OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. 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 Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

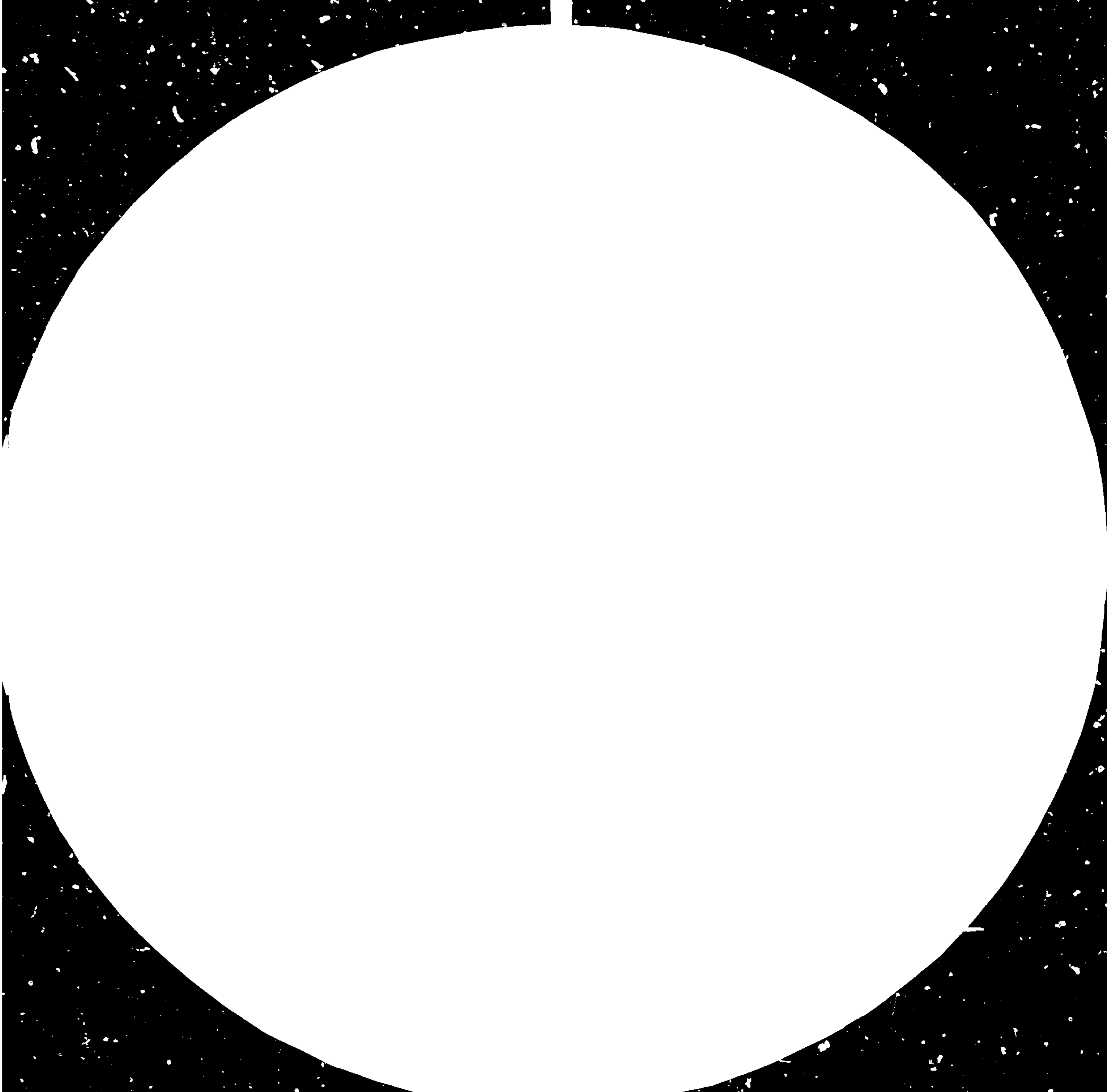
Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

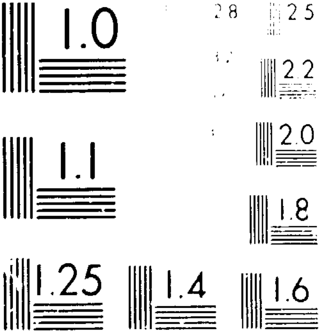
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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




1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

11288

RESTRICTED

DP/ID/SER.A/ ..
10 June 19-1
ENGLISH

IMPROVEMENT OF BUILDING MATERIALS MANUFACTURE

DP/CPR/80/010

CHINA.

Technical report: Cement study tour for the establishment of a cement development centre at Tian Jin*

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

Based on the work of A.M. Afify, expert in cement technology

United Nations Industrial Development Organization
Vienna

*This report has been reproduced without formal editing.

V.81-26277

Explanatory notes

Besides the common abbreviations symbols and terms, the following have been used in this report:

ATC	advanced technology center
cm^2/g	square centimeter per gram
dc	direct current
hp	horsepower
IHI	Ishikawajima Harima Heavy Industries Co. Ltd., Tokyo
ISO	International Standards Organization
KHD	Kloeckner Humboldt Deutz
kW	kilowatt
kWh	kilowatt hour
m^3	cubic meter
PCA	Portland Cement Association
rpm	revolution per minute
SF	flash-furnace suspension pre-heater
sp	suspension pre-heater
t/d	metric ton per day
t/h	metric ton per hour
t/y	metric ton per year
UNIDO	United Nations Industrial Development Organization
UNDP	United Nations Development Programme
ø	diameter

ABSTRACT

As part of the United Nations Development Programme (UNDP) project "Improvement of building materials manufacture" (DP/CPR/80/010) for which the United Nations Industrial Development Organization (UNIDO) is the executing agency, an expert in cement technology accompanied a delegation of Chinese cement experts on a study tour to the Federal Republic of Germany and the United States of America. The expert's mission was later extended to cover visits to selected Chinese cement plants with a view to suggest ways of adapting the findings of the study tour to local conditions.

During the two-month tour the delegation visited 12 cement works, four manufacturers of cement machinery and equipment and three research and development institutes thereby gathering information on the present status and future trend in cement technology, on the latest design of machinery and equipment as well as on the organization and the scope of activities of cement research and development institutes, including the equipment and instrumentation of research laboratories. This information was of great value in elaborating detailed proposals for the establishment of a cement development centre which is under construction at Tian Jin.

In addition to an account of the findings of the study tour on such issues as transfer of technology, energy conservation, automation, marketing etc., the report contains suggestions for the organization of the future centre, its manpower requirements, an assessment of training possibilities for the future staff as well as an exhaustive list of proposed laboratory equipment. The expert finally prepared a draft project proposal for further UNDP/UNIDO assistance.

CONTENTS

INTRODUCTION

Cement industry in China had started in 1889 when the first shaft kiln was installed in Tan San, and the first rotary kiln was erected in 1906 in Tan San Cement Plant with an installed capacity of 40000 t/y. After the liberation in 1949 the total cement production came to 660000 t/y. Abundant extensions were executed until the production came to 73.8 million t/y in 1979, produced by 3400 cement works, from which the large and medium cement plants were 49 factories producing 24.7 million t/y by 135 rotary kilns, operated by the following processes :-

- 62.56 % by Wet process with average calorific consumption 1503.5 Kcal/Kg. Clinker.
- 20.80 % by Lepol semi-wet process calorific consumption 1205.8 Kcal/Kg Clinker.
- 16.64 % by long dry process kilns with waste heat boilers : 1506.7 Kcal/Kg clinker.

A variety of cement types is produced to the following proportions :

49.98 %	Normal Portland Cement	91.38 %
41.40 %	Blast Furnace Cement	
3.49 %	Rapid hardening	8.62 %
1.50 %	Pozzolanic	
1.9 %	Oil well	
0.83 %	Low heat	
0.17 %	White	
0.71 %	Others.	

The large and medium scale cement plants are normally supplying cement to big projects as in main constructions, marine civil work, and development of main cities, whereas the small scale plants are vastly distributed for coping with cement demands over vast areas with economy in transport expenditure. This small scale production is generally utilized for local consumption, especially for agricultural and industrial development. Small scale cement plants require modest investments and comparatively short execution time. On the other hand they face several problems such as : long distances from raw materials resources, the heterogenity of clinker quality, and increased cost price. The first development objective would be to secure economic raw materials resources and to improve the process technology and plant management. Another main objective would be to reduce the evidently high calorific consumption. With the dry process works suspension preheaters were erected but still with excessive calorific consumption: mainly due to high exhaust gas temperature. Moreover the exhaust gases are not utilized for drying of raw materials but dryers are functioning in conjunction with supplementary heat generation. To this respect it is hoped to introduce secondary burning in precalciners to reduce the energy consumption to a considerable extent, and to utilize low grade materials such as lignite and waste combustibles by development of effective ways to invest these materials.

In order to achieve ambitious goals in amelioration of cement technology, a Development Center is being established in Tian Jin, expected start up in 1982. In the course of preparation of key staff for this center, a two months study tour to several modern cement works, was organized and cement machines suppliers, and development institutes in the field of cement technology were visited in USA and FRG, in order to allow the participants to familiarize themselves with the present status and development trends of the cement industry and the related research in the countries visited.

The study tour has been organized by UNDP/UNIDO, whereby the writer has accompanied a team of four Chinese leading personnel in the field of Cement Industry through the post DP/CPR/80/010/11-01/32.1.B. The expert has been specifically expected to:

- Advise the participants on the information received and observations made in order to maximize the benefits derived from the visits and to facilitate the integration of the aquired know-how into the context of the Chinese situation.
- Advise in general terms on the practical and administrative aspects of the establishment of a cement Research & Development Center.

I. FINDINGS AND CONCLUSIONS

OBJECTIVES AND OUTCOMES OF STUDY TOUR

The study tour was organized for the duration of 2 months for visits to establishments concerned with cement production, supply of cement making machinery, and cement research & development in USA & FRG. For accomplishment of the study tour, a group of 4 Chinese participants were delegated :

- Mr. Zhang Pei : Chairman of Council for Techno-Economic Society of Building Materials Industry.
- Mr. Li Tao-Ping: Director of Cement Development Center of China.
- Mr. Zhu Zu-Pei : Chief Eng. Of Cement Development Center of China.
- Mr. Gao Chang-Ming: Eng. in Charge of Raw Materials Dept. of Cement Dev. Center.

The main objectives of the study tour have been to familiarize participants with present status and development trends of cement industry, study the organization and activities of cement development institutes and their role in service of the manufacturing sector, raw materials investigations, application of low grade materials and industrial products in the industrial process.

For achievement of the said activities: 12 cement plants were visited: 7 in USA, Tijeras, New Mexico - Knoxville, Tennessee - Theodore, Alabama : all 3 belonging to Ideal Basic Industries- Ragland, Alabama: National Cement Co. - Balcones, Brannfels, Texas : General Portland Incorporation - Permanente, California : Kaiser Cement Co. - Davenport, Santa Cruz, California and 5 cement works in FRG : Fortuna, Geseke - Readymix, Beckum - Dyckerhoff Zementwerke, Mark II, Beckum - Dyckerhoff Zementwerke, Amoeneburg, Wiesbaden, Alsen Breitenburg, Lagerdorf, Hamburg. A summary of findings and observations from the said plant visits are exposed in annex III. The practice of various types of technologies were wittnessed in the said works especially the points of special interest:-

- Processing raw materials with excessive moisture or alkali chloride, synchronization of raw materials stacking & reclaiming by echo-lot system, prehomogenization by blending bed.

- Storage belt for raw materials securing regular feed, combined raw materials grinding by aerofall mill operated in conjunction with conventional tube mill for secondary grinding, acoustic device at mill shell determining set point for the feeding system.
- Various batch & continuous homogenization systems reducing chemical fluctuations by 15:1 in terms of standard deviation.
- Modernization involving raise of production capacity and reduction of specific calorific consumption, upgrading plant economics through introduction of a second string of pyroclon system, execution of civil and erection work without disturbing the functioning production line. Application of low grade combustibles, motor tyres and inflammable waste materials.
- Application of a variable bypass system to increase the ore to waste ratio, while still maintain low alkali content.
- Modern system for scanning the kiln shell temperature and graphic display on the central control panel, with the possibility for exposure of the whole shell circumference whenever required.

- Computer control on cement bulk despatch with self service system, magnetic card being processed by computer for billing the despatched cement. Loading cement bags with pneumatic stacking system on transport means.
- Process & operation control by digital computer system operated with a light pen & typewriter terminal, anlogue system for manual operation. TV closed circuit with cameras that can be focused at points of special importance.

Four machine suppliers were visited : 2 in USA : Fuller Co., Bethlehem-Allis Chalmers, Milwaukee and 2 in FRG; Humboldt Wedag, Cologne - and Krupp Polysius AG, Neubeckum, whereby philosophy was indicated:

- Trends in design to overcome industrial problems.
- Research work for modernization of industrial proceedings & rationalization of operational processes.
- Raw materials investigations revealing particular characteristics, enabling appropriate process determination, machines selection and detailed design.

- Clarification of basic principles for particular specilizations, recent innovations, and design development.
- Flash furnace suspension preheater, its virtues in raising production & reduction of specific heat consumption, application of low grade combustibles, pyroclone technology.
- Bypass system and its role in application of low grade raw materials.
- Modern concepts of clinker cooling, latest development in clinker coolers, regulating speed of grates with pressure, automatic dust disposal through air proof chutes.
- Modern facilities for research & development : chemical investigations, physical tests, microstructural & mineralogic analysis, pilot tests.

Four establishments concerned with study and development : in USA: Portland Cement Association, Skokie, Illinois - National Ash Association, Washington DC : were visited, in FRG: Zemlabor, Beckum, was visited. Technologic facilities devoted to scientific studies, research work on Portland Cement, Concrete, Technical services to promote materials quality, industrial safety, environmental control. The following aspects were of special interest:

- Up-to-date research equipment, their application, adaption to solve eventual problems.
- Informations assessing for energy conservation in the industrial field and in constructional design.
- Utilization of some industrial by-products for production of mixed cements.
- Organizational structure, ample personnel for conducting routine tests and research & development work.
- Liaision with cement producing units, adaption of research work for trouble shooting in existing works and planning for new projects.
- Educational facilities for programmes covering manufacturing process, management, maintenance.

Through the said tour, useful information was procured, practical operation and actual results were witnessed, research and development substantials were exposed. Discussions were held around industrial bottlenecks, procedures for scientific approach, with special reference to specific cases from the Chinese cement industry.

- Data were consulted for verification of handled information. Particulars were discussed with experts concerned to clarify principles & understandings,
- Research and development proceedings were illustrated by practical examples to assess results and to conclude principles. Relations with cement producers and machine suppliers were analysed, and general features for proceeding with new projects were approached.
- Organizational aspects were discussed in detail in both cases of Portland Cement Association in USA, and Central Laboratory of Dyckerhoff group in FRG. The Organization of personnel was indicated and duties and responsibilities were clarified.

The information procured during the study tour could be a guiding aid for development of the set up for the Cement Development Center of China, and useful basis for selection of equipment to be supplied to the center.

GENERAL REMARKS ON CEMENT INDUSTRY

One of the most important objectives for the study tour is the study of the general trends of cement industry in USA & FRG, and concluding in which way the industry in PRC would benefit of the said experience for appropriate amelioration and development. It would therefore be advantageous to sum up the findings from plant visits, trends of manufacturing and marketing, activities of machine suppliers, conclusions of research work of Portland Cement Association, experience of the National Ash Association, so as to extract the general philosophy of the whole trend, and to be able to judge what would match the Chinese industrial conditions.

Cement Industry in USA and FRG

The observations from the study tour have to be taken with extreme care. Some trends may be attributed to special conditions that encounter cement manufacture and utilization in a specific area, but still they may be taken as examples for response to national and international demands.

- <u>Flash furnace suspension preheater</u> :

The revolutionary trend in cement manufacture is the introduction of the fully efficient precalciner. The fuel consumption reaches an average of 40 % calorific economy. Meanwhile the adoption of dry pro ess SP system involves an increase of about 10 % for a portion comprising about 20 % of the total plant electrical energy requirement. The net result would be an over-all energy reduction of around 30 % . In the flash furnace it became a practicable experience to use low grade combustibles such as lignite. Even waste material can successfully be ignited such as motor tyres and inflammable waste materials. The reduced combustion in the calcination zone reduces the air requirement and consequently the volatilized alkalies and chlorides are carried along with a smaller amount of air, and the bypass system so becomes more practicable with better economics. The application of lower grade raw materials became possible, and qualities now used in the production process could have not been applied before with the traditional suspension preheater. Furthermore, the calcination up to 90 % in the precalciner reduces the role of the kiln to sintering covered by only 40% of combustion requirements. This secures mild heat leading to longer life for refractory lining, and more regular performance yielding better clinker quality.

- Alkali bypass system :

Renders appropriate solution to many problems in the dry process suspension preheater technology. Chlorides are nearly all volatilized by the sintering temperature, carried by the air draft to the upper part of the rotary kiln whereby the bypassed proportion is air quenched to pass into the solid form whereby it is discarded with the bypass dust. This eliminates the blockage of the preheater cyclones by chloride condensates.

The alkali bypass also removes a considerable percentage of alkalis carried by hot gases before they pass through the preheater. This avoids alkali occurence in the clinker and promotes the production of low alkali cement. This represents a special importance when the alkali content in clinker should be lower than 0.6 % to avoid dangers of alkali reactions with alkali reactive aggregates.

- Changing to Coal firing :

The cement plants in USA & FRG were originally coal fired. During the last half century, the kiln firing systems were converted to oil and gas firing which is known for easier and cleaner operation.

As a consequence of the great progressive inflation in oil prices since 1973: The combustion is greatly switched back to coal firing. Although the price of coal has been appreciably increasing, yet the policy has been to the line of coal application, being a combustible which is freely available apart of political susceptibilities. The converted combustion to coal firing has now attained 87 % of the total fuel used in cement industry. This attitude is continuously progressing, and it is planned that by the end of this year nearly 90 % of the plants will be coal operated. Provisions for oil or gas application will be restricted to emergency cases.

- Modernization of cement industry :

Mostly involves conversion from wet to dry process or to semi-wet in cases of excessively humid and sticky raw materials which necessitate wet raw mix preparation. Another important modernization is achieved through introduction of a flash furnace precalciner for promotion of energy economics and increasing the production capacity. When the modernization involves conversion of wet to dry process, the total water requirement is reduced by 65 % . The rest will be maintained for make up water for industrial purposes and provisions for fire protection. The conversion from wet to dry process has been depending on prevailing conditions of fuel and labour availability. When comparing these parameters in USA and Europe it is noticed that in the former case the conversion is much slower and considerable number of plants are still operated by the wet process, whereas in Europe the problem of availability of fuel and labour are more acute and therefore the conversion to dry process has been much more advanced. In FRG the number of plants still operated by the wet process is neglegible.

Cement plants modernization depends upon results of detailed feasibility studies. The first approach may indicate remarkable economy in energy consumption and appreciable increase in production capacity that may justify the high investments for conversion of an old wet process kiln to dry process with flash furnace precalciner. However in several cases it was found the most feasible to instal a completely new production line with an economically large size to replace entirely the old group of small size lines. In USA, it was seen unprofitable to spend much on projects involving life extension for extremely old machinery. The new investment was found to be so high compared with the value of the original units that the effort and financing of conversion would better be extended for construction of an entirely new plant with modern technology. In FRG the philosophy is different: The cement demand is lower than the production capacity. The severe competition led to construction of new production lines on modern lines of rationalized economy. The competing cement cost price has been in favour of completely abandonning the old wet process lines. The total number of wet process kilns is therefore progressively diminishing, being substituted by large scale dry units with flash furnace precalciners.

- Marketing aspects :

Cement distribution over vast areas is remarkable in USA. Due to the intensive cost of transport in comparison with the industrial cost price per ton, further existence of a considerable number of small scale plants is justified, where cement works are covering a comparatively limited area. The construction of large scale plants is subject to an extensive study for site location. It is the normal practice to locate the plant in a strategic distribution center, well established with economic means of marine or river transport. The last statistics in USA indicated that 84 % of total cement movement is achieved over distances less than 200 miles, and 50 % is shipped over less than 90 miles. Cement bulk despatch has increased up to 95 % of total requirements and only 5 % is packed in paper bags confined to small constructional maintenance work. Bulk cement despatch is still increasing with the progressive development of ready mix concrete.

- Energy Conservation :

Cement manufacture is one of the highest energy intensive industries. Energy accounts for about 50 % of direct cost price. Since the start of the energy crisis in November 1973, an evident response has been achieved for energy conservation in all phases of the industrial process from raw materials up to the final product. The general trend in modern cement plant construction is economically oriented, aiming at the reduction of energy consumption as far as possible. Among the endeavours in this direction are the following :-

- General trend towards large plants with economical size, with appropriate choice of site location in an economic distribution center, mostly adopting navigational means justifying transport over large distribution areas.
- Transport of raw materials by rubber belt conveyors known for extremely low energy consumption. Transport by trucks, being an intensive fuel consumer is reduced to a minimum.
- Appropriate selection of raw mix components with easiest crushability and grindability, and proper proportioning of raw mix with adequate proven moduli leading to easiest burnability, adjustment of burning conditions to produce uniform clinker with rationalized final grinding.
- Promotion of roller mill technology which could be an aid for energy conservation especially in cases of raw materials with comparatively high moisture content without having to apply a seperate dryer.
- Direction of kiln installation to dry process with flash furnace precalciner known to be most economic energy consumer. The modernization by conversion from wet to dry process, and introduction of preheater precalciner is justified by appreciable savings

in calorific consumption. The application of bypass system made it possible to use raw materials with alkali & chloride content which did not allow for adoption of dry process suspension preheater. The application of hot gases from the clinker cooler for flash precalciners contribute to energy conservation to a considerable extent.

- The modern design of storage and preblending of raw materials, the efficient homogenization reducing chemical deviations in raw mix composition enable easier kiln operation with more regular clinker texture and consequently better grindability, equipping the ball mill with well designed classifying lining plates, tend to spare final grinding electrical energy.
- Efficient dust collection systems contribute to better environmental pollution control. Meanwhile the retained dust being recirculated represents a high quality fraction which has already invested a considerable amount of energy.
- The advance in bulk cement technology realizes appreciable economy in despatch and application of paper bags, being the product of another energy consumer industry.

- The increasing production and utilization of blended cements is one of the most effective means for energy conservation. The mixing material requires no burning and would only need the electrical energy for final grinding. There is a recent trend to increase considerably the proportion of blended cements, especially with natural or artificial pozzalanic materials as admixtures.

- Project Design :

In recently executed projects it has been noticed that the turn key basis is avoided to eliminate restrictions to specific suppliers. Best reputed and well proven systems are selected among international sources. Elaborate engineering work is achieved to combine various supplies in a well harmonized set up, so that advantages are taken out of specialized achievements.

- Automation & Control :

The vast advance in central control, electrical interlockings, and computer displays are demonstrating a general feature of industrial development, especially in USA where a remarkable advance is achieved in the field of electronics. Quality control is followed up through automatic sampling, x-ray analysis, whereby raw mix proportioning, fine adjustments, and precise process control are instantaneously achieved through computerized action, inducing graphic displays, complex process loop control, and recorded outprints of current incidents for further reference. The motors control center is monitored by computer interlinking with sophisticated interlockings maintaining industrial security aspects. However, in spite of all facilities for maintenance and repairs by highly specialized and well trained electronic engineers, easily and quickly called at any time, yet provisions are made for back-up systems, stand-by computers and analog output stations are foreseen to maintain important operations and keep up uninterrupted production in case of computer failure. This requires a great deal of experience in avoiding damage to machinery and equipment.

Cement industry in PRC:

One of the main objectives of the study tour is to detect how to transfer modern technology to the Chinese cement industry in the present development phase. The abovementioned aspects have to be scrutinized to conclude suitability of adaption to the Chinese industrial conditions whenever feasible. For this purpose : samples of the Chinese cement works were visited, and the matter was discussed with Chinese experts in charge in the Ministry of Building Materials Industries. The main features are described in the following:-

- Raw materials resources :

Limestone and clay are the main raw mix components. Limestone is abundantly occuring, but the calcareous deposits were formed during several geological phases over extensive areas. This explains the varying nature of the limestone deposits. Thorough investigations are therefore required to disclose the chemical composition and physical properties of various deposits. This question may be the subject of first study to be tackled by the Department of Raw Materials Development after the start up of activities of the Cement Development Center. The study will serve the dual purpose of support for the existing cement works and raw materials investigations for new cement projects. Geological prospection will reveal the nature of various strata through well planned network of drill holes. Samples from the said drill holes will be subject of chemical analysis, physical tests, and instrumental investigations.

