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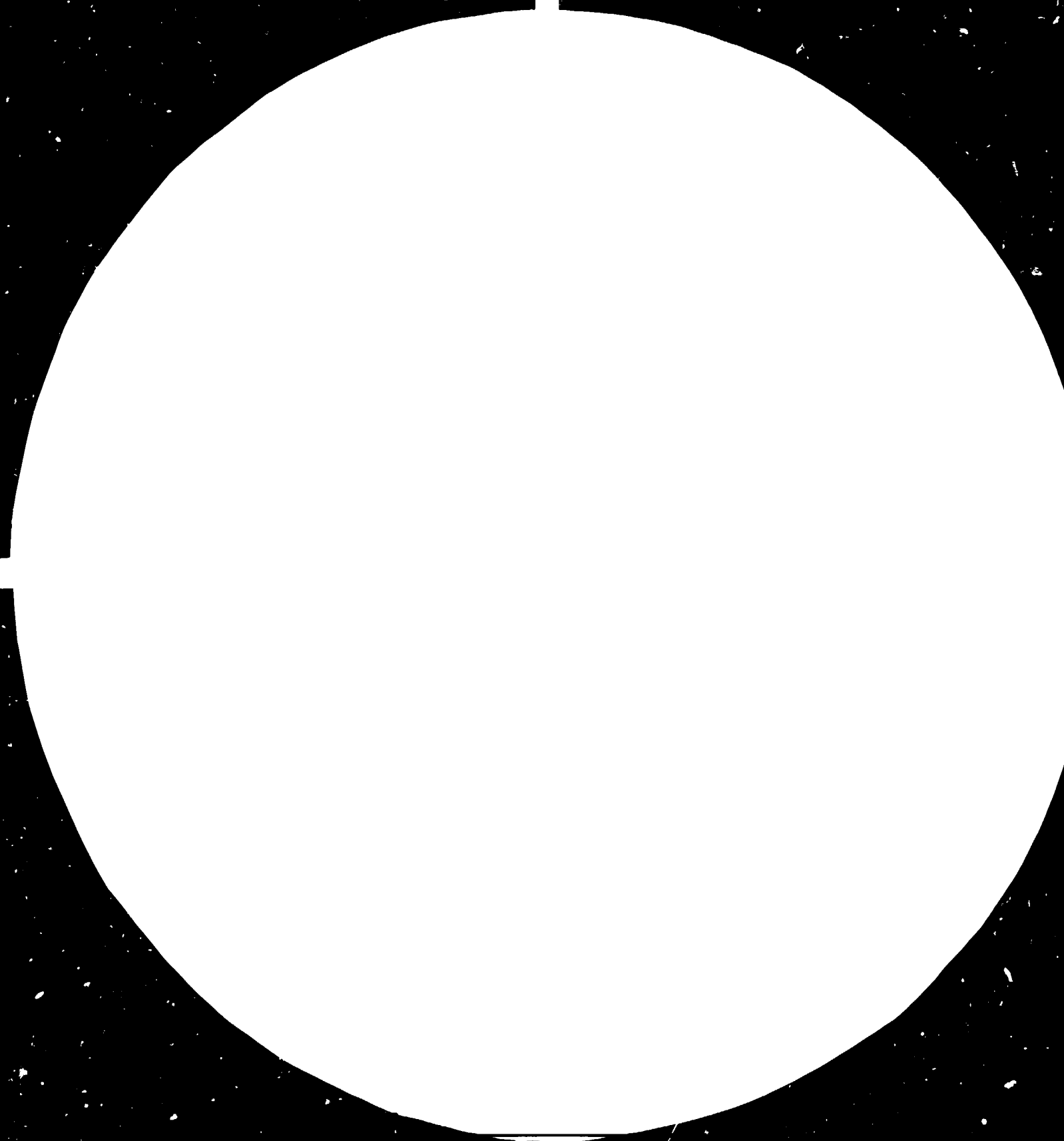

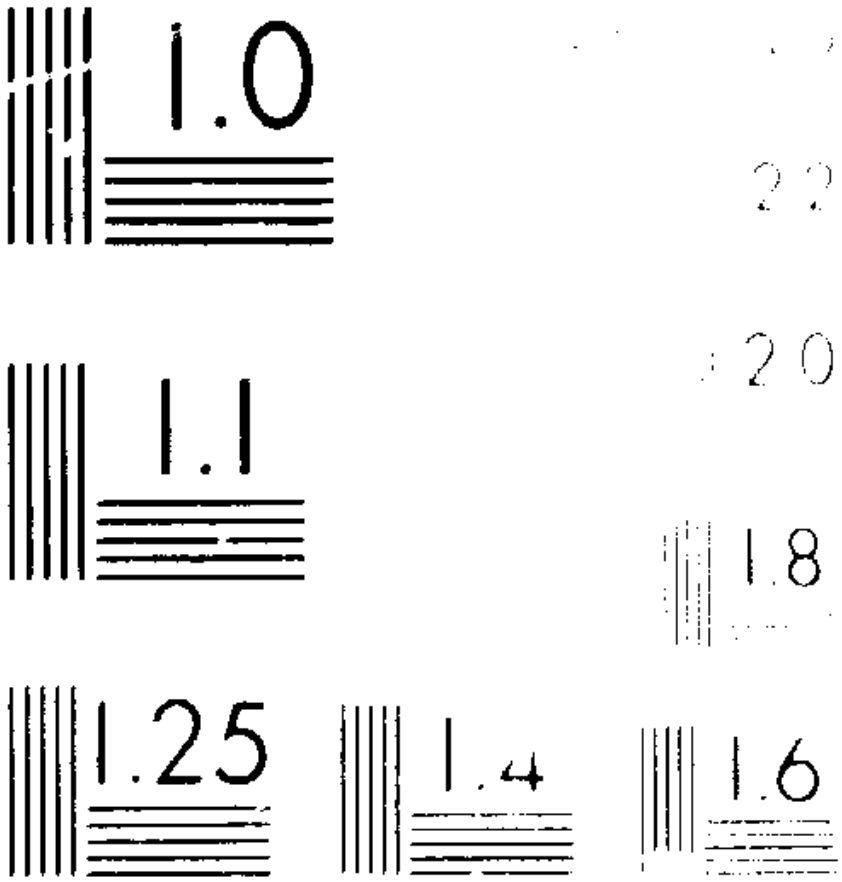
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Indonesia.

ASSISTANCE TO INDUSTRIAL DEVELOPMENT OF BUILDING MATERIALS MANUFACTURE, BANDUNG

DP/INS/74/034

INDONESIA

Terminal report

Prepared for the Government of Indonesia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Ir. Pratopo Soemitro, National Project Director
and Thomas Ringsholt, project manager

United Nations Industrial Development Organization
Vienna

V.83-51603

Explanatory notes

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

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References to dollars ($) are to United States dollars.

References to "tons" are to metric tons, unless otherwise specified.

An abstract of the technical and terminal reports of this project has been published separately. Also published separately was the "Abstract of technical reports and technical papers 1975-1982", which summarizes the contents of 91 technical reports and 83 technical papers on this project.

ABSTRACT

The "Building materials project" (DP/INS/74/034) was established in June 1975 by the United Nations Development Programme (UNDP) in co-operation with the Government of Indonesia to support existing national institutes in the promotion and development of indigenous building materials industries. The Government of Indonesia contributed Rp. 1,100,080,000 ($2,700,000) and UNDP contributed $2,434,647. The United Nations Industrial Development Organization (UNIDO) was the executing agency. The project ended on 31 December 1982.

The activities of the project included evaluation of raw materials, collection and dissemination of information, research, trouble shooting, demonstration activities, training activities, standardization work, elaboration of prefeasibility studies, investment promotion activities and support during construction and start up of industrial installations.

The project was most successful in the development of an Indonesian lime-kiln technology, training of trainers for bricklaying courses, development of Indonesian standard specifications for concrete and training of specialists to implement training courses in concrete technology.

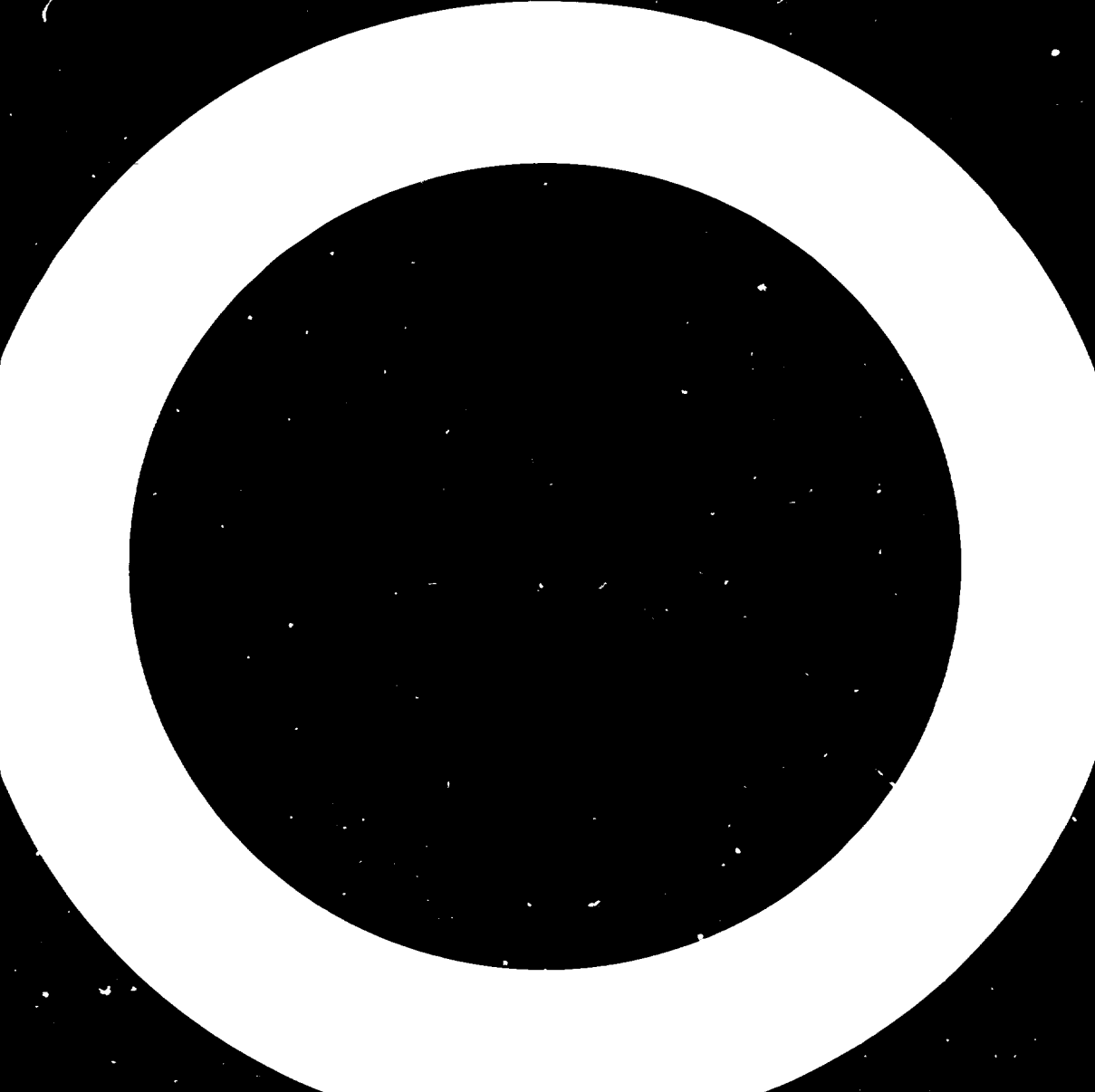
Some activities did not reach the take of point originally expected, but local personnel is well prepared to make appropriate follow-up when the situation calls for it. Into this category falls the development of refractories and the formation of a master plan for the development and diversification of the building materials industry.

Some research activities could not be converted into industrial activities, but served as interesting in-house training activities until their real value was assessed. The project was situated in Bandung, Central Java, but activities extended to all major development areas of Indonesia. The main recommendations of the project are as follows:

1. The further training of Indonesian experts abroad important to keep abreast with the development elsewhere.

2. The continued simultaneous promotion of construction and building materials industry in accordance with experience from Solo.

