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25 October 1985

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CEMENT DEVELOPMENT CENTRE

DP/CPR/82/014

PEOPLE'S REPUBLIC OF CHINA

China.

Technical report: Strengthening the operation of the Cement Development
Centre at Tianjin .

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

Based on the work of George R. Gouda, expert in cement technology

United Nations Industrial Development Organization

Vienna

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Explanatory notes

References to "tonnes" are to metric tonnes.

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

R and D Research and development

TCIDI Tianjin Cement Industry Design Institute

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

ABSTRACT

As part of the ongoing project "Cement Development Centre" (DP/CPR/82/014) an expert in cement process technology was sent by the United Nations Industrial Development Organization (UNIDO) acting as executing agency of the United Nations Development Programme (UNDP) to the People's Republic of China in order to strengthen the operation of the Cement Development Centre in Tianjin, part of the Tianjin Cement Industry Design Institute (TCIDI). The post was described as "technical adviser for cement centre". During his mission, which lasted one month from 14 August to 13 September 1985, the expert:

- (a) Made an organizational chart of the Centre indicating each department and analysing its function;
- (b) Drew up a long-term plan for the activities of the Centre, together with a list of priorities;
- (c) Indicated the Centre's requirements with regard to personnel training.

His main recommendations to the Cement Development Centre are as follows:

- (a) The acquisition of a pilot plant for cement production;
- (b) The acquisition of certain additional equipment, specific details of which are given in the report;
- (c) The provision of training for those who will use the new equipment and those engaged in the analysis of output;
- (d) The acquisition of an electronic workshop to maintain new equipment, together with an adequate supply of spare parts;
- (e) The acquisition for the Centre's library of as many as possible of currently available cement publications;
- (f) The arranging of conferences in the People's Republic of China in the near future, where cement and related topics can be discussed at the national and international levels;
- (g) The provision of English language teaching facilities.

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INTRODUCTION

Development of building material industries is given high priority by the Chinese Government. Three institutes have therefore been established in China, which are as follows:

- (a) Hefei Institute (for cement research);
- (b) Nanjing Institute (for designing cement plant);
- (c) Tianjin Cement Industry Design Institute.

The Tianjin Cement Industry Design Institute (TCIDI) is located in the northern suburb of Tianjin, which is 105 kilometres southeast of Beijing. It is under the supervision of the State Administration of Building Materials, and consists of two main divisions:

- (a) Cement Design Institute;
- (b) Cement Development Centre.

TCIDI has its own community, which includes:

- (a) The main building for administration, engineering and design of cement plants, computer, printing, library and technical information etc.;
- (b) The laboratory building for characterization of raw materials, clinker and cement, including chemical, physical and mechanical evaluations, and evaluations of burnability and volatility of raw mix etc.;
- (c) The pilot plant building for establishing a pilot plant for the cement industry (equipped with suspension preheater and precalciner system), including materials handling;
- (d) The training centre building for training the TCIDI personnel as well as staff of existing and new cement plants;
- (e) The mechanical workshop for necessary repairs;
- (f) The compressor station for supplying compressed air.

Most of the TCIDI staff have previous experience in the cement industry, and approximately 40 per cent of them are newly graduated from advanced technical institutes.

The three buildings of the laboratory, the pilot plant and the training centre are considered the main components of the Cement Development Centre, together with the library and technical information departments. The objectives of the Cement Development Centre are:

- (a) To assist the cement industry in China in increasing its capacity and improving the quality of its product;
- (b) To maximize the use of natural resources for cement production;
- (c) To maximize energy conservation at existing cement plants, throughout the production process;

(d) To characterize and evaluate the raw materials of new cement plants, and apply test results in plant design.

The expert was attached to the State Administration of Building Materials. The purpose of this mission was to strengthen the operation of the Cement Development Centre in Tianjin. The duties included:

- (a) Assisting and advising in the over-all development of the centre;
- (b) Development and strengthening of selected departments;
- (c) Reviewing ongoing and planned activities;
- (d) Advising on methods, manpower, and equipment utilization.

All the above duties were carried out during the time allowed for this mission, which was one month. In addition, several other topics were discussed and several lectures were presented where the participants ranged from eight persons to over fifty. The topics discussed and the titles of the lectures given are shown in annex I.

