation	12.08-10.09.'88	FLS, DENMARK
23	Mr. G.P. Sharma	11.17 System Design & Engineering (Mechanical)	19.09-25.10.'88	N. Staffordshire Polytechnic, UK
24	Mr. B. Kumar	11.22 Noise Reduction Techniques	31.12-03.02.'89	Stevens Institute of Technology, USA
25	Mr. U.R. Raju	11.02 Geology and Mining	04.02-03.03.'89	Portland Cement Association, USA
26	Mr. T. Madahaneshwar	11.14 Co-Generation	30.01-02.03.'90	Mitsubishi Mining & Cement Co., Ltd.
27	Mr. A.K. Dembla	11.08 Dry Process Kilns	11.02-12.04.'90	Institute of Technology, HUN



Annex IV

FELLOWSHIP TRAINING (cont'd)

SI No	Name of Fellow	Post No. & Title	Period of Training	Place of Training
28	Mr. Rajender Singh	11.25 Optimisation, Process Control & Simulation	24.09-24.11.'90	Rutgers University USA
29	Mr. S.K. Bandhopadhyaya	11.25 Optimisation, Process Control & Simulation	24.09-24.11.'90	Rutgers University USA

Annex V

STUDY TOURS

Three study tours were undertaken at various stages of the programme's implementation.

The first tour was organised just at the start of the project, during September-October 1985. A three-member team lead by Dr. H. C. Visvesvaraya, then Chairman and Director-General of NCB, visited the leading cement machinery manufacturers and consulting engineering companies in Denmark, France, Germany, Japan, Switzerland and the UK. In addition, the team observed large-sized modern precalciner kilns in Japan. The tour ended in Vienna with discussion in UNIDO. The tour was most useful for setting directions and guidelines for identification of experts and institutions for placement of training, as well as finding the prospective equipment suppliers.

The second tour was undertaken during September-October 1986 and was primarily to attend the "8th International Congress on the Chemistry of Cement" held in Rio De Janeiro, Brazil. These congresses on the cement chemistry are held every 6th year and are attended by the World Cement Industry. India is to host the 9th International Congress in New Delhi during November 1992 and NCB is the organising body.

On route back to India from South America, the team visited Germany and Switzerland to study the latest developments in the manufacture of cement.

The third study tour was organised to attend a Conference on Energy auditing held in Pilsen, CSSR during May 1987. The tour was useful in setting up the mobile energy diagnostic unit for NCB.

Study Tour Participants

<u>Sl No</u>	<u>Name</u>	<u>Period of Study Tour</u>
1	Mr. P.K.S. Iyer	08 Sep to 04 Oct 1985
2	Dr. N. Raghavendra	08 Sep to 04 Oct 1985
3	Mr. S.J. Raina	21 Sep to 08 Oct 1986
4	Dr. (Mrs.) S. Laxmi	21 Sep to 08 Oct 1986
5	Mr. K.H. Babu	21 Sep to 08 Oct 1986
6	Mr. Pradeep Kumar	04 May to 15 May 1987
7	Mr. K. Prakash	04 May to 15 May 1987

LIST OF EXPERTS/CONSULTANTS

Sl No	Post No	Title of the Post	Name of Expert	Remarks
1	2	3	4	5
1	11-02	Expert in Productivity Enhancement in Limestone Mining	Mr John A Holiv (USA)	First Mission completed (15 June to 13 Aug 1986)
2	11-02	Expert in Productivity Enhancement in Limestone Mining	Mr Daniell E Trevor (UK)	Mission completed (12 June to 12 July 1990)
3	11-03	Expert in Productivity Improvement through Raw Materials Technology	Mr G R Gouda (USA)	First Mission completed (02 Oct to 26 Nov 1986)
4	11-03	Expert in Productivity Improvement through Raw Materials Technology	Mr D P Jefferson (UK)	Mission completed (08 July to 11 Aug 1988)
5	11-04	Expert in Productivity Improvement through Optimisation of Ball Mill Operations	Mr Jorgen Cleemann (Danish)	First Mission completed in two parts (19 Oct to 28 Nov 1986 &
6	11-07	Expert in Productivity Improvement in Wet Process Plants	Mr C A White (U K)	First Mission completed (18 Nov 1985 to 31 Jan 1986)
7	11-08	Expert in Productivity Enhancement in Dry Process Cement Plants through Improving Kiln Utilization	Mr Tage Dano (Danish)	First Mission completed (13 Oct to 06 Dec 1986)
8	11-09	Expert in Productivity Enhancement in Large Precalculator Kilns through Improved Kiln Utilization	Mr Hiroshi Ishino (Japan)	First Mission completed (18 Sep to 17 Nov 1986)