3. The further technical support to this sector through international assistance.



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INTRODUCTION

The production of building materials for housing from local resources has a long tradition in Indonesia. Products such as bricks, blocks and roofing tiles are produced by simple technologies in small-scale family enterprises. In spite of uneven and often inferior quality these products are extensively used by the informal sector of the construction industry.

With the introduction of large-scale mass housing schemes to cope with the increasing need for adequate housing for the lower-income groups, a need for large quantities of standardized building materials arose.

The Government's low-cost housing programme was initiated in 1974 with the establishment of the National Housing Corporation, PERUMNAS. Initially the programme had to rely on building materials such as corrugated iron and asbestos-cement sheets and particle boards, produced in large-scale modern factories as the local producers were unable to deliver the materials in required quality and quantity.

Concurrently with the establishment of PERUMNAS, the Government, in co-operation with the united Nations Development Programme (UNDP) and the United Nations Industrial Development Organization (UNIDO), initiated an ambitious programme for upgrading the traditional local building materials enterprises to meet the higher requirements of the project "Assistance to industrial development of building materials manufacture, Bandung" (DP/INS/74/034).

The socio-economic significance of this programme lies in its intention to give these traditional industries, which involve large human resources, a chance to survive.

History of the project

The project "Assistance to Industrial Development of Building Materials Manufacture, Bandung" was established by the United Nations Development Project (UNDP) in co-operation with the Government of Indonesia in June 1975 for a period of five years, and was extended three times: in July 1980, July 1981 and January 1982. The Government of Indonesia contributed Rp. 1,100,080,000 ($2,700,000); and UNDP contributed $2,434,647. The United Nations Industrial Development Programme (UNIDO) was the executing agency. The project ended on 31 December 1982.

The objectives of the project were thoroughly discussed and the project activities re-evaluated in a mid-term review in March 1979, and additional financial feasibility study activities were instituted to support the implementation of results obtained through R & D activities carried out during the first phase of the project.

Long-term

The long-term objective of the project was to assist the Government to strengthen and accelerate the development of the building materials industries and to enable those industries to achieve a greater efficiency and productivity in their activities. This objective was to be obtained through

the strengthening of the Directorate of Building Research (Regional Housing Centre) and its Building Materials Development Laboratory (Ministry of Public Works), the Ceramic Research and Development Institute (Ministry of Industry) and the Institute for Research and Development of Materials and Technical Products (formerly the Materials Testing Institute) (Ministry of Industry).

Short-term

The short-term purpose of the project was to assist the Government:

(a) To establish a comprehensive technical plan to serve as a basis for the planning and realization of the Government's programme for the building materials industries. The plan would be based on surveys of the existing industries (both small-scale and large-scale, in rural areas and in cities), on existing manufacturing processes, on raw material resources and on technical and economical feasibility studies. That would take into account the immediate needs, the future demands and technology, and also the Government's policy;

(b) To strengthen the following existing institutes and agencies by incorporating them intensively in the project activities, which would help to raise them to a higher standing and also assure future local expertise:

Directorate of Building Research and its Building Materials Development Laboratory, the Ceramic Research and Development Institute and the Institute for Research and Development of Materials and Technical Products and other involved institutes;

(c) To intensify and extend the existing activities on R & D in the building materials field, including information and demonstration and to prepare standards, as well as to promote the implementation of results obtained in the building materials and construction industries;

(d) To assist with the solving of operational problems in the existing industries through the transfer of technology by establishing the training of technicians, and also to upgrade those industries by introducing new and simple production methods;

(e) To assist with the planning of equipment, and the starting up of demonstration activities for selected industries. The manufacture of equipment for demonstration plants would be entrusted to local manufacturers whenever possible;

(f) To supply all the technical and administrative assistance required for the establishmenmt and running of new factories.

The project is primarily R & D orientated, but its activities will be production orientated in support of the development programmes of the two ministries. The complete project document contains a more detailed description of project activities including the organization of demonstration plants. Some of the activities, such as the establishment of demonstration plants, the introduction of new and simple production methods and feasibility studies for the establishment of new factories, will have investment aspects. The Government has decided that the Ministry of Industry in co-operation with the Ministry of Public Works will be responsible for the follow-up activities including local investment.

Planning of the project

The original design of the project was principally based on strengthening the three R & D institutes (i.e. the Ceramic Research and Development Institute (CRDI), the Institute for Research and Development of Materials and Technical Products and the Directorate of Building Research (DBR)) and was mainly research oriented.

During the first four years extensive activities were carried out within the R & D institutes that resulted in a substantial strengthening of the capabilities of the institutes. Laboratory equipment was provided and the testing methods and facilities were improved and expanded. A variety of appropriate technology solutions were developed and improved machinery was designed and put into production. However, the implementation of those results in the building materials industries was found difficult within the original research oriented framework of the project.

The orientation of the project was accordingly charged in 1979 through a mid-term evaluation to make the means of the project more effective for the achievement of the direct objectives, and to obtain a stronger impact on the development of the building materials industries. Those changes included increased financing for the feasibility studies and emphasized direct extension services to the small-scale industries.

An additional strengthening of those activities was decided at the tripartite review held on 21 September 1981 in order to further consolidate the project's achievements with respect to direct assistance to small industries, whereby, during its final extension for 1982, it would establish outposted teams, each comprising one UNIDO expert and two staff members of the CRDI , in order to create models that should be continued and replicated after the project had completed operations. One such team was established in Solo to assist the co-operation of BIPIK/PERUMNAS in supplying clay roofing tiles from local small manufacturers to PERUMNAS for their Solo low-cost housing project. Another team was established in Bali to assist the local governmental agencies in transforming and relocating the numerous small lime industries that endanger the ecology of the coral-lime reefs.

The project also acted as a bridge for the full-scale implementation of the management project "Assistance in the development of building materials and supply industries for low-cost housing" (INS/81/006) which required solid support by the Directorate of Building Research's extension service of DBR, established on a firm and implementable basis during the last year of the project.

I. ACTIVITIES AND OUTPUTS

The main objective of the project was initially to strengthen the three national research institutes by assisting major R & D projects in the institutes. In that way, 10 major sectoral activities were covered with the assistance of 38 international experts, implementation of 39 fellowships abroad, and provision of equipment worth $600,000.

In late 1978 the project was re-oriented towards more interaction with the small-scale building materials industry with a view first, to implementing the research results obtained thus far and, secondly, to redirecting part of the CRDI capacity in conjunction with the small industries development authorities to provide technical and production management inputs into the small industries extension services activities and into development programmes for small industries.

In this way the activities finally converged on the lime and clay industries.

The lime industry

The lime industry is composed of more than 5,000 lime kilns (some 3,000 on Java and Madura and about 600 on Bali island) with an annual production of 5 million cubic metres almost entirely from cottage and small-scale categories having individual production capacities ranging from 1 to 30 cubic metres hydrated lime per day. Through the initial research phase of the project, considerable resources were deployed on the design of continuously operating vertical-shaft lime kilns with a capacity of 12-20 cubic metres hydrated lime per day. Although the developed kilns were promoted through demonstration projects (two of each kiln type), it was difficult to implement the new technology in the small enterprises owing to lack of investment capital and credit.

A new apprcach was, therefore, adopted, around 1979, in co-operation with a pilot UNDP/UNIDO project for the establishment of small industries development centres with the Ministry of Industry, and in conjunction with the Bank Indonesia's small investment credit promotion schemes. As a result concerted programmes were mounted by small industries development authorities in co-operation with the Ceramic Research and Development Institute in East Java and Bali. In these programmes the Institute, with assistance from the UNIDO project, undertook to provide technical and production management consultancy services; the small industries development authorities were to assist the entrepreneurs in management procurement and marketing and the Bank Indonesia, through its participating banks, was to provide credit. In this way three entrepreneurs have been directly assisted in establishing improved lime kilns in various parts of East Java, and several others have followed and are now being assisted solely by the CRDI staff.

The participation of that Institute under the auspices of the UNDP/UNIDO project with respect to the lime industry in Bali was more in the nature of assisting the provincial authorities to encourage the small lime manufacturers to use lime stone rather than corals as a raw material in order to maintain the beaches of Bali and hence the island's main attraction for tourists. In this regard considerable input was provided in designing the lime kilns to suit particular characteristics of the lime stone found on the island, which is rather soft.

Clay roofing tiles industry

In the case of the clay roofing tiles industry, efforts were concentrated in two locations in Central Java. Appropriate technologies of improved extruder with roller mill to produce uniform clay slabs at higher capacity (the machine being manufactured by local factories), and improved kiln design ensuring a higher fuel efficiency and a lower breakage rate (the kilns being built by local entrepreneurs) were successfully promoted.

In early 1980, two such projects were implemented under the supervision of an Institute staff member who had spent eight months at plant sites while five new tile plants were being discussed by the local manufacturers and credit institutions with the Institute acting as a technical consultant.

At a location in Solo, the matter was tackled in a different way. The National Housing Corporation was planning to build 3,500 units and the Institutes were keen on having the Corporation use locally produced roofing tiles. Arrangements were finalized early in 1983 to ensure the production of roofing tiles of the required quality in the desired quantities by the small-tile manufacturing firms in Solo, under the supervision of the Institute and the project, for consumption by the Corporation in their housing project. In order to meet the tight time schedules, the project donated through the Institute the production equipment developed by the project for demonstration and pilot operations before steps could be taken by the small industries development authorities to organize the small-scale manufacturers of clay roofing tiles to meet the Corporation's demands.

In view of such encouraging results, efforts were made to decentralize the project on the same lines as mentioned above, i.e. to post two or more full-time teams, each comprising one UNIDO expert and two Institute staff members, at various locations in order to have an in-depth and continuous interface over a period of approximately one year, and thus ensure co-operation and a lasting relationship between the institutes and the small industries development authorities.

Considerable additional training has been provided to the co-operatives and entrepreneurs by the institutes and the project on several aspects of low-cost housing construction technology.

The UNDP/UNIDO inputs of experts, fellowships, equipment and subcontracts is summarized in table 1. Table 2 gives a key to the participation of international experts in the 10 major sectoral activities. The remainder of this chapter describes briefly and evaluates the activities carried out and the outputs produced in those 10 sectoral activities.

Details of experts, associate experts, fellowships and equipment are given in annexes I-IV. A separate report presents abstracts of technical reports and technical papers 1975-1982.

Table 1. Summary of UNDP/UNIDO inputs

A. Experts

Sectoral activity	Senior experts (m/m)	Associate experts (m/m)
General: building materials and low-cost housing	90.5	42.0
Raw materials	16.0	31.5
Structural clay industry	60.5	36.0
Other ceramic industries	22.0	12.0
Lime industry	14.0	30.0
Lime-based building materials	15.0	-
Masonry	20.0	75.0
Concrete technology and other cement-based products	73.0[a/]	-
Wood products	6.0	12.0
Low-cost housing construction technology	28.0	65.0
Total	345.0	303.5

B. Fellowships

Sectoral activities	Fellowships (m/m)
Low-cost housing	14
Project management	7
Mechanical engineering	6
Concrete technology	12
Structural clay industry	15
Lime industry	14
Wood products	4
Construction technology	4
Geological survey methodology	2
Total	78 = $260,000

C. Equipment

Institute	Total	Laboratory equipment	Vehicle	Production equipment
		$		
D B R	285 000	165 000	36 000	84 000
C R D I	225 000	145 000	21 000	59 000
Institute for R & D of Materials and Technical Products	90 000	90 000	--	--
	600,000	400,000	57,000	143,000

D. Subcontracts

Sectoral activities	International	National	Cost ($)
Light weight aggregate plant	1		57 000
Lime industry		2	30 000
Structural clay industry		1	10 000
Building materials and housing		1	120 000
Total			217 000

a/ 54 m/m DANIDA

Ten major sectoral activities

1. General: building materials and low-cost housing

Activities

Activities for this sector included the following:

(a) Project management: monitoring and correlating sectoral activities, recruitment of experts and associate experts, subcontracting of consulting firms, arrangement of fellowships and study tours, procurement of equipment, participation in project reviews and preparation of project revisions;

(b) Outlining the general patterns for co-ordination of development of building materials industries and development of the construction industry based on general proposals for the provinces of North Sumatera, Maluku and Irian Jaya as well as a detailed proposal for a transmigration settlement in South-east Sulawesi;

Table 2. Key to the participation of international experts in major sectoral activities