Another important scope of research would be to utilize low grade raw materials and by-products from other industries.

- <u>The industrial process</u> :

The major part of the present cement industry in PRC is based upon shaft kiln technology and wet process rotary kilns. One of the important means for development of the existing cement production would be the conversion of some wet production lines to the dry process technology and introduction of flash furnace suspension preheaters for the sake of increased production and reduced energy consumption. But this direction has to be very carefully studied, taking in consideration the high capital costs to be invested for old machinery with various aging inconveniences and doubtful life, the limited capacities for the supporting machinery for preparation of raw mix and final product, and most complicated would be the size of clinker cooler and its suitability for hot air supply to a flash furnace precalciner. One of the factors may be the procedure for execution of the conversion, considering the down time for accomplishment of the required modifications. Every particular case would need a special study for the specific conditions, whereby the techno-economic substantials would determine the feasibility of conversion. Generally speaking it may prove to be the most advantageous to plan for installation of completely new production lines, with entirely promoted industrial conditions especially caring for energy conservation concepts and environmental protection precautions. The old production units may then be allowed to carry on with their role in production with any suitable ameliorations that may free them from any occasional difficulties and therefore promote their capacity for continued production.

- Plant size and site :

In the course of planning for installation of new plants ample attention should be given to the determination of the economic plant size. The economic concepts would go for bigger production units to attain an optimum of capital investment and production cost per ton of final product. In PRC there would be no limiting factors from the marketing viewpoint in virtue of bright prospects for future cement demands to cope with the long term development plan. On the other hand the extremely large units create difficulties in machines manufacture & in process operation. Here examples may be demonstrated by inconveniences in refractory lining for big kiln diameters, complications in drives and gears of large mills, plus many difficulties with materials to be applied for manufacture of machinery to resist especially advanced stresses. The most remarkable operational disturbance is the excessive cement temperature which creates complicated problems with cement quality and flowability due to partial dehydration of gypsum even with the most advanced cement coolers. Consequently it has been foreseen that rotary kilns for the new large size plants would be of 2000-4000 t/d production capacity. The plant site will then have to be adequately selected in a strategic distribution location well suited with economic means of transport. Meanwhile special consideration will still be devoted to distant land-locked areas where medium or small scale plants will have to be installed to cope with reasonable distribution areas.

- Machinery & Equipment :

Traditional cement machinery and equipment are manufactured in PRC in central workshops and considerable amounts of spare parts are produced in the works workshops. To cope with modern trends in cement machinery design there is a general plan for creating specialized workshops for rationalization of machine production. There are various designing fields that will have to be subject of prior efforts for future promotion, especially in the fields of power consumption, efficiency of homogenization, accuracy of weigh feeding, intensity of dust collection....etc. For designing new cement plants, a reasonable level of automation and control has to be adopted. It would be more feasible if this is confined only to parameters extremely necessary for protection against undesirable abnormalities and rationalization of process operation. All sophisticated loops should be avoided to elininate complication sources, maintenance difficulties, and failure risks. The automation and control installation have to be absolutely restricted to systems that can easily be handled by local experts, highly specialized and adequately trained in the specific field. Even in USA, with all facilities for procurement of expertise and spare parts from suppliers within short elapse of time, yet a newly designed modern control system is normally safeguarded by standby installation. Furthermore provision is made for a back up system for manual operation of important process stages. This high expenditure for financing stand-by installation and back-up system as precautional measures against failure of the original control device, would indicate the evident probabilities for failure and risk.

TRAINING POSSIBILITIES

The training possibilities were detected in every firm visited. In general, it was emphazised that future cooperation in this respect will be most willingly considered as soon as the official approach is initiated. Training would be more fruitful in USA in virtue of language facilities, resemblance in wide area distribution and abundance of wet process plants.

For fellowships in process and operation: the most practicable would be through "Kaiser Engineers" that may organize training programmes in one or more of cement works belonging to Kaiser Cement Co.

For fellowships related to process & machine design one of the machine suppliers : Fuller Co., Bethlehem, Pennsylvania, or Allis Chalmers Co., Milwaukee, Wisconsin.

Special interest and evident willingliness for availing training facilities were expressed by leading personnel from the abovementioned firms. Samples of actual training cases were exemplified for future consideration.

For research and development studies the most appropriate training would be in a development association well equipped with research facilities. The most remarkable training possibilities for the purpose are availed by the "Portland Cement Association". Especially designed training programmes are conducted, but devoted only to candidates from the member firms of the association. However it was emphasized that coping with UNIDO assistance, an approach in this respect will be handled as a special case which will be tackled with utmost goodwill. Regular training programmes are held in diversified fields including : Manufacturing process, Microscopy of clinker & cement, Plant maintenance systems, Fundamentals of placing and finishing concrete, Training of trainers, Sales and management, Supervisory and financial transactions....

Field training programmes are also organized by the "Educational Services Department" within the scope of special agreements.

ORGANIZATION SCHEME

The Chinese concepts for organizational parameters of the Cement Development Center were discussed to figure out a comprehensive organigram for the anticipated staff. This is of special importance as a starting point for planned recruitment of personnel with a foreseen level of qualification and experience. It would accordingly be a guide for establishment of a training plan, in terms of study tours, fellowship programme for training abroad, as well as local on-the-job training. Naturally the training programme should conform with the timing concluded for procurement of research installation in accordance with anticipated activities and available financing possibilities. The general outline of the concluded organigram is illustrated in annex VIII, and a job description should follow with adequate particulars about duties and responsibilities for each post.

The Research & Development Center will be headed by the General Director who will plan for the general policy and manage the main activities through high responsibles. The activities will be covered by 7 departments : 6 of them are technical to be monitored by the Chief Engineer of Research & Development, and one department taking care of financial and administrative affairs, the manager of which, together with the said chief engineer will be directly attached to the General Director. The 7 departments are :

1. Department for raw materials: comprising 15 members headed by a manager who will supervise 2 sections : one of them composed of 7 persons concerned with quarries and geological affairs: A geologist to establish prospection plans and follow up execution through 2 assistants who will be involved directly in prospection fields, sampling and reporting to the geologist. A group of 4 well experienced cement chemists who will assess the results of chemical analysis and physical tests, evaluate the findings and recommend adequate raw mix design, adapt and follow up the findings and quarrying schemes proposed by the geologist. One of them will act as chief for the section and 3 will mostly be visiting raw material sites for follow up procedure. The other section, composed of 8 persons : one chief & 3 acting

Chemists & 4 assistant chemists will take care of small scale pilot tests, covering comminution and pyroprocessing parameters up to production of laboratory clinker samples for further investigations. They will also cover the trouble shooting in the existing quarrying processes and perform adequate investigations which they may deem necessary for conclusion of adequate solutions for occasional problems.

2. Department for chemical analysis & Physical tests: This department represents the main laboratory work differentiated into 3 main sections :

a) Section for chemical analysis which will adopt the traditional wet analysis procedures. It will mainly be equipped for analysis of materials involved in cement industry as from raw materials up to final products comprising various types of cement. Provision will be made for equalitative identification and quantitative determination of unknown elements and compounds occasionally encountered in the course of raw materials exploration. Special analysis will be performed for calibration of electronic installation and designation of standard samples. This section will be composed of 2 chemists, well prepared to assess analytical problems and find out appropriate solutions.

b) Section of instrumental analysis :
based upon application of modern equipment for rapid determination of elements and compounds. The investigations will be performed by well qualified chemists, capable to operate modern equipment of x-ray fluorescence, atomic absorption, microscopy, photometry, determination of minor constitutents as alkalies, chlorides, sulphur, phosphorous by modern rapid determination procedures. This section is expected to have up to 8 chemists who will be subject to intensive training whether abroad in well distinguished modern laboratories or on the job by specialists of suppliers and short term international experts.

c) Section for physical tests :
Destined to perform investigations upon cement mortar and concrete in accordance with standard specifications with adequate regard to local code of practice. This section would be composed of a well qualified chemist who will act as chief & 2 laborants to be well trained for the purpose.

3. Department for technological studies :

This department is supposed to comprise up to 14 highly qualified well experienced experts, with a relevant background know how in the field of cement process technology and plant design. One of them is supposed to manage the department, 5 to be concerned with pyroprocessing studies, 4 to tackle research and development work in the field of comminution, and 4 to compose the section for design work of conveying installation and storage questions. Procurement of the said experts should be based upon the present capacities in cement research and design. It is worth mentioning in this respect that there are already about 500 engineers involved with advanced cement technology in the Design Institute for Cement Industry in Tien-Jin. About 50 of these experts are presently dealing with research work related to cement technology, 135 engineers specialized in mechanical design of cement making machinery. The rest are cement technology engineers in various other specializations such as civil construction, water supply, ventilation, electrical engineering ...etc., with various capabilities which can be coordinated for full design particulars of complete projects. This Institute was in possession of a pilot plant at the previous location at Beijing. The nucleus for this section to be carefully selected among the said engineers should be delegated to machine designers or well distinguished cement consultants for adequate fellowship programs.

4. Department for automation :
This department will be composed of 13 highly qualified, well experienced electrical engineers, with special skill in electronic fields to compose 3 sections : Section for monitoring electrical drives and inter-locking the power distribution to be composed of 3 engineers, section for instrumentation and control based upon 4 engineers covering the study, calib- n and design of works instruments and automatic control loops, and 5 to compose a section for computer technology starting from primary maintenance up to sophisticated designs with light pen and graphic displays. It is to be taken into consideration that there are already 3 well sized cement plants, of 1 million tons each, under construction with sophisticated interlockings, automatic loops, and computer control : 2 plants being supplied by the Japanese firm " Mitsubishi" with electronic supplies from "Toshiba";

and the third plant is being supplied by the Romanian enterprise " Usine Import Export " with electronic equipment produced in Bucharest under licence in cooperation with various Japanese firms. It would therefore be extremely beneficial to anticipate intensive training for the engineers of this department in the said firms for adequate elapse of time, probably much more than the contractual training specified within the supply agreement.

5. Department for development research :
This department is supposed to comprise 6 engineers with relevant experience in cement industry and an adequate background of economical knowledge. Two of them will draw up feasibility studies including techno-economic concepts. Members of the feasibility studies section should be capable to prepare the marketing basis in terms of areas of distribution and magnitude of demand which will contribute to selection of site location and plant size determination. The raw materials investigations reported by the first department will compose the base for decision concerning the choice of technological process. The techno-economic conclusions will act as guidance for selection of machinery types.

The second section will be composed of 3 engineers with a high capacity for planning to lay out and follow up the research and development schemes. They will develop schedules for long term research and arrange for short term studies. They will schedule the training particulars leading to a continuous promotion for local skills. They will establish a permanent system for follow up proceedings. Furthermore, this section will perform continuous efforts for exchange of technical information and promotion of international contacts for cooperation in the fields of industrial development.

6. Department for pilot studies :

This department will be responsible for pilot plant affairs starting from machinery design, supply, erection, and operation for conclusion of adequate solutions for occasional problems. The pilot plant has no limited scope but depends upon special design in accordance with the specific question to be tackled. Normally it would necessitate an intensive capital investment open to various forecasting possibilities. Hence it would be foreseen for later stages of execution.

This department will be composed of 10 persons covering activities of 2 sections : 2 engineers + 4 technicians to perform pilot tests, and 3 for repairs and maintenance of the pilot plant equipment. This group will be composed of a mechanic capable of electrical & oxy-acetylene welding, and an electrician with some knowledge about basic preventive maintenance for instrumentation. This group will be able to make simple spare parts made of sheet metal.

7. Department for financial and administrative services: This department will comprise 5 officials : the manager for the department & an accountant to deal with all financial affairs & a storekeeper who will take care of stock keeping as well as purchase questions, and 2 officers for settlement of personnel affairs including attendance, leaves, insurance, medical treatment ....etc.

The total number of full scale would therefore be 80 persons. The research and development center would be mainly concerned with questions concerning the large and medium scale cement plants.

UNIDO/UNDP ASSISTANCE

Cement industry has realized a remarkable expansion to cope with the rapid development. The major part of cement is produced by small scale cement plants with shaft kilns and wet process rotary kilns. The present cement industry needs a lot of efforts to overcome difficulties being encountered with raw materials heterogenity, high energy consumption and distinct environmental nuissance. The national development plan requires appreciable expansion of cement industry in the form of ameliorations and extensions for the present plants as well as installation of new cement projects in line with modern techno-economic concepts.

As a consequence of the great interest of the Government of PRC to promote the cement industry, the Cement Development Center is being constructed to support to development of cement industry.

UNIDO/UNDP assistance is required for starting up the center's activities and supporting its performance in approaching the ambitions targets.

Based upon the experience gained from the cement study tour, and considering the actual requirements for proper functioning of the Cement Development Center, a draft project proposal is drawn up in annex X for assistance during the first 4 years of operation (1982-1985). The project proposal comprises the most important assistance components :-

- International expertise in the form of short term consultancy covering the following disciplines :-
  - 11.01 : Technical advice.
  - 11.02 : Testing & evaluation of raw materials.
  - 11.03 : Laboratory tests
  - 11.04 : Raw mix design & pilot tests
  - 11.05 : Process Design.
  - 11.06 : Equipment selection.
  - 11.07 : Machine design.
  - 11.08 : Instrumentation & Control.
  - 11.09 : Computer science & technology.

- Training in the form of fellowship programmes for national specialists, study tours for key personnel of the cement industry, and in-service training for adaption of recent technology to Chinese working conditions. The proposed fellowships cover the following fields:-

  31.01 : Laboratory research.
  31.02 : Application of low grade materials.
  31.03 : Application of fly ash.
  31.04 : Preblending of raw materials.
  31.05 : Roller mill technology.
  31.06 : Preheater and precalciner.
  31.07 : Dust collection.
  31108 : Conveyors and cement despatch.
  31.09 : Automation and control.
  31.10 : Feasibility studies.

- Supply of a language laboratory to increase foreign language skills of nationals enabling them to benefit maximally of the above-mentioned training. Supply of research equipment with special modern scientific features where the international practice is highly appreciated.

II. RECOMMENDATIONS

On the basis of abovementioned informations, the following measures are recommended :-

UNIDO/UNDP Assistance

For starting up of the Cement Development Center of China with appropriate set up and rationalized activities, it is highly recommended that UNIDO/UNDP assistance would be extended in accordance with the project proposal detailed in Appendix 5.11 comprising :

- International expertise in the form of short term consultancy.
- Training to be achieved in the form of fellowship programmes for national technical personnel in various fields of industrial technology, study tours for key personnel to keep in touch with foreign technologies and international firms, and in service training for language and professional studies.
- Supply of research equipment having advanced technological features.

The said project proposal is drawn up for the period of 4 years 1982-1985, before the end of which the situation may be reviewed for conclusion of further action to be taken in this concern.

Training

To meet with the planned activities of the Cement Development Center in the field of research and support to cement industry, and as a pre-requisite for the anticipated development for the forthcomming phase in line with modern trends of industrial technology, training is of top importance and close necessity. National experts should be sent abroad to live in the industrial works, to get acquainted with philosophy of machine suppliers, and witness research work achieved by development associations, so as to follow up international industrial development, trace the latest achievements in process and design technology, and transfer all possible know-how to the Chinese practice.

This should be supported by study tours to see the implementation of modernization and practical advantages thereof. In-service training is of special importance for adaption of modern technology to the Chinese working conditions. All abovementioned activities are included in a comprehensive programme detailed in aforementioned project proposal for UNIDO/UNDP assistance.

Language Studies

It is essential to master a foreign language in order to establish the necessary link with the international technology through training procedures, technical publications, and scientific journals. It would be advisable to start with English language as numerous nationals have already some basic knowledge. This sort of preparatory language education is foreseen as one of the local activities covered by the project proposal.

Raw materials studies

Should be adequately performed for providing supporting information for the existing plants. Moreover full surveys are required in various locations to be clarified through geological investigations, chemical analysis , and physical tests to avail comprehensive basis for feasibility studies for establishment of new projects.

Process Conversion

It should be profitable if some wet process production lines would be converted to dry process technology with flash furnace precalciners in order to raise production capacity and economize heat energy consumption. However a careful study has to scrutinize every particular case to conclude the suitability based upon techno-economic factors. In general it would be the most advantageous to design completely new plants based upon well prepared feasibility studies, adopting the most recent concepts for energy conservation and environmental protection. The old works will have to be assisted to overcome eventual problems, to carry on with their role in production.

Plant Size

The modern economical considerations are in favour of larger production units for the sake of lowest capital investment and production cost per ton of cement. However various difficulties are practiced with units of excessive size. The expert shares the recommendation already concluded to go for kiln sizes of 2000-4000 t/d. The project location will be subject to a close feasibility study to determine the well suited distribution center with economic means of transport, taking into consideration the economics of raw materials transport. In distant land locked areas: medium and small scale plants will have to be considered.

Local machine manufacture

For rationalized local machine manufacture: specific specialization would promote continuous progress of machine components in terms of design particulars and material composition. Some design criteria have to profit of up-to-date achievements for advanced industrial technologies, especially in the field of power consumption, efficiency of homogenization, accuracy of weigh feeding, and intensity of dust collection.

Energy Conservation

While planning for new cement projects, and whenever feasible in the course of amelioration of the existing cement plants, aspects of energy conservation should be adequately considered. Points of special importance should be taken into consideration whenever possible such as :

Transport of raw materials by rubber belt conveyors, appropriate proportioning of raw mix components with industrially proven moduli, adjustment of burning conditions, rationalization of grinding parameters, adoption of dry process with flash furnace precalciners, adequate preblending of raw materials and homogenization of raw mix, efficient dust collection & recirculation, promotion of bulk cement despatch, increasing production of blended cements. Other minor factors would also be considered.

Blended Cements

The production of blended cements should be highly promoted. Thorough investigations are to be performed upon various mixing materials originating from natural or artificial pozzolanas. The development may be extended to production of mixed cements with inert mixing materials that have to be properly selected to have hard grain texture so as to act as grinding media for disintegration of clinker particles in the final grinding. The production of blended cements involves the application of national resources to increase appreciably cement production capacity just by utilization of extra cement grinding capacity, but with the same clinker producing installation. This is a well distinguished means for energy conservation, as it involves the utilization of mixing materials which need no pyroprocessing and would therefore consume no energy in this phase.

Environmental Protection

Should be adequately planned. New projects located out of the city skirts will be approached by housing and agricultural activities. The present environmental tolerance will be reconsidered in the near future with the growing community demands. The recovery of dust represents winnings which may pay for environmental protection installation in the long run.

Automation and control

Should be tackled with extreme caution to introduce the extent suiting the general conditions in PRC. It would be most feasible to allow for the automation and control absolutely necessary for protection of installation against abnormal operational particulars and rationalization of production process, giving prior importance to the human resources, freely available at a high degree of industrial adaptability. Automation and control installation should be restricted to the level to be handled and maintained by specialized nationals, who should receive utmost attention in suitable fellowship programmes.

Organization Scheme

The organizational parameters of the Cement Development Center were concluded with the Chinese group according to the organization chart drawn up in annex VIII which is recommended as a start to be applied as basis for recruitment of personnel. It has been taken as a guide for establishment of training plan. The proposal is composed according to the general set up of the center being built up of 6 technical departments headed by the Chief engineer of research and development, & financial & administrative department headed by the respective manager.

Aparatus Supply

According to the general set up of the Cement Development Center, and based upon conclusions drawn up from the experience of the study tour the recommended equipment are enlisted in annex IX, comprising :

- Proposed equipment, for purchase during 1[illegible]1 from the ongoing project DP/PRC/80/010 whereby a sum of US $ 92 200 was foreseen for nonexpandable equipment.
- Proposed purchase list of equipment covered by the proposed assistance project.

Both lists are arranged in order of priority, with technical specifications for international bidding. However, some items are recommended (by the Chinese group) from specific suppliers due to technical superiority reported by international experts during the study tour. The 2 lists comprise research equipment to be imported due to special technological features.

- proposed local supplies for the chemical laboratory.
- Proposed Local supplies for Physical Lab.
- " " " " concrete Laboratory.

Annex I

TRAVEL SCHEDULE

ADOPTED FOR THE STUDY TOUR

25.3.81	Arrival at New York, USA
26.3.81	Fellowship section, Office of Technical cooperation, UN, NY, USA.
01.3.81	Flight: New York-Allentoun/Bethlehem, USA.
2-5.3.81	Fuller Co., Bethlehem (Pennsylvania), USA.
05.3.81	Flight: Bethlehem-Albuquerque, USA.
06.3.81	Tijeras cement plant (Tijeras, New Mexico), Ideal Basic Industries,USA.
07.3.81	Flight: Albuquerque-Birmingham. USA
08.3.81	Ragland cement plant (Ragland, Alabama), National cement Co.,USA.
09.3.81	Flight Birmingham - Knoxville, USA. Knoxville cement plant (Knoxville, Tennessee), Ideal Basic Industries, USA. Flight Knoxville-Mobile, USA.
10.3.81	Theodore Cement plant (Mobile, Alabama), Ideal Basic Industries. Flight : Mobile-San Antonio , USA.
13.3.81	Balcones Cement Plant (Braunfels,Texas) General Portland Inc. USA.

14.3.81	Flight : San Artonio - Milwaukee, USA.
16-17.3.81	Allis Chalmers Co. (Milwaukee, Wisconsin), USA.
17.3.81	Flight : Milwaukee-Chicago, USA.
18-19.3.81	Portland Cement Association (Skokie, Illinois), USA.
20.3.81	Flight : Chicago - San Francisco, USA.
23.3.81	Permanente Cement Plant, Kaiser Cement Co., USA.
24.3.81	Travel : San Francisco-Santa Cruz, USA.
25.3.81	Devenport Cement Plant, Lone Star Industries Inc., USA.
26.3.81	Flight San Francisco - Washington DC.,USA.
27.3.81	US Office of International Visitors Program, National Ash Association, IFC, Washington DC, USA.
28/29.3.81	Flight : Washington - New York - Frankfurt-Cologne F R G.
30.3.81	Carl Duisberg Gesellschaft, Cologne FRG.
1-2.4.81	K.H.D. Industrieanlagen A.G., Cologne,FRG.
3.4.81	Cement plant Fortune, Geseke, FRG.
5.4.81	Trip Cologne - Beckum, FRG.
6.4.81	Readymix Zementwerke, Beckum, FRG.
7.4.81	Zemlabor : Institut fur Baustoffprufungen, Beckum. FRG. Dyckerhoff Cement Works Mark II , Beckum, FRG.

8.4.81	Krupp Polysius AG, Neubeckum, FRG.
9.4.81	Alsen-Breitenburg Cement plant at Laeger-dorf, FRG.
10.4.81	Trip Beckum-Wiesbaden, FRG.
13.14.4.81	Dyckerhoff Engineering GMBH, Wiesbaden, FRG.
15.4.81	Trip Wiesbaden-Cologne/Bonn, FRG.
16.4.81	Flight Cologne- Frankfurt-Vienna.
23/24.4.81	Flight Vienna-Beijing.
25.4.81	Briefing at UNDP Beijing.
27.4.81	Visit to Cement Development Center & Tian Jin Cement Works.
28.4.81	Visit to Capital Cement Plant in Lu Lee Hou
29.4.81	Discussions with officials from the Ministry of Building Materials Industries.
30.4.81	Discussions at UNDP Beijing.
1/2.5.81	Flight Beijing-Vienna.

Annex II

PERSONNEL MET DURING THE STUDY TOUR

A) USA :

- Ms. Nina Silvera : Fellowships Section, Office of Technical Coo-operation, UN.
- Mr. Waldemar B. Stack :Program Officer, Division of Professional Gov. exchange, Office of International Visitors Programme, Bureau of International Labour Affairs, US dept. of labour.
- Mr. Richard G. Schlauch : Vice President, Process products & Project division, Fuller Co.
- Mr. G. Kris Kapoor : Ass. Vice President, International regions, Fuller Co.
- Mr. Edward B. Greef: Regional Manager, Far East, Fuller Co.
- Mr. Li Fu : Ass. Regional Manager, Far East, Fuller Co.
- Mr. Peter Beckschi : Manager of training, Fuller Co.
- Ms. Josephine Gibson: Training Coordinator, Fuller Co.