9	11-10	Expert in Productivity Improvement through Preventive Maintenance	Mr L H Wallam (U K)	First Mission completed (29 Dec 1986 to 25 Feb 1987)
10	11-10	Expert in Productivity Improvement through Preventive Maintenance	Mr Palle Barnekov (Denmark)	Mission completed (14 March to 10 Aug 1988)
11	11-11	Expert in Productivity Management through Mechanical Maintenance	Mr H R Baugartner (Swiss)	First Mission completed (02 Apr to 26 May 1987)
12	11-12	Expert in Productivity Improvement through Maintenance of Electrical Equipment	Mr Akihiro Takeda (Japan)	First Mission completed (04 Nov to 31 Dec 1986)
13	11-14	Expert in Productivity Improvement through Cogeneration	Mr Robert G Erickson (USA)	First Mission completed (09 Jan to 28 Feb 1987)
14	11-15	Expert in Productivity Improvement through Conversion of Wet Process Plants to Semi-wet/Dry	Mr Anton Mikula (CSSR)	First Mission completed (19 Jan to 18 Mar 1986)
15	11-15 & 11-16	Expert in Productivity Improvement through Conversion of Wet Process Plants to Semi-wet/dry (Scheme & Erection)	Mr G G Rasmussen (Denmark)	Mission completed (27 Nov to 16 Mar 1988)
16	11-19	Expert in Productivity Improvement through Industrial Engineering Practices	Mr H H Brandt (Denmark)	Mission completed (19 Aug to 9 sep 1988)
17	11-20	Expert in Productivity Improvement through Selection, Installation, Use and Evaluation of Refractories in Cement Industry	Mr Ivan Peter Budimir (Yugoslav)	First Mission completed (05 Dec 1985 to 28 Jan 1986)
18	11-20	Expert in Productivity Improvement through Selection, Installation, Use and Evaluation of Refractories in Cement Industry	Mr Miroslav Potancok (CSSR)	Second Mission completed (24 Oct to 16 Dec 1986)
19	11-21	Expert in Productivity Improvement through Dust Reduction Techniques	Mr Robert W Highnam (U K)	First Mission completed (16 Oct to 02 Dec 1986)

20	11-23	Expert in Productivity Improvement through Coal Combustion Technology	Mr Harry B Locke (U K)	First Mission completed (23 Feb to 12 Mar 1986)
21	11-25	Expert in Process Control in Cement Industry	Mr G Czachor (Poland)	First Mission completed (09 Feb to 28 Apr 1987)
22	11-28	Expert in Productivity Improvement through Maintenance of Advanced Instruments and Electronic Control Circuits	Mr J konieczny (Poland)	First Mission completed (24 Oct to 16 Dec 1986)
23	11-62	Expert in Productivity Improvement through Computerised Maintenance	Mr Graham Eade (U K)	Mission completed (30 Nov to 18 Dec 1987)
24	11-64	Expert in Productivity Improvement through Safety Engineering	Mr Peter C Compes (FRG)	Mission completed (19 Jul to 11 Aug 1987)

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S U M M A R Y

EXPERT APPRAISAL

UNDP PROJECT IND/84/020 - STRENGTHENING NCB CAPABILITIES IN  
PRODUCTIVITY ENHANCEMENT OF CEMENT INDUSTRY (PEP)

EXPERT : Mr Palle Barnkob

ID : Annexure - I  
WORK PLAN : Annexure - II  
CV : Annexure - III

NCB Counterparts:

1. Mr A K Hishra  
2. Mr P Janardhana Rao

Plant Personnel Interacted:

1. Mr N Lokanathan, General Manager  
2. Mr H Ramalingam, Manager (Engg)

LOCATION : H/s India Cements Ltd., Bankamagar (Tamilnadu)

Sl No	Subject Covered in Mission	Aspects Covered			Outcome in terms of Project Objectives	
		Diagnosis	Methodology	Implementation	Achieved	Expected
1	Effectively diagnosing technological problems and productivity constraints.	- Heavily worn out lining plates were found in the raw mill.	Kiln inspection should be more frequent.	Plant advised to implement recommendations and seek further services from NCB, if required.	-	Long life for mill shell.
2	Formulating programme and methodologies for effective preventive maintenance and solving technical problems.	Kiln No 4, lower end, thrust roller is suspected to have developed cracks.  Roller bearings of the 1st tyre of all the kilns are exposed to heat from cooler.	Replacement of thrust roller suggested.  Provide an insulating wall between the cooler and first tyre.	-do-	-	Better floating of the kiln and more safety for air seals.  Improved bearings life.
		Uneven contact between tyre & rollers at pier No 2 of Kiln No. 4.	Kiln No 4 needs alignment correction at the earliest.	-do-	-	Reduced downtime of kiln and increased life of rollers, tyre and brick lining.

S U M M A R Y

EXPERT APPRAISAL

UNDP PROJECT IND/84/020 - STRENGTHENING NCB CAPABILITIES IN  
PRODUCTIVITY ENHANCEMENT OF CEMENT INDUSTRY (PEP)

EXPERT : Mr Palle Bannab

ID : Annexure - I  
WORK PLAN : Annexure - II  
CV : Annexure - III

NCB Counterparts:

1. Mr A K Mishra
2. Mr P Janardhana Rao

Plant Personnel Interacted:

1. Mr N Lokanathan, General Manager
2. Mr H Ramalingam, Manager (Engg)

LOCATION : H/s India Cements Ltd., Bankamagan (Tamilnadu)

Sl No	Subject Covered in Mission	Aspects Covered			Outcome in terms of Project Objectives	
		Diagnosis	Methodology	Implementation	Achieved	Expected
1	Effectively diagnosing technological problems and productivity constraints.	- Heavily worn out lining plates were found in the raw mill.	Mill inspection should be more frequent.	Plant advised to implement recommendations and seek further services from NCB, if required.	-	Long life for mill shell.
2	Formulating programme and methodologies for effective preventive maintenance and solving technical problems.	Kiln No 4, lower end, thrust roller is suspected to have developed cracks.	Replacement of thrust roller suggested.			Better floating of the kiln and more safety for air seals.
		Roller bearings of the 1st tyre of all the kilns are exposed to heat from cooler.	Provide an insulating wall between the cooler and first tyre.	-do-	-	Improved bearings life.
		Uneven contact between tyre & rollers at pier No 2 of kiln No. 4.	Kiln No 4 needs alignment correction at the earliest.	-do-	-	Reduced downtime of kiln and increased life of rollers, tyre and brick lining.

SUMMARY  
EXPERT APPRAISAL

UNDP PROJECT IND/84/020 - STRENGTHENING NCB CAPABILITIES IN  
PRODUCTIVITY ENHANCEMENT OF CEMENT INDUSTRY (PEP)

EXPERT	: Dr David P Jefferson	<u>NCB Counterparts :</u>	<u>Plant Personnel Interacted :</u>
JD	: Annexure - I	Sh U R Raju	As per list attached
WORK PLAN	: Annexure -II	Dr M M Ali	
CV	: Annexure-III		
LOCATION	: M/s Madras Cements Ltd R R Nagar (Tamilnadu)		

Sl No	Subject Covered in Mission	Aspects Covered			Outcome in terms of Project Objectives	
		Diagnosis	Methodology	Implementation	Achieved	Expected
1.	Intricacy of raw material deposits	(1) Complex deposits (a) with intense intrusions  (b) Scattered leases	(1) Traverses over the deposits, refusal of data, and discussions with officials.	(1) Improved drilling practices (a) Use of remote sensing techniques	1(a) Recommendations discussed.  (b) NCB be consulted	1 (a) High core recovery for better evaluation.  (b) Location of potential areas near works.
2.	Winning of raw materials	(2) (a) Variation in quality  (b) Top portion of limestone in a quarry fractured		2(a) Proper sampling of blast hole cuttings  (b) Separate benching of broken limestone	(2) Recommendations discussed	(2) Supply of (a) uniform limestone  (b) Safety in mining operations



