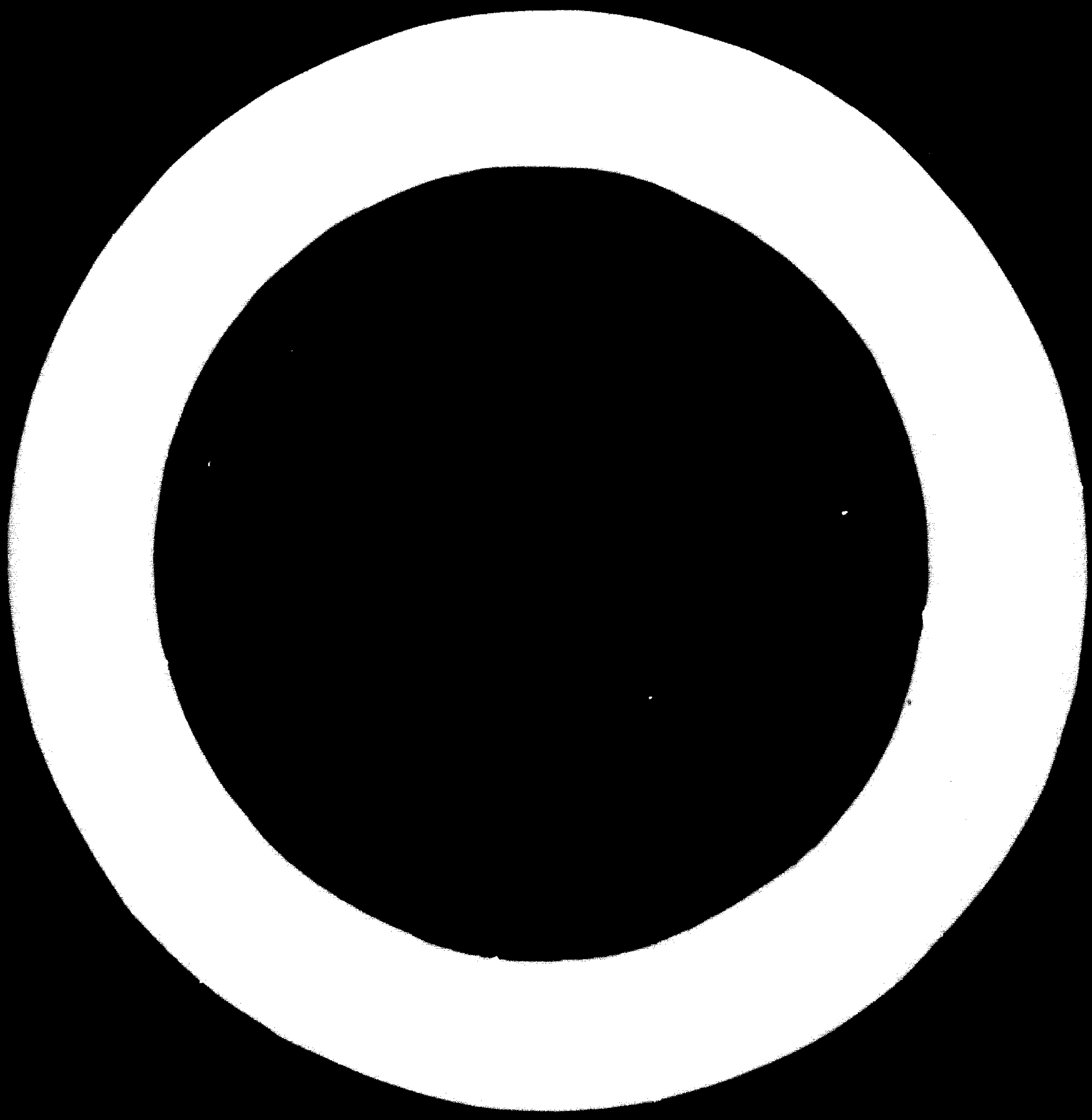
REPORT OF THE INTERREGIONAL SEMINAR ON THE CEMENT INDUSTRY

DENMARK

2-16 May 1964

UNITED NATIONS



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ST/TAO/SER.C/71

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INTRODUCTION

As part of its effort on behalf of the promotion of industrial development in the developing countries, the United Nations has convened a number of seminars and meetings of specialists on specific industries and industrial problems, for the purpose of disseminating information and exchanging experience between the developed and the developing countries. As the cement industry is one of the first to be established in the early stages of development, a seminar was arranged on the subject with these aims in view. The seminar aroused great interest among the developing countries, as is shown by the encouraging response received from the thirty Governments invited and the large number of participants.

The seminar was organized by the United Nations Bureau of Technical Assistance Operations and the Centre for Industrial Development of the Department of Economic and Social Affairs, in co-operation with the Government of Denmark's Board of Technical Co-operation with Developing Countries. It was held in the Krogerup High School in Humleback, from 2 to 16 May 1964.

The seminar took a comprehensive view of the whole industry, including investigations prior to, as well as the planning of, the establishment of cement works, together with the economic, technological, management, labour relations and marketing aspects of the industry. Thirty-four lectures were given by twenty-five lecturers, of whom six were non-Danish, one from the Federal Republic of Germany, two from Sweden, one from Iceland, one from India, and one from the headquarters of ECE in Geneva. Almost all the lecturers had wide experience of the establishment and development of the cement industry in developing countries. Thirty-two participants from twenty-two developing countries in Asia, Africa, Latin America and the Middle East, engaged in the cement industry in a managerial or technical capacity, and government officials concerned with the industry, attended the seminar. Widely differing and far-ranging accounts of experiences in the development and operation of the industry were presented and discussed, and the meeting proved most useful and stimulating to all the participants. During the two weeks of the seminar, visits were made to a cement plant, a concrete products factory and a manufacturer of prefabricated building parts. At the request of the participants, a visit was also paid to a cement machinery workshop.

The report consists of eight chapters, each containing abstracts of the lectures delivered on the particular aspect of the industry covered by the chapter, together with the relevant charts and tables, and a summary of the subsequent discussions. The report also includes the general conclusions and recommendations of the seminar.

[illegible]

[illegible] location near [illegible] land. [illegible] a number of factors, of which the most important are proximity to limestone and clay, cement markets, transport facilities, fuel and power resources and water supply.

The optimum size of plant must depend on local conditions in each country; however, it was generally agreed that under normal conditions the minimum economic plant may be estimated as having a capacity of about 100,000 tons a year. In cases where smaller plants than the suggested minimum are found to be feasible, it was held that a modern automatic shaft kiln might be the most suitable.

The relative advantages and disadvantages of the wet and dry processes were discussed but it was not possible to generalize upon which process is preferable. It was agreed that each case would have to be decided on its own merits, depending principally on fuel economy, suitability of raw material and water supply.

It was maintained that in starting-up new plants maximum efficiency is reached when a local organization is formed to co-ordinate the various factors relating to the establishment of the plant. It was also held that executing the project on a turn-key basis is not always advisable. On the other hand, note was made of the pitfalls involved in carrying sub-contracting of machinery in particular to extremes.