- Dr. George R. Gouda : Manager, Cement Technology, Fuller Co.
- Mr. David W. Friedman: Senior product sales engineer, Cement pyroprocessing systems, Fuller Co.
- Mr. Gerald R. Koch : Project engineer, Process Industry products group, Fuller Co.
- Mr. Sidney M. Cohen : Assistant Director of research, Fuller Co.
- Mr. James F. Borneman: Southern USA regional sales manager, Cement Industry, Fuller Co.
- Mr. John H. Maberry : Chief Engineer, Process Industry products group, Fuller Co.
- Mr. Ted M. Houseknecht: Laboratory Manager, Fuller Co.
- Mr. Wuu Hao : Sales Engineer, Crushing & Milling, Fuller Co.
- Mr. Leslie C. Bartholomew: Sales Engineer, Pnenmatic conveying, Fuller Co.
- Mr. Douglass V. Parmenter : Process simulator trainer, system engineer, Fuller Co.
- Mr. Fred Bauer : Vice president, Technical affairs, Cement division, Ideal Basic Industries.
- Mr. Kit Dobbins : Assistant to the president, Ideal Basic Industries.
- Mr. John C. Thomson : Assistant to the President & Project director, Ideal Basic Industries.

- Mr. Frank E. Briber,	:	Vice President, International Market Development, Allis Chalmers Co.
- Mr. A. P. Hunter,	:	Senior process engineer, Allis Chalmers Co.
- Mr. Ervin J. Klovers	:	Senior process engineer, Allis Chalmers Co.
- Mr. D. R. Olson	:	Senior process engineer, Allis Chalm ers Co.
- Mr. S. W. Tra southick	:	Manager, Pyro-processing & Cement technology, Allis Chalmers Co.
- Mr. William F. Braun	:	Manager, Cement & Chemical Project engineering, Allis Chalmers Co.
- Mr. J. J. Estes	:	Manager, Manufacturing, Allis Chalmers Co.
- Mr. Philip Chen	:	Project Sales Manager, Allis Chalmers Co.,
- Mr. George G. Sulzer	:	Manager, Process Research & Test Center, Allis Chalmers Co.
- Mr. F. I. Kohanowski,	:	Manager, Process & Application engineering, Allis Chalmers Co.
- Ms. Mary A. Wadsworth	:	Area vice president for PRC, Allis Chalmers Co.
- Mr. Morry Meier,	:	Regional Manager, Allis Chalmers Co.
- Mr. Eivind Hognestad	:	Director, Technical & Scientific Development, Portland Cement Association.

- Mr. Gilbert M. Lockhead : Vice President for Engineering, Ideal Basic Industries.
- Mr. James C. Huchison : Senior Engineer, Ideal Basic Industries.
- Mr. Joseph Mc Mullan : Plant Manager, Tijeras Cement plant, Ideal Basic Industries.
- Mr. Barry L. Lower, : Production supervision, Tijeras cement plant, Ideal Basic Industries.
- Robert E. Mummey : Maintenance supervisor, Tijeras cement plant, Ideal Basic Industries.
- Mr. Tom R. Johnson : Project Manager, Theodore Cement Plant, Ideal Basic Industries.
- Mr. Harold Covington : Plant Manager, Knoxville cement plant, Ideal Basic Industries.
- Mr. C. V. Henry : President, National Cement Co. , Birmingham.
- Mr. Fred Koester, : General Plant Manager, Balcones Cement plant, New Brunfels, General Portland Inc.
- Mr. J. T. Hills, : Assistant plant Manager, Balcones Cement Plant, New Braunfels, General Portland Inc.
- Mr. Charles M. Finch, : Administrator, Balcones Cement Plant, New Braunfels, General Portland Inc.

- Dr. I. D. Lin : Senior research engineer, Portland Cement Association.
- Mr. Howard M. Kanare: Associate Research Chemist, Portland Cement Association.
- Mr. Rob Roy, : Market & Economic Research Dept., Portalnd Cement Ass.
- Dr. Ellis M. Gartner: Manager, Basic Research Section, Portland Cement Assoc.
- Mr. Charles M. Weise: Manager, Process development section, Portland Cement Ass.
- Mr. George K. Mc Cord: Director, Project development, Portland Cement Association.
- Mr. Edward I. Kawala : Director, Educational Services dept., Portland Cement Association.
- Ms. Marilynn J. La Salle, Manager, Information services, Portland Cement Assoc.
- Mr. Victor Tchebitcheff: Vice president, Kaiser Cement Corporation.
- Mr. N. J. Norm Gilbertson, Plant Manager, Kaiser Cement Corporation.
- Mr. Klem Gus, : Process engineering manager, Kaiser Cement Corporation.
- Mr. Von Bargen Robert: Design & Project engineering Manager, Kaiser Cement corp.
- Mr. S rong Adolph : International Projects Manager, Kaiser Cement corporation.
- Mr. M. J. Bishop : Mineral resources manager, Kaiser Cement Corporation.
- Mr. Michael Janner, : Manager, China operations, Kaiser engineers.
- Ms. Deanna Cheung : Senior Financial Associate, Kaiser Engineers.

- Mr. David Maars,	:	Plant manager, Development Plant, Lone Star Industries Inc.
- Mr. John Laney,	:	Technical Manager, Develop. Plant, Lone Star Industries Inc.
- Mr. James N. Covey	:	Executive Vice President, National Ash Association Inc.
- Mr. Hussein Mustafa	:	Cement feasibility studies expert, International Finance Corporation.

B) FRG:

- Mrs. Rode-Wald	:	Carl Duisberg,Gesellshaft e.v., Cologne.
- Dr. R. Kuhs	:	Director Development Dept., Humboldt Wedeg, KHD Industrieanlagen A.G.
- Mr. Horst Herchenbach	:	Manager, Process Design, Humboldt Wedag, KHD Industrieanlagen A.G.
- Mr. Bernd Lube,	:	Sales Engineer, Humboldt Wedag, KHD Industrieanlagen A.G.
- Mr. Hubert Kornath	:	Chief, training section, Humboldt Wadag, K H D Industrieanlagen AG.
- Mr. H.G. Hoevel	:	Assistant, training section, Humboldt Wedag, KHD Industrieanlagen AG.

- Mr. Hanns W. Harberhaus : Manager, Sales & Marketing, Humboldt Wedag, KHD Industrie-anlagen AG.
- Mr. Rolf Jehmlich : Chemical expert, Control Section, Humboldt Wedag, KHD Industrieanlagen AG.
- Mr. Siegbert Bihlmaier : Development expert, Humboldt Wedag, KHD Industrieanlagen AG.
- Mr. Trautmann : Readymix Zementwerke, Beckum.
- Dr. Werner Loch : Director, Zemlabor, Beckum.
- Mr. E. Nissel, : Chemist, Dyckerhoff Engeneering, Wiesbaden.
- Mr. Raestrup : Krupp Polysius AG.
- Mr. Walter Staffhorst : Technical services, Krupp Polysius AG.
- Mr. Manfred J. Duerr : Manager, Kiln Projects, Krupp Polysius AG.
- Mr. Lutz T. Schneider : Mill Dept., Krupp Polysius AG.
- Mr. Josef Schumacher : Leader of research group, Krupp Polysius AG.
- Mr. Ernst A. Niemeyer : Works Manager, Laegerdorf Cement Plant AG.
- Mr. Richard Muenk : Member of the bard, Dyckerhoff Engineering GMBH, Wiesbaden. Director of technical cooperation, Dyckerhoff Zementwerke AG, Wiesbaden.

- Mr. Martin Moeck : Technical Leader, Dyckerhoff Zementwerke AG.
- Dr. Carl Schmitt-Henco: Head of Central Laboratory, Dyckerhoff Zementwerke AG.
- Dr. Heinz Zeeh : Chemist in the Central Laboratory, Dyckerhoff Zementwerke AG.
- Ms. F. Alter : Chemist in the Central Laboratory, Dyckerhoff Zementwerke AG.
- Mr. Parpart : Production Engineer, Dyckerhoff Zementwerke AG
- Dr. Bossdorf : Cheif Chemist, Dyckerhoff Zementwerke AG.

C) P R C :

- Mr. Alan Doss : Deputy Resident Rep., UNDP Beijing.
- Ms. K. Leitner : Assistant Res. Rep., UNDP Beijing.
- Mr. Gao Hai-Hong : Vice head of Bureau & Foreign Affairs, Ministry of Build. Mat. Ind.
- Mr. Wang Meng-Yan : Foreign Affairs Bureau, Ministry of Build. Mat. Ind.
- Mr. Hu Hong-Tai : Chief Eng., Capital Construction Bureau, Ministry of Build. Mat. Ind.
- Mr. Li Zi-Yuan : Capital Construction Bureau, Ministry of Build. Mat. Ind.
- Mr. Bian Zhan, : Vice President, Tian Jin Designing Institute of Cement Industry.

- Mr. Zi Xin-Tian,	:	Vice President, Tian Jin Designing Institute of Cement Industry.
- Mr. Lan Chan Wein	:	Works Manager, Capital Cement Plant.
- Mr. San E. Sin	:	Production Manager, Capital Cement Plant.

Annex III

TECHNOLOGY OF VISITED CEMENT WORKS

A. United States of America

1. TIJERAS CEMENT WORKS: IDEAL CEMENT CO., NEW MEXICO:

The most important features in this plant are :

- Limestone is crushed through 2 stages with a sieving device in between. The raw mill is closed circuit whereby hot gasses from the kiln are used for raw-mix drying down to 0.5 % moisture content.
- Two long dry-process kilns were operated with natural gas. With the continuous inflation of oil prices, both kilns were converted to coal firing since 1977 and the gas firing system is still kept for emergency cases. A 2-stage preheater was introduced with an emergency air damper for protection of preheater entrance. Each of both kilns was shortened by 21.336 m., and 8 circles of refractory castables were adapted to kilns lining. The rated output is now 750 t/d for each kiln with an increase of 31 %, and the heat energy consumption has been down to 780 K cal/Kg with a reduction of 28 %.
- T. raw mix is composed of 4 components : low & high grade limestone, clay, iron ore. Raw mix design is worked out by the chief chemist according to analysis results, provided by an ARL x-ray analyser and print out by an analysis computer. Automatic sampling for

raw mix is achieved through a sampling screw whereby hourly samples are transported to the x-ray analyser for routine control, according to which the components proportioning is automatically adjusted by a process computer, which also monitors the production process particulars.

- Before the conversion, the final grinding capacity was ample for grinding all available clinker, but lately an extra cement mill has been erected to raise up the cement production capacity of the whole plant up to 450 000 t/y.

2. **KNOXVILLE CEMENT PLANT: IDEAL BASIC INDUSTRIES, TENNESSEE:**

This plant represents a typical case of process conversion involving the following particulars :-

- The raw mix is prepared by a 3000 HP Mill, 12.192 x ∅ 3.658 m., with classifying lining plates. The mill was converted from wet to dry grinding with the process conversion in 1979. The raw mix was then provided with 3 blending units each composed of a homogenization installation constructed over a storage silo with Claudius Peters pneumatic equipment for continuous blending system with 10:1 reduction of standard deviation. The raw mix conveying is handled by air lifts.
- A dry process Fuller kiln : 50.292 x ∅ 3.658 m, rotation speed 3.3 rpm, with a flash furnace 4-stage suspension preheater, rated production capacity 1540 t/d which could attain 1814 t/d, with grate cooler, has replaced four wet process kilns since 1979. Firing is accomplished by coal in presence of natural gas installation for starting up. Provision is foreseen for oil firing whenever necessary.

An alkali bypass is provided for bypassing up to 35 % of total air draught, although satisfactory operation could be achieved with o % bypass. A bag house dust filter is performing satisfactory performance.

- Final grinding is accomplished by 2 ball mills of 2000 HP, dimensions 9.754 x Ø 3.353 m. producing 500 000 t/y. A Fuller Kenyon pneumatic pump is applied for conveying cement to storage silos.

3. **THEODORE CEMENT PLANT, IDEAL BASIC INDUSTRIES, MOBILE, ALABAMA:**

1.234 million t/y plant under construction, anticipated start up around July 1981. The following features were identified :

- Moisture abnormally high in raw materials, averaging 22 % which renders a sticky constitution with a very poor flowability in general and with remarkable adherence to silos & bins. Still the dry process is adopted, using rotary dryers utilizing hot gases from the grate cooler and additionally an accessory hot gas generator. Sand is ground in a wet ball mill as environmental protection against silicosis, and due to the sand texture known to be of harder grindability than limestone and clay which are especially easier to grind.
- Raw grinding by a roller mill of 3500 HP, comparatively small due to easy grindability of raw materials.
- Rotary kiln of Allis Chalmers design, 4170 t/d rated production capacity, Ø 4.877 m & length 54.864 m, grate clinker cooler with 9 chambers & automatic dust emptying. Dust collection by a bag house with glass fibers tube filters.
- Final grinding by FLS cement mills driven by twin motors of 6500 HP and symetro gears, final cement passed in a cement cooler.

- Cement storage silos of 48000 t storage capacity, despatch adapted for navigational shipment for covering requirements of the golf coast area.
- Hot gases from the grate cooler and accessory heat generator will be applied for the rotary dryers, flash calciner and raw mill.
- An emergency power generator is installed for kiln stirring & water pumps operation when the electrical current is interrupted & in cases of fire break out.
- In addition to the computerized interlockings, the central control is provided with a complete analogue system for manual operation in case the computer control is out of function.

4. **RAGLAND CEMENT PLANT, NATIONAL CEMENT Co., ALABAMA:**

In this plant there stands the world's first totally coal-fired flash calcining system equipped with an alkali bypass. The following achievements were noted :

- Modernization of the plant was accomplished by introduction of SF system which involved shortening of the 4.11/4.572 mØ kiln from a length of 152.4 m to 98.755 m. The kiln rotation was speeded up from maximum speed of 1.33 to 3.50 RPM which involved the substitution of the original two 150 HP motors by two new 300 HP dc motors. The kiln rated production capacity was raised from 1060 to 2000 t/d, which now attained 2300 t/d. The horizontal 15.240 x 3.048 m Fuller grate cooler was modified to include an inclined grate over the initial third of its length to allow for the higher production.
- The coal is ground by an 8.5 t /h Loesche air swept roller mill down to 20 % residue over 200 mesh. The drying air branches off the hot gas duct from the clinker cooler to the flash calciner. Dry pulverized coal from the roller mill passes through a cyclone and is transported pneumatically to a low pressure drop splitter for providing equal flow to each of the three flash furnace coal burners. The original oil

& gas burners are kept for application in emergency cases. The coal applied has about 30 % volatile matter and leaves 14 % ash for which the raw mix design accounts. The SP firing system utilizes primary air from pneumatic conveying.

- An alkali bypass is erected with a quench air fan and a conditioning spray tower. However the bypass is out of operation in virtue of chloride free raw materials applied for the time being.
- The original ball mill was replaced by a Loeshe airswept roller mill, sized for production of the increased raw mix requirements, using hot gases from the preheater exhaust for drying raw materials.
- The conversion proceeded without stopping the plant by installation of most of the substantials including the civil construction, suspension preheater, precalciner, alkali bypass, raw meal Fuller-Kinyon pneumatic conveying system, and a central control panel. Then the plant was shut down for cutting the kiln and accomplishment of connections, so that the down time could be reduced to six weeks after which the newly modernized plant resumed a smooth operation.

- A remarkable incident is that the limestone quarry pit was recently innondated by water that leaked from a neighbouring artificial lake after a heavy rain. The limestone crusher and quarry hauling equipment disappeared under water and the rubber belt conveying limestone from the quarry site to the factory became out of function. A thorough investigation was ready for another concession from a previous raw materials prospection. A new limestone quarry was opened, and was provided with a mobile crusher, adequate drilling and hauling equipment. Limestone transport, which has then been organized by dump trucks, was interrupted for only two weeks, during which clinker production was continued in virtue of ample stocks.
- A limited part of the production is finally ground as masonry cement whereby the limestone texture is suitable and the market demands are adequate.

5. **BALCONES CEMENT PLANT, GENERAL PORTLAND INC., BRAUNFELS:**

A newly installed plant with modern process technology and latest central control and computer incorporation. The following innovations were seen:

- Crushed limestone and clay are stocked in two raw materials storage halls (storage capacities 24000 & 6000 t respectively). Stacking is accomplished by an overhead shuttle belt conveyor in the form of a conical heap which is extended laterally by a shifting motion adequately adjusted through an echo system. Materials are reclaimed by a side scraper reclaimer automatically controlled to dump the sides on a rubber belt conveyor in a preblending sequence.
- The raw mixture is composed of three components (limestone, clay, iron source). Each is fed to a 360 t/h roller mill from a buffer hopper through synchronized constant weigh feeders. The raw mix proportioning is effected by a computer, based upon computed x-rays diffraction analysis.
- The fines from the roller mill & dust reclaimed by the electrostatic dust precipitator are conveyed by a series of screw conveyors to an aeropol blower which blows the procedes up to the top of homogenization system, based on continuous blending by overflowing successively over seven head silos to each of the lower storage silos, from which the raw meal

is lifted by a bucket elevator to a buffer bin, dozed by a Schenck weigh feeder and blown up by an aeropol blower to feed the kiln suspension preheater.

- The kiln (2500 t /d, 73.152 x Ø 4.597 m) is coal fired with provision for oil or gas firing when required. The firing system is designed with dual function for the kiln and future pre-calciner with the possibility to devote all firing capacity to the kiln whenever the precalciner is out of function. The produced clinker is cooled by a Fuller grate cooler with automatic dust emptying to a reclaiming drag chain conveyor. Hot gases from the grate cooler are applied at present for the primary and secondary kiln air requirements, whereas the surplus air is exhausted through gravel bed filters at present and until the erection of pre-calcination installation at a later stage. Clinker is conveyed by a deep bucket conveyor to 4 clinker silos (each with 8000 t storage capacity).
- Cement grinding is accomplished by 2 finish mills (ball type with classifying liners, installed power 5000 HP, rated output 96 t/h) provided with cement coolers. Grinding Blaine Specific Surface area is

governed from the central control panel by handling the separator parameters. Resultant cement is conveyed by a rubber belt conveyor to the bottom of cement storage silos from where it is blown up by an aeropol blower, a system which has been found to be the most economic with regular uninterrupted operation.

- Cement is despatched in bulk from 3 loading stations equipped for filling railway waggons, two of the loading stations of dual purpose, additionally for filling silo-trucks. The loading operation is computer controlled to adjust the flow speed and charge weight.
- With the said computer control the shift operation is maintained by only 4 persons: Production supervisor, Production assistant, Central control operator, Quality control chemist. An administration computer control is extended to follow up maintenance time recorded by badge readers and hence organize maintenance cost when computing essential information of work orders. The identification of preventive maintenance proceedings and spare parts ordering are also computerized. However a complete analog system is foreseen for manual operation which has been adopted during the starting up untill the computer component transactions are successively put into operation.

6. <u>PERMANENTE CEMENT PLANT, KAISER CEMENT CORP.,</u>
<u>CALIFORNIA</u>:

Modernization has been achieved to make it one of the most modern and cost efficient plants:

A production line with a preheater precalciner dry-process kiln, which is presently under commissioning, will replace the old 6 wet process kilns which will be abandoned upon completion of the scheduled phases. The following remarks upon the new production line were noted :-

- The kiln is equipped to burn principally coal, with provisions for oil & natural gas. Coal ash is worked out as a part of reacting components in the burning process and sulphur content is taken as a natural scrubber for stabilization of alkali content.
- Limestone and clay are crushed seperately in 2 stages: primary : jaw crusher, and secondary : gyratory crusher. Primary storage piles are built by a travelling tripper; storage capacity for high grade limestone 47000 t , for medium quality 52600 t , and for clay 21800 t. The three components are proportioned through weigh feeders to a 3rd. closed circuit giratory crusher. The mix is transported to a sampling tower where the samples are automatically extracted,

crushed, and analysed for further re-adjustment. Preblending is accomplished in a circular dome structure where raw material is deposited by a radial stacker and reclaimed by a cable scraper along the cross sectional area, for feeding the preblended bins. High grade limestone is used for corrections and adjustments. The raw mix is composed of limestone, laterite, dross, and iron ore additive.

Raw grinding is effected by two 16.266 x ∅ 4.597m, 5800 HP, 200 t/h center-peripheral discharge mills, in closed circuit with bucket elevators, air slides and air seperators. Hot gases from the preheater are used for drying the raw mix from 4.5 % to 0.5 % moisture content. Partial dedusting is effected by cyclones and final dedusting is accomplished in bag type dust collectors whereby dust is recuperated to the same bucket elevator to the blending silos. Raw mill product stream is continuously sampled for quality control through routine analysis. Raw mix is conveyed by air slides and bucket elevators, and radially discharged through distribution boxes into two 7700 t mixing chambers homogenization silos. Blended products are combined and routed via an air slide and bucket elevator to the kiln feed bin.

A complete stand-by transport system is provided for ensuring uninterrupted kiln feed.

The kiln is 76.2 x Ø 4.877 m, 3.2 rpm, with refractory lifters, dual string 4-stage suspension preheater with swirl precalciner, where raw meal is 90 % calcined. Firing is arranged for coal with provisions for oil and natural gas. Hot gasses from the reciprocating grate cooler are used for kiln combustion and for swirl precalciner. The system of refractory lifters promote exposure of kiln charge to the hot draught. Hot gasses exiting the preheater are diverted to raw grinding & coal disintegration. In case the grinding systems are not functioning, the hot gasses are cooled through an air to air heat exchanger before running through the bag filters. The partially cooled clinker procedes into two G-coolers, where an indirect heat exchange drops the discharged clinker temperature to 82°C, after which it is conveyed to two clinker storage silos of 41000 t capacity. A provisional 1000 t silo has been foreseen for high free lime clinker.

Coal grinding and drying is accomplished in two bowl mills, for the requirements of kiln and precalciner being 40 & 60 % of coal successively. Hot inert gasses from the preheater are used for the bowl mills. Pulverized coal is retained through a classifier and cyclone. Exhaust air is blown out through a bag type dust collector.

Final grinding is accomplished by the existing finish mills, being capable of grinding 5000 t/d of type 1 cement. Cement storage capacity is 94000 t. The existing cement grinding and storage facilities will be in use until the next stage of modernization.

The process and operation are designed and controlled by digital computer systems operated with a light pen and type-writer terminal : one system for motors monitoring and the other for process control. A third computer is provided as stand-by to function whenever one of the said computers would fail. Additionally 50 analog output stations are prepared to control vital operating parameters in case of total failure of the whole computer systems. Moreover the plant is provided with the most modern system for scanning the whole kiln shell temperature with a graphic display upon the control panel. The system is adjustable in terms of maximum temperature alarm and magnitude of a specific area, with the possibility for exposure of the whole shell circumference whenever required.

7. **DAVENPORT CEMENT PLANT, LONE STAR INDUSTRIES, SANTA CRUZ, CALIFORNIA:**

Modernization has been achieved by installation of a dry-process rotary kiln with flash furnace precalciner suspension preheater, a variable bypass system to increase the ore-to-waste ratio from 4:1 to 12:1 and still produce low alkali cement in accordance with requirement of the present code of practice. The related processing equipment has been provided from raw materials reclaim up to the cement silos to replace the old wet process plant, raising the annual production capacity from 363 000 t/y to 703 000 t/y, and bringing the plant into compliance with the environmental laws and regulations. A reduction is anticipated in calorific consumption from 1305 to 930 Kcal/kg clinker, and in labour requirement from 0.9 to 0.41 manhour per ton cement. The new installation is under commissioning, after which the old plant, comprising 3 Lepol kilns will be abandoned.

The plant visit revealed the following main features:-

- The raw material reclaim comprises 2 areas:

a- Limestone and shale to be received from the existing quarries via an overland belt conveyor across 5.6 km, to be stacked in 3 stock. piles: shales, and high & low grade limestone, each of which is reclaimed by an apron feeder controlled by a belt scale.

b- Sand and iron ore for composition adjustments. Both are conveyed to storage bins from which they are extracted using weigh- feeders to a common conveyor system with limestone and shale to the raw materials surge bin mounted on load cells controlling the weight of overall flow to the raw materials grinding system.

Raw gindings is effected with a roller mill driven by a 1750 HP motor, rated production capacity 170 t/h of raw mix with a fineness of 80% passing 200 mesh screen, where drying is accomplished by exit gasses from the kiln system from 7.7% down to 0.5% moisture.

Exhaust gasses are dedusted by an electrostatic dust precipitator.

A emergency air heater is installed to provide additional heat whenever raw materials moisture exceeds 7.7% or the kiln system is operating at more than 50% bypass.