Sl No	Subject Covered in Mission	Aspects Covered			Outcome in terms of Project Objectives	
		Diagnosis	Methodology	Implementation	Achieved	Expected
3.	Handling and Homogeni- sation of raw materials and fuel.	(3) (a) Improper sampling  (b) Segregation while stacking		(3) (a) Adoption of autosampling methods.  (b) Installation of aluffing discharge system, and modification for stacking/ reclamation system at works.	(3) (a) Recommenda- tions discussed  (b) -do-	(3) (a) Better quali- ty control  (b) Uniformity in kiln feed
4.	Raw Mix Design	(4) Multicomponent mix and hold-ups in cyclones.		(4) Standardization of mix compo- nents and quality control.	-do-	(4) Efficient kiln opera- tion and production of good clinker.

LIST OF EQUIPMENT RECEIVED UNDER THE PROJECT

Sl No	Name and Specifications	Utility	Cost	Remarks
<b>A OPTIMIZATION, SIMULATION AND PROCESS CONTROL EQUIPMENT</b>				
1	Optimisation, simulation and process control system	Optimisation of cement plants operation in India (through simulation and effective process control) by increased production, improved quality, reduced power and fuel consumption and effective training of manpower	US \$ 428,300	Received from M/s FLS Denmark
<b>B FIELD TESTING EQUIPMENT</b>				
2	Radiation Pyrometer (infra-red total radiation and two-colour ratio type) 0-2200°C (preferably in two or more steps) Portable type, complete with all accessories like battery charger, lens, attachments, tripod stand, carrying case etc.	Measurement of flame and material temperatures in the burning zone, cooler and kiln back end	US \$ 6,396	Received from M/s Capintec International Inc, USA

- |   |  |                     |   |
|---|--|---------------------|---|
| <p>3 Carbon monoxide and oxygen analyser (Portable type)<br/>Range : Oxygen 0-20.9%<br/>Carbon Monoxide 0-0.2%<br/>Complete with carrying case and all other accessories</p>  | <p>Monitoring of flue gas in kiln and preheater in order to study combustion and leakages</p>                                  | <p>US \$ 2,366</p>  | <p>Received from<br/>M/s Telegan, UK</p>                        |
| <p>4 Infrared Thermometer for kiln shell scanning (Portable type) along with direct viewing infrared camera for viewing hot-spot on the kiln shell</p> <p>Range 0-600°C<br/>Complete with all accessories, lens attachments, carrying case etc.</p> | <p>Monitoring of kiln shell temp. for studying refractory conditions, length and position of the burning zone etc</p>          | <p>US \$ 17,778</p> | <p>Received from<br/>M/s AGEMA, UK</p>                          |
| <p>5 Portable hand held type temp. measurement system with digital output with interchangeable sets of probe attachments for the following ranges:</p> <p>0 - 300 deg. C.<br/>0 - 600 deg. C.<br/>0 - 1200 deg C.</p>                               | <p>Measurement of temp. at critical locations in cement plants (e.g. cooler exhaust, secondary air, kiln inlet temp. etc.)</p> | <p>US \$ 3,422</p>  | <p>Received from<br/>M/s Wahl International Limited<br/>USA</p> |
| <p>6 Fuel efficiency monitor (FEM)(Portable Type)<br/>Fuel Efficiency (0-100%)<br/>Oxygen (0-20%)<br/>Exhaust Temp (0-600 Deg. C)</p>   | <p>Monitoring of Fuel (Coal Efficiency, O<sub>2</sub>)</p>   | <p>US \$ 4,174</p>  | <p>Received from<br/>M/s FLS<br/>Denmark</p>                    |