The expert acknowledges the excellent collaboration, and kind hospitality offered by all Chinese colleagues at the Tianjin Cement Industry Design Institute, especially the Institute's President, Vice-President and Chief Engineer.

RECOMMENDATIONS

1. Additional equipment should be acquired. The list of this equipment is given in section C below, and it is estimated that the cost will be approximately \$US 300,000.
2. A pilot plant for the cement process should be established. The cost is in the range of \$US 1.5 million, depending on the equipment requested, its capacity, and the country supplying it.
3. Appropriate equipment should be selected, suitable for characterizing cement raw materials, kiln feed, clinker and cement. Training personnel in use of this new equipment and in the analysis of test results is essential.
4. A reasonable amount of spare parts for the equipment should be purchased, and an electronic workshop should be built to carry out maintenance functions, the latter to be run by qualified personnel.
5. The Cement Development Centre should interact and co-ordinate with the Design Institute in selecting the equipment for new cement plants with different capacities and systems.
6. In order to accomplish recommendation 5, the key personnel of the Centre should be trained in the different methods of evaluating raw materials, laboratory-prepared clinker, plant-produced clinker, cement quality etc. and in the presentation of highly technical and clear reports. For this purpose, an expert should work closely with the personnel of the centre, and facilities made available for training abroad.
7. The Centre should work on introducing new equipment and technology, such as dust collectors, a bypass system, a roller mill, a preblending system etc. Training abroad and the securing of expert assistance are recommended.
8. It is advisable that most of the Centre personnel should have previous experience in the cement industry and also a good knowledge of the English language, so that they should gain maximum benefit from training abroad or in-house. It is therefore necessary to provide courses in English.
9. A vigorous training programme should be instituted, and opportunities for career development provided for those working at the Centre, at the Design Institute and in the industry generally.
10. A conference at the national and international levels should be arranged in China, at which views of scientists and experts can be exchanged.
11. The library should be supplied with any available books, magazines and publications on cement.
12. Various researches into cement should be carried out, e.g. into limits of alkalis in cement (to prevent potential alkali-aggregate reactions), into the applications of kiln dust, into the use of low quality limestone etc.

ACTIVITIES AND OUTPUT

The following summarizes all the activities that have been undertaken in performance of the duties arising from the project's aim, namely the strengthening of the operation of the Cement Development Centre.

A. Organizational chart

The Tianjin Cement Industry Design Institute is planned as an intensive centre with co-ordinated activity in technology and planning related to cement plant design and cement research and development. The Government of China, the Chinese cement industry and cement machinery manufacturers will actively participate in the work of TCIDI.

An organizational chart is suggested (see figure I). The establishment of an advisory committee is suggested, to advise the Institute on the appropriate types of projects and studies to pursue and on the best R and D projects to undertake, so that the activities of the Institute are directed towards the needs of the country. This committee can also provide subsequent ongoing evaluation of the Institute's activities, (both design and development), and contribute to the formulation of future plans. The committee could, for example, consist of the President of TCIDI, representatives of the State Administration of Building Materials, of the Natural Resources Authority, of the Ministry of Urban and Rural Development and Environmental Protection, of the Ministry of Finance etc. Although this organizational chart includes both the Cement Design Institute and the Cement Development Centre, the present report is concerned only with the activities of the Cement Development Centre. It does not cover any activity related to the Cement Design Institute. To avoid confusion, the following nomenclature is used for the two main divisions of the TCIDI:

- (a) Cement research and development centre;
- (b) Cement plant engineering and design centre.

B. Long-term plan for developing and strengthening the Cement Development Centre

In order to develop the Centre so that it can respond efficiently to the needs of the Chinese cement industry, the following are suggested as the basis for a long-term plan for its activities:

<u>Activity</u>	<u>Priority</u>
(a) Evaluation of cement raw materials for both the existing and new cement plants, by using the modern equipment within the Centre. It is intended that, after evaluation of the raw materials of the existing plants, recommendations will be implemented to improve both quality and quantity of production. Evaluation and characterization of the raw materials of new cement plants will ensure that the most suitable processes, equipment selection, engineering and design are obtained. This will lead to efficient and economic plant operation. Following experiments performed in different departments, a comprehensive report on raw materials should be issued, giving recommendations on raw grinding, burnability, volatility, potential clinker etc. The Centre should improve its performance in this	High

area, as evaluation of cement raw materials is essential to effective design of cement plants;