Budgetline / Project personnel 11 Expert/post title	Sectoral activity 1 General BM + LCH	2 Raw Materials	3 Structural clay	4 Other ceramics	5 Lime	6 Lime-based BM	7 Masonry	8 Concrete and cement-based products	9 Wood	10 LCH Construct. Tech.
11-01 Project Manager	■									
02 Raw Material Assessment		■								
03 Structural Clay Industrial			■							
04 Applic. Structural Clay							■			
05 Refractories				■						
06 Lime Industry					■					
07 Lime-based Build. Mat. Ind.						■				
09 Wood Preservation									■	
10 Building Material from Wastes									■	
11 Concrete Technology								■		
12 Light Weight Aggregates				■						
13 Low-rise Housing.										■
14 Fibre Cement Industry								■		
15 Mortar Technology						■	■			
17 Multi Storey Housing										■
18 Short-term Consultants				■						■
19 Bull's Trench Kiln			■							
20 Design of Dryers			■							
23 Soil-Lime Blocks						■				
26 Roof Structure									■	■
27 Lime, Techno-Economic					■					
28 Struct. Clay, Techno-Economic			■							

Notes:

BM = building materials
LCH= low-cost housing

(c) Preparation of an implementation model for the upgrading of small-scale lime industries comprising preparation of feasibility studies, assistance for loan applications and technical assistance for the construction of kilns and training of operators;

(d) Preparation of an implementation model for the upgrading of the small-scale roofing-tile industry to supply standardized products to low-cost housing construction projects;

(e) Preparation of housing construction capacity studies in nine major development centres in Indonesia;

(f) Standardization which included the following;

(i) Market research on quality achievements of building materials and ceramic products;

(ii) Testing of samples for identification of quality;

(iii) Formulation of draft standards for building materials and ceramic products;

(iv) Elaboration of draft standards in technical committees;

(v) Consensus meetings on the standards in the Indonesian Industrial Standard scheme;

(g) Organization of seminars, workshops and technical discussions.

Outputs

Outputs for this sector included the following:

(a) Strengthening of the three national R & D institutes to international level;

(b) Specific technical outputs as described below under sectoral activities 2 to 10;

(c) Implementation model for the upgrading of small-scale lime industries by joint action by investors, banks, local governmental agencies and national R & D institutes;

(d) Implementation model for the upgrading of small-scale structural clay industries by joint action by local co-operatives, banks, local governmental agencies and national R & D institutes;

(e) In 1982, a national workshop called The Development of the Building Materials Industry, identified a total of 21 basic building materials and canvassed the problems of the corresponding industries. The findings emphasized: the system approach of development, availability of raw materials, production technology, demand and supply, and prospects of development;

(f) Evaluation of the housing construction capacity in nine major development centres: Jakarta, Bandung, Semarang, Surabaya, Medan, Palembang, Tanjungkarang/Telukbetung, Samarinda/Balikpapan and Ujung Pandang;

(g) Delivery of technical concepts for the formulation of UNDP/UNIDO second phase project "Assistance in the Development of Building Materials and Supplies Industry for Low-Cost Housing" (INS/81/006);

(h) Standards for building materials and ceramic products as listed below:

Indonesian Industrial Standards
(formulated by CRDI)

Code No.	Title of Standards
SII 0020-80	Chamotte type refractory cement and brick
0021-78	Clay brick
0022-81	Clay roofing tile
0023-73	Ceramic tile
0024-80	Building lime
0054-74	Test method for the determination of acid resistancy of enamel
0080-75	Test method for the determination of forming water for ceramic raw material
0081-75	Test method for the determination of drying and firing shrinkage of ceramic raw material
0082-75	Test method for the determination of dry bending strength and after firing of ceramic raw material
0083-75	Test method for the determination of Pyrometric Cone Equivalent by Seger Cone
0084-75	Test method for the determination of grain size distribution by sieving for ceramic raw material
0133-75	Glass pharmaceutical bottles
0138-75	Glass bottles for beverage
0189-78	Sheet glass
0190-81	Tempered glass for road vehicles
0243-79	Glazed ceramic tiles
0280-80	Quartz sand for colourless glass production
0286-80	Fine fire clay for refractory
0288-80	Ceramic insulator, pin; strain and shackle types
0347-80	Quick lime for steel industry
0349-80	Glass tube for ampoule
0350-80	Ampoule for medicine
0380-80	High alumina refractory
0449-81	Dense and near dense ceramic mosaic
0450-81	Clay for chamotte type refractory
0451-81	Ceramic tableware
0452-81	Extremity of lead and cadmium solubility for glazed kitchenware
0453-81	Glass bulb for glass lamp
0514-81	Lime for agricultural use
9571-81	Glass flask (thermos)
0572-81	Glass tube for thermo-luminescent lamp (general use)
0574-81	Low-tension ceramic insulator, R type
0575-81	Low-tension ceramic insulator, T type
0583-81	Ceramic floor tile
0584-81	Unglazed acid resistant ceramic tile
0604-81	Perforated brick
0604-82	Compression and tensile strength of low-voltage ceramic insulator
0604-82	Laboratory glassware
0604-82	Drinking glass (pressed process)
0604-82	Low-voltage ceramic insulator, half-globe belt type
0604-82	Kaoline for fine ceramic
0604-82	Ceramic washstand, vitreous china type
0604-82	Chamotte type and high alumina type ramming mix

Indonesian Industrial Standards
(formulated by the Institute for Industrial Research and Development for Material and Technicalware)

Code No.	Title of Standards
0024-72	Cement floor tile
0025-76	Corrugated asbestos cement sheet
0026-72	Fibro-cement sheet
0051-79	Test method for the determination of grain size for concrete aggregate
0052-80	Sampling and quality of aggregate for concrete
0053-74	Test method for the determination of soft particle in coarse aggregate for concrete
0075-75	Test method for the determination of fine particle (less than 70 microns) of coarse aggregate for concrete
0077-75	Test method for the determination of organic materials in fine aggregate for concrete
0078-75	Test method for the determination of sound hardness for concrete
0079-75	Test method for the determination of the hardness of crushed stone, natural stone and aggregate for road foundation by use of Rudolf cylinder
0087-75	Test method for the determination of abrasion resistance of coarse aggregate for concrete by use of an Angelas machine
0088-75	Test method for the determination of soundness of concrete aggregate by use of sodium or magnesium sulphate-saturated solution
0191-78	Asbestos cement pipe
0284-80	Solid concrete blocks
0285-80	Hollow concrete blocks
0287-80	Standard sound for cement testing
0378-80	Natural building stone
0379-80	Marble as building material
0447-81	Concrete roofing tile
0448-81	Unreinforced concrete pipe
0455-81	Test method for the determination of alkali reactivity aggregate-cement mixture by use of the mortar bar method
0456-81	Test method for the determination of flat and elongated particles in coarse concrete aggregate
0457-81	Test method for the determination of light particles in concrete aggregate

Evaluation

The outputs provided under this sector may be evaluated as fully adequate.

2. Raw materials

Activities

Activities for this sector included the following:

(a) Surveys of raw materials for ceramics, lime and Pozzolana in areas of Java, Sumatera, Sulawesi, Nusa Tenggara Barat, Bali, Kalimantan Selatan, Kalimantan Timur, Maluku and Irian Jaya;

(b) Formulation of survey methods and guide-book for ceramic raw materials;

(c) Formulation of testing methods and guide-book for ceramic raw materials;

(d) Research and development of testing methods for ceramic small-scale industry;

(e) Establishment of data bank on ceramic raw materials of Indonesia;

(f) Design and prototyping of appropriate tools for raw-material testing for ceramic small-scale industry;

(g) Complete inventory of raw materials with suggestions for suitable building-materials processing in selected regions;

(h) Special survey in connection with a transmigration project.

Outputs

The outputs for this sector included the following:

(a) Methods for clay mineral identification, i.e.: MA; specific surface and Atterberg;

(b) Exploitation of raw materials from rice fields by establishment of reclamation system;

(c) Utilization of shale as alternative to rice field clay;

(d) Raw material data bank comprising 600 locations;

(e) Promotion of new types of building materials based on available raw materials;

(f) Design of testing equipment, i.e. Pfefferkorn, Atterberg and hardness tester;

(g) Locating deposits of scarce raw materials, i.e. Toseki, pyrophyllite, diaspore.

Evaluation

The activities in the raw materials sector have been carried out within the raw materials sections of the CRDI and DBR may be evaluated as fully adequate. Those sections are continuing activities according to the systems now established, CRDI focusing on specific raw materials for structural clay and ceramic industries, and DBR on general raw materials surveys for the identification of new or alternative building materials.

3. Structural clay industry

Activities

Activities for this sector included the following:

(a) Evaluation of the raw materials problems of the structural clay building materials industry;

(b) Classification of the clay-based building materials industry into four categories according to size, and identification of the specific problems of each category;

(c) Identification of methods to improve quality and productivity of structural clay industry;

(d) Design and prototyping of appropriate tools and equipment for the mini-scale structural clay industry;

(e) Design and prototyping of simplified tools for the mini-structural clay industry;

(f) Establishment of kiln construction guide book for the small-scale structural clay industry;

(g) R & D on natural drying of roofing tiles and bricks;

(h) Study on the techno-economy of the Hoffman kiln and design of appropriate technology brick factory suitable to Indonesian conditions;

(i) Studies on the diversification of energy sources for the small-scale structural clay industry;

(j) Comparative study on the utilization of ceramic roofing tiles, galvanized sheets and asbestos-cement sheets for roofing;

(k) Study on the needs of ceramics experts in Indonesia;

(l) Study on the further development of ceramic technology in Indonesia.

Outputs

Outputs for this sector included the following:

(a) Appropriate equipment and tools for tiny scale units, i.e., manual extruder, vertical extruder, manual roll crusher, ramming press machine for solid and perforated bricks, working table and bifunctional kiln (updraught and downdraught);

(b) Appropriate equipment for small-scale units, i.e., roll crusher, modified extruder and an updraught kiln with a capacity of 25,000 roofing tiles per day;

(c) Design of Hoffman kiln with a capacity of 40,000 bricks/chamber (21 chambers);

(d) Classification of the structural clay industry based on investment and equipment:

Scale	Number of industries
Large	9
Medium	11
Small	2,300
Tiny	90,000

(e) Research of clay deposit in several centres, i.e. Aceh, Java, Bali, Nusa Tenggara Barat, Kalimantan Timur, Kalimantan Selatan and Riau;

(f) Operator training in structural clay industry centres, i.e. Aceh, Sumatera Utara, Riau, Lampung, Sumatera Selatan, Java, Kalimantan Selatan, Sulawesi Utara, Sulawesi Selatan, Nusa Tenggara Barat and Timor Timur;

(g) Introduction of the utilization of coal as fuel for bricks and roofing-tile firing to obtain better economy. Promotion of the utilization of coal;

(h) Introduction of the utilization of rice husk for the firing of bricks (successful). For roofing-tile firing technical improvement is needed;

(i) Compilation of reliable data on the pattern and structure of the Indonesian structural clay industry;

(j) Justification of Palentong-type roofing tiles to be promoted in Indonesia;

(k) Establishment of data proving that roofing tiles are cheaper than other types of roofing material;

(l) Justification of the need for the establishment of a ceramic academy in Indonesia;

(m) Justification of the need for a ceramic society in Indonesia;

(n) Development of small-scale roofing-tile industries in Kebumen and Solo in co-operation with the Bank Indonesia in the framework of guidance and optimalization of the small industry credit system;

(o) Utilization of the coal firing of bricks and roofing tiles in downdraught kiln, followed by loan for erection of kiln by PT Taba in Bekasi;

(p) Development of small-scale roofing tile industry in Solo related to PERUMNAS project.

Evaluation

The activities in this central sector have been carried out within CRDI and have generally given useful results by developing appropriate technology equipment, tools and kilns. The activities were carried out over a considerable length of time (7 1/2 years) with varying success. The results

now available have proven to be most adequate, but further development work is needed especially on firing technology and small-scale production management. Expansion of training facilities for the training of operators and production managers is urgently needed.

CRDI is well equipped and staffed to tackle these challenges.