In developing countries, the industry often has to provide its own utilities, such as power, housing, etc., which adds to the total capital requirement, the largest factor being the power facilities. The opinion of the meeting was that steam and gas turbines are generally economical, although for small plants that are not likely to expand, small diesel engines are more economical.

Great emphasis was laid on the proper training of personnel and it was agreed that where local training facilities are found to be inadequate arrangements should be made for training abroad, preferably in association with machinery suppliers.

It was felt that adequate plant maintenance, particularly preventive maintenance, could not be over-emphasized in developing countries where capital is the production factor in shortest supply. Where foreign exchange for spare parts is difficult to obtain, some developing countries have resorted to the production of spare parts in order to avoid loss of production owing to the absence of an adequate supply.

[illegible]

[illegible] skilled labour, [illegible]. Under these [illegible] cement plants gradually, [illegible] plants in the advanced countries, [illegible]. Special stress was laid on the importance of [illegible] relations, as well as [illegible] level control.

It was agreed that in proximity to a large market [illegible] facilities might be found economical, depending on [illegible] including the availability of slag or like material for [illegible] cost, favourable transport costs for clinker and lower cost of [illegible] grinding. When possible, the bulk transport of cement might also be found economical, having the possible advantage of saving the cost of the bags in foreign exchange, as well as being simpler than packing the cement.

Mindful of the conclusions reached, the meeting felt that the United Nations should continue its efforts to promote the development of the cement industry in the developing countries and should extend assistance in the form of, *inter alia*, geological surveys, feasibility studies, and the practical training of personnel. The meeting also felt that the United Nations should play an active role in the establishment of an international standard specification for cement. Finally, the meeting noted the usefulness of seminars for the purpose of disseminating information and exchanging experience at the international level, and recommended that the United Nations should continue its efforts to promote specific industries.

I. BACKGROUND AND DEVELOPMENT OF PORTLAND CEMENT

1. The History of Portland Cement (Dr. A.H.M. Andreasen)

The lecture opens with an account of the technique used in antiquity and in the Middle Ages in the application of mortars, and the theories held in those times about the manufacture and setting of mortar and its final properties.

Portland cement was not invented overnight but was developed gradually during the latter half of the eighteenth and the earlier half of the nineteenth centuries by such men as Smeaton, Vicat, Aspdin, Parker and Johnson, and its growth should be viewed in the light of the search for scientific knowledge which marks this epoch, when false doctrines regarding the forces of nature, as old as mankind itself, were of necessity abandoned.

Once Portland cement had been developed, later activity concentrated on three points: the most rational possible method of production; the most rational possible application - preferably using entirely new designs; and the broad scientific study of both these fields that is characteristic of the present day.

2. Salient Characteristics of Portland Cement (C.A. Bang Petersen)

The lecture opens with a discussion of the position of the Portland cement (PC) industry in the development of the less developed countries. The industry is of great importance to the general, or infrastructual, development of a country and, unlike the majority of industries, it does not demand an industrial climate in order to be able to exist.

The following points are brought out as being characteristic of the PC industry:

(1) Raw materials are available in most countries.

(2) Plants are usually placed close to limestone deposits.

(3) Large investments, low capital turnover (Chart I.2-1).

(4) Heavy transport costs are important in the consideration of economies of scale as against transport costs.

(5) The technology of manufacturing PC is relatively simple.

(6) The manufacturing process is undergoing gradual development over the years and revolutionary innovations are few.

(7) The design of PC plants imposes heavy demands on the consultant engineers, when compared with most other industries, because of variations from one location to another in the physical and chemical properties of the limestone.

(8) The PC industry has always been open to newcomers and process patents and secret know-how have never played a significant part in it.

(9) Portland cement is a highly standardized product, which means that marketing possibilities depend mainly upon selling price.

The importance ascribed to the PC industry from the point of view of the developing countries is due not so much to the industry itself as to the extensive applications of the product and to the many cement-using industries which will follow as the natural consequence of the establishment of a PC plant.

Portland cement is a very cheap commodity with numerous uses. The user requires no special technical training.

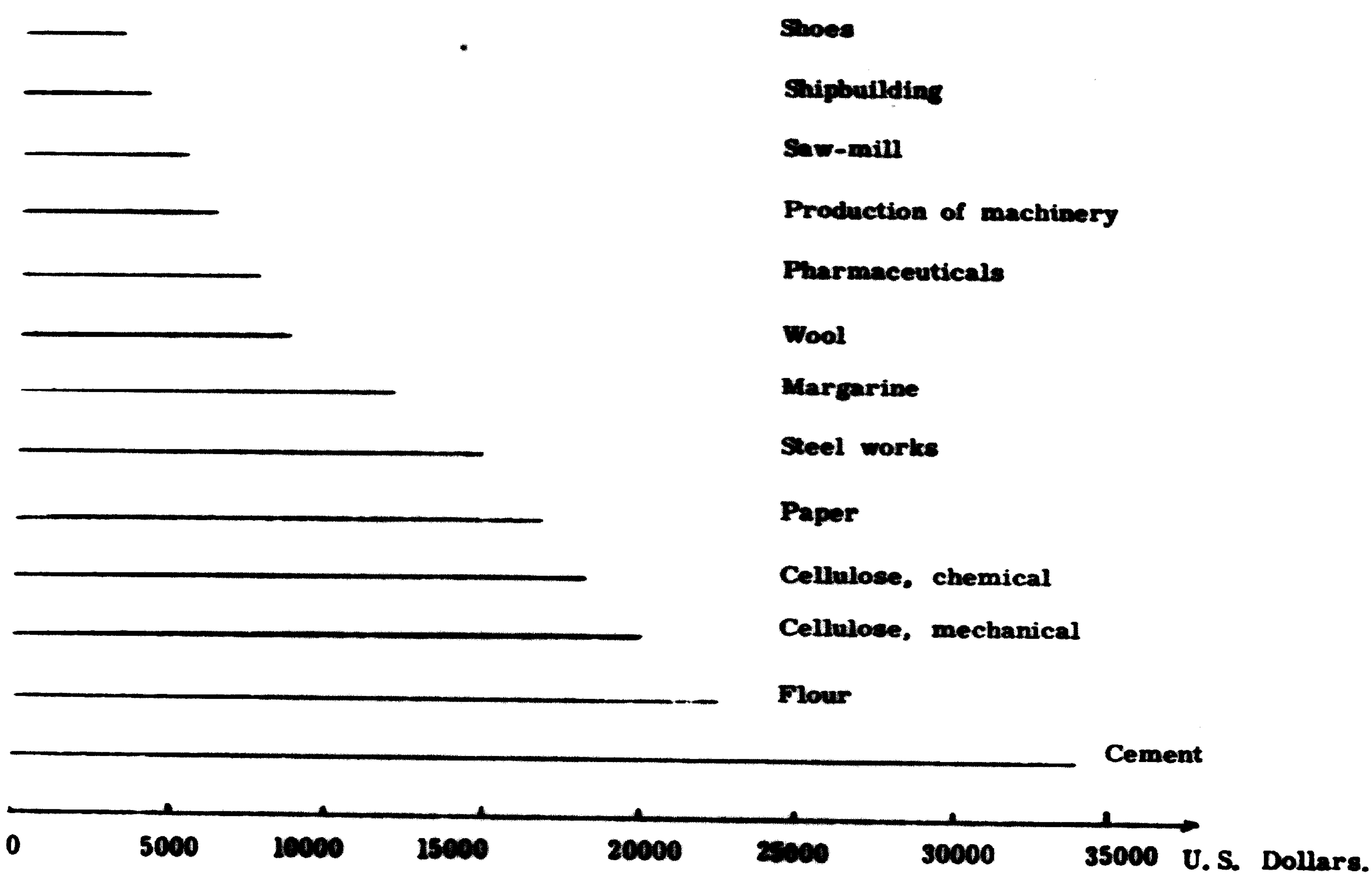
The principal clients of the PC industry are: government agencies, public works administrations, contractors and builders, concrete product manufacturers, asbestos cement plants, and producers of ready-mix concrete.