Homogenization is performed through blending chambers system in 2 silos of 3000 t each, reducing chemical fluctuations by 15:1 in terms of standard deviation.

Coal is dried and ground in a bowl mill designed to handle coal feed of 10% moisture. Drying is accomplished by low oxygen gases from the preheater exit. A booster fan is used to overcome the negative static pressure at the preheater exit. Pulverised coal is collected in a surge tank from which it is pneumatically conveyed to the kiln firing and precalciner through 2 weigh-feeding systems. The kiln feed system consists of a metering and air lift systems feeding through a rotary air lock and tripping valve thus availing a double seal protecting the air slide from heat damage in case of power failure. The kiln is 56 x Ø 3.962 m, rated at a daily production of 2050 t, designed to accept a feed of 1.3% total alkali and 0.5% moisture content . The bypass system is designed to be operated at 50-100% bypass to secure clinker production of less than 0.6% alkali content. The clinker is cooled down to 65°c in a Folax cooler with 3 grate sections of which 1 is inclined + 2 horizontal, with 9 undergrate compartments and 7 undergrate cooler fans with hydraulic drive system. The cooler air flows as secondary air for kiln burning zone combustion and tertiary air to the precalciner and excess air is vented to the atmosphere through a graval bed filter. Exit gasses from the preheater are passed through a conditioning tower for adjustment of temperature for raw mill safety, and moisture for efficient operation of electrostatic dust precipitator.

Final grinding is accomplished by 2 finish mills 11.633 x Ø 3.658 m, driven by 3000 HP motor, rated at a production of 60 t/h at 3700 cm^2/g Blaine specific surface area. Produced cement is passed through a cement cooler for avoiding complications in poor flowability from cement silos.

The central control system is incorporating motor and process control system distributed over 5 major areas. Overall sypervision of the system is monitored from the central control, whereby the operator can change set points as well as start and stop in plant sections in any of the remote devices from the operators console. A computer generates graphic displays and performs more complex process loop control than is possible with the remote process control devices. A back-up system is provided for intermediate control. If the computer fails, the system will continue to operate with the only loss of graphic display, the more complex process control loops, and miscellaneous alarms not critical to plant operation. The central control room is provided with a closed circuit T V system with cameras which can be focused at points of special importance.

B. Federal Republic of Germany

1. FORTUNA ZEMENTWERKE, GESEKE

The visit to this plant was arranged by Humboldt-Wedag in order to demonstrate latest achievements in ameliorating and increasing the production capacity, cutting down the heat energy consumption and the appropriate planning to minimize production losses. The restructured plant stands as a representative example for upgrading plant economics through a well-tailored modernization.

A dry process kiln with dimensions 50 x Ø 3.2 m was first installed with a four-stage suspension preheater. A second string of pyroclon was lately introduced. The civil and erection work was performed while the kiln was in operation. The stoppage was therefore reduced to a very short time for the connection between the old and new parts and for junction of the tertiary air duct from the grate cooler to the flash furnace. The rated production capacity for the kiln was consequently raised from 650 to 1500 t/d of Portland clinker. The modified installation is still under commissioning, and the practical results for the fuel economy are not yet finally established. However the target is a heat energy consumption of 760 K cal/kg. clinker. to which the results attained so far are close.

2. READYMIX ZEMENTWERKE, BECKUM

In Readymix Cement Works in Beckum, a model is demonstrated for economical extension achievement. The plant visit revealed the following:-

- In 1971-1972 an extension was installed by addition of a complete new production line of 1 million t/y, with modern concepts of cement technology and an ideal specific capital expenditure of about 58 DM/t of installed capacity. The investment has been retained at a satisfactory rate through the economical cost price in virtue of well planned lay-out and experience of personnel, involving 4630 t yearly production/worker, heat energy cosumption of 755 K cal/kg clinker, and electrical energy consumption of 85 KWH/t of produced cement.
- The raw mix is composed of 80°/o marl + 20°/o high quality limestone.

The marl is crushed by a 650 t/h Hazemag single rotor hammer crusher, then transported to the works on a rubber belt conveyor. The raw mixture is disintegrated by a Pfeiffer roller mill, driven by a 1000 KW motor, rated at 210 t/h of raw mix with a fineness of 10°/o residue retained upon 4900 mesh sieve, whereby the exhaust gases from the preheater are used for drying and carrying up of fine raw mix to an electrostatic dust precipitator preceeded by a settlement chamber. The raw mix is moved out by a screw conveyor to air lifts that transport the raw mix up to the storage silo of 6500 M^3 storage capacity. The homogenized raw mix is conveyed by air lifting to feed both preheater strings.

- The kiln is 80 x Ø 5.3 m, capacity 3000 t/d clinker with 105 t/h of raw meal totalling 210 t/h, with a conversion factor of 1.68. The heat energy consumption is 755 Kcal/kg of clinker, in virtue of 2 ry firing in a precalciner whereby 85°/o fuel ail + 15°/o of coal are presently applied to maintain a temperature of 900°c. Required oxidising air for both precalcination and sintering processes passes through the clinker cooler and rotary kiln. Through precalcination the said economic parameter of calorific consumption is realized and regular performance is secured, with a consequent longer lifetime for refractory lining and therefore shorter stoppages. Acounter-current shaft clinker cooler is satisfactorily functioning, coping with 3000 t/d production, and still overcomming dust and noise problems. With reduction of moving parts in this innovation 30°/o lower initial capital cost was invested and minimal wear and tear are noted. The produced chinker is transported by a steel bucket conveyor to 2 clinker silos of 40000 t storage each built up of steel, thus realizing economic investment and no high temperature risks.

- Final grinding is accomplished by a finish grinding ball mill 14.3 x Ø 4.6 m, rated production capacity 150 t/h of cement having a fieness of 2600 cm^2/g Blaine specific surface area, driven by 2 x 2200 KW motors, electrical energy consumption 30 KWH/t cement. Cement is stored in 2 cement silos, each with a storage capacity of 12500 t.

Despatch of cement is rated at 600 tn/h: with and average of 80°/o in bulk and 20°/o in bags. Bulk loading is effected automatically within an efficient self-service system. The driver has to switch on the process and all then procedes antomatically by computer control adjusting the cement flow and monitoring the filling rate and weight and arranging the end point action. Every bulk truck is composed of 3 compartments: 2 for bulk cement despatch on the way out of the works and the middle compartment for supplying fuel oil on pulverized coal to the factory. A magnetic card is processed by the computer for billing the despatched cement.

- The whole plant operation is monitored from a central control panel, except for a seperate control stand at the crusher location and local computer control of bulk loading. A TV camera exposes the flame state at the central control. Material levels in silos and bunkers are detected by Gamma- Rays installation.

3. **DYCKERHOFF ZEMENTWERKE, MARK II, BECKUM:**

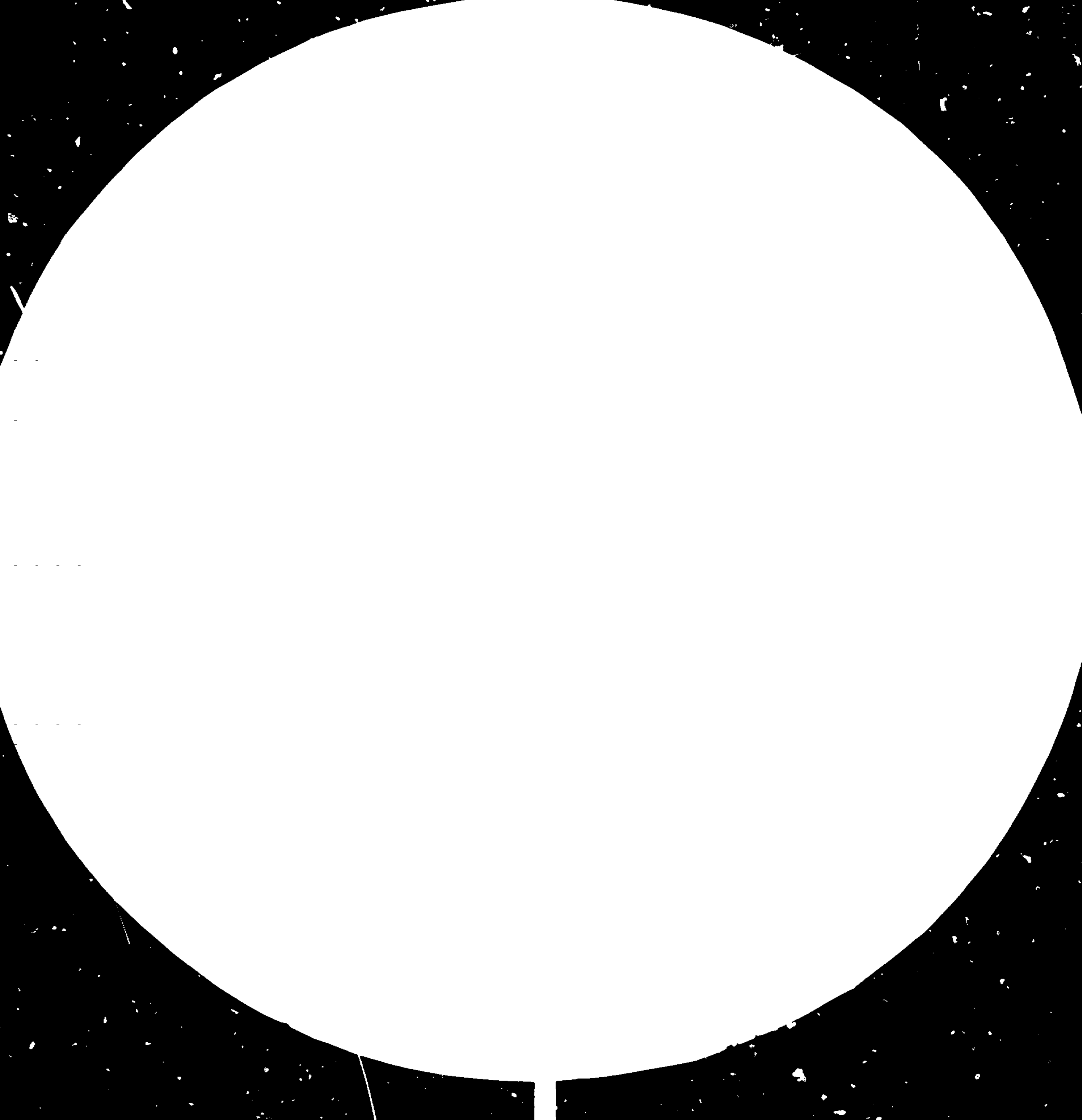
The visit to this cement plant was organized by Zem-labor Beckum as an instance for cooperation in the field of quality control and development of cement types with promoted market demands.

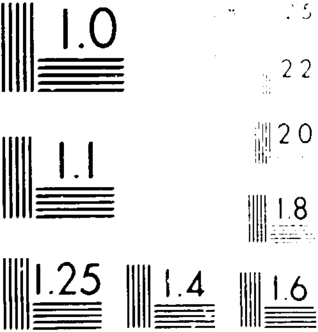
The two - component raw mix (limestone and marl) is prepared through a roller mill of 270 t/h production capacity, using hot gases from the kiln exiting the suspension preheater. The system is provided with an electrostatic dust precipitator from which fine raw mix + dust are retained by a screw conveyor, then pneumatically lifted to the homogenization system, being composed of 7 top silos to be filled by the overflow method, then emptied together to a storage silo of 10 000 t capacity, from where it is lifted by a bucket elevator for feeding the kiln heat exchanger.

The kiln system is an example for free selection of machinery and equipment of specially favourable features the engineering work being organized by Dyckerhoff engineers for harmonization and interlinking between various components. The kiln is provided with a four-stage Dopol (Polysius) suspension preheater, to which Dyckerhoff Engineers intoduced precalcination by firing coal and low grade combustibles, composed of motor tyres and inflammable waste materials. The kiln is F.L.Smidth 89 x Ø 5.5 m, production capacity 3 000 t/d, driven by twin motors 2 x 400 Kw, with 10 Unax planetary rollers of tube dimensions 22.3x Ø 2.1 m. The cooler system is enclosed in a sound proof chamber for environmental protection, whereby the cooler tubes function is supplemented by water cooling. The resultant clinker is then conveyed to 3 concrete clinker silos with total storage capacity of 45 000 t.

Finish grinding is accomplished by a cement ball mill dimensions 15.4 x Ø 4.4 m, production capacity 150 t/h, driven by twin motors 2 x 2000 KW. The cement mill system is enclosed in a sound proof construction as a measure taken in the course of environmental protection. Cement is stored in 4 cement silos of 5000 t storage capacity each, from which it is despatched either through an automatically adjusted bulk despatch system, or in paper bags by a rotary packing machine.

Automatic control of the process is effected from a central control panel with optimum interlocking system, monitoring the production process and securing all possible protection measures for machinery and equipment. The laboratory is well equipped with control installation, including x-ray analysis facilities for routine checking of analysis upon periodic samples obtained by automatic sampling and pneumatic conveying systems.




1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

4. **ALSEN-BREITENBURG ZEMENTWERKE, LAEGERDORF, HAMBURG:**

The plant visit was arranged by Krupp Polysius AG to demonstratate advantageous achievement in conversion of wet process into semi-wet technology, introduction of coal firing with highest precautions against explosion hazards. The plant represents an instance for raw materials with high moisture and alkali chlorides content necessitating raw mix preparation by the wet process, then disposal of the largest amount of water to get rid of alkalies and attain better calorific economy.

Laegerdorf plant was first established in 1884, originally had 25 vertical kilns, then extensions were achieved with wet process rotary kilns. The last extension has been a semi-wet production line of 3300 t/d.

The raw mix is compsosed of 80°/o soft porous chalk with over 22°/o water and 20°/o sticky sea clay with 26-30°/o water content, quarried by open cast working below sea level. The chalk is 94-97°/o $CaCO_3$, mainly calcite, originating from sludge consisting of shells of dead micro-organisms. The clays are deposits of extremely fine weathering products of silicate-rich rocks in the sea. Chalk which is mixed with washed clay slurry in a slurry drum. Due to the said nature of raw materials, in addition to the main question of raw materials characteristics and clinker quality, various factors were taken into consideration including operating behaviour, dust extraction, heat and electrical energy consumption, labour, maintenance, and investment costs, the process was designed based upon wet raw materials preparation then semi-wet burning with filter cake briquettes and low bypass stream.

In virtue of the fine nature of raw materials, the chalk quarry and clay pit represent the storge areas. The pit and quarry operations and slurry processing are simple and advantageous . The background experience and pilot plant research indicated the semi-wet process with 7°/₀ bypass gas to be the most favourable. The system was accordingly installed with an output of 3300 t/d with a Lepol kiln installation, filter cake of 21.7°/₀ moisture content, calorific consumption of 890 K cal/kg clinker, using automatically operating chamber filter presses. Due to the fine plastic water retaining nature of raw mix, piston diaphragm pumps compress the slurry in 100 chambers. The filter cake obtained is first stored in round hoppers and then metered to the screen compactor. Electrical power requirement for the kiln including the processing of filter cakes is 18 KWH/t and for the travelling grate cooler 5.5 KWH/t. Electrical energy requirement for raw preparation plus kiln system is 30.1 KWH/t. A low dust loss of 1.55°/₀ of the clinker output has a fabourable effect on lowering the alkali level in the clinker, particularly since these dusts generally occur in the form of solvable potash filter dust.

The kiln is dimensioned 90 x Ø 6.0 x 5.6 m, speed 1.7 r pm, rated output 3300 t/d, designed with high shell stiffness for longer lining life. The cooler is Recupol horizontal travelling grate with cooler waste air recovery on the preheater grate. Next to the cooler is a disc type clinker hammer crusher of 1.45 m impact circle diameter The travelling grates of the preheater and cooler are equipped with a central lubrication system. The cooler recirculating and waste air are freed from dust via 2 x 5 cyclones to protect the fan. Recuperated dust is fed directly to the clinker conveyor. Clinker is removed by a scooper conveyor to the clinker bunker of the new cement grinding plant of 220 t/h on to the clinker hall of 7500 t useful capacity through an open drag conveyor with remotely controlled switches for intermediate unloading.

The coal pulverization and firing systems were also seen during the plant visit. A central coal grinding and drying plant is installed with indirect firing and intermediate **storage** of pulverized coal. Imported coal is transported from vessels by **railway waggons, self dumping** into a sub-surface tipping bunker, whereby coal is reclaimed to a storage silo. Extraction is effected with an Aumund pan conveyor leading to a rubber belt conveyor provided with a seperating magnet and an induction probe. An electromechamical multiple roller weigher with integrating action is incorporated in the belt conveyor for measuring the rate of coal discharge. The coal is then passed through a triangular roller **screen** whereby bulky bodies are fed to a hammer crusher with impact breaker plate. A bucket elevator lifts the coal to a chain conveyor delivering to 3 storage silos on to the mill feed bin, which is provided with an ultrasonic level control to limit empty space for eliminating excessive air. Coal is fed from the whole bunker section, to aviod blockage, over an apron feeder, weight monitoring by a drag sensor. Due to variations of coal types, an air swept ball mill is applied, 10.25 x Ø 4.0 m with two compartments predrying & grinding, with an intermediate diaphragm with lifting scoops. The drying compartment is equipped with flights to lift and shower the moist coal through the hot stream. The grinding chamber is provided with liner plates developing a lifting and classifying action for grinding balls. The rated output is 55 t/h, power requirement 1360 KW, 25.0 KWH/t coal. The mill is mounted on a sliding shoe bearing at the inlet end. An air classifier seperates the pulverized material in the exhaust air discharged from the mill into: fines to remain in the air stream, and tailings returning through the bottom outhet.

Dedusting is effected with an electrostatic precipitator operating with forced draught, equipped with two precipitating fields in which the exhaust air is cleaned to 30 mg/Nm^3 dust content. The explosion hazard at the inlet of electrostatic dust precipitator is reduced by cutting down the dust concentration below the flammability limit. The precipitator is fitted with an automatic voltage control unit which is set at a voltage below the spark-over limit. 82 explosion doors are provided, with rust resistant steel movable closing flaps, each venting aperture provided with sealing rim. Pivots for these flaps can be electrically heated to ensure functional readiness unhindered by ice formation. In the event of ignition the casing is rapidly inertized with carbon dioxide. A screw conveyor without a center bearing delivers the finished products from the cyclones and electrostatic dust precipitator to the pneumatic conveyor.

5. <u>DYCKERHOFF ZEMENTWERKE, AMOENEBERG, WIESBADEN:</u>

This factory was first established in 1864. The method of spraying slurry into the wet-process rotary kilns wes developed in 1930 S. There had been several innovations in the wet process technology that retained a good position in the cement industry in its region. Cement marketing is favoured by the economic transport facilities over the R hine River.

Two completely new dry process production lines of 2500 t/d each have been inst-alled and the old wet process units were consequently stopped. The new production units were well planned to reduce the heat energy consumption, economize the personnel cost, rationalize the maintenance and repairs expenditure, and prevent air pollution.

The raw mix components: limestone marl and clay marl + overburden sand correction are handled by a double roll crusher, the rollers consisting of circumpherencial rings provided with teeth and ridges. The crushed mix is adjusted in accordance with analysis results of samples taken by a sampling station mounted for the crusher output. Samples are taken by a sampling chute isolating 24 extracts per hour at an overall rate of about 12 t/h. Samples are delivered to a pilot station for further comminution in a 2 stage roll crusher to 12-16 mm. product size. A paddle sampler extracts 600 Kg /h which are dried and ground in a small roller mill, then samples of 1 Kg are taken at half hourly intervals from a mixer. The operation of quarry excavation is controlled on the basis of analysis results of the said samples.

Due to the heterogenity of raw materials, substantial prehomogenization is performed in a blending bed system composed of a circular stockpile at the center of which stands a tower to which a stacking machine and bucket wheel reclaimer are pivotably attached. At the top of the central tower is the transfer point where the material is fed to the stacker, which can slew through 360° and deposit the raw materials in a series of raws on a circular track of 100 m diameter with a travel speed controlled by a weigh belt installed on the stacker bridge so as to obtain raws of constant cross section. The stacker builds up a stack pile of 50 000 t while another stockpile of similar storge capacity is being reclaimed. The material is reclaimed by a circle-shaped cut, taken perpendicularly to the center-line of the pile, at 3 levels so as to supply the grinding and drying plant with material at an automated and program-controlled feed rate. The scooped material is carried to the works by an overland rubber belt conveyor feeding a storge belt conveyor, designed to even out minor interruptions in operation and secure regular feed to the grinding and drying plant. The storage belt is fed by a mobile belt controlled to deposit a continuous layer of constant depth. Combined grinding is achieved by an aerofall mill operating in conjunction with a conventional tube mill for secondary grinding of oversize particles, together with necessary cyclones and classifiers. An electro-acoustic device at the aerofall mill determines the set point for the weigh belt feeder and the speed of the storge and intermediate belts. The material removed from the aerofall mill with flow of gas is precipitated in two cyclone stages. The oversize material is precipitated in the first stage. A part of the oversize is delivered by air activated conveyors and bucket elevators to rotary air seperators in which the final classification is effected. The fines from the seperator are added to the finished product from the mill.

The tailings are fed to two tube mills of 6.5 x Ø 3.8 m for further grinding. Samples are taken from the product by mechanical means. According to its analysis corrections can be adjusted from the control room by addition of high or low correcting meal by means of a weigh-belt feeder from 2 correction silos 2500 m^3 each. For drying raw mix: waste heat from kiln exit gases is utilized. The hotter part of air from the cooler is used, being extracted in the middle of the cooler and passed through a multicyclone system for dust removal before delivery by a blower to the grinding and drying plant. Due to the high moisture content this is supplemented with hot gas from an auxiliary firing system whereby the hot intermediate air from the cooler is used as combustion air. The capcity of aerofall and secondary grinding mill is 176 t/h for a fineness of 1% residue on 0.2 mm and 16% residue over 0.07 mm sieve. Dust is collected by an electrostatic dust precipitator whereby an evapourative cooler is applied for effective dust collection even when the grinding and drying plant is not functioning. The dust, together with raw meal from the grinding and drying plant is conveyed to the blending compartments: composed of seven 350 m^3 bins which are successively filled by the overflow method, then emptied simultaneously into a finished meal silo of 7500 m^3 storage capacity. Despite the considerable inhomogenity of raw materials, a good homogenisation is achieved with 0.2°/₀ standard deviation.

The two kilns are 80 x Ø 5.2 m, driven by two synchronized steplessly variable 200 KW direct current motors with dopol preheater and Fuller cooler, rated capacity 2000 t/d, heat energy consumption 760 Kcal/kg clinker. Each kiln is fed by a screw feed pressure-operated pneumatic conveyor, with a third unit as stand-by.

Feed is proportioned by a continuous measuring device, being extracted from an 8 t bin kept full by overflowing, supported on load cells, enabling checking and calibration of the said dosing equipment. An auxiliary drive is provided with electric motor supplied by current from a stand-by diesel generating set.

Clinker is cooled in a Fuller combination type cooler, reciprocating frequency varied with pressure in the first of 5 compartments. Clinker dust is collected in hoppers with monitored emptying to a drag-chain conveyor. A hammer crusher is provided for breaking lumps larger than 40 mm. The hotter part of the exhaust air is dedusted by multicyclone before being supplied to the grinding and drying plant. The rest of exhaust air is passed through a cyclone-type gravel-bed filter.

Monitoring and controlling the process is a chieved from a central control desk where all necessary switching operations can be carried out. Flaptype desks are where all necessary switching operations can be carried out. Flaptype desks are recessed into the wall below the mimic diagram, designed to enable individual drives to be switched.

Quite a wide range of cement products are produced in various Dickerhoff plants, including Normal, Super-fine, High early strength, Sulphate resistant, Expansive, Pozzolanic, Blast furnace slag, Masonary, White and coloured cements. Within the scope of each type, various compositions & colours are tailored to suit the market needs. Extensive efforts are exerted for quality control and for managing raw materials composition and process particulars for keeping up satisfactory standards.

The central laboratory for Dyckerhoff cement plants was visited. The main activities for this laboratory is for assistance of the works laboratories at production sites for checkings on chemical analysis and physical tests and for research and development work, aiming at trouble shooting for occasional industrial difficulties in the manufacturing processes and studies for innovation in various fields of cement industrial activities.

An explanation was made for organization of laboratory personnel with a brief introduction to the scope of work for each group in fields of chemical analysis, physical tests, raw materials investigations, research and development. The installation for different activities were intoduced with special reference to their performance . Catalogues for supplies of laboratory installation were presented. These informations contributed to the apprapriote selection of installation to be applied in the research and development center.