4. Other ceramic industries

Activities

Activities for the refractory industry included:

(a) Evaluation of the refractory industry in Indonesia;

(b) Study of the objectives of the refractory industry in Indonesia;

(c) Conducting workshops and training;

(d) Design and construction of testing equipment for refractory raw materials and products suitable for use by the refractory industry in Indonesia;

(e) Establishment of testing methods for refractory raw materials and products;

(f) Conducting R & D on castable refractories;

(g) Conducting R & D on dense grog;

(h) Conducting R & D on recycling of used or scrapped high alumina bricks.

Activities for the industry for artificial light-weight aggregates (ALWA) included:

(a) Evaluation of the possibilities for the manufacture and application of ALWA in Indonesia;

(b) Pilot plan. in Cilacap as demonstration plant and for research purposes.

Outputs

Outputs for the refractory industry included:

(a) Testing method for refractories;

(b) Prototypes of testing equipment, i.e. MOR, PCE and reheat shrinkage kiln;

(c) Conception of dense grog. Several refractory clays have been found and identified that can be used as raw material for dense grog without pretreatment. It is advisable that a factory be established specializing in producing refractories;

(d) Conception of filler clay, flint clay is normally used;

(e) The conception concerning castable refractories is important as this material has not yet been used extensively in Indonesia where, as in developed countries, 75 per cent of the refractories used are unformed. Consequently unformed refractories should be developed;

(f) Ramming mix of castable refractories has been successfully developed using scrapped high alumina bricks from portland cement and the steel industry;

(g) Short-term training of refractory consuming industry;

(h) Advise on the development of insulating refractory materials using indigenous raw materials.

Outputs using ALWA included:

(a) Establishment of the possibilities of utilizating ALWA for light-weight concrete panels and prefabricated components for low-cost housing;

(b) Establishment of the suitability of raw material (shales) in Java for ALWA production;

(c) Demonstration of prototype housing utilizing ALWA components.

Evaluation

The activities on refractories and ALWA that (together with a marginal activity in ceramic art wares) comprise the project's limited assistance to ceramic products other than the central structural clay products have been reasonably successful in that they have strengthened the institutes' capabilities in new fields. The refractory activity at CRDI is expected to expand considerably, and the institute, although now equipped to enter this field by assistance from the project, is seeking additional technical assistance. On ALWA continued R & D activities are performed by DBR and CRDI with bilateral technical assistance from Japan.

5. Lime industry

Activities

Activities for the lime industry included:

(a) Survey and evaluation of the lime industry in Indonesia;

(b) Prototype design and erection of vertical kiln, continuous process capacity 10 t/d, Sobek type, in Bandung, Semarang and Medan;

(c) Development and erection of improved traditional continuous vertical kiln, capacity 6 t/d in Yogyakarta and Bali;

(d) Comparative techno-economy evaluation of traditional vertical kilns, the Sobek kilns in Bandung, Semarang and Medan and the 6 t/d capacity kiln in Yogya and Bali;

(e) Modification of Sobek continuous vertical kiln;

(f) Feasibility study for the lime industry in East Java and Bali, and assistance to three entrepreneurs in East Java (feasibility study and negotiations with bank);

(g) Design and construction of a continuous vertical kiln for training and demonstration purposes for Bipik in East Java;

(h) Construction and testing of three t/d economy scale continuous kiln in Bali;

(i) Trial operation of a traditional Cubluk kiln in Bali with inland lime stone instead of coral lime;

(j) Experiments on burning of dolomitic lime in existing kiln in Madura;

(k) Improvement of burners and slaking equipment;

(l) Conducting lime seminars in Solo and Bali with emphasis on feasibility studies;

(m) Study on the utilization of an alternative fuel (coal);

(n) Evaluation of quality of lime from small-scale industry;

(o) Follow-up of the lime seminar in Bali (proposal for emergency solution and long-term solution (mini industrial estate).

Outputs

The outputs for the lime industry included:

(a) Construction of three prototype kilns (Sobek 8/10 t/d) in Bandung, Semarang and Medan;

(b) Construction of two prototype kilns (6 t/d) in Solo and Bali;

(c) Construction of a 6 t/d simplified kiln in Ponorogo, East Java, for Bipik;

(d) Construction of economy-scale 3 t/d continuous kiln in Bali;

(e) Design of kiln suitable for dolomitic lime;

(f) Proof that the small Cubluk (traditional) kilns that are used in Bali for burning coral can be improved for burning inland lime stone;

(g) Design of a continuous vertical kiln for coal firing;

(h) Design of improved burners and lime slaker;

(i) Construction of Cubluk kiln, using wood as fuel, capacity 4 m^3.

(j) Design of a continuous vertical kiln using coal as fuel with a separate system of firing;

(k) Finding that only 55 per cent of the product of the small-scale lime industry complies to requirement of SII 024 - 73 (Industrial Standard for building lime);

(l) Demonstration and training courses for private companies;

(m) Design and construction of lime kilns in Madura and Ponorogo in co-operation with Bank Indonesia and Bipik;

(n) Design and construction of lime kiln in Rangkasbitung in the framework of regional development planning with the assistance of USAID;

(o) Draft proposal for mini industrial estate in Bali for relocation of coral-using lime industries;

(p) Preparation of model feasibility study for small-scale lime industries;

(q) Proposal for technical co-operation among developing countries (TCDC) project for transfer of lime technology from Indonesia to Malawi.

Evaluation

The sectoral activity in the lime industry is one of the central activities of the project and may be evaluated as fully adequate. By down-scaling kiln designs from more advanced countries and by modifying traditional Indonesian kilns, a variety of designs have been developed, erected and thoroughly tested. The most suitable kilns have been identified (6 to 3 t/d).

Although the economy of the lime industry will probably justify larger-size kilns in the future, the extensive R & D activities carried out at CRDI and DBR with assistance from the project have developed the capabilities of the institutes to an extent where no or limited foreign assistance will be needed for the further development of the lime industry in Indonesia.

6. Lime-based building materials

Activities

The activities for lime-based building materials included the following:

Soil-lime blocks:

(a) Improvements of production process for Pozzolana-lime blocks;

(b) Improvements of the curing method by utilizing solar energy;

(c) R & D on laterite lime blocks and stabilized soils-lime blocks;

(d) R & D on sand-lime bricks and gasbeton (aerated concrete blocks);

(e) R and D on Pozzolana-lime cement;

(f) Comparative feasibility study of various possibilities for production of Pozzolana-lime binders.

Mortar technology:

(a) R & D on plastered bamboo mat elements and on ferro-cement;

(b) Improvements of plastering techniques;

(c) Research on selection of raw materials and composition for mortar and plaster mixes;

(d) Detailed mix-design method for mortar and plaster;

(e) Characteristics of mortar and plaster mixes and application.

Outputs

Outputs for lime-based building materials included:

Soil-lime blocks:

(a) Implementation R & D results through Government projects (PERUMNAS etc.);

(b) Simple soil-lime block machine;

(c) Improved production methods for Pozzolana-lime blocks;

(d) Demonstration factories on Pozzolana-lime blocks in Bandung, Surabaya, Yogyakarta, Medan and Solo;

(e) Feasibility studies on Pozzolana-lime cement factories;

(f) Establishment of gasbeton factory on Batam island.

Mortar technology:

(a) Revised standards for mortars and plasters;

(b) Code of practice for mortar and plasters;

(c) Demonstration activities;

(d) Training courses.

Evaluation

The project activities on soil-lime blocks have supplemented general ongoing activities at DBR. Improvement of the production process for Pozzolana-lime blocks has been introduced in the industry. R & D on lateritic soil-lime blocks has been initiated, however, further development work is needed before the process can be introduced to the industry.

Introductory R & D on gasbeton has been successful as it resulted in the establishment of a commercial factory on Batam island. Prefeasibility studies for various sizes of Pozzolana-lime cement plants have been prepared, but have not yet been used.

The development work on mortar technology has been successfully implemented in connection with bricklaying and plastering courses, as described below.

7. Masonry

Activities

Activities for masonry included:

(a) Introduction of new clay products and methods;

(b) Development of bricklaying and plastering techniques and tools;

(c) Tests of strength of brickwork with various classes of bricks and mortars;

(d) Test results and statistical analyses of brick properties for revising brick standards;

(e) Proposals for revised standards for bricks, roofing tiles and sewer pipes;

(f) Preparation of draft proposals for a code of practice for masonry construction.

Outputs

Outputs for masonry included:

(a) Instruction courses in bricklaying and plastering;

(b) Expansion of training activities in bricklaying and plastering for vocational instructors and supervisors in Bandung and Solo. Courses given in Bandung for instructors from various regions;

(c) Implementation of revised brick standards;

(d) Draft code of practice for masonry construction;

(e) Techniques and standards for roofing tiles;

(f) Laying techniques of sewer pipes;

(g) Demonstration in prototype houses.

Evaluation

The sectoral activity on masonry is one of the central activities of the project. Based on a large-scale research programme with testing of mortars, bricks and masonry elements, the activity developed a comprehensive course in bricklaying and plastering, which is given regularly by DBR. Improved tools have been developed and put into production. A draft code of practice for masonry construction completed the success of this activity.

8. Concrete technology and other cement-based products

Activities

Activities for concrete technology and other cement-based products included:

Concrete technology:

(a) Study on the quality of Indonesian portland cement;

(b) Study of the production techniques and quality control of concrete;

(c) Research on the mix design method of normal concrete, and preparation of a guide-book for concrete mix design and quality control;

(d) Study and statistical analysis of the quality of concrete produced at 46 building sites (1970-1977);

(e) Research on the quality of Indonesian aggregates, testing methods and standards;

(f) Research on the strengths of concrete using different aggregates;

(g) Research on the improvement of aggregate quality and study on the manual of aggregate processing;

(h) Conduct training and courses:

(i) Post graduate courses in advanced concrete technology - 30 participants (ITB Bandung);

(ii) Training course in concrete mix design and quality control held twice at Gresik (42 participants); five times at DBR (90 participants); and eighteen times at the Institute for R & D of Materials and Technical Products (220 participants);

(iii) Upgrading course on testing of aggregate and concrete (23 participants).

Fibro-cement products:

(a) Preliminary R & D of pulp-cement boards and fibro-cement boards using organic waste fibres;

(b) Development of appropriate production machinery for flat-sheet and roofing-tile fibro-cement products;

(c) Lay-out of demonstration plants.

Outputs

Outputs in concrete technology and other cement-based products included:

Concrete technology.

(a) A guide-book for concrete mix design and quality control has been prepared to support mainly the Indonesian Concrete Code PBI 1971;

(b) Training courses in concrete mix design technology and quality control for the various levels available, the dissemination of information on the methods and achievements in concrete technology through universities, institutes and other educational centres.

Fibro-cement products:

(a) Initiation of R & D on fibro-cement sheets and tiles;

(b) Establishment of guidelines for improvements in production process for asbestos-cement flat sheets;

(c) Establishment of demonstration plant for pulp-cement boards (with bilateral assistance from Japan);

(d) Application of fibro-cement boards for ceilings in prototype houses;

(e) Introduction of waste fibro-cement roofing tiles.

Evaluation

The major activity in this central sector is the extensive R & D on concrete technology based on local materials and conditions. Manuals on mix design, aggregate processing and training have been developed, and regular courses are given by the Institute for Research and Development of Materials and Technical Products and DBR. This work is successful and has great economic importance for Indonesia and other developing countries as proper concrete technology results in savings of cement and improved durability of concrete structures.

R & D on small-scale fibro-cement products from wastes has been initiated at DBR for further follow-up.

9. Wood products

Activities

Activities for wood products included:

Timber products:

(a) R & D on design of low cost pre-fabricated timber elements;

(b) R & D on standard panels and construction building components;

(c) Development of improved drying and preservation technology;

(d) Development of an on-site assembly system for nailed roof trusses;

(e) R & D on utilization of low-grade timber for roof construction.

Building materials from organic wastes:

(a) R & D on local synthetic binders;

(b) R & D on building materials from various organic wastes using organic and inorganic binders;

(c) Design and development on simple equipment;

(d) Study on marketing prospects and social economic aspects;

(e) Assistance to particle-board factory for improved production.

Outputs

Outputs for wood products included:

Timber:

(a) Nailed roof trusses from various secondary species;

(b) Precut system for production of housing elements;

(c) Lay-out of component workshop (Cibadak);

(d) Improvement of drying and preservation demonstration plants (Bandung, Semarang, Cibadak, Surabaya and Bali);

(e) Manual on standards for timber roof trusses;

(f) Manual on on-site assembly system for nailed roof trusses.