The establishment of a PC industry may give rise to industries for the production of: asbestos cement (numerous products), building blocks (several types), light-weight building blocks, concrete roofing tiles, floor tiles, building elements, and concrete pipes.

In conclusion, some hints are given on estimating market possibilities on the basis of construction activity envisaged in the region or country.

Chart I.2-1

Investment per employed person in buildings and machinery for various industries in Sweden in 195-.



[illegible]

[illegible]

(1) [illegible] construction, [illegible]

(2) Concrete and concrete products [illegible] material in Europe and are steadily increasing [illegible].

(3) Concrete may be expected to play an even more important [illegible] developing countries than in the more developed countries, [illegible] of steel, light metals and plastics construction may be more competitive. The disadvantage of concrete in developing areas [illegible] cement production [illegible] for substantial investment in factories equipped with major heavy machinery, but this would generally be compensated for by the multiplying [illegible] effect of a cement factory. Even in cases where the cement has to be imported, such importation seems to produce a far less serious effect on the economy than the importation of more finished products such as steel and other metals.

The activities of the ECE Committee on Housing, Building and [illegible] include the industrialization of house construction and building [illegible]. Publications on these subjects are regularly issued by the ECE [illegible]: Annual Bulletin of Housing and Building Statistics for Europe [illegible] European Housing Trends and Policies.

The ECE Committee on Steel will shortly publish a study on the use of steel in construction, in which technological and economic trends in the use of steel as a building material will be analysed in detail. Factors which may affect the quality of concrete and are hence of importance from the point of view of its use in steel reinforced concrete construction include the following:

(a) The homogeneity of the cement [illegible] control of raw material, firing temperature, grinding, storage and [illegible].

(b) The quality of the inert material (gravel, rubble, sand), which should be as high as possible.

(c) The use of vibrators for compacting concrete [illegible] reduced water requirements.

(d) The use of additives, which [illegible] concrete.

(e) The use of [illegible] to control the concrete [illegible].

(f) Special treatment of the concrete after setting, such as steaming or coating to slow down evaporation and thus reduce shrinkage.

The result of these improvements, or possibilities for improvement, has been that permissible stresses have increased from 40 kg. per square centimetre at the beginning of this century to 100 kg/cm² for reinforced concrete and to as high as 250 kg/cm² in some pre-stressed concrete structures.

II. ECONOMIC AND FINANCIAL ASPECTS

1. Production, Consumption and Cost Structure (M.T. Ehlers)[1/]

World production of cement has been steadily increasing, rising since 194[illegible], at the rate of 9.2 per cent per annum. (Chart II.1-1). The fastest rates of growth are shared by the Asian countries, the centrally planned economies, and the countries of the Middle East; the slowest growth is registered by North America. These differentials in rates of growth have resulted in changes in the patterns of cement production and in the share of the various regions in total production. Although North America and Western Europe together still account for the greater part of total world output, their share has decreased from 72.1 per cent in 1947 to 51.0 per cent in 1960. (Chart II.1-2).

The substantial increase in world cement production is reflected in the level of *per capita* consumption. Chart II.1-3 shows the level of *per capita* consumption and the historical trend for the major regions of the world. Chart II.1-4 indicates the relationship between total cement consumption and gross national product for the OECD countries.

As regards the cost structure of the cement industry, Table II.1-1 indicates an order of magnitude for the major components of the total production cost.

Table II.1-1

Composition of unit cost for cement production in selected countries

(Percentage of total)

Item	Germany (Fed. Republic)	USSR	United States of America
Depreciation	21.6	9.6	22.5
Wages	8.2	22.3	13.9
Fuel	21.5	37.1	14.3
Power	12.5		12.6
Others	36.7	31.0	36.7
	100.0	100.0	100.0

An important characteristic of production cost is the decrease in average cost with an increase in scale of operations, this being attributable primarily to returns to scale for fixed investment, labour and overhead costs.

1/ Summary based on the lecture delivered by M. T. Ehlers and data obtained from *Studies in Economics of Industry*, No. 1, United Nations Publication, Sales No.: 63.II.B.3.