- (b) Co-operation with different governmental authorities in the location of raw materials and the selection of sites for new cement plants. Performance of feasibility studies; High
- (c) Achievement of the position of over-all leadership in China in clinker microscopy, so that the Centre can evaluate the different clinker of the cement manufacturers, and advise on measures to improve quality. For the latter purpose, seminars and teaching courses should be set up by the Centre; High
- (d) Evaluation of raw material deposits for new cement plants, to be carried out under the Centre's supervision, including prospecting, geology, core drilling, quality and quantity analysis. Interaction with the Design Institute in the selection of processes, engineering and equipment; High
- (e) Establishment of a cement pilot plant consisting of all the requisite equipment from crusher to clinker cooler. Provision of suspension preheater and precalciner systems for a kiln with a changeable angle of inclination. Performance of different experiments on this pilot plant both for existing plants that have production problems, and for new plants. Analysis of the data obtained and their correlation with large-scale production; High
- (f) Development or acquisition of a cement process simulator, especially the preheater and precalciner systems. Training of cement plant personnel in its operation and control; High
- (g) Employment of a trouble-shooting consultant to handle production problems at existing plants with a view to increasing quality and quantity of production. The consultant would monitor processes and clinker quality; High
- (h) Reduction of energy consumption at existing cement plants by means of an energy-audit of those plants which have high energy consumption; High
- (i) Collection of data from existing Chinese cement plants, including data on raw materials, equipment and processes. Application of these data to equipment sizing, raw and clinker grinding and fuel consumption. Evaluation of raw materials may be necessary to correlate existing data with that obtained at the Centre; High
- (j) Training of personnel of existing and new cement plants and of TCIDI in cement processes, chemistry and technology. Close co-ordination with the Training and Career Development Department in preparation of the training courses; High

- | | |
|--|--------|
| (k) Work on different aspects of improving cement quality produced from small cement plants; | High |
| (l) Studies of rehabilitation prospects of existing plants with the help of outside expertise, as required; | High |
| (m) Measurement and written analysis of the quality and quantity controls of cement through all different stages of production; | Medium |
| (n) Participation in the commissioning of new plants designed by Tianjin Institute or by any other company; | High |
| (o) Communication with scientists inside China and abroad. Exchange of ideas and technology. Participation in international conferences and/or meetings concerning cement technology, chemistry, automation, quality control etc. Co-operation with local universities and exchanges of ideas and views; | High |
| (p) Arrangement of one of the international conferences on cement in China, as well as arrangement of a National Conference every two years (approximately), for the Chinese cement industry itself; | High |
| (q) Development of a new process, and new equipment, suitable for local conditions and available raw materials; | Low |
| (r) Development of new applications and uses of waste materials produced from cement plants; | Medium |
| (s) Provision of training for personnel involved in processes and quality control, together with training in the use of laboratory equipment; | Medium |
| (t) Work on determination of the limits of alkali content in cement to avoid potential alkali-aggregate reactions. | Medium |

The Cement Development Centre will co-operate closely with the Design Institute in designing a 2,000 tonne-per-day cement plant equipped with a precalciner system after evaluating and characterizing the raw materials to be used. It will also participate in the commissioning of this plant and evaluate its operation.

The Centre will be involved in performing experiments with, and in evaluation of, the roller mill and the alkali bypass and dust collector systems.

C. Equipment recommended for the Cement Development Centre

Annex II shows the equipment that is currently in the possession of the Centre or has been ordered. It is suggested that the following additional equipment be purchased to enable the Centre to maintain a modern and complete laboratory that will meet all its needs. Once it has acquired this equipment, the Centre can be considered an up-to-date and modern laboratory capable of supporting a broad spectrum of testing requirements in the cement field. It will be capable of performing comprehensive analysis and extensive characterization using modern instrumental techniques. The following additional equipment is recommended:

- (a) X-ray fluorescence (and the required equipment for flux sample preparation, together with several reference samples);
- (b) Pilot plant for the cement process including crusher, raw mill, dryer, and rotary kiln with suspension preheater/precalciner system and cooler;
- (c) Standard ball mill to determine bond work index;
- (d) Roller mill (laboratory scale);
- (e) Equipment for coal analysis;
- (f) Mini-scanning electron microscope (SEM) capable of adding an energy dispersive X-ray analysis (EDAX) in the future;
- (g) Equipment of sample preparation for SEM studies;
- (h) Abrasion test equipment;
- (i) Sample splitter;
- (j) Equipment for measuring gas velocity and air flow;
- (k) Equipment for analysing the exhaust gas of the kiln, for dew-point, N_xO_y , dust load etc.;
- (l) Equipment for cement testing according to one of the foreign cement specifications.