Annex IV

PHILOSOPHY OF MACHINE SUPPLIERS

A. United States of America

1. FULLER CO., BETHLEHEM:

One of the most useful visits was that to Fuller Co. designers and machine suppliers. Research and development work are promoting cement manufacturing technology. A satisfactory review was made in an approach to process promotion and research procedures. Fuller philosophy in development of appropriate design was explained for several types of equipment known to be Fuller speciality. A special emphasis was made for.:

- Flash calciners: as means for reduction of the role of rotary kiln by accomplishment of 90% of calcination in the heat exchangers , and therfore confining the role of kiln to sintering, thus reducing its necessary volume by less than half for the same capacity as compared with the suspension preheater kiln. The flash calciner suspension preheater, commercially proven system is now produced under licensing agreement with the Japanese Co.IHI.

The raw mix is heated in the preheater and then fed into the flash furnace where it is 90% calcined, then passed over to stage IV where it is collected and fed to the rotary kiln. The tertiary air duct carries hot air from the grate cooler to the flash furnace for secondary combustion. The spinning air from the vortex chamber simultaneously accomplishes combustion of fuel and heat absorption by the pulverized material. This system reduces the burden previously charged to the rotary kiln, thus securing longer brick life and therefore less downtime is necessary. In virtue of the regular operation an easier operation is practiced and better quality of clinker is secured. Also air pollution is reduced due to lower temperatures in the flash furnace to about 900°c, and thus lower NOx, but this factor has to be carefully studied to disclose exceptional conditions in case of a specifie coal composition, Because only 40°/₀ of total fuel is burnt in the kiln, and only 10°/₀ of the calcination is effected, the amount of kiln exhaust gas/t of clinker is substantially reduced. This results in a higher concentration of alkalies in kiln exchaust gases. Thus the size of bypass system is drastically reduced. The result is reduced capital costs in virtue of smaller kiln and bypass dimensions & lower electric power consumption due to the reduced gas flow.

This system can restore an old small uneconomical kiln into a highly productive operation. An existing wet kiln may be modified to increase its production 3 to 4 times with consequent saving in power and labour, but specific consideration has to be given to the kiln conditions and capacity of machinery and equipment for the rest of the process.

- Bypass system: was developed to eliminate chlorides hampering the proper operation of the suspension preheater and to reduce alkalies for promotion of low alkali cement production. Chlorides which are almost completely volatilized in the burning zone and recondensed in stage 4 are recirculated and concentrated, and consequently cause build ups and plugging. Sice alkalies and sulphur are only partially volatilized in the burning zone, they eventually leave the kiln in the clinker and therefore adversely affect its quality. The main philosoply of the bypass system is to drive out a part of gases to an air quenching chamber to cool the objectionable compounds (mainly compounds of Cl, alkalies, & sulphur) to cause the rapid transition from vapour to solid state and prevent liquid formation. A programme for evaluation of bypass fraction has been developed by tracing concentration and volatility of various undesirable components and readjustment in accordance with practical experience. When an excessive bypass of 30% or more proves to be necessary, the operation of an Sp kiln may be impracticable SF with bypass is advantageous, as much smaller bypass is required to create the same effect. With some raw materials when the volatility of alkali is law it would be economic to increese volatility through the use of additives in raw feed.

- Clinker cooling: the role of Fuller air quench reciprocating grate coolers were explained in providing quick quenching of clinker, recuperating heat to provide high temperature secondary air, clinker cooling to a low temperature for safe handling by other system equipment, clinker conveying to a point where it can be discharged onto a low temperature conveyor; clinker sizing to preclude entrance of large pieces into the rest of the system. The designing principles were mentioned for dividing the undergrate plenum chamber into a number of compartments each with its own fan to supply air at a pressure and volume compatible with conditions in the specific section.

An emphasis was made to possiblities of taking air from the cooler to flash calciners or dryers and venting excess cooling air to the atmosphere. Optimum cooling conditions were emphasized through maintaining proper air flow and bed depth by regulating the grate speed to assure proper clinker retention time and air distribution. The sizing of clinker was demonstrated through dircharging it through a grizzly and hammer breaker of which the upswinging hammers strike oversize pieces and drive them back onto the grate for additional cooling of their hot cores before they again approach the grizzly. Development of the clinker cooler has recently been achieved to cool clinker and recuperate heat simultaneously, with a minimum of maintenace and down time. Engineering analysis of the cooler design resulted in structural components providing adequate resistance against heat, wear, and mechanical stresses and provide ample operating flexibility to permit the control necessary to the clinker fluctuations. The evolution practiced for the cooler development was traced with the reduction of grates slope, introduction of horizontal cooler, and ultimately the combination cooler with multidrives, 3° slope at the feed end section with the hottest product, followed by 3° slope at the cool zone grate section. Any succeeding sections would be horizontal, the clinker being cool enough to be safely handled. The spillage conveyor was moved outside the cooler with air operated double tripping valves to reduce leakage of cooling air. The pressure in each compartment regulates speed of corresponding grate sections. An internal wheel design has been incorporated, eliminating all openings in the side frame except for drive shaft penetration, resulting in a more efficient use of cooling air. A viewport for periodic visual inspection of the wheel is included in the design. An improved shaft seal is being used on the crosshead shaft. The clinker breaker hammers may now be replaced without removing an entire rew of hammers. Supporting the lewer end of the grizzly assembly allows for thermal expansion. For avoiding additional stacks the gases not used for combustion or drying are recirculated after passing through a low pressure drop mechanical dust collector and air-to-air heat exchangers in parallel. The automatic control for cooler operational parameters add to merits of cooler functioning.

A survey visit was also made to the research and development facilities of Fuller in Catasauqua, where the role of the research team in product development and in problem shooting was discussed. A bief account was given of procedures adopted to evaluate suitability of raw materials, propose adequate equipment design and predict future performance. For this purpose a demonstration was performed for computer application; data analysis and conclusion formulation. The research and development comprise a well established laboratory equipped with installation for chemical analysis, modern research equipment. A visit was performed for microstructural investigations being achieved by application of the University electron scanning microscope.

Pilot tests are practiced in a well equipped pilot plant in Catasauqua, provided with model installation for development of various aspects of cement technology including comminution, pyroprocessing, and pneumatic transport.

The visit and related explanation were organized by the training department which is adequately provided with experienced responsibles and uptodate educational facilities, Training cources are availed in various branches of operation and maintenace. Training cources are available in: automatic control, cement plant process simulation, preventive maintenace, supervision, management for technical dep . Heads, problems solving & decision making. Seminars are organized in operation, maintenace, Fuller Kinyon pumps, rotary compressors, grate coolers, mill systems, conveying, process systems... etc.
Most modern is the automatic process control course recently prepared to meet demands for plant personnel to apply the latest control technologies. Hands on training in controller tuning and loop operations are performed on the "Process Simulator Trainer" covering important fields including: Application of process control, Instrument characteristics, process loops, Variable measurements, Control signals, Controller actions: proportional, reset, derivative, Final control elements & Controller tuning concepts. The distinct advantage of simulator training is the ability of trainees to develop operating skills without affecting plant operation, experience various of malfunction, break downs and failures that would othewise interrupt plant activities and damage equipment.

2. ALLIS CHALMERS Co.

The visit to Allis Chalmers Co. was very useful, as it provided good knowledge about continued efforts of designers to overcome problems encountered in practical experience, and information about achievements of the advanced technology center (ATC) team in developing adequate technologies.

Allis Chalmers Co. is dealing with a wide range of mining and processing systems, cement making machinery and equipment. Modern achievements in the field of cement technology were studied. An innovation in the design of the traditional suspension preheater was explained: by removing the limitation in production capacity and increasing the specific loading of the kiln by raw mix precalcination before feeding to the kiln.

The development of RSP (Reinforced Suspension Preheater), being produced under licence agreement with Japanese firm Onoda could drop the specific heat consumption to 74 Kcal/Kg clinker, and increase the specific kiln loading to 2.5 times the normal suspension preheater. A swirl furnace is included in the preheater 3rd & 4 th stages with hot air from clinker cooler through a recoup duct feeding the swirl furnace by 3 branches. Fuel is furnished and burnt to provide the high heat input required for decarbonation of the raw mix. Kiln exhaust gas is also used for preheating, and the swirl furnace provides a 2 nd heat source. Only 40°/o of the total fuel is burnt in the kiln; that lowers the gas volume flowing through the kiln and the heat released therein, permitting smaller kiln, with consequently lower investment and shipping costs. It also costs less to maintain a smaller kiln, the refractory life is improved in virtue of smaller diameter and lower heat intensity and and stable operation. The bypass operation involves less dust and heat loss, the quantity of bypass gas from an RSP kiln being approximately 40% from that of an SP with same bypass percentage. Seperate firing of kiln and preheater results in better control of the process.

There are two gas paths from the cooler to the preheater mixing chamber, with consequently common differential pressure between start and end points. The recoup duct has greater resistance at its desired flow rate than the kiln at its desired flow rate. To compensate for this imbalance, an additional resitance is added to the kiln in the form of an orifice located between the kiln feed and housing & the mixing chamber. The desired flow in each path is obtained by sizing of the resistance controlling orifice. Desired flow split is obtained through a damper in the recoup duct. A single preheater string would be used up to 3000 t/d, and for higher capacities a double string preheater is used. The preheater- kiln air seal utilizes a cooling air passage incoprporated in the tapered end section of the kiln shell. Dust return buckets are provided at the lowest point in the air seal assembly. A floating seal ring with 4 roller contacts loaded by counterweights, supported on tracks at the seal horizontal centerline, permits axial kiln expansion and movement. The combustion in swirl calciner occurs at a relatively low gas temperature due to the rapid heat absorption by suspended mix as calcination occurs, quenching the gas to a calcining equilibrium temperature. Combustion gas and partially calcined material exit from the bottom of the furnace through a duct to the mixing chamber, where decarbonation up to 85°/o occurs. Coal as fuel in the swirl furnace is introduced downward at 2 coal burners in moderate cases, and 3 burners in cases of larger capacity.

Various other systems known for Allis Chalmers supplies were explained:

- Stoker type clinker cooler: effectively recoups heat and grate plates for longer life.
- The ACL system travelling grate cooler: makes it possible to produce top quality low- alkali cement form high-alkali raw materials, being a travelling grate preheater/kiln system with double bypass and an Allis Chalmers stoke cooler.
- Roller mills: being manufactured and marketed under licence agreement with G.Pfeiffer A.G, FRG; with 3 roller design, grinds and classifies cement raw mix, handling raw materials size 5-10 cms with moisture up to 18°/o ; Quick-change segmented roller liners, easily replaced inside the mill; Designed to use recuperated heat from suspension preheater system, being well proven means of energy conservation.

The ATC was visited, whereby research means and procedures were seen and discussed. The ATC conducts process development, ore and mineral testing, for best utilization of natural and energy resources. Facilities are available for performance of individual lab. scale tests, on more extensive investigations on a pilot scale to duplicate complete process flows, whether a single circuit or an integral plant. The test program permits specialized experts to develop complete process flow sheets and select size and design equipment for the specific case.

Complete facilities are available for investigating every important processing phase. The study starts with chemical analysis and mineralogical examination. Representative testing facilities of interest were indicated:

- Raw materials analysis: data used to evaluate potential clinker proportion, determine mix proportions, levels of alkali, sulphur, and chlorine that can affect system operation.
- clinker analysis: determination of major oxides and phases, evaluation of clinker potential by microscopy.
- Coal investigations: measuring heating value, composition procedure to develop data on the amount of clogging and build-up of ash and meal, of special importance to performance of coal fired systems.
- Particle size analysis: various tests are adopted to determine the physical properties of fine particles or agglomerates. Most important tests performed are: sieve analysis, infrasizer analysis, Blaine specific surface area.
- Thermal analysis: Determination of specific heat enthalpy and temperatures of major compound reactions. These data, related to pyroprocessing equipment design and operation, include: thermogravimetric analysis, differencial scanning calorimeter, differencial thermal analysis.

- Alkali volatility test: determining the amount of alkali removed from a sample of raw meal at various temperatures and atmospheres. Data derived from this test can be used to design kiln bypass requirements.
- Clinker burnability tests: determining the relative ease of burning into clinker: a given raw meal of given composition By microscopic examination, clinker quality and potential can also be checked.

The development of processing parameters continues with extensive tests in the pilot plant. Extensive facilities permit practically unlimited range of investigations for various processing parameters:

- Crushing & screening: possiblities include jaw cushers, hammer mills & roller crushers. Each unit can be operated individually or may be integrated into a continuous open or closed circuit, with a variety of screens positioned before and between crushing stages.
- Roller mill circuit: complete roller mill installation for application studies, combining drying, ginding, and classifying into one operation. Material is fed to a rotating table, set with 3 grinding rollers, fastened downward onto the table by loaded spring pressure, into a stream of hot gases. Ground material is carried up by rising gases to a chassifier, oversize particles are returned into the grinding zone.
- Ball mill systems: complete grinding circuits, in pilot scale, are maintained for continuous grinding investigations. Conventional mills are available and can be operated wet or dry in open or closed circuit. Mills can be augmented

with an assortment of screans, thickeners, slurry tanks, filters, cyclones, air classifiers, and other auxiliaries. Filtering of slurry from the grinding mills is accomplished with disc drum or pressure filters.

- Comminution laboratory crushability and grindability tests are conducted to determine the materials bond work index, a value from which comminution equipment requirements are calculated. Metal wear in grinding mills varies with each material. Abrasive character is evaluated by abrasion testing, results of which are applied for designing process equipment.

- Agglomeration: product quality improvement and raw product application, resulting from altering size, shape, density; or other material properties, are evaluated in a complete compacting and granulating circuit, equipped for homogenizing, prewetting preheating prior to seperate or integrated compacting and granulating stages.

- Pyroprocessing: Thermal process studies are made in continuous pilot circuits using a suspension preheater tower, travelling grate, a selection of conventional and ported rotary kilns and static or dynamic bed coolers.

Typ ical processes investigated include drying, dehydrating calcining, burning.... The pilot plant is equipped to transport received materials directly to pyro-processing equipment or to continuously prepare agglomerated feeds before subsequent pyro-treatment.

These facilities may be considerd as a model to be quoted for the set up of the Chinese Cement Development center.

B. Federal Republic of Germany

1. HUMBOLDT WEDAG, KHD INDUSTRIEANLAGEN A.G. COLOGNE:

During the visit: 3-days programme was arranged, an intensive explanation was given of the whole scope of machinery and equipment in the field of cement industry, with special reference to latest development achieved by KHD in machinery design, and recent innovation for rationalizing cement making processes. Examples of conversion processes were exposed to evaluate the progess developed with old machinery, modernized for attaining doubled production, reduction of fuel consumption, and attaining reguler operation with consequent rationalized quality.

- Clarification was made with examples for application of multicyclone separators for closed circuit grinding, which enable a production rate up to 500 t/h of finish ground material with one separator still yielding top quality cement with a fineness up to 6000 cm^2/gm Blaine specific surface area.
- An explanation was given for the principle of tandem raw grinding and drying by the closed circuit ball mill provided with hammer crusher which reduces the size of raw materials before entering the mill and thus spares the effort to be exerted for crushing in the first compartment. Furthemore a considerable proportion of grinding is also economized as the fine part of crushed material is carried by the upgoing stream of hot gasses straight to the gravity seperator, which returns the coarse particles

to the mill for further disintegration, and the fines are carried up to the cyclone seperator, whereby it is conveyed to the homosilo.

- The evolution of raw meal preheating for rational clinker production was traced since the introduction of Humboldt suspension preheater with multicyclone system at the beginning of the fifties. In collaboration with the Japanese firm IHI, the pyroclon system was developed whereby fuel of any type is burnt in a precalciner in a gas atmosphere formed by the rotary kiln waste gasses and clinker cooler waste air. The raw meal is thus preheated to decarbonation. Multiline preheater was developed by matching the number of lines to the desired overall capacity with advantageous patterns for cross sections of individual lines. Use could be made of coarse coal, truck tyres, wooden remains, still keeping the temperature near to the dissociation levels. Kiln dimensions could be maintained within economic levels with extended service span of refractory lining and an increased production capacity. Close studies are being performed to apply the most economical solutions to specific cases and capacities of types of pyroclon systems.

R: Regular: where combustion air for the pyoclone firing facility is directed as tertiary air in a seperate line.

S: Special : Where combustion air is passed through the rotary kiln in order to attain a high degree of calcination through higher temperature exposure, the exit gas losses can be reduced by addition of a 5th. preheater stage. A precalcining rate of 95% can be realized by high firing rates at the precalciner. The resulting high waste gas temperatures and related heat losses will be compensated for by a 5th. preheater stage. The R system with short kiln and 5 - stage preheater is characterized by low heat consumption and investment costs.

In cases where available raw materials do not allow for dry processing of raw meal, processes have been developed for changing over the wet process klins to dry process to save thermal energy but still maintain the wet preparation of raw materials. In this case the homogenized slurry is subject to mechanical dewatering to a residual water content of 17 - 22% then thermally dried to residual moisture of less than 1% in a special flash dryer by utilizing waste - gas heat from the burning process or cooler. This arrangement enabled drastic reduction of specific heat consumption especially when combined with pyroclon system.

- Selection criteria were surveyed including:
- Effect of location in respect of plant size, dust laiden gas, noise emission, space and area requirements, layout possiblities, raw materials influences, altitude of plant location, and demands of attendant personnel.
- The comparison was extended to cover capital expenditure of mechemical equipment, electrical installation, refractory materials, insulating work, building operations, erection and commissioning procedures, and spare parts requirements.
- The operating costs were approached for each type with special reference to heat consumption, electrical power

requirement, wear and maintenance burdens, operational availability.

- Some design and engineering problems were mentioned such as possibilities for design improvements, flexibility of throughput, clinker quality, coating formation on the cooler, and suitability for hot air offtake.

- Electiostatic dust precipitators air installed for dedusting large flow rates of waste gases behind kilns, grinding & drying installation. The electiostatic dust precipitator is preceded by an evaporating cooler for water injection to hot and dry kiln waste gases to meet strict requirements for environmental protection.

Qualities were surveyed, specially mentioning durability at high temperatures, insensitivity to grain size fluctuations, reliability in respect of seperating superfine dust particles and low energy requirements as a result of small pressure losses.

A close explanation was given in the department for electrical engineering and automation for incorporation of optimum electric equipment from high voltage incoming feeders via energy distribution, electrical drives, monitoring and controlling up to the control center and different control standards. The control systems are focused on facilitating process particulars for the operating staff. Miniaturized construction and colour display units for multitude of variables are suitably presented to the operating staff, whereby computers are used for data processing.

Control programs are developed and tested for different production processes resulting into comprehensive programme packages for fully automatic process run and synchronized starting and stopping of the plant.

General information was given about the function of monitoring & interlock systems of relay type with electronic cards or with programmable control unit, the incorporation of computer for data processing scan, log and alarm systems process control and optimization, the adaption of computerized "WARTAS" system for planning of preventive maintenance and organization of spare parts depositing and ordering.

A review was also made for the x-ray fluorescent spectrometry based upon excitation of atoms by x rays. Reference was made to the special DIMEX system which provides an electronic facility for interfacing with a process computer, and forms a complete unit which delivers control signals that have been matched to the specific needs of the process computer. The x.ray fluorescent analyser continuously measures a flow of

sample material that has been branched off the main flow of particle size reduced to analytical fineness. The x-ray fluorescent analyser is integrated in a closed loop with the sample processing facilities and process computer. Sampling and transport facilities are designed to meet the continued analysis.

Several technologies were also explained:

- The application of high pressure water pumps for clearing the preheater checking, heavy building in the entrance of the rotary coolers, and for eating up growing teeth of clinker ring formation.
- Study for effect of flame temperature in comparison with sintered charge in the buringing zone.
- Determination of optimum draught speed for the least dust development
- Application of special kiln hood for dedusting and conditioning of tertiary air from cooler on the way to the pyroclon .
- Applica on of low grade fuel as lumpy coal, briquetted lignite, motor tyres, wooden chip upto 20% of fuel requirements in the pyroclon, and advantages of consequent slow oxidation. The harmful pollutants contained in these fuels are absorbed in the preheater and are found in the clinker in a harmless form.
- Governing conditions for development of NO_x & SO_x in exit gases.

Ultimately the research and development laboratory was visited, whereby various physical and chemical investigations were plained with applicability of adequate laboratory installation for the purpose. Some of the installations are tailored to match the diversified fields of specialization in the mining and metallurgical fields. Others are applied for study of new raw materials prospected for the study of installation of a new project. The experience & know how are implemented for deriving appropriate relations leading to the designing criteria of machinery.

2. KRUPP POLYSIUS AG., NEUBECKUM:

The visit to polysius Co. was very useful for reviewing an important side of the question of conversion in the course of modernization of the present cement works The main concern in this visit has been the conversion of wet precess to semi -wet process: mainly keeping wet process preparation of raw mix, then adopting the semi - wet processing through mechanical dewatering by disposal of practicable portion of water content, then feeding the raw meal to the kiln in the form of semi- et material on Lepol grate. This procedure procures special importance in cases where wet process raw materials preparation is preferable due to excessive moisture in raw materials and where leaching out of alkalies and chlorides is required for obteining low alkali cement. Automatic pressure filters are mostly applied for the purpose, preferable to suction filters in virtue of higher efficiency and more drying capacity. The increase in production would necessitate revision of the cooler capacity, For installation of a new cooler of larger capacity the procedure for evaluation was considered for the main factors of cost, downtime, and limited space. To meet the requirements for the production of low alkali cement, a by-pass arrangement can be installed for the continuous discharge of gases with alkali content. The by-pass arrangement also reduces the danger of operating problems such as chokes and buildups.

For the Lepol grate using pellets instead of raw meal reduces the dust load in the kiln exhaust gases. The amount of waste dust with the same percentage of by-pass is lower than with suspension type preheater.

Various factors influencing the conversion were discussed. In the course of raw materials preparation, the main role of hot gases application for drying raw materials was pointed out. The criteria for selection of the type of mill were approached, depending upon composition of raw materials, whether the air swept mill or the roller mill.

Discussions were extended to deal with concepts of approaches in responses to combined economical outcomes for the energy crisis, rising labour cost, and the consequent need to reduce the operating costs. The two main domains of conversion were tackled: viz. conversion from the wet to semi-wet process, and shifting to coal to replace the oil firing. The main targets of the conversion being saving of fuel and increased production. It has been emphasized from practical experience that in wet process every 1% of water content in the slurry would require 20 K cal/Kg. of energy. This fact stands as a guidance for the economy of conversion of wet to semi-wet process.

The impact of fuel oil price increase upon the cost price of cement was analysed and the consequent trend to coal firing was traced, with special emphasis to process engineering in respect of energy consumption, product quality and environmental protection. Major attention has been paid to ensure that the optimal specific fuel consumption is maintained, and possibilities for utilization of cheap waste materials as fuel. The effect of coal ash upon clinker composition parameters was exposed, supported by examples from the actual practice, especially when low grade coal with high ash content is used.

Special reference was made for instances where sulphur or chlorine content is excessive, and the role of by-pass system in solving the quality problems. The factors to be taken into consideration within the engineering aspects of coal firing are: caloific value, ash and moisture content, voletile constituents fineness of pulverization, primary air proportion and temperature, secondary air temperature and velocity. All grades of coal can be fired in the prepol precalciner. Low grade materials can just as well be utilized such as charcoal, oil chalk, and even wood shavings and motor tyres. The coal grinding mill is heated with inert waste gas from the preheater. Special mention has been presented for safety precautions by implementing cool firing. Elaborate measures to prevent access of oxygen as well as extensive fireprevention and fire-fighting arrangements were discussed. Three elements of explosion, namely: oxygen, ignition source, and coal dust concentration were exposed with possible measures for avoiding coincidence of their accumulation. Precautions by providing adequate area of explosion doors were exemplified by instances from practical experienee.

The visit was extended to see the development center comprising the laboratory research area and pilot plant studies, dealing with questions arizing from numerous parts of the world, whether investigations for new raw materials for future projects or through follow up proceedings for works under commisioning or continued operation. One of the first targets of raw materials investigations is to conclude raw mix design, recommend machinery type, foresee materials charfcters and therefore the behaviour in the chosen process.