Chart II.1-1

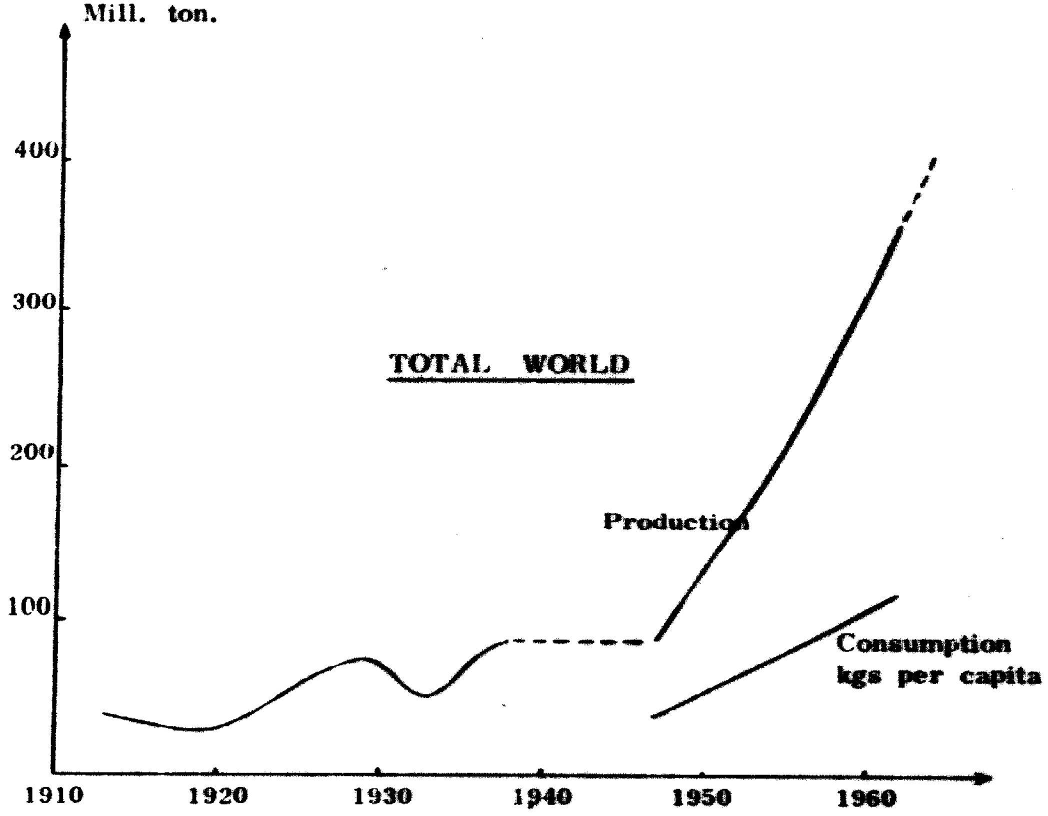


Chart II.1-2

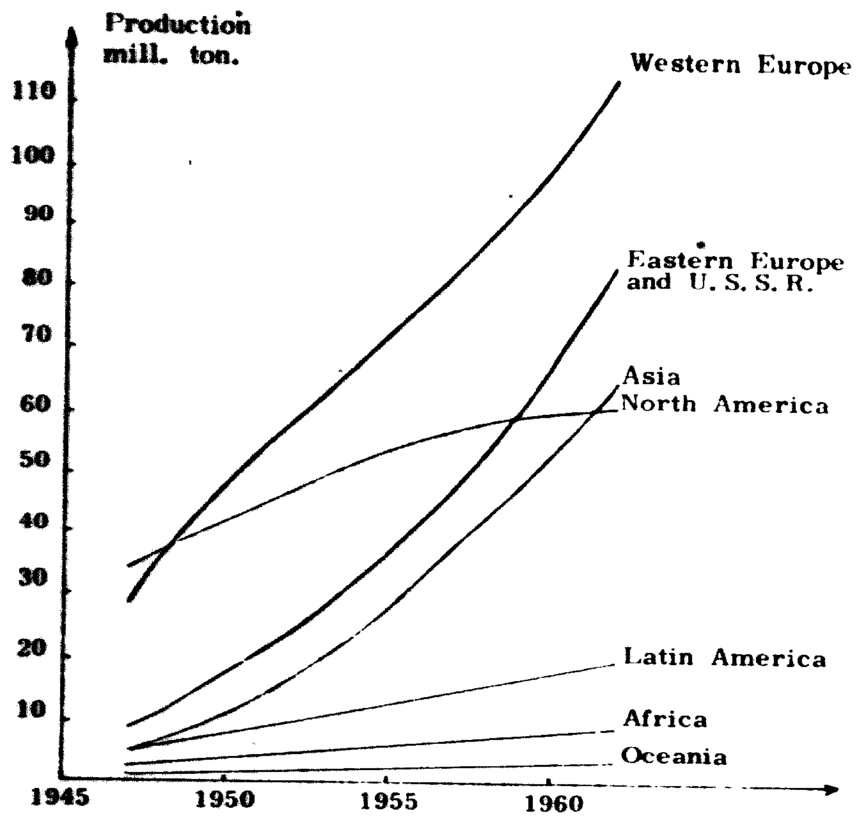


Chart II.1-3

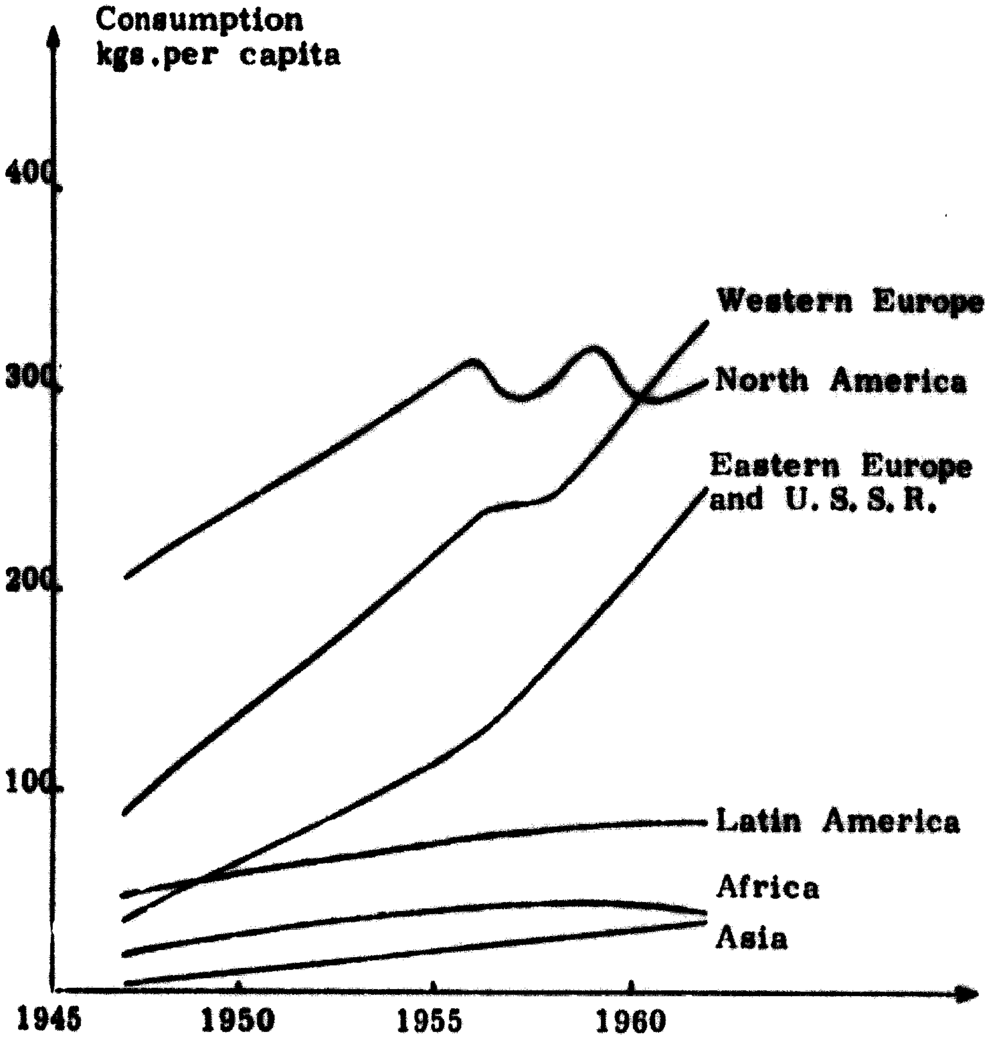
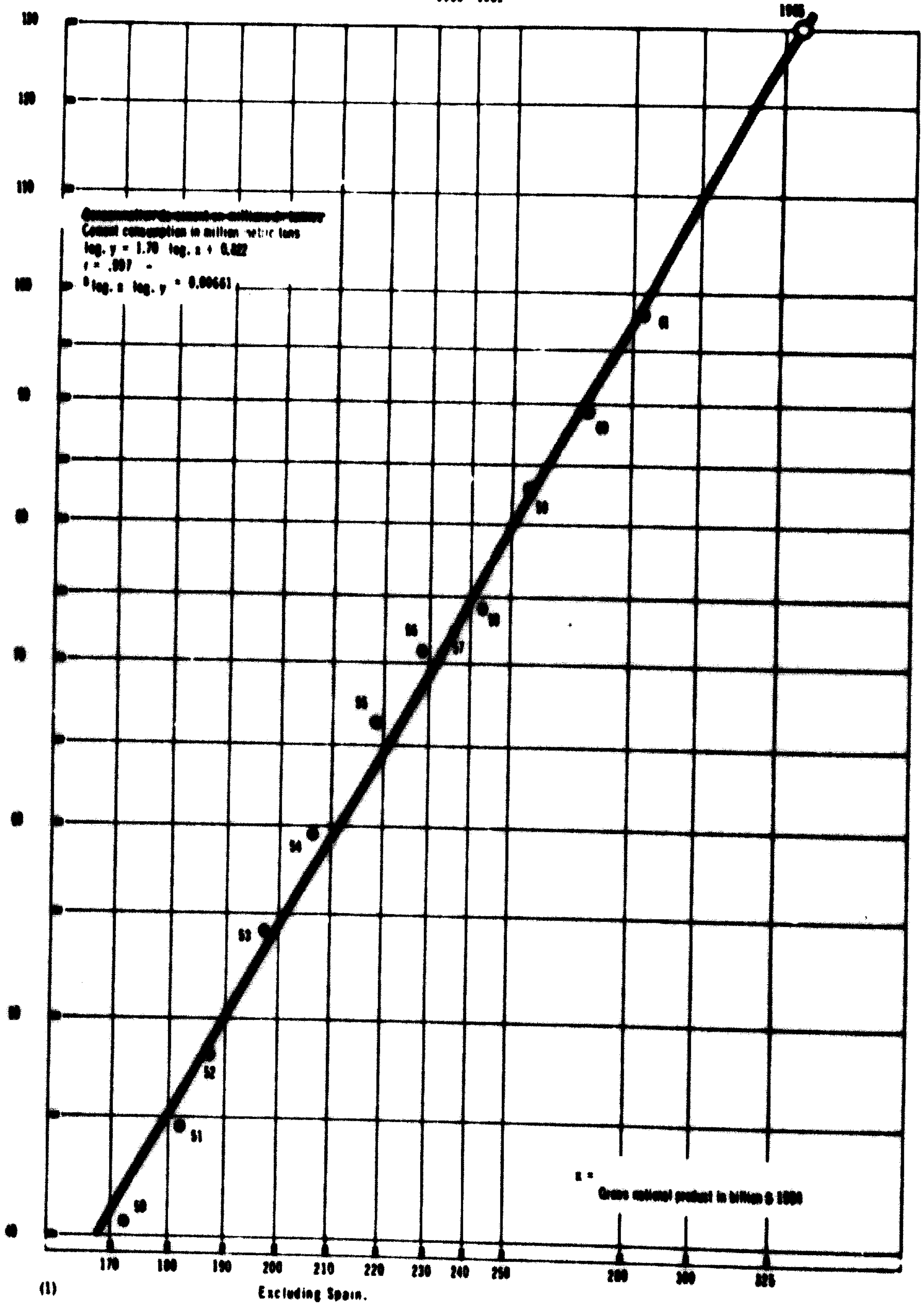

Consumption
kgs.per capita
400
300
200
100
1945
1950
1955
1960
Western Europe
North America
Eastern Europe
and U.S.S.R.
Latin America
Africa
Asia

Chart II.1-4

CEMENT CONSUMPTION AND GROSS NATIONAL PRODUCT IN EUROPEAN O.E.C.D. COUNTRIES (1)

1950 - 1961



(1) Excluding Spain.

Chart II.1-5

Fixed investment related to capacity in Germany (Federal Republic), USSR, United States of America and developing countries