7	Dust sampler (Air Sampler) for determination of suspended dust particles in ambient air Range : 1.13 to 1.3 m <sup>3</sup> /mn	Determination of suspended particulates in air and granulometry	Received from H/s Anderson USA
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Complete with basic units and accessories like carrying case, inhalable particulate set, impactor/pre-separator arrangement to determine the granulometry, filters, sample shield arrangement, flow recorder and controller etc (Portable type)

8	Stack sampler (Portable type) Range : 100 ng/mn <sup>3</sup> to 300 ng/mn <sup>3</sup>	For measurement of dust concentration in dust collectors, stack etc for performance evaluation	Cost of items (6 & 7) US \$ 29,614	-do-
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Temp. of gas : (Ambient to 900 deg. C.)  
Gas velocity : 0.5 to 30m/sec  
Specific gravity of dust:  
1.5 to 3 gm/cc  
The unit should be completed with in-situ particle size fractionators, other accessories and carrying case

9	Opacity Monitor (Optical method)  Dust concentration range: 50 mg/Hm <sup>3</sup> - 40 gns/Hm <sup>3</sup>  Gas temp. Ambient to 350 deg. C.  Portable type, complete with all accessories and carrying case.	Measurement of dust concentration in stacks	US \$ 19,090	Received from M/S Dynatron Inc, USA
10	Portable vibration meter with frequency analyser	Detection and measurement of vibrations generated by various rotating machineries in order to predict impending/breakdown	US \$ 26,718	Received from H/s IRD Mechanalysis (UK) Ltd
11	Shock pulse meter with accessories Range: 0-100 g acceleration	Detection of shock pulses emitted by different bearings of rotating machinery in cement plants	US \$ 3,095	Received from M/s SPM Instruments Sweden
12	Kiln Shell Ovality Tester (Portable Type)	Measurement of Shell Ovality of Kiln	US \$ 10,239	Received from M/s Holderbank Switzerland
13	Sonic ear, with amplifier and Recorder/Indicator (Portable type)	Recording and measurement of grinding mill level in order to optimise and control the feed rate etc	US \$ 19,078	Received from M/s S+B Elektronik West Germany
14	Ultrasonic Flaw detector/ thickness gauge with all accessories	Detection of cracks, voids, laminations in metals and welds as well as thickness of metals	US \$ 8,560	Received from M/s Baugh & Weeden Ltd., England

15	Hand held instant action Hygrometer with probe and complete with all accessories Range : 0 - 100 % RH Accuracy : -2% -1 digit	Measurement of relative humidity at different locations of cement plants in gas streams containing dust	US \$ 1,032	Received from M/s Unit Export Ltd., Great Britain
16	HP 2934A Dot Matrix impact Printer including graphics, USAC II, ISO etc.,	To use for cement process Simulator's Training station data printing	US \$ 3,000	Received from M/s Hewlett Packard GmbH Vienna
17	Hand held Service Manometer with probe and accessories Range : 0 - 199.9 m bar Operating Temp. : 0 - 1000	Measurement of draft and differential pressure at different locations of cement plants	US \$ 920	Received from M/s Testotherm Vienna
18	4KVA Uninterrupted Power Supply System for Simulator Trainer with 1 hour backup	For uninterrupted power supply for Computer	US \$ 13,125	Received from M/s Aplab Ltd., Thane, India
19	3 KVA Uninterrupted Power Supply System for CAD/CAE with 1/2 hour backup	For uninterrupted power supply for CAD/CAE	US \$ 8,125	Received from M/s HCL New Delhi, India
20	Laser Kiln Aligner	For Kiln Alignment	US \$ 26,067	Received from M/s Refair (Jersey) Ltd., UK

**C SPARE PARTS & ACCESSORIES OF FIELD TESTING EQUIPMENT**

i/ Radiation Pyrometer (ROS-5E)	US \$ 1,565	Received from M/s Capintec Inc, USA
ii/ Combustion Test Kit	US \$ 2,077	Received from M/s Telegan, UK
iii/ Thermovision 110	US \$ 2,069	Received from M/s Agena, UK
iv/ Shock pulse meter	US \$ 1,239	Received from M/s SPM Instruments Sweden
v/ Fuel Efficiency Monitor System	US \$ 5,566	Received from M/s FLS, Denmark
vi/ Vibration Measurement System	US \$ 552	Received from M/s IRD Mechanalysis, UK
vii/ Stack Sampler	US \$ 3,535	Received from M/s Andersen Saampler Inc
viii/ Sonic Ear	US \$ 100	Received from M/s S+B Elektronik, West Germany
ix/ Portable hand held type tempt. measurement system	US \$ 800	Received from M/s Wahl International Ltd., USA
x/ Optimisation, Simulation and Process control system	US \$ 4,594	Received from M/s F L Snidth & co., Denmark