In the development center: various activities were studied:

- Traditional chemical analysis promoted by modern facilities for stirring, shaking, automatic titiation .... etc
- Detection of chemical nature by the help of useful apparatus such as calorimeters, flame photometer, atomic absorption spectrometer . .... etc.
- Qualitative and quantitative mineralogical investigation with the help of Rentgen diffractometry and fluorescence, high temperatue microscopy ... etc.
- Studies of fine structure with modern facilities of microscopy to determine the microstructure and therefore back-up the chemical knowledge with explanation to different behavior for materials of identical chemical composition.
- Reveal of physical nature of materials such as particle size distribution and behaviour in relation to temperature rise .

The pilot plant is well equipped with models availing the industrial conditions for study of various features, and conclusion of material behaviour on an industial scale. The pilot plant is furnished with various installations for crushing, grinding, mixing, granulating, briquetting drying, burning, and cooling. Of the main pilot plant equipment provided are:

- Ball mills of various types and sizes.
- Roller mills with different roller wheels and plates possibilities for testing the grinding parameters as well as wear intensity.
- Rotary kiln with different alternatives before the inlet and after the outlet.
- Belt weigh-feeders provided with regular flow of material from adequataly sized hoppers.
- Various types of conveying equipment, sieving devices, granulators, pelletizing installation, homogenizing facilities, dust filter,..... etc.

In the cource of technological investigations, many alternatives are provided for adaption of the required handling. For example: The kiln can be adapted with different alternatives of feed devices and heat exchanges. any of Polysius systems: Lepol , Dopol, Gepol, Prepol, are available in a handy tower construction which can provide the same kiln shell with the required conditions anticipated to be the most suitable whereby practical results are detected. Meanwhile, various types of chinker coolers may be adapted to the kiln system. Raw materials are hoisted to hoppers which can serve various operations and cope with different alternatives.

Various components of pilot plant equipment can be connected to a control pannel whereby the best proceedings can be centrally controlled, various parameters are indicated, and particulars recorded for further reference.

The system of samples keeping enables future reference to any particular case after considerable elapse of time.

Annex V

INTRODUCTION TO CEMENT ENGINEERING GROUPS

1. KAISER ENGINEERS, USA

During the visit to Kaiser Cement Co., meeting was arranged with leading personnel of the consulting group "Kaiser Engineers", where a briefing was given. According to informations exposed by Kaiser Engineers representatives and literature about activities of the said consulting group, it is said to be one of the world leading engineering and construction arganizations. Its origin reverts back to 1914. Since then it has provided technical planning, engineering and construction knowledge, with special experience in handling large difficult projects in remote locations where introduction of new technology has been achieved, with special reference to the know how in the field of suspension preheaters with flash furnace precalciners. The group provides consultancy over a wide range of activities including survey and market analyses, industrialization water plans and expansion programs, engineering and planning studies, schedules, controls, computer applications, operation planning and management, detailed design, and training programmes.

The said information has been noted for future reference, with special interest in training activities. Kaiser Engineers may be approached for training cement technical personnel in cement factories where Kaiser Engineering have exerted a special effort. Training in this case would be more suitable than many other possibilities where the questions of language and availability of training facilities may be a decisive factor.

2. DYCKERHOFF ENGINEERS, FRG

The visits to Dyckerhoff cement plants Mark II in Beckum and Amoeneberg in Wiesbaden were organized and guided by Dyckerhoff Engineers. It was well emphasized that Dyckerhoff Engineers plan for all technical affairs for the group of cement works which are in fact of an appreciable size, widely distibuted over vast areas of diversified conditions. Dyckerhoff engineers assess results of research work in Dyckerhoff central laboratory and plan for modernization of existing cement plants with special concern for environmental protection, energy conservation, and appropriate application of low grade combustibles. Dyckerhff Engineers also conduct feasibility studies for new production lines and adapt the most up-to-date design to satisfy the latest requirements. The most suitable designs are selected from various origins, and detailed engineering work is achieved to combine the whole assortment of machineny and equipment into well harmonized production lines with the best technical and economic possibilities. It was stated by experts from this group that consulting work has been extended to numerous countries of various industrial conditions.

Special training programmes can be tailored according to needs whereby practical studies can be organized in cement works of Dyckerhoff group. Intensive language courses may be arranged at request. Technical management is negotiable to cope with special conditions.

Experts of Dyckeiloff engineers mentioned some examples from practical expeiece in various locations.

Annex VI

STUDIES AND DEVELOPMENT

1. PORTLAND CEMENT ASSOCIATION, SKOKIE, ILLINOIS, USA

Established in 1916, dedicated to improving and extending the uses of Portland Cement and Concrete, it is supported primarily through voluntary contribution by member companies in USA and Canada, and through contract research and educational fees. Activities include: scientific research in Portland cement and concrete, engineering work in all fields of concrete use, development and promotion of new and improved cement using products and methods, market research and reporting, professional and vocational education in concrete technology and construction practice, marketing, sales, management, and manufacturing processes, technical services, to improve the quality of concrete, industrial safety, and environmental control for member companies.

The visit to Portland Cement association revealed a lot of information in the fields of cement and concrete research. Through long experience, a wealth of useful data and practical knowledge clarify the sides of problems before laboratory research begins. This created the capability to contribute in national execution of projects from the earliest planning through completion, and consequently prevent many problems from ever occuring.

Procedures for scientific approaches were explained, and the organizational structure was clarified through comprehensive analysis. Special attention was paid to investigate various particulars of the activities practiced so far, being an adequate model for technological facilities devoted for scientific study of cement and concrete to be adopted for future activities of the Chinese Research and Development Center after adaption of activities to accord with special conditions in China.

The testing and resarch capabilities were explained through a slide display, and an indicative demonstration in various laboratoires, with observations and remarks made on laboratory equipment and research installation applied for solving industrial problems. Samples of studies were exemplified on recent work: strains, deformations, & loads, using nondestructive sonic techniques, precise determinations can be achieved for concrete strength, and pinpoint internal cracks, voids, and other flows electronically. Consequently remedial measures can be recommended.

For energy conservation, facilities are provided for testing heat transmission and insulation characteristics of full size wall assemblies under simulated in-service conditions, to provide data for improving energy efficiency of building systems. Special efforts are extended to develop improved light weight concrete using conventional and special aggregates, including expanded shales, slate and clay aggregates, and polystyrene beeds, with evaluation of fibre reinforcement to improve cracking resistance of low density concrete.

Studies are conducted for repairability of damage caused by fire and explosion as well as modernization of older buildings to with-stand heavier loadings. Heat testing furnaces are linked to computerized data acquisition system that gathers diversified test information and provides it in a printed form, assisting in determination of high temperature properties such as short and long term creep characteristics, compressive and splitting tensile strengths, modules of elasticity, and thermal expansion

The informations section maintains a library relevent to the specific and engineering aspects of cement and concrete technology, including a vast collection of references, periodical volumes, patents, governmental and university reports, technological publications, bibliographies, journals, international literature, exchange agreements are maintained with cement and concrete associations, institutes, testing laboratories through-out the whole world. Information is also available in the form of digests, translations, comprehensive literature searches, and other library services .

Educational facilities are arranged for in-house programs, covering manufacturing processes, sales & management, maintenace, & special subjects.

Class sessions are held with aid of audiovisual teaching equipment, including closed circuit television system. Research and development laboratories are used for demonstration. Field training is procuring an increasing interest due to the increased cost of transportation resulting from the energy situation. Special programs are accordingly arranged to accord with specific cases.

The set up of activities achieved by the Portland Cement association is the most suited for adoption in the cource of organization of the Chinese Cement Development Center.

2. NATIONAL ASH ASSOCIATION, WASHINGTON D.C.

During the visit to "Notional Ash Association", a general survey of flyash occurence and properties was exposed in a narrative explanation, slides show, and photomicrograph display. Specific characteristics for each of the different types resulting from various classes: raw or calcined natural pozzalanos, fly ash produced from burning anthracite or bituminous coal, and fly ash from ligniteor sub-bitumenous coal, were discussed with a special stress upon the economic aspects of fly ash applications. Published research work and useful literature was obtained treating numerous aspects including

- Instances for using flyash as stabilizer for bridges.
- Bottom ash utilization as fine drain fill in construction of multiple purpose dam.
- Use of fly ash for filling underground cavities remotely with dry material pneumatically injected through a borehole to seal openings, prevent air movement, and reduce subsidence.
- Use of bottom ash in cold mix with emulsified asphalt for treatment of secondary roads.
- Bottom ashes in road construction
- Fly ash - sulphate sludge - lime road bulding material
- Ash as impervious fill for storage tanks.
- Fly ash embankment used as stabilizer for correction of slip caused by poor drainage.
- Fly ash application for production of high quality brick-sand and other fired structured products.

- Cement stablized fly ash pavement
- Light weight aggregate designed to meet all requirements of modern construction practice, basic material is pulverized fuel ash.
- Pulverized and sintered at 1300°c to produce hard spherical nodules with a 40% void ratio.
- Application as admix in mass and structural concrete including pumping, grouting, slip forming with better results in environments subject to freezing and thawing and acid attack.
- Use as additive to improve concrete properties to prevent corrosion of the embedded reinforcing steel.
- Advantageous improving resistance of concrete to sulphate attack.
- Effectiveness to overcome undesirable effects of heat produced by hydration of cement in dam construction.
- How fly ash improves concrete blocks , pipes and ready mix concrete.
- Status of technology for the production of aerated concrete from fly ash.

Statistics were developed for various ash applications on the commercial scale.

- Mixed with raw materials before forming cement clinker.
- Mixed with clinker or cement

  Partial replacement of cement in concrete and blocks.
- Light weight aggregate
- Fill material for roads, construction sites, land reclamation, ecology dikes.
- Stabilizer for road bases, parking areas.

3. ZEMLABOR, BECKUM, FRG

Zemlabor: Institute for Building Materials Investigations, is a private testing enterprise based upon 60 years experience in scientific cement investigations, being performed through uptodate research procedures and modern laboratory techniques.

The scope of activities covers the advice in all questions related to construction including building materials production, technologic examination. This covers various scopes related to cement, mortar, concrete, building and construction practice, with an adequate background know-how about characteristics and behaviour of cement products in normal life practice. The institute performs research work upon cement and concrete, and conducts a follow up and development investigations, based upon experienced chemical analysis and physical tests. To this effect it examines building materials and assures proper execution of construction work & highways establishment. It supervises concrete producing plants for readymix concrete, precast and prestressed components, special architectural walls and partitions, building bricks, and light weight concrete, with adequate control upon aggregate constitution, mixing proportions & transport substantials.

It maintains the production of standard sand for cement testing in accordance with the specifications of composition, granulometry, and packing.

Zemlabor organizes training programmes in the field of cement and concrete studies and standard specificrtions requirements. Theoretical teaching sessions are organized followed by actual workshop practice achieved through integration in the daily laboratory work. Technological information prints are issued for the sake of full comprehension.

During the visit to Zemlabor, the study group was guided in a tour through various research sections where a demonstration was made to aquaint the group with equipment applied and procedures adopted for achievement of chemical investigations for cement, mortar, concrete, and aggregate, as well as follow up of eventual problems of waterproofness of cement elements, wear and tear upon concrete members, heat effect upon constructional masses, factors upon early and late stregth of mortar and concrete, frost and thawing phenomena, long term effect of sulphate water, elasticity of prestressed components.

Zemlabor organized a visit to Dyckerhoff Mark Il Zementwerke to demonstrate a living instance of practical cooperation in the field of quality control.

Annex VII

VISITS ARRANGED IN PRC

1. CEMENT DEVELOPMENT CENTER: CONSTRUCTION SITE

In PRC a visit was arranged to the construction site of the Cement Development center. The living quarters buildings are nearly ready, pending for minor finishing work. The main construction activities are now devoted to the main building of the Cement Development Center, on a total area of 1100 m^2, with an internal useful area of 600 m^2.

It is foreseen that the sellar will be devoted for physical tests for cement & concrete

- 1st floor for administration
- 2nd floor for offices for the director, engineers & chemists.
- 3rd floor for research work comprising laboraties for chemical analysis,

x- ray analysis, microscopy, particle size studies, raw mix burnability, microstructural investigations, thermal diffraction analysis, flame photometry, particle size studies. Raw mix burnability, carbon & sulphur analysis, physical analysis of raw materials and cement.

- 4th floor: for electrical control and distribution, instrumentation and control, thermodynamics, thermal instruments, grindability test, technology of comminution, pyroprocessing, dust collection, ventilation, conveyors , and cement despatch. There will be a provision for civil construction research in the uppermost 5 floors.

In the annex building:

1st. floor: will be for typing, archive, printing and computer facilities.

2nd. floor: Informations arrangements, secretarial work

3rd. floor: Library.

In the present stage of execution, the sellar is ready for casting its roof which will serve as ground for 1 st. floor. The finished part was the most complicated as it comprised foundation pales especially designed for the special week nature of the soil, and for the increased effort for pumping the ground flowing water & water proofing of the concrete work for the sellar construction.

It has been stated by the site resident civil engineers that the overground construction work will be much easier, enabling the termination of the civil work for the first 5 floors by the end of the current year 1981.

The uppermost 5 floors 6-10 are scheduled for execution during 1982.

2. TIAN JIN CEMENT PLANT

This cement plants is the nearest to the site of the Cement Development center. It is composed of 2 main processes:-

Shaft kiln process: comprising 3 raw mills Ø 2.5 x L.3.9 m with 13 t/h production capacity + one raw mill Ø 2.2 x 4.4 m producing 10 t/h of raw mix. There are 2 shaft kilns Ø 3.6 & height 10 m. Producing 17.5 t/h with specific calorific consumption of 1000 k cal/kg. clinker. Finish grinding is accomplished by 5 cement mills: 2 cement mills Ø 2.6 x 7.9 m producing 14.5 t/h, & 3 cement mills Ø 2.5 x 6.5 m.

Wet process rotary kiln plant: an extension which was commissioned since 5 months, comprising a slurry mill Ø 4.6 x 13 m producing 45 t/h.

The rotary kiln Ø 3.5 x 145 m producing 23 t/h, with specific heat consumption of 1400 Kcal/kg. clinker. Finish grinding is accomplished by 2 cement mills: Ø 3 x 9 m with 35 t/h production capacity inclosed circuit

In addition to normal Portland cement, blast furnace cements is produced with 30-40% granulated slag content.

The actual production for the year 1980 was in the vicinity of 360 000 t which exceeds the rated annual production capacity 330 000 t by about 9%.

3. CAPITAL CEMENT PLANT

This plant is located in Lu Lee Hau city, and represents a model for cement manufacture by semi-wet process, rotating pelletized nodules over a Lepol grate and by the dry process combined with waste heat boilers.

The plant was first commissioned in 1942 with 4 dry process kilns Ø 2.4 x 39 m with 5 t/h chiker production for each. Hot exhaust gases being applied for waste heat boilers, thus consuming 1600 K cal/kg. clinker. Raw mix is prepared by 3 raw mills Ø 2.47 x 1 7.5 m; producing 27 t/h in closed circuit with seperator. Final grinding is accomplished by 2 closed circuit cement mills Ø 2.2 x 2.5 m & Ø 2.2 x 12 m. In the beginning 100 000 t/y were available which were doubled to 200 000 t/y by 1952, due to introduction of some modifications, and still more output has been attained in virtue of blast furnace cement production since 1953.

Extensions were executed in 1958 & 1975 by installation of 2 Lepol semi-wet kilns Ø 3.7 x 50 m producing 800 t/d each, with specific heat consumption of 1150 kcal/kg. The clinker production was thus raised to 730 000 t/y for the whole plant. Adequate extensions have accordingly been achieved in the raw and finish grinding which then became 6 raw mills & 11 cement mills, that led to an annual production of 300 000 t normal Portland cement + 1 million t of blast furnace slag cement. about 35°/o of the produced cement is despatched in bulk by special tank railway waggons, and 65°/o packed and distributed in bags over building sites of smaller consumption. The total man power is 3500 of which 50°/o are devoted for services including educational and medical activities.

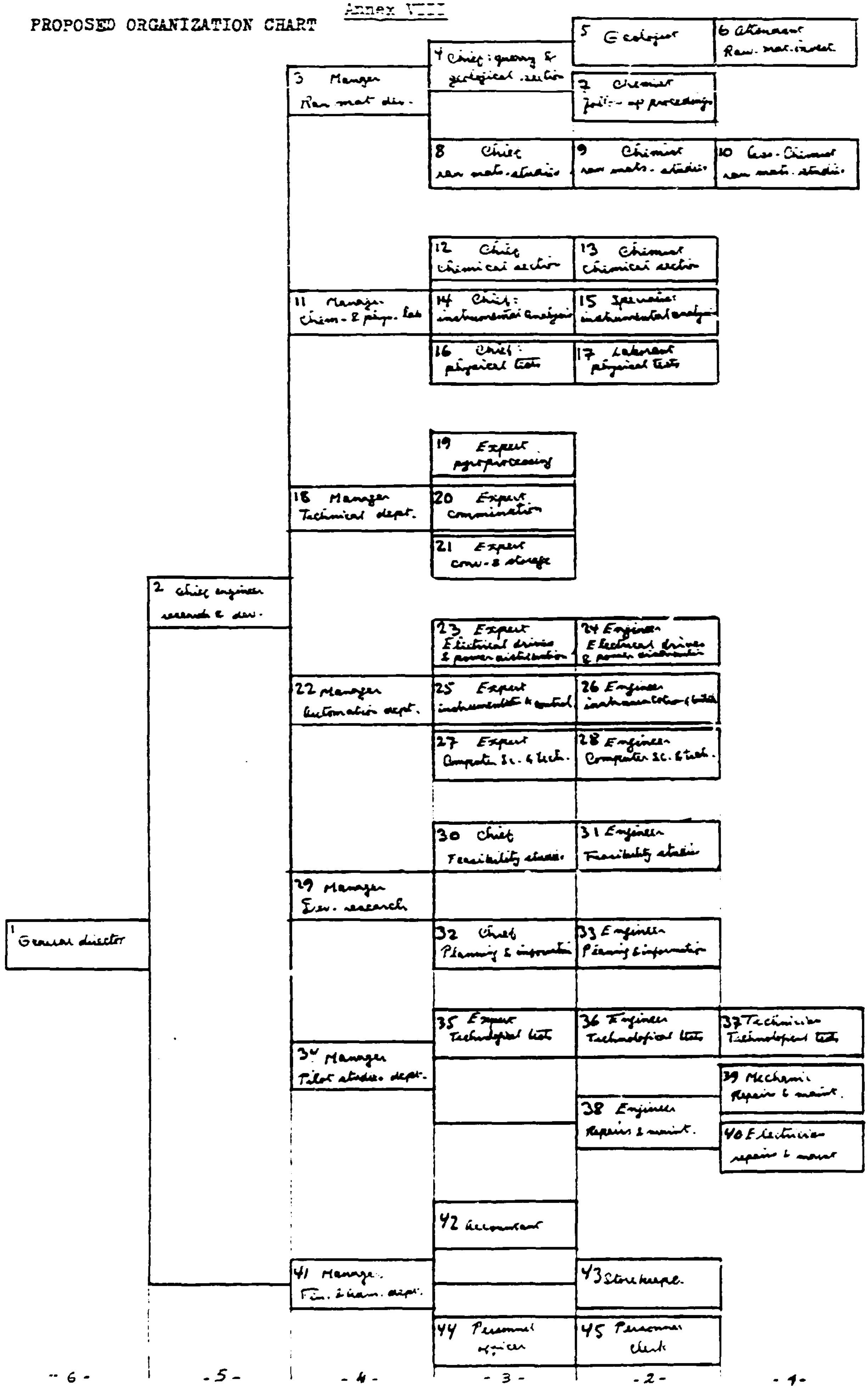
The plant workshop is producing more than 50°/o of spare parts requirements, with a capability for rolling and machining kiln sections with minimum mechanical resouces.

The plant is mainly concerned with 2 main problems:

- Reduction of air pollution which is more aggravated with the increasing environmental concern. To this effect a long term plan has been projected for provision of electrostatic dust precipitotors.
- Energy conservation: as the specific heat consumption is comparatively higher than the recent international achievement in this respect. In the course of planning for the near future the said main fields of action have been foreseen for improvement of insulation under refractory lining in the calcination zone and elimination of air leakage for reduction of heat losses.

Annex VIII

PROPOSED ORGANIZATION CHART



Ser. No.	Level	Pers. No.	Job Title
1	6	1	General director
2	5	1	Chief engineer for research & dev.
3	4	1	Manager, raw materials dev. division.
4	3	1	Chief, quarry & geological section
5	2	1	Geologist
6	1	2	Attendant, raw mat. investigations
7	2	3	Chemist, follow up proceedings.
8	3	1	Chief, raw mat. studies section.
9	2	3	Chemist, raw mat. studies
10	1	4	Ass. chemist, raw mat. studies
11	4	1	Manager, chemical & physical lab.
12	3	1	Chief chemical section
13	2	1	chemist, chemical analysis
14	3	1	chief, instrumental analysis section
15	2	7	Specialists, instrumental analysis
16	3	1	Chief, physical testing section
17	2	2	Laborant, physical tests
18	4	1	Manager, technological dept.
19	3	5	Expert, pyroprocessing
20	3	4	Expert, comminution
21	3	4	Expert, conveyors & storage.
22	4	1	Manager, automation dept.
23	3	1	Expert, elect. drives & power distribution
24	2	2	Ergineer, elect. drives & power distr.
25	3	1	Expert, instrumentation & control
26	2	3	Engineer, instrumentation & control
27	2	3	Engineer, computer science and technique

Ser. No.	Level	Pers No.	Job title
28	2	4	Engineer, computer science & technology
29	4	1	Manager, development research dept.
30	3	1	Chief, feasibility studies section
31	2	1	Engineer, feasibility studies
32	3	1	Chief, planning & information section
33	2	2	Engineer, planning & information
34	4	1	Manager, pilot studies dept.
35	3	1	Expert, technologic tests.
36	2	1	Engineer, technologic tests.
37	1	4	Technician, technologic tests.
38	2	1	Engineer, repairs & maintenance
39	1	1	Mechanic, repairs & maintenance
40	1	1	Electrician, repairs & maintenance.
41	4	1	Manager, financial & adm. dept.
42	3	1	Accountant.
43	2	1	Storekeeper
44	3	1	Personnel officer
45	2	1	Personnel clerk
		80	Total

Annex IX

PROPOSED RESEARCH EQUIPMENT

1. PROPOSED PURCHASES FROM ONGOING PROJECT DP/CPR/80/010

Power supply: Voltage : 220 V

Frequency: 50 HZ

Test materials; Portland clinker & cement and their raw materials: limestone, clay, sand, iron ore, gypsum ..... etc

a- Flame photometer: enabling reliable and rapid determination of potassium and sodium; Ignition preferred electrically, with a flame guard automatically interrupting the gas supply when flame is extinguished, making possible high degree of operating safety; High reliability and precision; With microprocessor to accomplish the calculation; Preferably with protection against false operation steps by signalling test errors and when exeeding measuring range; Measuring ranges adequately dimensioned; Automatic gas & air pressure control; Storage of zero & standard values by key actuation, apparatus check by a check key; atomizer system sample saving; Fracture proof; With easy accessible nozzle head; compressed air supply by external compressor. Gas: Propane.

b- Sulphur analyser: for routine determination of available sulphur between 0.005°/o & 100°/o in coal, coke, oil, and other fossil fuels.

Solid state resistance furnace with complete operator safety, devoid of hazards, automatic Oxygen shutoff; amperometric titration technique unaffected by normal interference; Direct digital read out by microprocessor converting titrant volume to °/o.

C- PHmeter : With transistorized d.c. amplifier and built in veltage source for potentiometric titrations, complete with combination electrode. With improved temperature coefficient of better than 5 micro-volt per°c. The indicator scale mirror backed. Protected against overflowing liquid by compact structure, sealing rings around protruding control spindles, and tightly fitted glass covers. PH ranges : 0 to 8 PH, 6 to 14 PH .

Accuracy: PH better than 0.02; mV better 0.1 mV,± 0.5°/.

d- Atomic absorption spectrophotometer : with accurate gas flow controls,high resolution temperature compensated grating monochromator, peak height on peak area measurement and digital display of concentration, absorption or emission. A deuterium arc lamp background corrector to be provided as accessory. with data centre: compact programmable colculator providing data processing facilities. Program for concentration readout via curve-fitting supplied stored on magnetic cards. Results to be printed out on the inbuilt printer together with statistical information and error warnings.

e- Research binocular polarizing microscope: for investigation in incident & transmitted light, with rotatable analyzer, binocular & photo tube. Basic stand : comprising: lamp housing with tungsten halogen lamp, heat filterconversion filter, diffusion disc & green filter, interchangeable pol vertical illuminator with prism polarizer, rotatable aperture & field diaphragms, objective centring clutch for single objective change with 5 objective changing rings & diffusion disc.