Building materials from organic wastes:

(a) Formulation of low-cost durable particle board;

(b) Improvement in particle-board production (Cibadak);

(c) Feasibility study on utilization of agricultural wastes;

(d) Appropriate-scale production processes for wood-wool boards in Medan, Bogor, Cirebon and Gresik;

(e) Implementation through demonstration houses;

(f) Establishment of experimental laboratory for board production from various organic wastes.

Evaluation

In the wood products sector assistance has been given to the promotion and pilot activities of DBR on drying, preservation, timber elements, nailed roof trusses and particle and other types of board from organic wastes. The assistance has brought initiated and ongoing research into the implementation phase and may thus be evaluated as adequate. Further effort is needed for the implementation of the developed results, and DBR has initiated this phase.

10. Low-cost housing construction technology

Activities

Activities for the low-cost housing industry included:

(a) Comparative study of various existing building materials and elements related to design and production of low-rise building;

(b) R & D on low-rise building elements (local raw materials);

(c) Production and testing of recommended materials in demonstration houses in full scale;

(d) A comparative study on various building materials for high-rise buildings;

(e) Development of building materials and elements for high-rise buildings specially light-weight elements and light-weight structural concrete;

(f) Preparation of guide-lines for the optimal choice of building materials and components for high-rise building;

(g) Development of simplified and improved low-cost hosing construction technologies, especially concerning roof structures.

Outputs

Outputs for the low-cost housing industry included:

(a) Demonstration prototype houses;

(b) Improvements of the utilization of particle-board wall panels (PERUMNAS Bandung, Depok, Bogor, Solo);

(c) Development of the open building system - concept for low-cost housing;

(d) Development of the rationalized construction method for multi-storey buildings in Indonesia;

(e) Improved construction technologies for masonry and roof structures.

Evaluation

The activity in this sector, which links the development of building materials to the development of construction technology, has prepared useful and sound concepts for the rationalization of traditional construction methods and laid the groundwork for the gradual introduction of industrialized building methods by analysing the suitability of materials and components, and by introducing the open-building system concept. Further R & D in this field is urgently needed and should be strongly pursued by DBR. The activities under this sector have initiated this work and were thus most useful.

II. ACHIEVEMENT OF IMMEDIATE OBJECTIVES

The project's achievements in relation to its immediate objectives are evaluated below.

The first objective, to assist in the establishment of a technical plan to serve as a basis for the planning and realization of the Government's programme for the building materials industries, was during the mid-term review in 1979 characterized as "unlikely to be implemented within the framework of this project" as this would require "much larger inputs of expertise than foreseen and probably a greater range of data than presently available in Indonesia".

It should, however, be noted that the project has succeeded in assembling the major elements of this technical plan by its formulation of package assistance programmes to the structural clay and lime industries (see chapter II), and specifically in its establishment of the "Solo model" for the upgrading of local roofing-tile industries for supply to Government low-cost housing projects (see chapter II). These elements have become models for the second phase of the UNDP/UNIDO low-cost Housing Project (INS/81/006), which will pursue further the establishment of a national system for interlinkage of the development of the building materials industries with the housing construction programmes, the programmes for development of industrial growth centres, and other national programmes such as transmigration housing, school buildings etc.

The project has also assisted in the development of a data bank for raw materials resources, in the identification of process development for 21 basic building-materials industries, in preparation of feasibility studies for the lime and structural clay industries, and in giving technical inputs to the formulation of governmental policies in the field of building materials development.

The project's achievement of this objective may thus be evaluated as reasonably successful.

The second objective, to assist in "strengthening the institutes and agencies by incorporating them intensively in the project's activities ... to develop them into a higher standing and ... assure a further local expertise" was the main rationale behind the design of the original project work programme. The work programme was, during the informal mid-term review discussions, characterized as having a strong research bias, and was substituted by a more direct approach to solving problems in the industries. The activities of the project, during the first four years, were deliberately carried out within the three national institutes so as to obtain achievement of the project's second objective, and this approach, although on the one hand it hampered simultaneous direct field activities, on the other hand, by successfully strengthening the three institutes to what is now regarded as international level, laid the ground for the successful implementation of problem-solving research and extension-service activities that were carried out during the project's last 3 1/2 years.

The strengthening of the institutes was carried out with assistance from international experts, provision of equipment, and arrangement of fellowships, group training, seminars and workshops. The three institutes have been strengthened in the following fields:

Institutional and individual capabilities
Raw materials identification and utilization
Manufacturing processes
Quality control and testing procedures
Problem solving
Knowledge and experience
Design of products and equipment
Training and extension services.

The project's achievement of this objective may thus be evaluated as successful, and the resulting strengthening of the institutes as extremely important.

The third objective, to assist in intensifying research and development in the building materials field, information and demonstration activities, setting standards, as well as implementing results in the building materials and construction industries, specifies the various types of activities to be carried out. The project has been substantially assisting these types of activities in 10 major sectors of the industries (see chapter II).

The project's achievement of this objective may be evaluated as successful.

The fourth objective, to assist in solving operational problems in the existing industries through the transfer of technology by establishing the training of technicians, and also upgrading these industries by introducing new and simple production methods, specifies the scope of activities carried out mainly during the last 3 1/2 years of the project. By concentrating on selected sectors of the industry, notably in the fields of structural clay industry, lime industry, masonry construction and concrete technology, substantial results were obtained (see chapter II).

The project has achieved this objective, and the activities and the abilities of institutes have been substantially increased in the field of training and extension services for the transfer of technology to the industry, promotion of new materials and methods and for trouble shooting etc.

The fifth objective, to assist in the planning of equipment and the starting up of demonstration activities for selected industries was pursued with reasonable success during the full project period.

Prototypes of testing equipment were developed (Pfeffercorn, bending test machine etc.). Prototypes of production machinery and equipment were developed and transferred to commercial manufacturing machine-shops where they are now produced and consumed extensively in the industry (extruder for brick and roofing tiles, friction press for tiles, moulds for roofing tiles, clay ball mill, roller crusher, lime slaker, tunnel kiln etc.).

Promotional demonstration factories and workshops have been erected in several regions in the fields of lime kilns, brick kilns, wood preservation, wood elements, light-weight aggregates, light concrete elements and soil-lime blocks.

Although several of these demonstration plants obviously serve an important purpose, especially in introducing new products in lesser developed regions, experience has shown that the commercialization of the demonstrated processes is difficult as the plants are operated under non-commercial conditions. Consequently these activities were scaled down during the last years on the project and substituted by active assistance to investors in direct establishment of commercial units.

The project's achievement of this objective may thus be evaluated as successful although its findings indicate that demonstration by establishment of large non-commercial demonstration plants lacks direct impact on the industry.

The sixth objective specifies the project's obligation to supply all technical and administrative assistance required for the establishment and running of new factories. This has successfully been done in selected cases, notably in the structural clay industry and lime industry sectors (see chapter II).

The project successfully achieved this objective.

III. UTILIZATION OF PROJECT RESULTS

The activities of the project have been carried out within the programmeframework of the three national institutes and the results obtained are thus generally in accordance with the Government's programme for development of the building materials industries in the present and the next five-year development plans.

Based on the project's considerable achievements and its successful strengthening of the institutes, it may be concluded that the project's results are directly applicable and it is envisaged that they will be utilized in the following Government programmes:

Identification of the utilization of the national raw material resources
Improvement of the structure of the building materials industry
Formulation of Government policies in the building materials field
Transfer of technology to traditional small-scale building materials industries
Provision of training and upgrading of industrial staff
Development of production equipment and machinery
Trouble shooting for the industry
Extension services
Improvement and development of technology
Planning of development programmes
Continuation of activities within the framework of the project
Co-operation with other UNDP/UNIDO technical assistance programmes.

The project's results and achievements will have an increasing effect on the development of the building materials industry through its interlinkage with other sectors such as:

Construction industry
Mining
Agriculture
Rural socio-economical development
Engineering industries
Export promotion.

The project has thus been extremely useful.

IV. FINDINGS

During the implementation of the project the observations listed below were made in relation to the three major elements of the technical assistance.

Experts

In view of the multitude and magnitude of the development activities in the building materials field a shortage of experienced senior national experts has been identified. This shortage has resulted in delays as it has been difficult to attach experienced national experts on a full-time basis to the many project activities. To a certain extent this was overcome by developing systematic lists of national expert's functions and responsibilities coupled with elaborate job descriptions and work plans for the national experts posts.

There were also difficulties, in some cases, in identifying and selecting international experts with the specialized knowledge and experience necessary for the continuously changing needs of the national teams. To a certain extent this was overcome by having several experts attached to the same activity whereby a variety of views were made available to the institutes.

The attachment of associate experts made a substantial contribution to the progress of the project.

Training

Training abroad has served as post-graduate specialist training for national experts in important subjects and has thus played an important role in the progress of the project.

Equipment

Besides the generally accepted usefulness of the provision of basic laboratory and testing equipment, the experience of the project shows that provision of production equipment for direct introduction into small-scale industries has substantially accelerated the implementation of the project's results.

V. RECOMMENDATIONS

The following activities are recommended to further consolidate and develop the achievements of the project:

1. R & D should be continued and intensified with emphasis on problem-solving activities.

2. The specialized training of national experts should be continued by fellowships abroad.

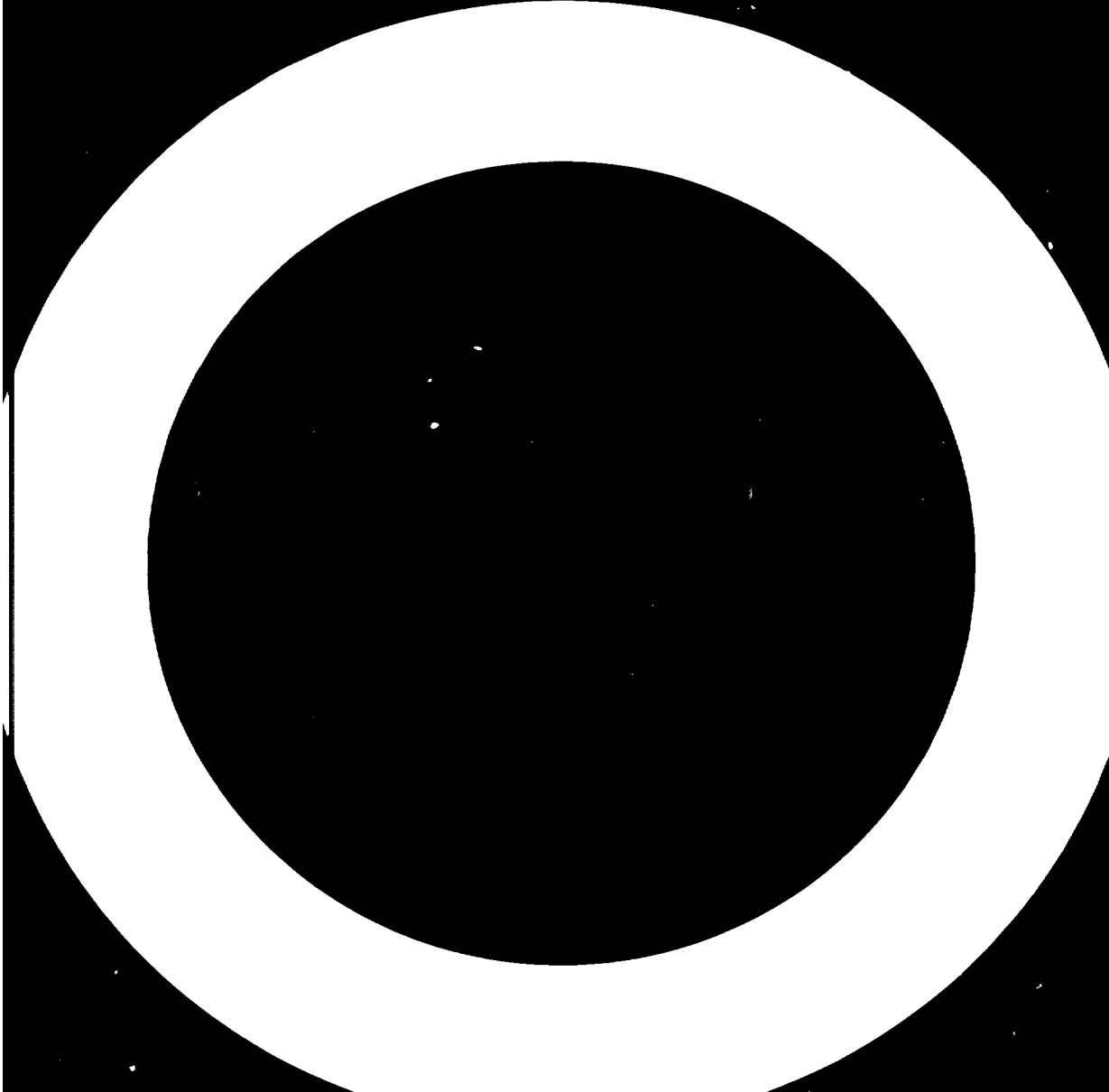
3. The training of industrial extension service officers should be intensified.