**SUB-CONTRACT I**

TITLE : Development and application of simulation, optimisation and process control system

AMOUNT US \$ : 200,000

AWARDED TO : M/S F L Smidth & Co  
Denmark

LIST OF EQUIPMENT : 1) Two additional work stations  
2) Spare parts

REMARKS : The above sub-contract was taken in order to increase the training capabilities of NCB through simulator.



**SUB-CONTRACT II**

TITLE : Development of modern methodologies through mechanical and electrical system design and engineering

AMOUNT US \$ : 98,540

AWARDED TO : M/S HCL Limited  
New Delhi (India)

LIST OF  
HARDWARE/SOFTWARE :

HARDWARE

- 1) Apollo DN 300 work station
- 2) Serial parallel board providing additional 2xRSC and 1 parallel post
- 3) PLC PC compressor board providing an IBM PC compatible DOS environment and MS DOS software
- 4) Colour Graphics Printer
- 5) XY Plotter
- 6) Digitizer A4 size
- 7) Busybee 286 NEAT

SOFTWARE

- 1) AEGIS - Operating system
- 2) Domain - IX
- 3) GMR
- 4) 2D & 3D Graphics Primitive
- 5) STADD-III
- 6) Fortran 77 Compiler
- 7) AEC-MECH
- 8) ANSYS
- 9) LISP
- 10) AUTOCAD AND SCAN CAD

**SUB-CONTRACT III**

TITLE : Energy Audit System

AMOUNT US \$ : 127,395

AWARDED TO : M/S NIFES Limited  
UK

LIST OF EQUIPMENT : 1) Temperature Measuring Instrument  
2) Gas/Air Flow/Pressure Measuring Instrument  
3) Gas Analysis Instruments  
4) Continuous Recorders  
5) Ultrasonic gas Leak Detector  
6) Bomb Calorimeter

LIST OF  
HARDWARE/SOFTWARE :

HARDWARE : IBM PS2 Model 30 Computer Erson Dot  
Matrix Printer Microwave Data Collection  
System

SOFTWARE : Spread sheet package word processing  
package, Data Base package. Statistical  
analysis package, kiln heat balance  
programme, Mounting and target setting  
package

TRAINING : Two NCB officials trained in the energy  
auditing at M/s NIFES, UK. It was desired  
to give a wide overview to energy auditing  
and energy conservation techniques in  
cement technology

REMARKS : The Energy Bus and Energy Audit equipment  
facilities were extensively used for the  
purpose of energy audit studies in Indian  
cement industry. Three cement plants  
detailed audit studies were already completed.

**SUB-CONTRACT IV**

**TITLE** : Process Optimisation in Cement Plants

**AMOUNT** : US \$ 294,290

**AWARDED TO** : M/s F L Smidth & Co  
Denmark

**LIST OF EQUIPMENT** :

- 1) Portable velocity/flow measuring instruments
- 2) Dual trace oscilloscope
- 3) Portable microprocessor gas analyser system
- 4) Sequential blasting machine and Seismograph
- 5) Computer hardware 40 mb hard disc

**SUB-CONTRACT IV**

**TITLE** : **Process Optimisation in Cement Plants**

**AMOUNT** : **US \$ 294,290**

**AWARDED TO** : **M/s F L Smidth & Co  
Denmark**

**LIST OF EQUIPMENT** :

- 1) **Portable velocity/flow measuring instruments**
- 2) **Dual trace oscilloscope**
- 3) **Portable microprocessor gas analyser system**
- 4) **Sequential blasting machine and Seismograph**
- 5) **Computer hardware 40 mb hard disc**