Rot ry stage mounted on ball bearings, graduated in degrees & with verniers. Inclined binocular Pol-Photo tube with automatic sharpness conpensation. Incident light stage micrometer

1 mm - 100 intervals.

Stain free incident light objectives and transmitted light objectives : 5 x , 10 x , 20 x , 50 x , & 100 x

Attachable mechanical stage with click stops for point counting complete. Camera system for photomicrography : fully automatic 35 mm microrcope camera, Photoautomat consisting of interchangeable 35 mm magazine, Motor adapter with objective, Shutter piece for integral measurement.

f - Equipment for raw mix burnability testing :

- Laboratory muffle furnace, with fully automatic regulating system providing current supply voltage to the heating elements. Actual value indication for selecting the operating temperature; Energy regulator for infinitely variable setting of the heating capacity; Selector switch for maximum constant temperatures; High quality refractories; Equal temperature distribution. Temperature range : ambient to 1500°c

Internal volume : large 30 x 30 x 30 cm.

- Ditt ; Temperature range : ambient to 1600°c

Internal volume ; Small 15 x 20 x 15 cm.

g - Equipment for raw mix grindability testing : composed of grinding device; based upon application of a set pressure upon abrasion resistant steel balls disintegrating the test material for fixed periods, plotting the grinding time against the resultant fineness and conclusion of relation of pilot characteristics to the industrial scale.

Recommended suppliers :

Based upon the experience of experts questioned obout the said equipment during the study tour, and invirtue of technical superionrity, specific suppliers are recommended by the study tour fellows for some of the abovementioned equipment as follows :-

Item		Equipment	Recommended supplier
a	-	Flame photometer :	Eppendorfer Netheler U. Hinz GmbH, 2000 Hamburg, FRG,
e	-	Polarizing microcope:	Nikon, Japan.
g	-	Raw mix grindability tester :	Tonindustrie Prüftechnik GmbH Kopenhagenerstr. 60 - 74 c,1000 Berlin 51, FRG.

2. PROPOSED PURCHASES FROM THE PROPOSED PROJECT

Power supply : Voltage : 220 V

Frequency: 50 HZ

Test materials: Portland clinker & cement & their raw materials: limestone, clay, sand, iron ore, gypsum .... etc

a - x - ray fluorescence analyser : complete x-ray fluorescence quantometer equipment of the multi-channel instrument for the quantitative simultaneous determination of up to eight elements (Si, Al, Fe, Ca, Mg, K, Na, & Cl). The instrument will be autonomous, compact unit and its modular concept assures flexibility to cope with changing analytical requirements, to be furnished complete with:

- Thermo-stabilizer against fluctuation of ambient temperature
- x-ray tube and power supply complete
- Measuring and read-out section complete, with instruments, wiring & strip chart printer

An incorporate mini-computer system complete including:

- cabinet for housing all computercomponent.
- Central processing & control unit.
- Electronic filter assembly to protect computer against radio frequencies.
- Magnetic tape casette system
- Printer terminals
- Essential accessories : including:
- Motor-generator voltage stabilizer.
- Closed circuit water cooling system
- Sample preparation equipment for finsihed products: grinding mill

with container, oil hydraulic press.

- Sample preparation equipment for raw materials.
- Operational supplies : including :
  - Oil for vacuum & hydraulic press for x-ray analyser.
  - Paper sheets, ribbons for printer.
- Supervision & advice: the supplier will render technical services for supervision of erection, putting into operation and taking over tests in Tien Jin, PRC.

b- Particle size analyser:

For automatically plotting the size analysis as a graph of cumulative mass percent versus particle diameters; The apparatus will provide for scanning the sedimenting sample by a beam of x-rays whic gives a high resolution. A solid state digital sequencer controls all instrument functions to continuously solve the fundamental relationship of Stokes low and data are automatically plotted on cumulative mass percent versus equivalent spherical diameter

- Programming : easy for any sample density as well as for different liquid densities & viscosities.
- Accuracy : ± 1°/₀
- Particle size range : 100 to 0.01 μ m.
- Data presentation : continuous graphic plot of "cumulative mass percent" versus "Equivalent spherical diameter"
- Resolution : The sedimentary sample scanning in a narrow beam less than 0.2°/₀ of the total distance scanned permitting high resolution.
- Wetted materials: Stainless steel, vinyl on rubber tubing.
- Accessories : To be provided: an adequate set of accessories for rational routine sample dispersion and cell clean up for 5 years operation involving

1500 samples analyses.

c- Electronic air permeability apparatus:

For quick determination of specific surface area. Apparatus electronically controlled timing register with indication in terms of 1/10 second; electric suction pump; absolutely tightly sealed solenoid valve; vertically adjustable electrode for calibrating; observation window in the front plate.

- Accessories : ample amount of operational material for 5 years involving 1500 samples: filling oil, circular filters of 40 mm Ø, dust filters, stamper for pressing out specimens.

d- Coal analyser : for determination of moisture, volatiles, ash, & fixed carbon, with automatical display of information for furnace & oven temperature & time remaining for run. Compact self contained system comprizing :-

- Muffle furnace : of high performance to be operated as static air furnace for valatiles or forced air furnace for ash determination. Temperature range : Ambient to 1000 °C. selectable in 1°c increment. Temp. uniformity ± 10°c, temp. accuracy ± 2°/₀ , accepts 40 samples simultaneously.

- Oven : for moisture determination; forced air determination with 4 complete atmosphere changes per minute. Temperature programmable from ambient to 140°c selectable in 1°c increments. Temp. accuracy ± 2°/₀ , accepts 40 samples simultaneously.

- Sample crucibles : self-sealing fused quartz cups with self sealing lids which rise to allow combustibles and noncombustibles to escape during the volatiles run, then sink back to restore seal; Eliminate the need for manual repositioning;

and provides and oxygen-free atmosphere which prevents samples from ashing during volatiles run.

- Desiccators : 2 each accepting 40 samples simultaneously, for cooling samples in a dry atmosphere, ensuring accurate dry basis results.

- Microprocessor: Built-in operational programs for volatiles and ashing determinations; Processes signals from keyboard for entering own programs; Performs all necessary calculations including that for °/o of fixed carbon from dry weight, volatiles & ash data; Controls heating temperature, atmosphere, and duration of run in furnace and oven.

- Printer: Records the results of each determination. Data to be printed at the end of each analysis or stored in the memory for recall at any time. Results grouped & printed out as °/o of sample weight under the appropriate sample number.

e- DTA system equipment : for high temperature differential thermal analysis, comprising: Thermal analysis controller, Differential thermal analyser, connecting cables, spares and accessories kit including 4 replacement furnace cartridges, 4 Oven thermocouple assemblies, 12 platinum sample cups, alumina & platinum liners; purge tube. O-rings, spatula, tweezers ..... etc.

- Thermal analysis recorder : Two range-selectable channels for the simultaneous recording of 2 thermal analysis signals as a function of time or sample temperature; Independent third pen event marker for temperature scale indication and remote pen lift and reset operation.

f.- Raw mix designer: Small desk top programmable computer for raw mix proportioning according to anticipated design; Capable of conclusion of feeder setting based upon calculated feed carbonate target yielding selected clinker parameters of LSF, SiR, mineralogical constituents, starting with oxide analysis for available components and coal ash content; applicable for conclusion of adequate raw mix corrections based upon composition of raw mill discharge on x-hours cumulative sample, entering oxide analysis, required parameters, and designed target, and concluding new components proportions.

g- Scanning electron microscope : with high resolution top stage; low spherical aberration lens, Micro-computer controlled electronics ; magnification range 10 x to 3000 x , pneumatic vibration isolation mounting,

Automatic vacuum system with gun and specimen airlocks; large specimens bottom stage; 100 mm Ø x 75 mm thick size with full specimen coverage from edge to edge, x-y motions ± 28 mm, rotation 360°; Tilt- 10° to + 80°; Dual signal imaging; ultra - high resolution recording with camera and polaroid film holder; Automatic data entry on micrographs; Variable scan speeds; Dynamic focusing; Gamma control; Wave form display 360° scan rotation.

- Accessories : complete set for adequate operation in research work.

- Supervision & advice : the supplier will render technical services for supervision of erection, putting into operation and taking over tests in Tien Jin, PRC.

h - X-ray diffraction analyser : Automatic powder x-ray diffractometer to be used for qualitative and quantitative sapmle analysis. The system should be applicable for analysing a great number of samples with accurate results. Through microprocessor control it will be possible to carry out automatically a complete analytical program which may involve several different measuring operations and modes for each sample, without needing someone consistantly in attendance.

The system comprises :-

- H.V. generator (4 kw maximum power)
- x-ray tubes (Cu, Co, Fe targets)
- Vertical goniometer
- Automatic sample charger (for up to 35 samples)
- Channel control unit
- Motor control unit
- Automatic divergence slit
- X-ray focusing monochromator
- Input / output teleprinter
- Recorder (Chart)
- Minicomputer.

Recommended suppliers:

Based upon the experience of experts questioned obout the said equipment during the study tour, and in virtue of technical superiority, specific suppliers are recommended by the study tour fellows for some of the obovementioned equipment as follows:-

Item	Equipment	Recommended supplier
a	x-ray Fluorescence analyzer:	applied Research laboratories Königstrasse 5, 4000 Dusseldorf, FRG
b	Particle size analyzer	Micromeritics Instrument Corporation, 5680 Goshen Springs Rd., Norcross, Georgia 30 093, USA.

3. RECOMMENDED LOCAL SUPPLIES

CHEMICAL LABORATORY

Qty	Description
1	Precision Laboratory balance Capacity 2000 g Accuracy: 0.1 g
1	Precision balance Capacity: 7 kg Accuracy: 0.1 g
1	Drying oven Temp. range: 25 - 220 °C Approx. inner dimensions: 100 x 80 x 50 cm
1	Electrical laboratory screening machine for sieve diameter 200 mm
1	Set of 12 sieves With bottom diameter: 200 mm 0.063 _ 0.075 _ 0. 9 _ 0.125 0.18 _ 0.25 _ 0.5 _o.71 _ 1 _ 1.18_1.7_2mm wire mesh Sieve bottom non ferrous metal
1	Sample splitter with 1 in. and 1 / 2 in. chut. opening

Qty	Description
1	Precision balance Capacity: 400 g Accuracy: 0.01 g Including an infrared drying unit for moisture determination and 2 spare bulbs
1	Digital analytical balance Capacity: 200 g Accuracy: 0.5 mg
1	Drying oven Temp. range: 25–220°C Dimensions: 1000 x 800 x 500 mm
3	Semi – automatic burettes for titration Capacity: 2 l Graduation: 50 ml Readability: 0.1 ml
1	Automatic water distillation apparatus; water supply, checking cooling water, switching on and off automatically incase of lack of water or storage vessel being filled; outflowing cooling water passing through control device into the still.

Qty	Description
2	Muffle furnace with max. temperature of 1150 °C with spare heating elements Approx. inner dimensions: 26 x 16 x 45 cm
1	Orsat apparatus incl. appropriate absoprtion vessels. solutions, standard gas cylinder, and 3 rubber bags for gas sampling.
3	Hot plates up to 350 °C 1500 W Approx . dimensions: 25 x 35 cm
3	Magnetic stirrer with variable speed and heating, approx. 12 x 12 cm

Qty	Description
1	Water bath with shaking device and temperature control for free lime determination
1	Water bath with four openings
1	Hood 1200 x 8000x 2400 mm incl. connections for warm and cold water. pressurized air, gas, and electrical outlets.

Qty	Description
	Balance Room
2	Blaine apparatus for determination of specific surface of cement including spare manometer liquid and filter paper discs, officially calibrated
2	Stop watches with 1/10 sec. graduation
2	Sets of standards for calibartion of the Blaine apparatus
2	Digital analytical balances Capacity: 200 g Accuracy : 0.1 mg
1	Digital precision balance Capacity: 400 g Accuracy: 1 mg
1	precision laboratory balance Capacity: 2000 g Accuracy: 0.1 g
5	10 g weighing scoops
5	20 g weighing scoops
1	Balance table

10 funnels , long stem fluted, accurate, 60°, Ø 65 mm, stem 150 mm

4 funnels, powder, polypropropylene; top I.D. 150 mm

2 funnels, stainless steel; top I.D. 50 mm

2 semi-automatic burettes 3-way stop-cock ,25 ml

4 semi-automatic burettes 3-way stop-cock,25 ml

2 automatic burettes, 25 ml

Beakers, high

10	50 ml
10	100 ml
10	250 ml
20	400 ml
10	600 ml
10	800 ml
10	1000 ml

Erlenmeyer flask, cop joint 24 / 40,

20	250 ml

Erlenmeyer flask, wide neck with ring finished neck,

30	300 ml
5	500 ml
5	1000 ml

Condensers, bulb type; with bottom joint 24/40

5	length 500 mm

Narrow neck bottles, polyethylene

10	100 ml
10	250 ml
10	500 ml
20	1000 ml

Wide neck bottles polyethylene

10		250 ml
10		500 ml
20		1000 ml
5		dropping bottles with cover stopper, 100 ml, brown
3	Kg	glass rods in different dimensions
3	Kg	glass tubes in different dimensions
12		narrow neckbottles, polypropylene, 20 liters with rubber stopper
20		glass plates 120 x 120 mm

Measuring glass cylinders with round foot, graduated

5	10 ml
5	50 ml
5	100 ml
5	250 ml
3	500 ml
3	1000 ml
5	pipettes, volumetric, glass, capacity 5 ml
5	idem: 10 ml, 20 ml, 50 ml
3	automatic pipettes 50 ml
5	pyknometers with ground-in thermometer and lateral capillaries, capacity 50 ml
100	test tubes of 160 x 16

Wash bottles, flat bottom flask, with rubber stopper and glass tubes

3	500 ml
5	1000 ml

10 wash bottles, plastic, 500 ml

Thermometers, general purpose centigrade scale, 76 mm immersion

5 -20° to 150 °c,

5 - 5° to 400 °c,

3 - thermometers, wall type, indoor, centigrade scale

watch glasses

10	40 mm Ø
10	100 mm Ø
10	125 mm Ø
10	150 mm Ø
10	175 mm Ø

Volumetric flasks (graduated)

5	250 ml
5	500 ml
5	1000 ml

wide neck bottles with [illegible] lids (sample bottles for powder, white glass)

100	100 ml
100	250 ml
50	500 ml
10	1000 ml
50	2000 ml

Sample containers (tin boxes or plastic)

30	500 ml
20	1000 ml
10	2500 ml
10	5000 ml

5 desiccators, 250mm I.D.

2 agate mortars with pestle, standard quality, only cavity flawless
approx. 125 mm outer Ø
approx. 100 mm inner Ø

20 wire gauzes with asbestos insertion, 16x16 cm

10		evaporating dishes of porecelain, medium-depth with spout, 100 ml	
10		idem 150 ml	
6		plate supports, with steel tube, burettes can be easily pushed down, for 2 burettes.	
2		burette brushes 30 mm Ø	
5		filtering funnel supports consisting of iron plate support with plastic plate for 2 funnels	
10	pk	round filters,	11 cm Ø, no 5891, black ribbon,su.s
10	pk	idem	11 cm Ø no 5892, white ribbon s u. s
20	pk	idem	11cm Ø NO5893, blue ribbon, S U. S
200	pk	filterpaper discs, ¼" dia. (Blaine)	
12		test tube brushes	
1		assortment of glass brushes	

Rubber hose, red,

15 m	5 mm Ø
30 m	8mm Ø
15 M	10 mm Ø
15 m	15 mm Ø

?	Buchner funnels of porcelain 65 mm Ø	
20	policemen for analytical work, narrow	
10	spatula spoons of alumina,	20 . long
10	idem	140 mm long
1	set cork borers, 10 cm boring length, with solid brass handle, set of 18 borers, Ø 5 - 26 mm	

10 porcelain dishes 305 mm inner and outer Ø. glazed

50 melting crucibles of porcelain, 30 mm high, capacity 18 ml

10 idem, capacity 25 ml

2 pipette support of plastic with 24 borings

porcelain mortars with pestle

1 100 mm Ø
1 210 mm Ø
1 290 mm Ø

6 fine hair brushes, 95 mm long

10 brushes, with brass wire bristles mounted in wooden handle

5 test tube holders of wood

2 test tube supports for 12 tubes of PVC

10 support clamp with two corner jaws (angular clamps) of steel, corrosion proof lacquered, clamping width 25 mm

10 idem, 40 mm

3 support clamps without sockets, round jaws. clamping width 25 mm

3 idem, 40 mm

double spatulas of pure nickel , narrow form

3 10 cm long
3 15 cm long

spatula spoons, pure nickel, 15 cm

100 rubber stoppers, assorted, 6-50 mm Ø

2 crucible tongs of pure nickel, 20 cm

2 idem, 60 cm

5 m vacuum hose, 5 mm inside Ø, 5 mm wall thickness

5 m vacuum hose, with gauze insert, 10 mm inside Ø
3mm wall thickness

5 weighing boats of aluminium with counter weight,
80 mm long

3 water jet pumps low water pressure (0.5 kg/cm2),
which is required to obtain the final vacuum
(vapour pressure of water).

12 pairs of rubber gloves, heavy type, medium size

2o sample containers with closing clamps, capacity
7.5 l for sample storage
plastic bags of various sizes

1 tool box, containing hammers, 1 pair of cutting
pliers. set of iron and wood saws, flat
pliers , various screw drivers, ruler 2 m, set of
adjustable wrenches, steel brush, set of fork wr-
enches 6-40 mm, etc.

1 glass cutter

5 tripod supports of steel, Ø 5 in.
10 tube clamps with steel spring

5 asbestos cement sheetings (under hot plates)

1 set of balance weights, precision grade 50 g to
5 mg

10 triangles of nickel-chromium (side length 2 in.)

2 balances, triple beam, metric, max. 2 Kg

1 hygrometer, wall type
10Pcs universal indicator paper PH 1-10 including col.
scale

2 kg glass wool

5 kg silica gel with moisture indicator (blue gel)

200 g stopcock grease

4. PROPOSED LOCAL SUPPLIES

PHYSICAL TESTS LABORATORY

COMPRESSION TESTING MACHINE 600 KN max. test load

consisting of:

COMPRESSION TEST FRAME

in rigid two column design with adjustable test height bymeans of middlespindle for compression tests on cement prisms, light concrete, refractories, lime, plaster, and natural stones

connected to:

MEASURING AND CONTROL CABINET

Rack design with function modules for load control, load measuring and load indication; pressure generating unit incorporated in lower part

1	Laboratory jaw crusher feed opening 100x100 mm variable slit from 1 - 20 mm
1	Laboratory ball mill for clinker grinding capacity: max. 20 kg
10	Sieves M 100 Diameter 200 mm
10	Sieves M 200 Diameter 200 mm
2	M^2 M 100 stainless steel screening cloth
2	M^2 M 200 stainless steel screening cloth

Qty.	Description
1	Precision balance Capacity: 7 kg Accuracy: 0.1 g
1	Vibrating machine for mortar cubes acc. to BS 12
2	Vicat apparatus complete with 6 spare needles, 1 mould, and 10 glass plates
10	Le Chatelier ring for determination of cement expansion
25	Cover glass plates for le Chatelier rings (50 x 50 mm)
10	Weights for Le Chatelier rings and length compactor
1	Water bath to boil the Le Chatelier rings
40	Moulds for cubes acc. to BS 12

Qty.	Description
1	Shrinkage tester incl. 100 measuring pins
1	Moisture cabinet for sample storage, water bath
1	for 200 mm dia. sieves incl. vacuum cleaner, mini filter, and small collection filter
1	Set of sieves for air jet sieving machine ASTM No 325-200-100-50- 30-20-16-8-4-3/8"- 1/2"-3/4"-1"
3	Le Chatelier flasks for determination of specific gravity
1	Thermohygrograph to record temperature (approx. 5-40°C) and humidity (0-100%) with recording mechanism,
3	Double moulds 1"x1"x 10" (ASTM) for shrinkage tester

5. PROPOSED LOCAL SUPPLIERS

CONCRETE LABORATORY

Technical laboratory balance

Laboratory concrete mixer

Slump cone, complete set

Set of moulds

Compression machine 3000 KN for test on cubes.

" " 1200 KN " " " cylinders

Universal compression machine 3000 KN for compression/flexion tests

Compression machine 2000 KN for tests on cubes.

In situ mechanical measurement

Climate conditioning cabinet

Air entrainment meter

Flow table

Ultrasonic concrete tester

Concrete penetrometer for setting time

Accelerated curing tank

Manual flexion testing machine

Machine for flexion testing on tiles, briquettes ... etc

Compression machine 5000 KN

Apparatus to measure hydraulic shrinkage

Comcrete permeability apparatus

Steel reinforcement detection meter

Core drilling machine

Grinding machine for cubic and cylindric specimens.

Specimen cutting machine

For aggregate:

Splitters

Jaw crusher

Mechanical shaker

Grinding mill

Abrasion testing machine

Drying oven

Compression resistance tester for granules

Carbide moisture tester for sand & fine aggregate.

Sieven cloth, complete set according to standard

Sieves, perforated plate, complete set according to standard

Laboratory balance

Hygrometer for moisture measurement

Annex X

DRAFT PROJECT PROPOSAL

A. Development objectives

The main objectives of the project are:

(a) To rationalize the technical level of industrial research for the cement industry through scientific studies making use of modern concepts of international technological advances;

(b) To promote the utilization of natural resources through well-planned raw materials investigations as support for the present industry and as a basis for future expansion;

(c) To realize an appreciable quantitative and qualitative increase of the cement production as a fundamental basis for development;

(d) To further and accelerate the social and economic development of the country by contributing to the progress of activities in the construction sector.

B. Immediate objectives

The immediate objective of the project is to create a technology pool in the form of a Cement Development Centre, which shall co-ordinate all efforts for the development and modernization of the cement industry, thereby ensuring that the cement industry progressively fulfils its role as supplier of all cement necessary for development and progress. This objective will be met through the following approach:

(a) Centralization and rationalization of research work for the development of the cement industry, applying the most effective development-oriented methods and proceedings;

(b) Performing well-planned raw materials research as assistance to the existing industry and in preparation for the establishment of new cement plants;

(c) Trouble-shooting in existing cement works, such problem solving being based on intensified research work;

(d) Establishment of a comprehensive technical plan for the modernization of existing cement plants aiming at production increase and energy conservation;

(e) Elaboration of a technological basis for the establishment of new cement industries, including detailed techno-economic studies and plans for the execution based on the most modern concepts.

C. Special considerations

The project will raise the technical level of the personnel so that they will be more useful to the country in respect of quality of work and quantity of production. The partial mechanization which will be achieved through the modernization of existing cement plants will certainly reduce the volume of labour force. The question of employment is of special importance in China. However, all surplus labour will be needed for the horizontal expansion of the cement industry. The redeployment of personnel from the present industrial units in the new cement works will require well-planned upgrading of skills to cope with modern operational requirements. The introduction of modern concepts of automation and control will open up opportunities for female workers to increase their capabilities and to become members of the national technical staff.

The latest trends in cement works design will naturally care more for environmental protection and elimination of ecological disturbances. This will have a favourable impact on health and sanitation and will thus contribute to the preservation of the environment.

D. Background and justificaiton

To cope with the rapid industrial development and the expansion of the construction sector in China, the capacity of the cement industry has grown rapidly from 40 000 t/y in 1906, when the first rotary kiln was installed in Tang Shan, to 80 191 000 t/y in 1980. China has at present about 3 400 cement plants. About 1/3 of the cement is produced by 51 large- and medium-size plants supplying to important construction projects, mostly marine civil work and urban development. The remaining 2/3 is produced by small-scale plants with shaft kilns and wet-process rotary kilns, generally catering for local consumption, especially in rural areas. The main utilization has been for the construction of housing for about 800 000 people employed in the agricultural sector.

Since more ambitious targets aiming at a higher standard of living have been announced, a substantial increase in the cement production is required to reach that development target; yet, considering extension possibilities and available resources, a growth rate of 5 to 6% has been forcasted by the present five-year national development plan for the period up to 1985. This rate of increase would be realized through the following measures:

(a) Full utilization of the potential of the existing works through rationalization of operation and maintenance, overcoming eventual difficulties and elimination of bottlenecks;

(b) Increase of present production capacities through modifications and improvements of existing production lines;

(c) Extension by additional production lines to be incorporated into some of the existing units;

(d) Erection of new cement works using the latest cement technologies, such projects being based on thorough feasibility studies including comprehensive investigation of such fundamentals as suitable raw materials and sound techno-economic basis.