4. The provision of pilot production equipment to selected small-scale industries should be continued.

5. The co-ordination between the building materials industry development and the construction industry should be intensified by developing the Solo model into a higher national interlinkage scheme with the direct and active responsible participation of local governmental agencies (Kanwil/Dinas Perindustrian and PU, KUD's, Banks etc.).

6. The Solo model should be implemented in industrial growth centres, PERUMNAS projects, transmigration projects, Inpres projects, other governmental projects and private sector projects through the UNDP/UNIDO Low-cost Housing Project.

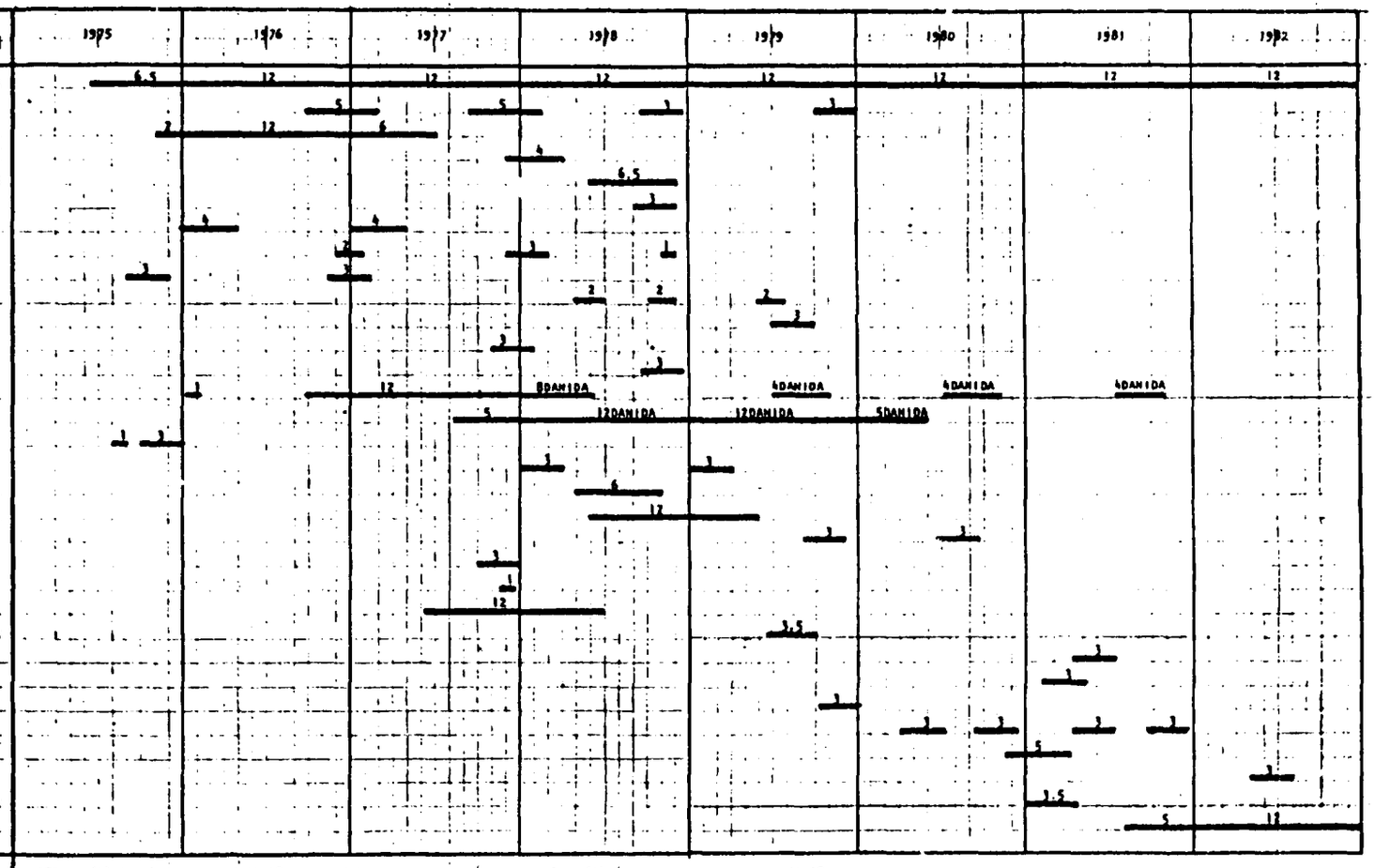
7. Future technical assistance to the institutes should rely more on national expertise, with a few carefully selected international complementary experts, training and provision of production equipment.



Annex I

IMPLEMENTATION BY EXPERTS

Post number	Post title	Name	Time spent m/m
11-01	PROJECT MANAGER	Ringsholt	90.5
11-02	RAW MATERIALS ASSESMENT	Hill (1)	16
11-03	STRUCT.CLAY INDUSTRY	Sedalia	20
		Feibler (2)	4
		O'Bannon	6.5
		Johansen (3)	3
11-04	APPLIC.STRUCT.CLAY PROD.	Bryrup	8
11-05	REFRACTORIES	Knizek	6
11-06	LIME INDUSTRY	Sobek	6
11-07	LIME-BASED BUILD.MAT.	Grana	6
		Fujino (7)	3
11-09	WOOD PRESERVATION	Christensen	3
11-10	BUILD.MAT. FROM WASTES	Liska	3
11-11	CONCRETE TECHNOLOGY	Hansen (5)	33
		Ulla Kjaer	34
11-12	LIGHT WEIGHT AGGREGATES	Madsen (4)	4
11-13	LOW-RISE HOUSING	Lehtinen	6
11-14	FIBRO CEMENT	Bourne	6
11-15	MORTAR TECHNOLOGY	Jain	12
11-17	MULTI STOREY HOUSING	Lehtinen	6
11-18	SHORT TERM CONSULTANTS	Gravesen (constr.ind.)	3
		Sorensen (constr.ind.)	1
		Kroes (ceramic art)	12
11-19	BULL'S TRENCH KILN	Jain	3.5
11-20	DESIGN OF DRYERS	Goonewardena	3
11-23	SOIL-LIME BLOCKS	Rahsi	3
		Fujino	3
11-26	ROOF STRUCTURES	Eijgelaar (6)	12
11-27	LIME,TECHNO-ECONOMY	Banerjee	5
		Dabelstein	3
11-28	STRUCT.CLAY,TECHNO-ECON.	Knizek	3.5
		Koopmans	17
	TOTAL		345
	(of which 54 m/m DANIDA)		

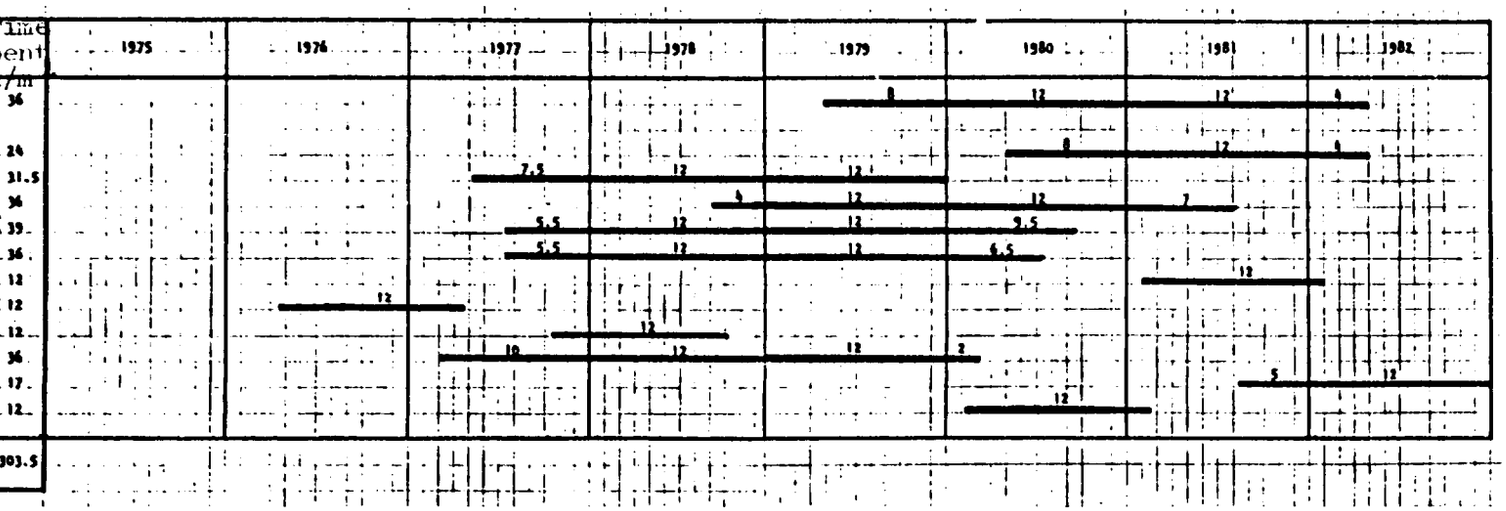


NOTES: (1)Hill 4m/m charged 11-18 (2)Feibler 4m/m charged 11-18 (3)Johansen 3m/m charged 11-18
(4)Madsen 4m/m charged 11-05 (5)Hansen 10m/m charged 11-06
(6)Eijgelaar 9m/m charged 11-18 (7)Fujino 3m/m charged 11-18