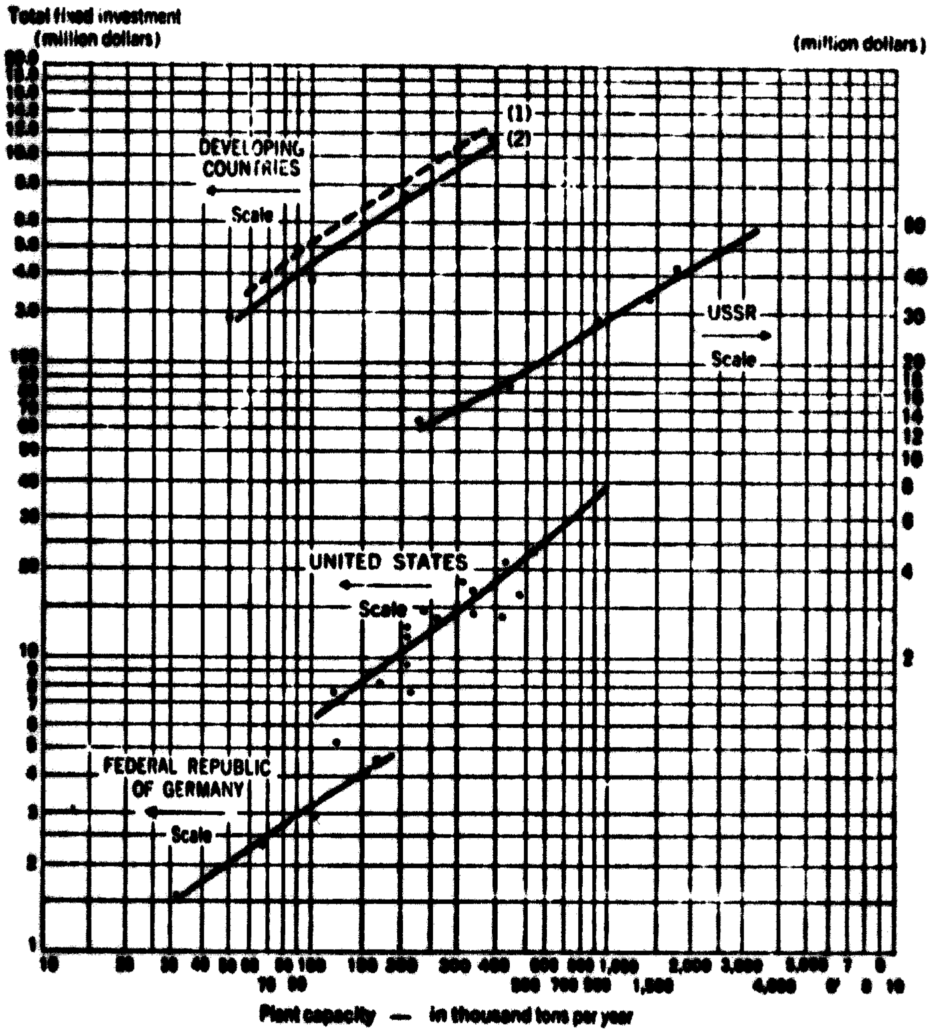
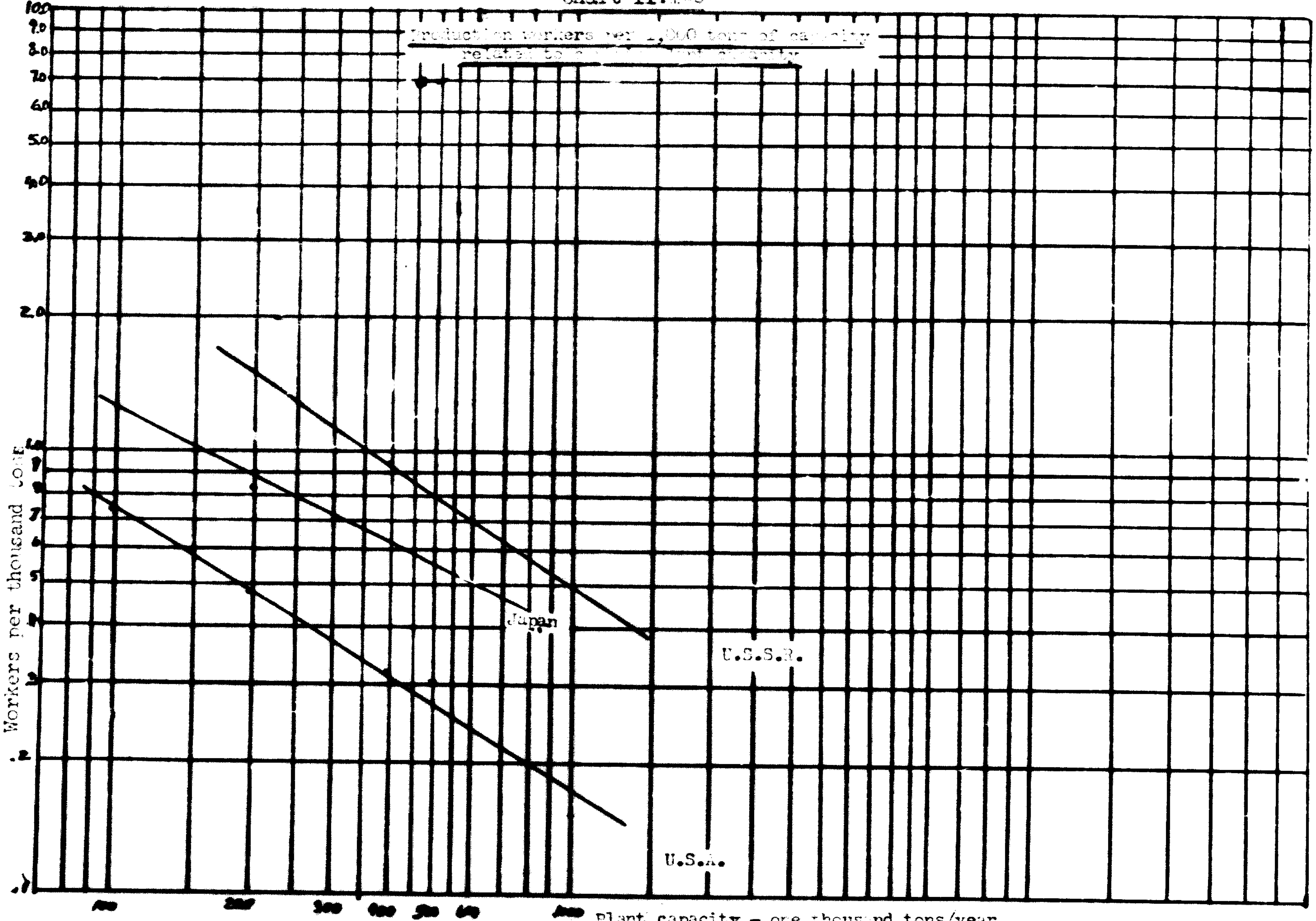


Chart II.1-6



Production workers per 1,000 tons of capacity
related to plant capacity
Japan
U.S.S.R.
U.S.A.
Workers per thousand tons
Plant capacity - one thousand tons/year

The influence of scale [illegible] on the basis of data av[illegible] [illegible]. The three sets of data indicate [illegible] size and total of investment [illegible] increase in size and th[illegible] [illegible] elasticity varies from 0.[illegible] in the [illegible] 0.77 in the United States data.

Similarly, Chart II.1-6 shows that average [illegible] production decrease with the increase in the scale [illegible].

With respect to fuel, power, limestone, [illegible] significant variation in unit input requirements [illegible] operations.

2. Trade in Portland Cement (A. Mouritzen)[1]

World trade in cement has increased from about 4.[illegible] million tons in [illegible] about 12.0 million in 1962. However, since 1955 it has tended to stabilize [illegible] level of 11 to 12 million tons. (Chart II.2-1). Western Europe has been the most active region in international trade. It has been predominant in the export market and has maintained its relatively high share of total world imports. The trend, however, has been toward a decrease in its share (Charts II.2-2 and II.2-3). Despite the increase in local production of cement in the developing regions of the world, these have remained the most active in the import market, except for Latin America, which has consistently reduced its share of total world imports, from 37.7 per cent in 1947 to a low of 4.7 per cent in 1960. Africa remains a major importer of cement although its share in the total shows a slightly declining trend. On the other hand, Asia, the Middle East and the centrally planned economies show an increasing trend for their share of total world imports. On the export side, the share of the developing countries of the world has increased from about 4 per cent in 1947 to about 27 per cent in 1960. The centrally planned economies have also recorded a high increase in their share of the export market. The share of the North American countries in world trade has been relatively low.

Net trade (export minus import), depicted by net export and net import [illegible] region, shows that Western Europe and the centrally planned economies have been net exporting regions since 1952. However, the volume of net export of the former has shown a declining trend. Africa, the Middle East and Latin America have been net importing regions, with the latter gradually achieving a position of self-sufficiency. Since 1951, Africa has recorded a slow downward trend in the volume of net import. Asia has been, on the average, a net importer since the war, although the region has been approaching self-sufficiency since 1955. In the years immediately after the war, the North American countries were net exporters, after which followed a period of self-sufficiency, and the situation has been one of net import since 1953.

World trade comprises only a small share of total world production (3.5 per cent in 1960), and has shown a moderate downward trend.

1/ Summary based on the lecture delivered by Mr. A. Mouritzen and data obtained from Studies in Economics of Industry, No. 1, United Nations Publication, Sales No.: 63.II.B.3.