The present cement industry cannot supply the required quality, quantity and variety of cement to cope with the ambitious development objectives. With a view to overcome this difficulty, the Government of China is devoting special attention to the cement industry and is establishing the Cement Development Center with the aim to support the development and promotion of new improved technologies and plant design based on modern scientific findings.

For that purpose local experts require substantial support to enable them to utilize all their potentialities, thus contributing in the most effective manner to the development programme. UNDP/UNIDO assistance would be the appropriate support for realization of the said objectives; it would promote the role of research work for industrial development; realize the transfer of know-how through international experts' advice in various fields of research and technology; upgrade the scientific knowledge and technical experience through fellowship programmes, study tours and in-service training; and, in addition ensure the supply of research equipment, internationally proven to be the best means for extraction and processing of scientific information.

The strategy of the present readjustment is to adapt modern scientific approaches to promote development through research findings, making use of modern technologic achievements in the advanced industrialized countries.

The projected expansion in the cement industry will avail cement to the majority of the population for the establishment of proper housing facilities after having secured life substantials. This gives special importance to rationalization and the increase of cement quality and quantity. In addition to the constructional benefits anticipated as a consequence of the development of the cement industry remarkable social benefits will also be realized especially by creating additional employment opportunities through the development of the industry.

E. Outputs

The purpose of the project is to assist in the establishment of the Cement Development Center, to render advisory expertise for its start-up, and to support its functioning so as to assure the realization of its objectives.

The most important outputs are :

(a) Adaption of the building of the Cement Development Center for appropriate fulfilment of its programme of activities, follow-up of its installation with services, including advice on technical and organizational aspects to ensure its proper functioning;

(b) Assistance in the taking over, installation, and putting into operation of all necessary equipment for analysis and testing of raw materials, clinker, cement mortar and concrete;

(c) Transfer of national personnel from other duty stations to the center in Tien Jin;

(d) Training of professional personnel from the Center or from the cement industry through assignment of international experts to the center;

(e) Training of professional personnel from the Center or from the cement industry through study tours or fellowships ;

(f) Organization of an Interregional Seminar on Cement Technology in 1984 to review the latest development of the cement industry in China and in other countries;

(g) Translation of Chinese documents of interest for developing countries into selected official United Nations languages and translation of selected documents, articles and papers of interest for China into Chinese;

(h) Reports summing up results of raw materials investigations and results of trouble-shooting techniques;

(i) Establishment of a well-equipped laboratory for checking and calibration of instrumentation;

(j) Development of new practices for automation and control with all basic substantials for proper functioning.

F. Activities

The Cement Development Center will be the focal point for the transfer of know-how from abroad to China, and the organization planning the implementation of innovations resulting from local investigations or imported technologies.

In order to assume this role, extensive contact-making and correspondence with other similar institutes and with foreign companies working in the field of the cement production will be necessary in order to have some of these development partners to release qualified engineers and scientists for temporary assignments to China through the United Nations.

Special attention should also be given to combine bilateral co-operation with the planned project activities in order to supplement the UNDP/UNIDO input by additional expertise, fellowship training, study tours and equipment. The ongoing industrial development of China makes this country an ideal partner for developed countries to support their commercial relations with China through bilateral assistance.

Transfer of know-how from abroad to the Center will be secured through the assignment of international specialists on short-term basis, covering disciplines of importance for the development of the Chinese cement industry and the Cement Development Center.

Particular attention will be given to the creation of a dynamic technology base for large-scale cement industry, that can further improve and develop the Chinese engineering capacities.

UNIDO will further extend headquarter's support to the development of the Centre in the form of an annual visit to prepare for and participate in a tripartite evaluation of the project with possible project revisions to follow in accordance with the development of national, international and bilateral co-operation.

Fellowship training and study tours will be organized and cover various areas from basic training of Chinese engineers to work in large-scale cement plants to the advanced training of Chinese scientists and engineers who will gradually take over the design of new large-scale cement plants. The proposed fellowship programmes cover all fields of cement technology and research aspects deemed to be necessary for effective development.

Furthermore, research equipment will be furnished to support the scientific investigations, including the most modern installations capable of exposing materials characteristics which can not be revealed by traditional chemical analysis and physical tests.

The Center will co-ordinate the training of the Chinese experts abroad. Upon their return it will start them up at home with the new facilities, make them work on specific tasks related to new and existing cement plants, send them for further training if needed or include foreign specialists in the team to enhance the transfer of know-how.

G. Inputs

1. To be provided by the Government

(a) Salaries of the national staff, at home and abroad, during the fellowship programmes and study tours;

(b) Investments necessary for the main construction of the Cement Development Center and living quarters for local staff and international experts;

(e) Supplies for local equipment : for the chemical laboratory, the cement physical tests and the concrete laboratory;

(d) Provision of secretariat, office space, catering facilities and local transport for international experts;

(e) Secretariat and interpretation for project activities ;

(f) Sundry expenses for minor items not included in the above-mentioned statement.

2. To be provided by UNDP

11.01 Technical adviser, 12 man-months in split missions : 6 m/m over the first half of 1983, 3 m/m at the beginning of 1984, and 3 m/m during the period April-June 1985.

An engineer or chemist with long and high-level experience in the technical as well as the management aspects of cement development centers. He will be expected to: (a) Advise on the general set-up of the Cement Development Center; (b) Organize the proper application of research equipment in the service of various branches of research; (c) Train local staff in the assessment of results to conclude the specific significance of observations, and their technologic consequences; (d) Follow-up the organizational aspects to adapt duties and responsibilities planned for the technical staff; (e) Assure the proper functioning of the Center as a whole and its contribution towards the development objectives.

During his first mission, the expert will assist the Director of the Center to start-up the technical and managerial activities, and during his last mission he will advise on further steps to be achieved, and draft a project proposal for extended UNDP/UNIDO assistance.

11.02 <u>Adviser in testing and evaluation of raw materals</u>.

3 man-months in two split missions: 1 m/m during July 1982 and 2 m/m during July-August 1983.

A chemist or chemical engineer with long and high-level experience in the field of testing and evaluation of raw materials for cement production. The expert will be expected to: (a) Advise on the appropriate test and analysis procedures for raw materials, giving special consideration to minor undesirable components; (b) Demonstrate modern analytical techniques, whether by wet analysis or by instrumental investigation; (c) Giv guidance on the correct interpretation of chemical, mineralogical and micro-structural information for the conclusion of anticipated characteristics and expected behaviour in the course of industrial processing; (d) Revise the geological investigations, establish the geographic location of raw material deposits of suitable qualities, evaluate confirmed and probable reserves of such deposits, and propose adequate measures for future proceedings.

11.03 Consultant in laboratory testing. 3 man-months in two split missions: 1 m/m during September 1983 and 2 m/m during July - August 1985.

A Chemist with relevant experience in cement laboratory work. The expert will be expected to: (a) Illustrate the best procedures for checking various process paremeters; (b) Demonstrate particulars for appropriate follow-up of production proceedings, with special emphasis to significance of eventual phenomena and proposal for remedial measures to overcome industrial problems; (c) Conduct chemical analysis and physical tests for cement, mortar and concrete; (d) Advise on the proper application of modern equipment being introduced to cement laboratory work.

He will further be required to ensure that appropriate procedures will be adopted by issuing comprehensive instructions and will be responsible for the training of the national personnel in those rationalized procedures.

11.04 Consultant in raw-mix design and pilot testing. 3 man-months in two split missions: 1 m/m during October 1983 and 2 m/m during July-August 1984.

A chemist or chemical engineer with considerable theoretical knowledge and practical experience in cement composition and technology. The expert will be expected to: (a) Work out the most appropriate raw-mix design to be composed of two or more components according to available resources; (b) Propose the suitable correctives, if required, after a techno-economic study of materials which can be locally procured and would suit the industrial process; (c) Propose proper ratios and moduli for the most convenient processing; (d) Advise on and conduct pilot tests to produce clinker on a semi-industrial scale, perform the necessary quality investigations of the product and conclude further modifications to be performed accordingly.

11.05 Consultant in process design. 3 man-months during the period October - December 1984.

An engineer with long experience in cement industrial technology and appropriate know-how in process design.

The expert will be required to: (a) Assess results of raw materials investigations, study possibilities of local machine manufacture including modern trends in machine design and propose accordingly the appropriate process design; taking also into consideration the local availability of manpower, maintenance facilities as well as distribution channels; (b) Making use of latest technology in process design, propose ways of applying innovations leading to energy conservation and increased environmental protection; (c) Prepare a forecast of expected benefits and draw-backs, if any, of such process re-design.

11.06 Consultant in equipment selection. 3 man-months during the period October - December 1984.

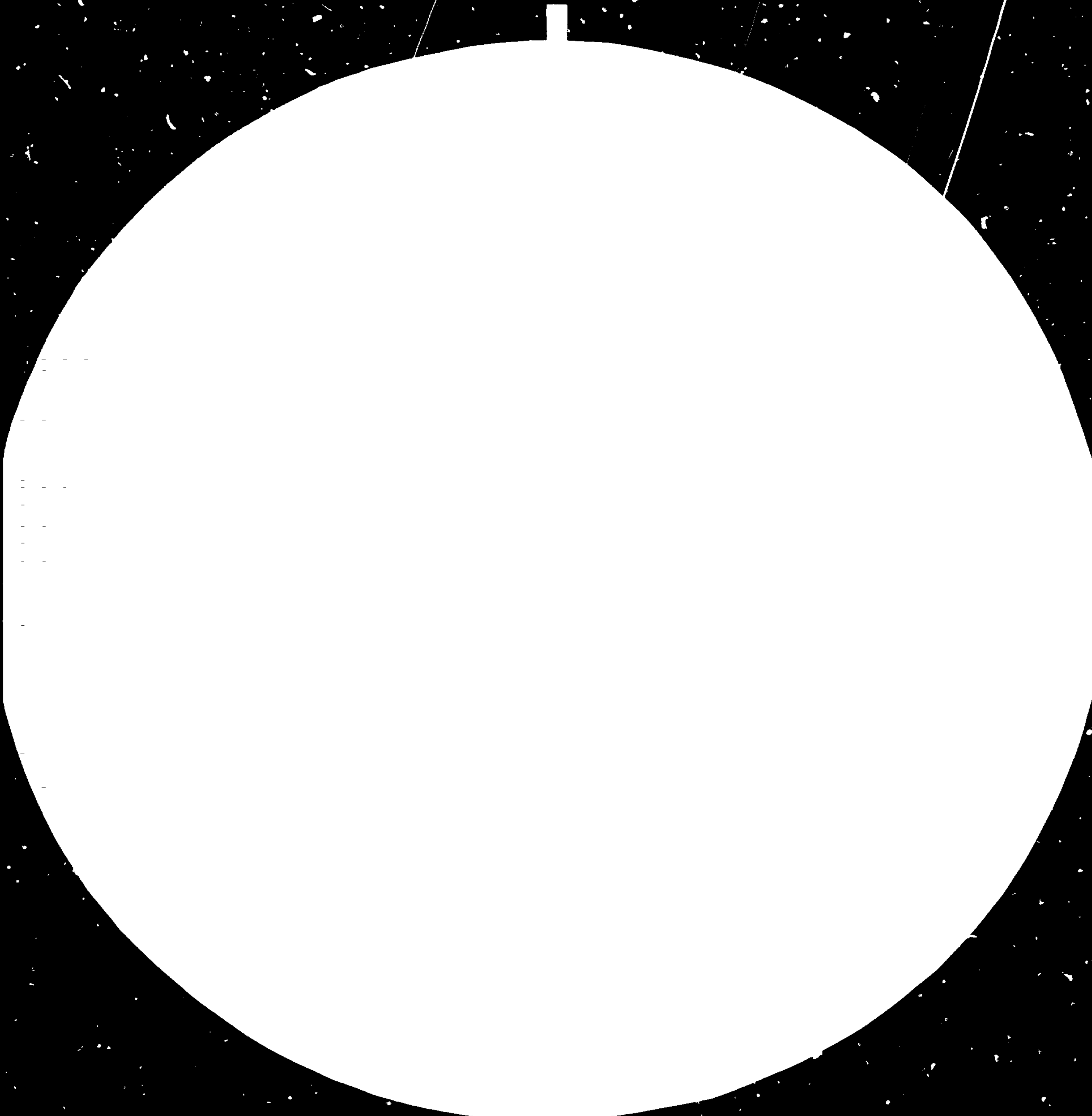
An engineer with advanced know-how in machine characteristics, long experience in cement producing works and appropriate knowledge of modern trends in cement process technology.

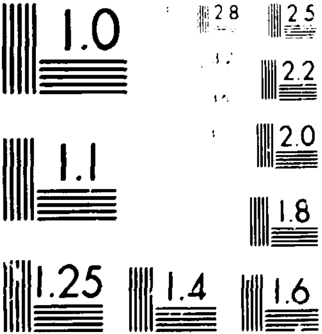
The expert will, in close co-operation with the expert in process design and with his national counterparts, select the cement-making machinery and equipment best suited to local conditions. He will give special consideration to the process promotion, especially to energy conservation and environmental protection. Possibilities for local manufacture should be a guiding factor in the selection process, and the introduction of new international designs should take into consideration local conditions, facilities for maintenance and procurement of spare parts.

11.07 Consultant in machine design. 4 man-months in 2 split missions: November - December 1982, and July - August 1985.

A mechanical engineer with relevant experience in machine design, preferably from one of the well-distinguished machine suppliers. The expert will study local conditions in national workshops, and the performance of locally-manufactured machinery in terms of operational efficiency and maintenance characteristics. In co-operation with national engineers concerned with machine design he will propose the most appropriate designs to promote

82.09.14




1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

techno-economic advantages. He will further propose: (a) Means for adaption of modern designing principles to the Chinese proceedings. He will further propose the suitable material composition to cope with the anticipated operational conditions. He will establish the basic substantials for electrical facilities to be adapted and a reasonable degree of automation and control to be introduced.

11.08 <u>Consultant in instrumentation and control</u>, 3 man-months in three split missions: August 1982, November 1983 and November 1984.

An electronic engineer, with profound theoretical knowledge and practical experience in the field of instrumentation and control. During his first mission of one month, the expert will assist in the initial establishment and start-up of basic control systems, follow up and possibly ameliorate work proceedings. He will then advise on the formation of an instrumentation laboratory with possibilities for maintenance and calibration of measuring instruments for the proper functioning of control panels. He will propose the most reasonable extent of automation with necessary interlocking of main production units to adjust material flow and rationalize operational parameters with ample degree of automation and control. The automation and control parameters will be explained, and maintenance systems will be established. A special study will be devoted to existing automated control sytems, and special advice will accordingly be formulated for new projects, based on the experience gained with already functioning systems.

11.09 <u>Consultant in computer science and technology</u>, 4 man-months during the period September - December 1985.

University graduate in electronic engineering or mathematics, PhD in computer engineering and relevant experience with computers, including systems analysis, design, soft-ware programming, and knowledge of hardware. The expert will be required to: (a) Prepare a survey on computer applications in the cement industry and in research work, and, subsequently advise on appropriate computerized control in relevant fields; (b) Propose suitable systems for process control, preventive maintenance, and stock-keeping for spare parts; (c) Organize and educational course in the said fields for the national personnel concerned; (d) Formulate the technical problems, draft technical reports and documents, and advise on programming techniques necessary for obtaining useful information in order to achieve the project target; (e) Study new projects, and, in the light of local possibilities and the nature of problems encountered, define the most appropriate systems for the respective purpose, including definition of required periferals (input and output devices, secondary storage memory etc.); (f) For computers already in function, assure that the suppliers maintenance instructions are correctly followed.

Fellowship training will be provided in the following areas:

31.01 Laboratory research. (27 m/m)

2 chemical engineers: 6 months each in X-ray fluorescence analysis

1 chemical engineer: 3 months in atomic absorption and flame photometry

1 chemical engineer: 2 months in diffraction microscopy

1 chemical engineer: 2 months in particle size studies

1 chemical engineer: 4 months in electron microscopy

1 chemical engineer: 4 months in X-ray diffraction analysis

31.02 Application of low-grade materials. (24 m/m)

2 geologists: 3 months each in geological investigations

2 geologists: 3 months each in quarrying low-grade materials

4 chemical engineers: 3 months each in process-related research

31.03 Application of fly ash. (6 m/m)

2 chemical engineers: 3 months each in the utilization of fly ash in cement industry

31.04 Pre-blending of raw materials. (4 m/m)

1 chemical engineer: 2 months in pre-blending bed and sampling station

1 chemical engineer: 2 months in raw-mix homogenization

31.05 Roller mill technology. (8 m/m)

1 chemical engineer: 4 months in technical design

1 mechanical engineer: 4 months in equipment design

31.06 Pre-heater and pre-calciner studies. (9 m/m)

1 chemical engineer: 3 months in technical design

1 mechanical engineer: 3 months in equipment design

1 chemical engineer: 3 months in operation and control

31.07 <u>Dust collection studies.</u> (6 m/m)

1 mechanical engineer: 2 months in equipment design: bag house, gravel bed

1 electrical engineer: 2 months in equipment design: electrostatic precipitator

1 chemical engineer: 2 months in technical design for dust collection systems

31.08 <u>Materials conveyors and cement dispatch.</u> (10 m/m)

1 mechanical engineer: 2 months studying large elevators and drag chain conveyors

1 mechanical engineer: 2 months studying air lifts and pneumatic conveyors

1 mechanical engineer: 2 months studying packing and pelletizing

1 mechanical engineer: 2 months studying cement bulk dispatch

1 mechanical engineer: 2 months studying measuring and feeding

31.09 <u>Automation and control.</u> (38 m/m)

2 electrical engineers: 3 months each studying electrical drives and power distribution

2 electronic engineers: 4 months each studying control centres

4 electronic engineers: 6 months each in computer studies

31.10. Feasibility studies. (4 m/m) 2 economists/ engineers: 2 months each: techno-economic studies, 1ry and final feasibility study.

The following equipment will be furnished:

40.01. Basic equipment for a language laboratory. For the training in foreign languages necessary for accomplishment of the technical training particulars, whether in the form of fellowship programmes or in-service training. This supply will be one of the first project activities to allow for ample preparation time of nationals to follow the proposed training schedule.

40.02. A series of specialized research equipment which is not among the normal local production. This equipment will assist the Chinese research workers to gather scientific information which cannot be obtained by the traditional apparatus. A provisional equipment list has been drawn up based upon the experience gained during the cement study tour of March/April 1981, but the final volume of equipment supplies will be determined after international bidding and selection of the purchasable equipment according to the tendered values and available funds.

H. Preparation of work plan

A tentative work plan in the form of bar chart is attached as a preliminary guide. As soon as feasible a detailed work plan for implementation of the project will be prepared by the National Project Co-ordinator in consultation with the representative of UNIDO headquarters during the yearly review mission. The agreed work plan will be attached to the document and will be considered as an integral part.

I. Institutional frame work

The Ministry of Building Materials Industry will, as the government implementing agency, co-ordinate the various activities of the project in consultation with the units directly involved in its implementation.

PROJECT BUDGET PROPOSAL

Project personnel

10. Project personnel **11. Experts / Post title**	Total		1982		1983		1984		1985	
	%	$	%	$	%	$	%	$	%	$
11-01 **Technical adviser**	12	75 300	-	-	6	37 200	3	18 600	3	19 500
11-02 Testing and evaluation of raw materials	3	18 400	1	6 000	2	12 400	-	-	-	-
11-03 **Laboratory testing**	3	19 200	-	-	1	6 200	-	-	2	13 000
11-04 Raw-mix design and pilot testing	3	18 [illegible]	-	-	1	6 200	2	12 400	-	-
11-05 **Process design**	3	18 600	-	-	-	-	3	18 600	-	-
11-06 **Equipment selection**	3	18 600	-	-	-	-	3	18 600	-	-
11-07 **Machine design**	4	25 400	-	-	-	-	2	12 400	2	13 000
11-08 **Instrumentation** and control	3	18 400	1	6 000	1	6 200	1	6 200	-	-
11-09 **Computer science** and technology	4	26 000	-	-	-	-	-	-	4	26 000
11-99 **Total** experts	38	238 500	2	12 000	11	68 200	14	86 800	11	71 500

FELLOWSHIPS

30.00 Training 31.00 **Fellowships**	Total		1982		1983		1984		1985	
	%	$	%	$	%	$	%	$	%	$
31.01. **Laboratary research**	27	48 600	-	-	27	48 600	-	-	-	-
31.0.2. Application of low-grade materials	24	50 400	-	-	-	-	24	50 400	-	-
31.03. **Application of fly ash**	6	10.800	-	-	6	10 800	-	-	-	-
31.04. Pre-blending **of raw materials**	4	8 400	-	-	-	-	4	8 400	-	-
31.05. **Roller mill technology**	8	14 400	-	-	8	14 400	-	-	-	-
31.06. Pre-heater and pre-calciner	9	18 900	-	-	-	-	9	18 900	-	-
31.07. **Dust collection**	6	12 600	-	-	-	-	6	12 600	-	-
31.08. **Conveyors** and cement dispatch	10	24 000	-	-	-	-	-	-	10	24 000
31.09. **Automation** and control	38	91 200	-	-	-	-	-	-	38	91 200
31.10. **Feasibility studies**	4	8 400	-	-	-	-	4	8 400	-	-
Total fellowships	136	287 700	-	-	'1	73 800	47	98 700	48	115 200

UNDP contribution (in $US)

	Total		1982		1983		1984		1985	
	%	$	%	$	%	$	%	$	%	$
11. PROJECT PERSONNEL										
11.99 Total experts	38	238 500	2	12 000	11	68 200	14	86 800	11	71 500
15.00 Experts travel		10 000		300		2 200		4 200		3 300
16.00 Other personnel costs		20 000		5 000		5 000		5 000		5 000
19.00 Total personnel component		268 500		17 300		75 400		96 000		79 800
30. TRAINING										
31.00 Fellowships	136	287 700	-	-	41	73 800	47	98 700	48	115 200
32.00 Study tours	40	78 000	10	15 000	10	18 000	10	21 000	10	24 000
33.00 In sevice training		127 200		46 200		24 000		27 000		30 000
39.00 Total training component		492 900		61 200		115 800		146 700		169 200
40. EQUIPMENT										
40.01 Language laboratory equipment		50 000		50 000		-		-		-
40.02 Research equipment		650 000		350 000		140 000		80 000		80 000
40.00 Total equipment component		700 000		400 000		140 000		80 000		80 000
50. MISCELLANEOUS										
51.00 Operation/ maintenance		24 000		6 000		6 000		6 000		6 000
52.00 Reports		11 400		1 000		3 000		4 200		3 000
53.00 Sundries		3 200		100		600		1 400		1 100
59.00 Total miscellaneous		38 600		7 100		9 600		11 600		10 300
TOTAL		1500 000		485 600		340 800		334 300		339 300

Government contribution (in RMB (¥ x 1 000))

	Total	1982	1983	1984	1985
National staff, salaries at home and aborad	1 125	180	270	315	360
Buildings and staff quarters	5 000	4 000	1 000	-	-
Local equipment	2 000	500	1 000	500	-
Secretariat, office space, catering facilities, local transportation for experts	250	30	50	70	100
Secretariat and interpretation for project activities	80	10	20	30	20
Sundries	180	30	50	50	50
TOTAL	8 635	4 750	2 390	965	530

SCHEDULE OF ACTIVITIES

Activity	1982	1983	1984	1985
11.01 Technical adviser		—	—	—
02 Testing and evaluation of raw materials	—	—		
03 Laboratory testing		—		—
04 Raw-mix design and pilot testing		—	—	
05 Process design			—	
06 Equipment selection			—	
07 Machine design			—	—
08 Instrumentation and control	—	—	—	
09 Computer science and technology				—
16.00 Other personnel	—	—	—	—
31.00 Fellowships				
01 Laboratory research		—		
02 Appl. of low-grade materials			—	
03 Appl. of fly ash		—		
04 Pre-blending of raw materials			—	
05 Roller mill technology		—		
06 Pre-heater and pre-calciner			—	
07 Dust collection			—	
08 Conveyors and cement dispatch				—
09 Automation and control				—
10 Feasibility studies			—	
32.00 Study tours	—	—	—	—
33.00 In-service training	—	—	—	—
40.01 Language laboratory	—			
02 Research equipment	—	—	—	—