Annex II

IMPLEMENTATION BY ASSOCIATE EXPERTS

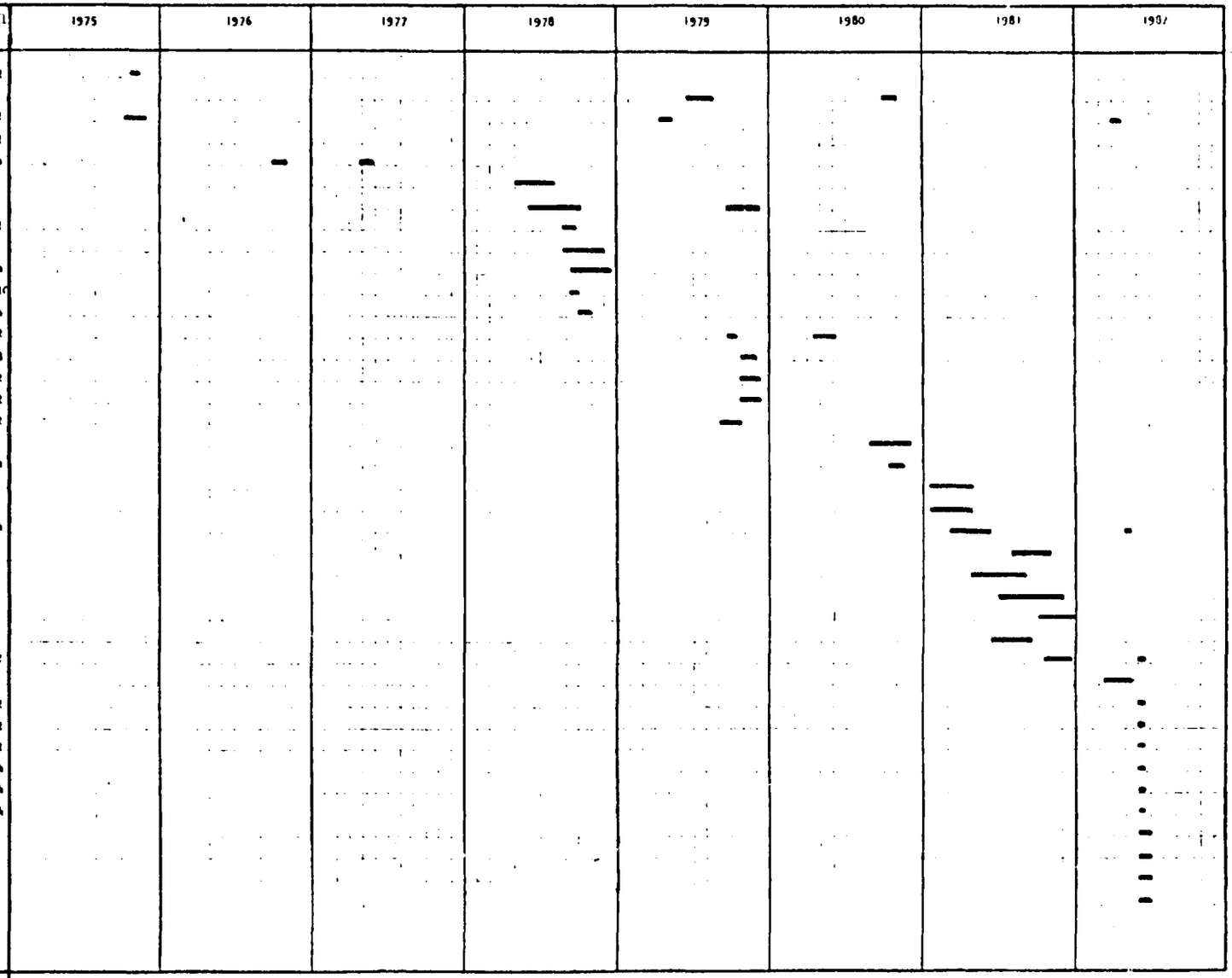
Post title	Name	Time spent m/m
TECHNICAL ADMINISTRATION & FINANCIAL FEASIBILITY	H. Dabelstein	36
IMPLEMENTATION OF R & D RESULTS	Y. Kinoshita	24
RAW MATERIALS ASSESMENT	F. Dirks	31.5
STRUCTURAL CLAY INDUSTRY	A. Koopmans	36
APPLICATION OF STRUCTURAL CLAY PROD.	I. Christensen	39
" " " " "	L. Vasseur	36
REFRACTORIES	E. Alessandrelo	12
LIME INDUSTRY	E. Raphael	12
AGRICULTURAL & FOREST PROD. WASTES	H. Bach	12
LOW-RISE HOUSING	H. Crombez	36
LOW-COST HOUSING	H. De Smet	17
MULTI-STOREY HOUSING	D. Wylezol	12
	TOTAL	303.5



Annex III

FELLOWSHIPS AND STUDY TOURS

Post Number	Post title	Name	Duration m/m
01	31	Darubroto	ALWA	1/2
			CERAMIC ENG.+ EDUC.&TRAINING	2 + 1
02		Bitonga	ALWA & WOOD WORKSHOP + STUDYTOUR	1 + 1 1/2
			B.M. WORKSHOP	1/2
03		Sumardi	CONCRETE TECHNOLOGY	3/4 + 3/4
04		Sumani R.	FIELD GEOL.& FIELD TRAINING	3
05		Sjarif M.	MECH. ENG. WORKSHOP TRAINING	4
06		Z. Aksa	INT. CONFERENCE + PROJ. MANAGEMENT	3/4 + 2 1/2
07		Emma Tabri	MECH. ENG. WORKSHOP TRAINING	3
08		Randing S.	TRAINING & TESTING CONSTR. MAT.	3 1/4
09		Rasroen R.	INT. PAPER BOARD SYMP.	1/10
10		M. Parka	CONCRETE TECHNOLOGY	3/4 + 3/4
11		Nadhiroh	CONCRETE TECHNOLOGY + STUDYTOUR	1/2 + 1 1/2
12		Sumandojo S.	WAEP SEMINAR	2/3
13		Abdurachim	WOOD WASTE MATERIALS	1 1/2
14		Anwar Sanusi	WOOD WASTE MATERIALS	1 1/2
15		F. Lontoh	BUILDING PROCESSES	1 1/2
16		Ui. Sutrina	CERAMIC MACHINERY & EQUIPMENT	3
17		A. Hariman	INTERNATIONAL CONFERENCE	3/4
18		Nano Tresna	CONCRETE TECHNOLOGY	3
19		Usman Sumantri	CONCRETE TECHNOLOGY	3
20		E. Poernomo	REFRACTORIES + CLAY IND. STUDYTOUR	3 + 1/4
21		Sudarsin Hadi	FINE CERAMICS	3
22		Rosasih Kosim	SMALL-SCALE CERAMIC INDUSTRY	4
23		Anwar Jusuf	PROJECT MANAGEMENT	5
24		Sugoto	MANAGEMENT & IND DEVELOPMENT	3
25		Andriati	LAB. INSTRUMENTATION	3
26		E.P. Wanto	LIME INDUSTRY + STUDYTOUR	2 + 1/2
27		Suprapto	FIRE RESEARCH	2
28		E. Purba	LIME INDUSTRY STUDYTOUR	1/2
29		Biyanto	LIME INDUSTRY STUDYTOUR	1/2
30		S. Bunarto	LIME INDUSTRY STUDYTOUR	1/2
31		Maniek S.	CLAY INDUSTRY STUDYTOUR	1/4
32		Suripto	CLAY INDUSTRY STUDYTOUR	1/4
33		Sumaryono S.	CLAY INDUSTRY STUDYTOUR	1/4
34		Saleh A.	LOW COST HOUSING CONSTRUCTION	1
35		Nemoto F.	LOW COST HOUSING CONSTRUCTION	1
36		Suhari M.	LOW COST HOUSING CONSTRUCTION	1
37		Pratopo S	LOW COST HOUSING CONSTRUCTION	1
38		Hartono	HEAVY CERAMICS	2
39		Sri Indriati	REFRACTORIES	1
			TOTAL:	78.02



Annex IV

LIST OF EQUIPMENT DELIVERED 1975-1982

HQ Req. Ref.	Item No.	Qty.	Unit	Description	US Dollar Equivalent	P.O./Shipping Advice Ref.	Received			Condition	Qty. on hand	Remarks
							Qty.	M	Y			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
75/1	1	1	EA	PROJECT VEHICLE, HOLDEN KINGSWOOD SEDAN	6,800.-	LP	1	9	75	F	1	
75/1	2	1	EA	PROJECT VEHICLE, HOLDEN PREMIER	7,050.-	LP	1	9	75	F	1	
76/1	1	5	EA	INTEROFEN OIL INJECTION [illegible] BURNERS	15,854.-	15-6-00230	5	11	76	G	5	
75/1	3	1	EA	PROJECT VEHICLE, HOLDEN TORANA	6,870.-	LP	1	11	75	G	1	
76/1	4	1	EA	PROJECT VEHICLE, HOLDEN KINGSWOOD STATION	6,988.-	LP	1	6	76	G	1	
76/1	5	1	EA	PROJECT VEHICLE, HOLDEN KINGSWOOD STATION	7,108.-	LP	1	9	76	G	1	
75/2	-1	1	EA	SPARE PARTS FOR LABORATORY KILN MODEL HT16 TEMPERATURE, REGULATOR F. NABER HT16 KILN	1,588.-	15-5-01025	1	8	76	G	1	
77/2	HTI/2	1	EA	EL34-030/1 "VIBRO" CONSISTOMETER, 220/240 V 50 HZ SINGLE PHASE A/C/, COMPLETE	1,512.-	15-7-00503	1	3	78	G	1	
77/4	1	3	EA	MOD. P3N/200 BAR PRESSURE TRANSDUCERS, 350 OHMS WITH 3-METER FIRMLY FIXED CABLE	1,910.-	15-7-00476	3	2	78	G	3	
77/6	1	1	EA	PROJECT VEHICLE, TOYOTA LANDCRUISER 1977		P 19-7-2726	1	2	79	G	1	
77/6	2	1	EA	PROJECT VEHICLE, TOYOTA LANDCRUISER 1977		LP	1	2	79	G	1	MOD 19-7-2726
77/2	9	1	EA	EL 38-460/01 HEAT OF HYDRATION APPARATUS 220/ 240V 50 HZ 1 PH.A.C.	585.-	15-7-00628	1	2	78	G	1	
77/2	10	4	EA	EL 23-680/01 MULTIFLOW MIXERS CAP. 14 DM3 220/ 240V 50HZ 1 PH. A.C.	6,936.-	15-7-00628	4	2	78	G	4	
77/2	19	1	EA	CT-164-8 VIBRATING TABLE	474.-	15-7-00629	1	4	78	G	1	
77/2	20	1	EA	CT-162A LABORATORY VIBRATOR	314.-	"	1	4	78	G	1	
77/2	21	1	EA	CT-804-8X SIZE DETERMINATION TEST SET (LESS ONE LT-98)	936.-	"	1	4	78	G	1	

HO Acq. Ref.	Item No.	Qty.	Unit	Description	US Dollar Equivalent	P.O./Shipping Advice Ref.	Received			Condition	Qty. on hand	Remarks
							Qty.	M	Y			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
77/2	5	1	EA	3-INCH HORIZONTAL DEAIRING EXTRUSION MACHINE COMPLETE WITH 3 HP MOTOR 400/440 V 3 PH 50 HZ A.C., VACUUM PUMP AIR FILTER AND IRON BASEPLATE S/N 1721	5,926.-	15-7-00488	1	4	78	G	1	
77/2	MTI/3	2	EA	TYPE SK1 COUNTER-CURRENT SMALL MIXERS, CAPACITY 50 l, COMPLETE WITH DRIVE MOTOR AND STARTER, 220 V.50 HZ/1 PH. A.C.	9,339.-	15-7-00505	2	6	78	G	2	
77/2	DER15	1	EA	TYPE 2203 SOUND LEVEL METER, PRECISION	1,352.-	15-7-00142	1	4	78	G	1	
77/2	15.1	1	EA	4220 PITCHPHONE	498.-	"	1	4	78	G	1	
77/2	15.2	1	EA	2306F LEVEL RECORDER	2,248.-	"	1	4	78	G	1	
77/2	13	1	EA	INDUSTRIAL AUTOCLAVE MOD. 910H3/1750	9,043.-	15-7-00630	1	10	78	G	1	
77/2	13.1	1	EA	AUTOMATIC PACKAGE BOILER, MOD. 200EL/1750.-	10,816.-	15-7-0630	1	10	78	G	1	
77/2	18	1	EA	MICROSCOPE HEATING STAGE TYPE 1350 (515113)	2,084.-	15-8-00146	1	4	78	G	1	
77/2	18.1	1	EA	TRANSFORMER (500164)	575.-	15-8-00146	1	4	78	G	1	
77/2	18.2	1	EA	TEMPERATURE INDICATOR (580622)	498.-	15-8-00146	1	4	78	G	1	
77/2		1	EA	DIGITAL STATIC STRAIN INDICATOR W/PRINTER	10,878.-	15-7-00558	1set	10	78	G	1	
77/2	9	1	EA	2086 MODEL-C TON HYDRAULIC PRESS COMPLETE 27000-13	570.-	15-8-00143	1	10	78	G	1	
77/2	MTI/1	1	EA	LABORATORY SCREW CLASSIFIER	3,840.-	15-7-00507	1	6	78	G	1	
77/2	MTI/7	1	EA	LABORATORY CURRENT WASHER	1,882.-	15-7-00507	1	6	78	G	1	

HQ Req. Ref.	Item No.	Qty.	Unit	Description
(1)	(2)	(3)	(4)	(5)
77/2	TI/4	1	EA	LABORATORY JAW CRUSHER
77/2	4.1	1	EA	ELECTRIC MOTOR
77/2	CRI/1	1	EA	CAM PRESS, SEMI-AUTOMATIC, MOTOR DRIVEN, KPM 150/5
77/2	1.1	1	EA	PNEUMATIC ROTARY CYLINDER
77/2	CRI/2	1	EA	VACUUM EXTRUSION PRESS, VERTICAL, MOTOR DRIVEN, COMPLETE, V10sp
77/2	2.3	1	EA	FEEDING WORM STEEL/HARD METAL (V5-519)
77/2	2.4	1	EA	COMPRESSION WORM 92ø steel/hard metal
77/2	CRI/5	1	EA	LABORATORY MIX-MULLER SIMPSON MOD. LF
77/2	CRI/35	1	UNIT	BICKLEY MODEL 1800B PCE FURNACE SERIAL No. 1201
77/2	CRI/32	1	EA	FOSTER CAMBRIDGE P 130L POTENTIOMETRIC TEMPERATURE INDICATOR, RANGE 0-1600°C
77/2	CRI/10	1	EA	SEDIMANTATION BALANCE
77/2	CRI/7	1	EA	MOISTURE TESTER KK 316-600, DRYER-BALANCE-TYPE
77/2	CRI/8	1	EA	HEATING/DRYING OVEN
77/2	19.1	1	EA	MULTIFLOW MIXER 14 DM3