Spare parts for the recommended equipment should be given a high priority; also, spare parts for those which have already been ordered.

In addition, there are two other departments, which have the minimum of equipment and facilities. It is the opinion of the expert that these two departments should acquire additional equipment, indicated below.

Training and career development

This department currently has a video cassette recorder, a slide projector, a video camera and a tape recorder. It is recommended that it increase its equipment to at least two automatic slide projectors, two video cassette recorders operating on different systems and speeds, and a portable video cassette recorder for the video camera. Also required are several tape players with earphone attachments for English language training.

Library

The library of the Institute is considered to have a rather poor collection of technical books and magazines. The Institute should therefore obtain as many as possible of the books available on cement, design and engineering, and to subscribe to relevant magazines. Reference books for identifying inorganic compounds as a result of X-ray diffraction analysis, must also be available. The importance of such books to the Institute's work underlines the necessity for personnel to acquire adequate proficiency in English as a second language.

D. Different departments of the Centre and their activities

It is planned that TCIDI will be the national centre for research and co-ordinated activity in technology generation and technology transfer related to cement.

The Cement Development Centre should be structured with different R and D departments, including a pilot plant for development and testing of raw materials, processes and equipment. The Centre should dedicate its work and capability to supporting planned and existing cement plants. It should provide a complete range of laboratory testing including mechanical, chemical and physical characterizations of cement raw materials, clinker and cement, and should also offer specified consulting services. It should greatly help the Institute in undertaking design and engineering projects. However, the staff of this Centre should be of sufficient experience to offer a vast body of knowledge on the constitution and properties of cement materials from raw to finished products. It is suggested that the Centre should have the following departments:

(a) Pilot plant. The plant would perform studies of the raw materials for cement production on a small scale, either by the suspension preheater system or by the precalciner system. The process engineers of the pilot plant should be able to supply data to evaluate process performance, and to participate in commissioning and test running of a 700 tonne-per-day cement plant with a preheater system;

(b) New cement projects and feasibility studies. The department would concern itself with the evaluation of new cement projects and perform feasibility studies for these plants and for conversion from wet to dry process, if requested;

(c) Prospecting for raw materials. The department would assist in carrying out geological studies and prospecting for cement raw materials for new cement plants. Quarry operation, blasting, handling, and transporting these materials would be its responsibility. It is understood that the geological work is the responsibility of a geological group outside the Institute, but the mining group belongs to the Institute. It is suggested that the Centre should collaborate with this geological group to familiarize itself with the deposits;

(d) Chemical analysis laboratory. The department would determine major and minor oxides of all the materials related to the cement industry and would back up and complete the work of X-ray fluorescence. It would also perform the raw mix design, burnability and volatility tests of the raw mix;

(e) Crushing, grinding and powder technology. The department would carry out sample preparation, assess physical and mechanical properties of the raw materials as well as perform grindability tests and particle size distribution;

(f) Physical laboratory. The laboratory would perform the analysis required by using the X-ray diffraction, X-ray fluorescence, differential thermal analysis; also thermal gravimetric analysis, and Leco and atomic absorption. It would be capable of testing coal and its combustion properties;

(g) Microscopic studies. The department would characterize raw materials, laboratory-prepared clinker and the clinker from different cement plants by using a polarized microscope and a scanning electron microscope;

(h) Quality control of cement and trouble-shooting. The department would carry out a complete evaluation of the cement, and make recommendations for better quality. It would act as a trouble-shooter and consultant for cement plants with production problems. The process engineers of the pilot plant, and those from other departments, could join this group to evaluate the processes of existing cement plants with the aim of energy conservation;

(i) Cement process simulator. The department would build a simulator of the cement pyroprocessing system and train the cement industry personnel on it, in co-ordination with the Training and Career Development division;

(j) New developments. The department would work closely with the engineering department, to develop new equipment, to carry out research into dust problems and their applications, and into the permissible limits of the alkalis in cement to avoid potential alkali-aggregate reactions. This department would also introduce the technology of the roller mill, dust collectors, and other new equipment;

(k) Electronic workshop. Most of the expensive equipment that has been ordered (or will be ordered) is based on electronic technology. It is therefore essential to have an electronic workshop attached to the Centre for the maintenance and repair of this equipment. Necessary spare parts should also be stocked at the Centre.