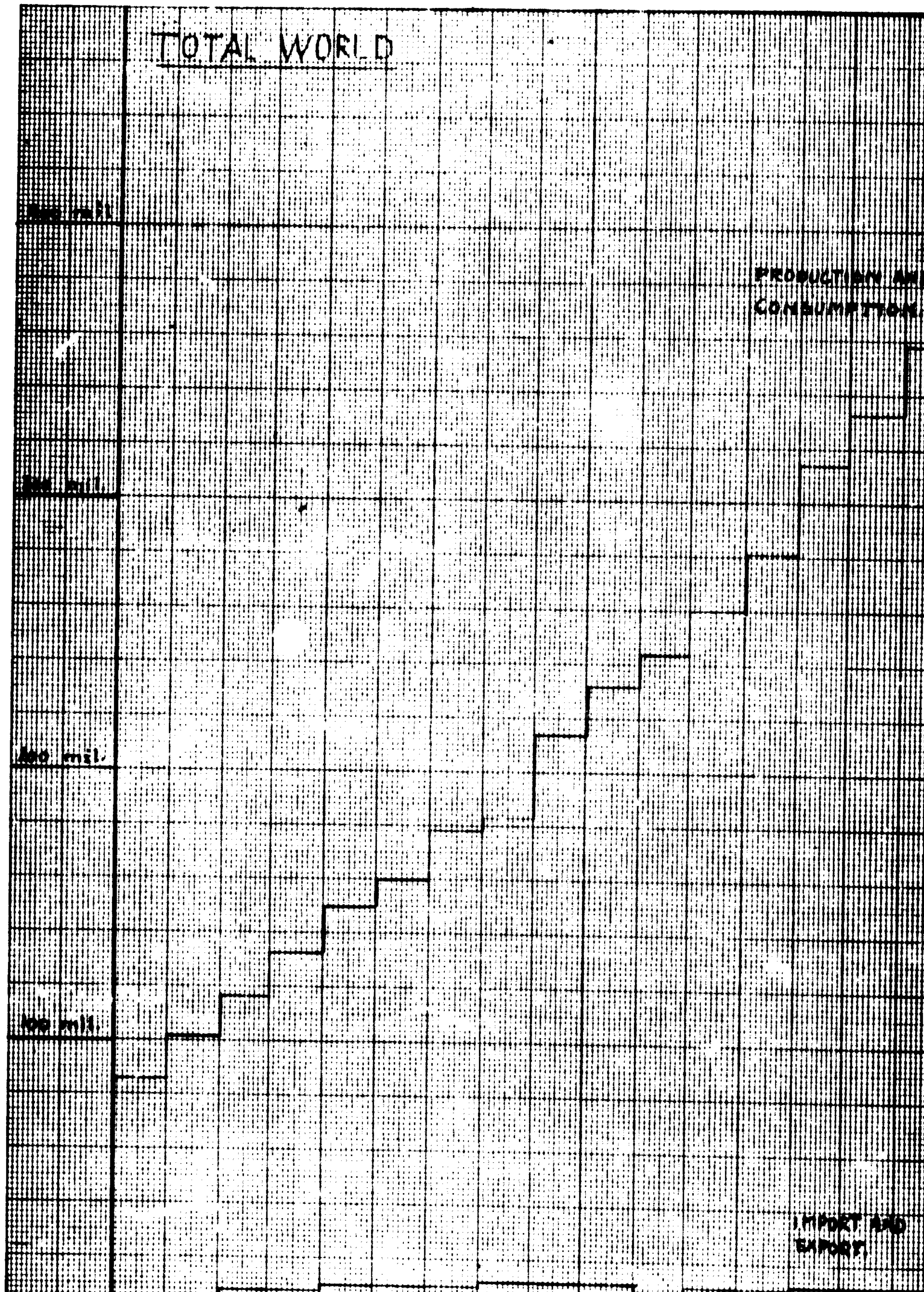

TOTAL WORLD
100 mil.
PRODUCTION
CONSUMPTION
IMPORT AND
EXPORT.
1950
1955
1960
TABLE I.