US Dollar Equivalent	P.O./Shipping Advice Ref.	Received			Condition	Qty. or Items	Remarks
		Qty.	M	Y			
(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
6,900.-	15-7-00507	1	10	78	G	1	
542.-	15-7-00507	1	10	78	G	1	
16,038.-	15-7-00741	1	10	78	G	1	
986.-	15-7-00741	1	10	78	G	1	
27,981.-	15-7-00741	1	10	78	G	1	
538.-	15-7-00741	1	10	78	G	1	
716.-	15-7-00741	1	10	78	G	1	
3,293.-	15-8-00145	1	6	79	G	1	
4,839.-	15-8-00202	1	6	79	G	1	
270.-	15-8-00412	1	5	79	G	1	
4,796.-	15-8-00683	1	6	79	G	1	
1,422.-	15-8-00684	1	6	79	G	1	
1,809.-	15-8-00684	1	6	79	G	1	
2,158.-	15-8-00685	1	5	79	G	1	

HQ Req. Ref.	Item No.	Qty.	Unit	Description	US Dollar Equivalent	P.O./Shipping Advice Ref.	Received			Condition	Qty. on hand	Remarks
							Qty.	M	Y			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
77/2	19.2	1	EA	VIBRO CONSISTOMETER	2,012.-	15-8-00685	1	5	79	G	1	
77/2	19.3	1	EA	KANGO VIBRATING HAMMER	751.-	15-8-00685	1	5	79	G	1	
77/2	MTI/13	3	EA	MEASURING DEVICESCOMPL. 7010-22	2,189.-	15-8-00686	3	4	79	G	3	
77/2	MTI/13.1	3	EA	CLAMPING DEVICES, 7010-01	762.-	15-8-00686	3	4	79	G	3	
77/2	DBR/25.1	1	EA	RD 400 DOUBLE-ACTING ACTUATOR, MAX. CAPACITY 400 kN	11,526.-	15-8-00775	1	6	79	G	1	
77/2	DBR/25.2	2	EA	RD 100 DOUBLE ACTING ACTUATOR MAX. CAPACITY 100 kN	13,411.-	15-8-00775	2	6	79	G	1	
77/2	MTI/11	1	EA	CT-399 ACCELERATED CONCRETE STRENGHT CURING TANK	628.-	15-8-00830	1	6	79	G	1	
77/2	MTI/12	1	EA	TYPE 1601/B2MPU ELECTRONIC THERMOMETER	227.-	15-8-00831	1	4	79	G	1	
77/2	MTI/12.1	1	EA	TYPE 1695 SELECTOR UNIT	358.-	15-8-00831	1	4	79	G	1	
77/2	MTI/5	1	EA	SHAKING SCREEN	6,503.-	15-7-00507	1	10	78	G	1	
77/2	CRI/	1	EA	20 TONS JACK	222.-	15-8-00201	1	10	78	G	1	
77/2	CRI/6	3	EA	PRESSURE GAUGES, METRON, 210,350,700 KG/CM^2	9,757.-	15-8-00201	3	5	79	G	3	
77/2	CRI/6.2	1	EA	TEMPERATURE REGULATOR WITH INDICATOR	608.-	15.7.00506	1	2	78	G	1	
		1	EA	ANEMOMTER			1	11	77	G	1	brought along by Mr. Christenson from Australia
	DBR	1	EA	REX ROTARY SCANNERTREAM CUTTER	2,281.-	LP	1	11	77	G	1	
	DBR	1	EA	IBM TYPEWRITER	990.-	LP	1	12	77	G	1	

HO Ref. Ref.	Item No.	Qty.	Unit	Description
(1)	(2)	(3)	(4)	(5)
77/2	MTI/14	1	EA	VERNIER MICROSCOPE, CO-ORDINATE, WITH 170mm HORIZONTAL AND 100mm VERTICAL SCALE
77/2	CRI/48	2	EA	X-RAY TUBES TYPE PW 2233/20
77/2	DBR/14	1	EA	UNIVERSAL MILL 'ORIGINAL PALLMANN' TYPE PX 315
77/2	14.1	1	EA	PENDULUM BEATERS
77/2	14.2	1	EA	HAMMER RING
77/2	14.3	1	EA	BEATER NOSES
77/2	14.4	1	EA	FAN-SHAPED WHEEL
77/2	14.5	1	EA	TURBO IMPELLER
77/2	14.6	1	EA	FAN-SHAPED IMPELLER
77/2	14.5	1	EA	PIN DISCS
77/2	DBR/18	1	EA	LEITZ-ORTHOPLAN MICROSCOPE
				VEHICLE: TOYOTA CROWN CHASSIS No.: MS 64-004149 ENGINE No.: 2M-754868 REG. No.: B 75780-59
79/1		6	EA	SOIL BLOCK MACHINES
77/2	MTI/	1	EA	SPECIMEN CUTTING MACHINE, SOUTTER 5520

US Dollar Equivalent	P.O./Shipping Advice Ref.	Received			Condition	Stock	Remarks
		Qty.	M	Y			
(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
812.-	15-9-00308	1	1	80	G	1	
4,337.-	15-9-00508	2	9	79	G	2	
5,707.-	15-8-00804	1	8	79	G	1	
1,746.-	15-8-00804	1	8	79	G	1	
2,020.-	15-8-00804	1	8	79	G	1	
1,161.-	15-8-00804	1	8	79	G	1	
2,639.-	15-8-00804	1	8	79	G	1	
2,731.-	15-8-00804	1	8	79	G	1	
2,731.-	15-8-00804	1	8	79	G	1	
3,206.-	15-8-00804	1	8	79	G	1	
9,290.-	15-8-00146	1	6	79	G	1	
on loan	from UNDP JRS	1	6	76	F	1	second hand car
28,800.-	LP	6	12	[illegible]	G	3	a) [illegible]
24,729.-	15-9-[illegible]	1	11	[illegible]	G	1	

HQ Req. Ref.	Item No.	Qty.	Unit	Description
(1)	(2)	(3)	(4)	(5)
77/?	DBR	1	EA	HIOKI 3202 DIGITAL CLAMP TESTER (SER.NO4453)
77/?	DBR??	1	EA	ALNOR JNR VELOMETER (634-111-020)
77/?	DBR?1	1	EA	DCR11 MOISTURE METER COMPLETE (4301)
77/?	DBR?0	1	EA	FLUKE MOD. 2166T THERMOMETER 718018
77/?	CR1 6	1	EA	SOIL SAMPLER, CN 1030
77/?	MT1 8	6	SET	THREE GANG MOULDS
	PM 3	1	EA	UNDERWOOD TYPEWRITER, TYP. 18
	PM 4	1	EA	OLYMPIA TYPEWRITER, TRAVELLER
	PM 5	1	EA	MARTIN YALE REAM CUTTER
				LABORATORY EQUIPMENT:
18/1	5	1	EA	KK333-020 OVEN
	5.1	1	EA	KK266-340 CHAMBER FURNACE
	5.1.1	1	EA	HEATING ELEMENTS FOR FURNACE
	6	1	EA	NO.4610 PARTICLE SIZE DETERMINATION DISTRIBUTION APPARATUS COMPLETE WITH ACCESSORIES
18/1	DBR/1	3	EA	CARBON DIOXIDE ALKALIMETER
"	"	1	EA	WATER, BATH GALLENKAMP
"	DBR/2	2	EA	MOORE-WRIGHT M2025FL1 ELECTRONIC DIGITAL MICROMETERS COMPLETE WITH BATTERY
"	DBR/3	2	EA	75050 HEATING AND DRYING OVENS, COMPLETE
"	DBR/4	1	EA	TEST SCREENING MACHINE JEL 200/00, COMP.
"	DBR/4	1	EA	TC-31 THERMAL CONDUCTIVITY TESTER, COMP. WITH EF-01 ELECTRIC FURNACE AND ACCESOORIES
20/01	1	1	EA	SOIL BLOCK/BRICK PRESS

US Dollar Equivalent	P.O./Shipping Advice Ref.	Received			Condition	Qty. on hand	Remarks
		Qty.	M	Y			
(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
130.-	15-8-00132	1	10	77	G	1	
161.-	15-8-00134	1	10	77	G	1	
399 -	15-9-00135	1	10	77	G	1	
594.-	15-9-00136	1	10	77	G	1	
283.-	15-8-00144	1	11	78	G	1	
1,390.-	15-7-00628	6	2	78	G	6	
65.-	LP	1	9	78	G	1	
70.-	LP	1	9	78	G	1	
1,040.-	LP	1	11	77	G	1	
513.-	15-9-00987	1	9	80	G	1	
3,040.-	15-9-00987	1	9	80	G	1	
463.-	15-9-00987	1	9	80	G	1	
8,489.-	15-9-00987	1	9	80	G	1	
235.-	15-9-01007	3	7	80	G	3	
743.-	15-9-01087	1	7	80	G	1	
610.-	15-9-01088	2	3	80	G	2	
1,260.-	15-9-01089	2	4	80	G	2	
983.-	15-9-01091	1	4	80	G	1	
22,532.-	15-9-01128	1	6	80	G	1	
1,500.-	LP	1	11	80	G	1	MOD. 15-0-4645

HQ Req. Ref.	Item No.	Qty.	Unit	Description	US Dollar Equivalent	P.O./Shipping Advice Ref.	Received			Condition	Qty. on hand	Remarks
							Qty.	M	Y			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
78/1	MTI/1	1	EA	WEMCO RMER JIG, COMPL. WITH TWO MOTORS 380V/50Hz/3ph A.C. AND SET OF SPARE PARTS	20,800.-	15-9-01077	1	10	80	G	1	
78/1	CRI/1	1	EA	DVA STEREOMICROSCOPE COMPL.	3,391.-	15-9-01090	1	10	80	G	1	
78/1	MTI/2	1	EA	TYPE IBM VIBRATING FEEDER compl.	1,667.-	15-9-01092	1	10	80	G	1	
78/1	DBR/1	1	EA	MULTI MAGNE-DRIVE MIXER (NO. 1380-1)	725.-	15-9-01124	1	8	80	G	1	
"	M.4	1	EA	CHEMICAL ADDER WITH HEATERS (1390)	275.-	"	1	8	80	G	1	
"	M.6	1	EA	DITTO, WITH TEST TUBES	250.-	"	1	8	80	G	1	
81/1	DBR28	2	EA	MIXERS *	6,500.-	LP	2	6	81	G	2	MOD. 19-1-4509
	DBR28	5	EA	BLOCK PRESSES *	12,250.-	LP	5	6	81	G	5	- " -
81/3	CRI49	2	EA	EXTRUDERS WITH ENGINE SHORT TYPE *	31,025.-	LP	2	12	81	G	2	MOD. 19-1-4613
	CRI49	8	EA	SCREWPRESS WITH MOULDS *	incl.	LP	8	12	81	G	8	- " -
	DBR29	1	EA	GENERATOR SET *	7.015.-	15-1-0717						
	CRI48	3	EA	SWIRLAMIZER OIL BURNER	148.-	15-9-465	3	7	81	G	3	
	DBR30	500	set	BRICKLAYERS TOOLS(for course particlpants)	15,860.-	LP	500	7	81	G	0	MOD 19-1-4558
	CRI50	1	EA	EXTRUDER SHORT TYPE W/ENGINE *	10,500.-	LP	1	5	82	G	1	MOD 19-1-4656
	DBR31	1	EA	EXTRUDER LONG TYPE W/ENGINE *	12,400.-	LP	1	5	82	G	1	
	CRI	6	EA	SCREW PRESSES + TWO EXTRA MOLDS *	10,946.-	LP	6	5	82	G	6	MOD 19-2-4507

* Production equipment for extension service activities