The Cement Development Centre is a cement technology centre working in accordance with fundamental science. It is industry-oriented, geared to applications and products rather than the imperatives of science. Its personnel should have the technical skills to solve fundamental problems.

Written reports and documents are an important aspect of its work. There should be key technical personnel to collect all the data and reports of the raw materials evaluations, and to convey their significance and relevance in a final comprehensive report. The report should include all the different results which are useful for process calculations and engineering work.

Personnel with experience in crystallography and microstructure of raw materials and clinker are recommended for the microscopic studies department. Skills in the analysis of data and the ability to prepare a descriptive report are essential. Training and reading published materials on these subjects are therefore highly recommended.

It is also essential that personnel should be trained on the new equipment such as X-ray diffraction, differential thermal analysis etc., and on interpretation of test results.

E. Training and career development

It is recommended that ICIDI should institute a technological talent development programme, under which it could regularly organize and conduct applied training courses for the existing personnel of the cement plants and the Institute at all levels. These training courses should be directed towards updating technological expertise within the cement industry in China, and transferring technology with the smallest possible time-lag. They should aim to improve the trainees' abilities by supplying them with new information that can be applied in the field.

A trainee curriculum is urgently needed. Although certain tasks are currently required to be performed by ICIDI, the means at its disposal to

accomplish such tasks are limited by the capabilities of the individuals concerned, staffing requirements etc. The provision of adequate staffing is therefore recommended.

The most important factor in any organization is the competence of its individual employees. Competence is primarily acquired through experience. Scholastic background, courses of instruction, and previous work experience are to be considered in selecting qualified people, though not to the exclusion of actual cement plant experience.

Proper staffing of the Cement Development Centre becomes of even greater importance with the introduction of modern equipment. Skills are required for the maintenance of this equipment, which needs qualified personnel, an electronic workshop and a reasonable amount of spare parts.

Training should include formal classroom training, in-house and training abroad (for selected personnel), and attendance at relevant conferences. In this connection, training the personnel of the Institute in the English language is highly recommended and should be encouraged. Training of the Centre's personnel on new equipment (such as XRD, DTA, SEM, laboratory roller mill etc.) must also be considered.

The following is a list of some suggested courses which can be offered to train the employees of the Institute:

Topic I - Courses on raw materials, intended for geologists, raw materials technologists, mining engineers, production engineers, production chemists and process engineers:

- (a) Properties requirements of cement raw materials;
- (b) Prospecting for cement raw materials;
- (c) Economic considerations of quarry operation;
- (d) Crusher operation and maintenance;
- (e) Transportation, handling and storage of cement raw materials;
- (f) Quarry equipment.

Topic II - Courses on the chemistry of Portland cement, intended for production chemists, process engineers, trouble-shooting engineers and quality control personnel:

- (a) Chemistry of cement;
- (b) Range of chemical composition in the cement;
- (c) Tools used by the cement chemist in mix design;
- (d) Microstructure of clinker;
- (e) X-ray utilization in the cement industry;
- (f) Removal of minor oxides from the SP and PC systems;
- (g) Ring formation and composition;
- (h) Phase transformation during sintering.

Topic III - Courses on cement process, intended for cement chemists, process engineers, trouble-shooting engineers and production engineers:

- (a) Criteria for cement process;
- (b) Crushing, drying and grinding processes;
- (c) Storage and pneumatic conveying;
- (d) Preblending and blending processes;
- (e) Instrumentation in cement plants;

- (f) Selection of cement process and equipment;
- (g) Alkali bypass;
- (h) Ball mill and roller mill;
- (i) Conveyors and elevators in the cement industry.

Topic IV - Courses on pyroprocessing, intended for production chemists/engineers, burners, trouble-shooting engineers, cement technologists, kiln engineers concerned with design, application and maintenance:

- (a) Burning practice;
- (b) Refractories;
- (c) Cement coolers;
- (d) Coal preparation and firing;
- (e) Technology of preheater and precalciner systems;
- (f) Functions of rotary kilns.

Topic V - Courses on quality and quantity controls, intended for cement technologists, production chemists, industrial economists, process engineers and quality control staff:

- (a) Quality control in cement manufacture;
- (b) Methods of testing the cement;
- (c) Importance of percentage of SO_3 ;
- (d) Effect of coal ash on clinker quality and composition;
- (e) Importance of homogeneity of raw materials and kiln feed.

Topic VI - Maintenance and safety in the cement industry, intended for maintenance managers, maintenance engineers, and production personnel of cement plants:

- (a) Mechanical and electrical maintenance in cement plants;
- (b) Safety in cement plants.

Topic VII - Air pollution in the cement industry, intended for engineers/technologists concerned with operational maintenance and environmental control systems in cement plants:

- (a) Environment control in cement plants;
- (b) Dust collection systems in the cement industry;
- (c) Electrostatic precipitators in the cement industry.

Topic VIII - Others, intended for cement plant managers:

Management in cement plant and other courses related to pollution control, safety, maintenance, quality and quantity control etc.

F. Conclusions

By the end of 1985, the construction of the Cement Development Centre will be nearly complete, and most of the equipment which has been ordered will have been installed and put into operation. Although it is recommended that some further equipment be bought, the Centre can work satisfactorily until the new equipment arrives.

The national economy of the People's Republic of China will benefit from this Centre, since it will carry out complete studies and evaluations of local raw materials necessary for new cement plants, which will result in an

efficient design and engineering of plants by the Tianjin Design Institute. It will also assist the Chinese cement industry in increasing its capacity by establishing new cement plants with different capacities, all based on updated technology in the cement field.

The Centre will be equipped with the most modern equipment (when all the equipment is installed and working), capable of technology transfer and of introducing new equipment and processes to the Chinese cement industry. It will also offer its services to the existing cement plants and assist them in improving and increasing their production, in quality and quantity controls, in reducing their energy consumption, and in using their existing equipment and resources more efficiently. Personnel of existing and new plants will benefit from the Centre through the courses which will be organized by the Training and Career Development Department in co-ordination with the Centre.

It is recommended that selected personnel from the Centre should be given training abroad, that specialized experts should be invited to China, and that conferences should be arranged to keep the Centre up-to-date with cement industry technology. A poor command of the English language is considered a barrier to progress in these areas, and English courses should be offered regularly to the personnel, so that they can achieve maximum proficiency in the language.

Annex I

TOPICS DISCUSSED AND TITLES OF LECTURES GIVEN

Topics

1. Organizational chart
2. Equipment available and equipment necessary for training
3. Equipment available and equipment necessary for printing, copying, binding and archives
4. Computer facilities at the Institute
5. Characterization of cement raw materials
6. Mining and handling raw materials

Lectures

1. Methods used for evaluating cement raw materials, and equipment selection
2. Quality control of cement production and physical and chemical testing
3. Scanning an electron microscope and its application to the clinker microstructure
4. Kiln feed requirements for suspension preheater and precalciner systems - limits of chlorides, alkalies and sulfates
5. Automation and process control in the cement industry

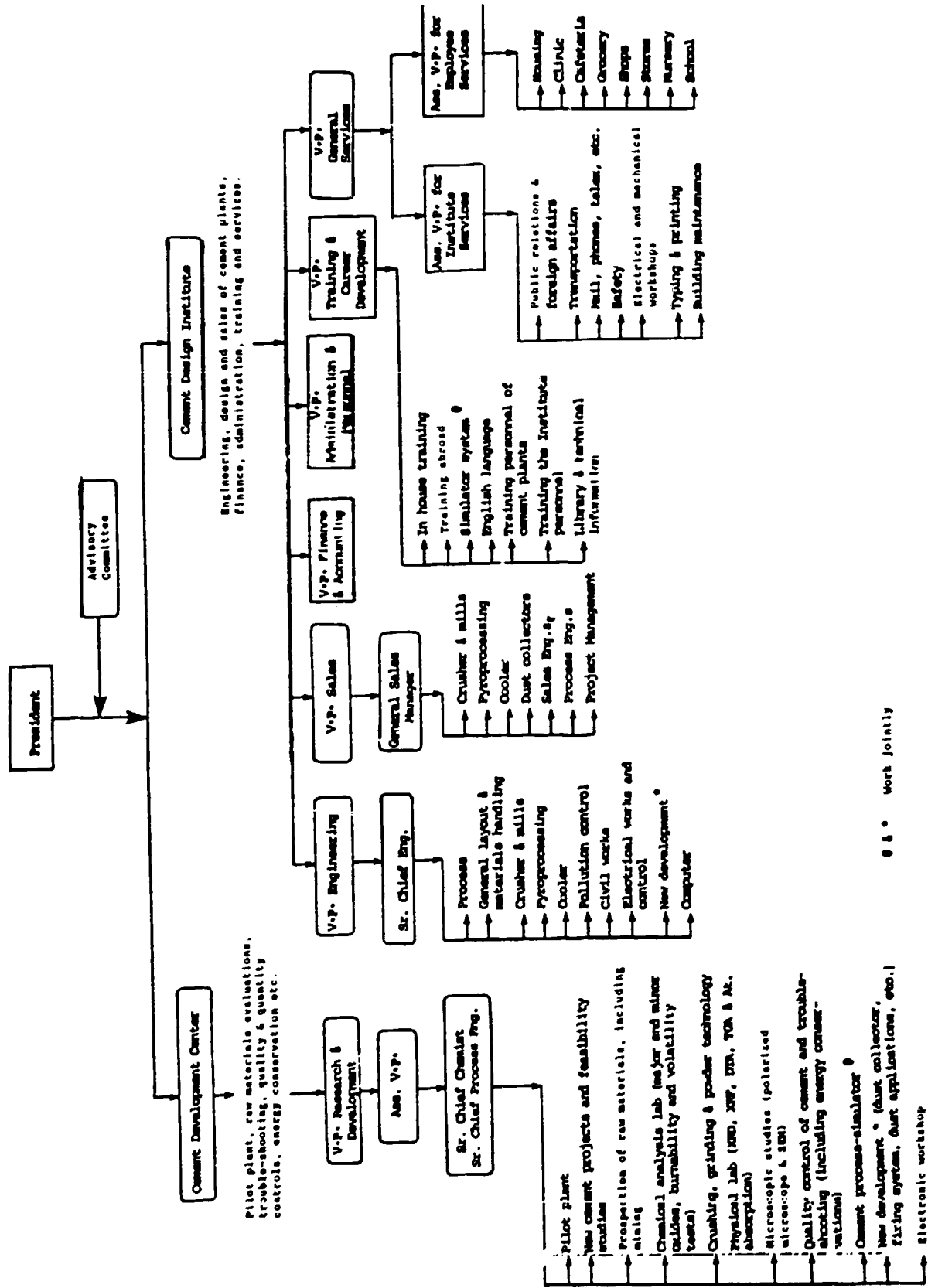
Annex II

EQUIPMENT NOW AVAILABLE AT THE CENTRE, OR THAT HAS BEEN ORDERED FOR IT

1. Wet chemical laboratory
2. Leco apparatus (for SO₃ analysis)
3. Crushers
4. Humidity chamber
5. Particle size analyser
6. Sonic sifter
7. Soap film flow meter
8. Polarized microscope
9. DTA/TGA/DSC/TMS/TADS (to be ordered) a/
10. Equipment for cement testing according to Chinese specifications
11. Digital manometer
12. Electronic thermometer
13. Flame photometer
14. Furnaces, including high temperature furnace
15. X-ray diffractometer
16. Photo-elastic meter
17. Equipment for vibration analysis
18. Different sizes of sieves with shaker
19. Laboratory-scale ball mill (designed by TCIDI)
20. Moisture content determination and dryers
21. Mechanical testing machines
22. Balances
23. Small laboratory for environmental protection, partially equipped
24. Atomic absorption
25. Small scale laboratory to study blending and angle of repose

a/ It is recommended that only DTA/TGA should be ordered, together with some spare parts for both.

Suggested organizational chart of the Tianjin Cement Industry Design Institute



• • • Work jointly

Note: V.P. - Vice President
 Asst. V.P. - Assistant Vice President
 Sr. - Senior
 Eng. - Engineer

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