Chart II.2-2

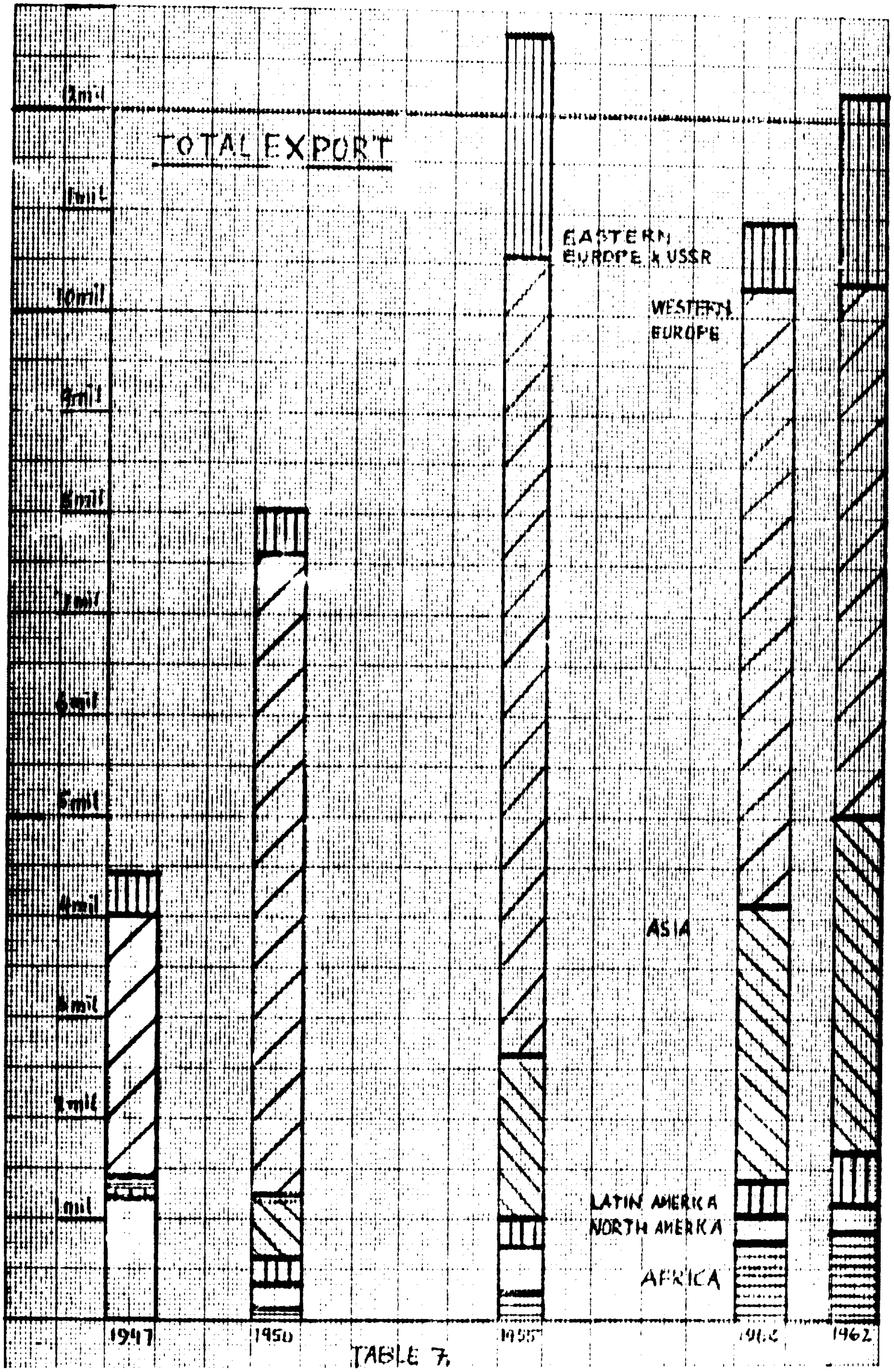
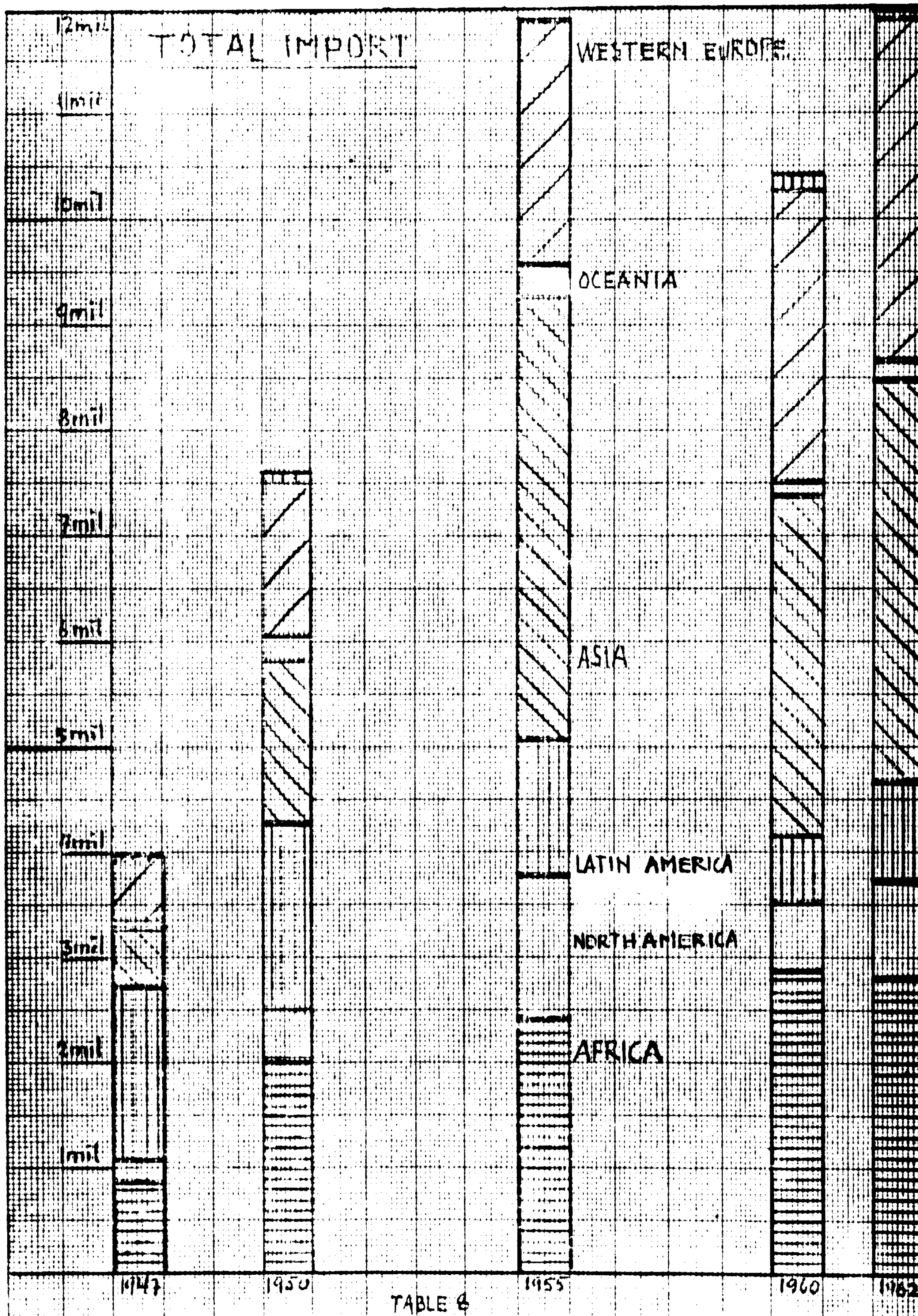

TOTAL EXPORT
EASTERN EUROPE & USSR
WESTERN EUROPE
ASIA
LATIN AMERICA
NORTH AMERICA
AFRICA
1947
1950
1955
1962
TABLE 7.

Chart II.2-3


12mil
11mil
10mil
9mil
8mil
7mil
6mil
5mil
4mil
3mil
2mil
1mil
TOTAL IMPORT
WESTERN EUROPE
OCEANIA
ASIA
LATIN AMERICA
NORTH AMERICA
AFRICA
1947
1950
1955
1960
1962
TABLE 6

3. Financial Assumptions for New Plants (S.A. [illegible])

The purpose of this paper is to examine the financial [illegible] cement factory with a yearly capacity of 100,000 tons [illegible] country.

The installation cost of such a plant is estimated to [illegible] cash for the plant proper, assuming that power [illegible] purchased.

The plant is based on serving an area of roughly [illegible],000 [illegible] of about 2,000,000. Selling the cement at [illegible] per [illegible] of 50 [illegible] capacity of the plant is estimated to range from $500,000 to $1,[illegible] a year, depending on the run-factor and on sales, and this money is available for [illegible] of depreciation, loans and profit.

Of the total cost, it is assumed that 50 per cent, or $2.5 million [illegible] raised locally, whereas $2.5 million can be arranged as loans from foreign sources.

These loans can be repaid with interest over a period of about seven years, upon which the national capital will earn a very fair return on its investment.

4. Financial Assumptions for a Hypothetical Plant in India (K.V. TalcherKar)

When a detailed project report is being prepared on the establishment of a Portland cement works, the company promoters must be given a picture of the profitability of the scheme, and for this purpose a reasonably accurate forecast must be made of production costs. In India, such a forecast is made on the following lines.

The estimate of actual production forecast against installed capacity is based on 330 days of daily rated production from the kiln for one year of operation. For the first year or so, it is customary to take only 80 to 85 per cent of production, in order to allow for stoppages to correct any defects that may emerge. Thereafter, actual production is estimated to be 95 per cent of installed capacity.

To make an estimate of production costs, it is necessary to be fully acquainted with the costing process normally used in operating a PC works. Varying adjustments may have to be made for such items as the type of quarry operation adopted, the nature of the limestone to be crushed and ground, the mode of transport, the quantity of correcting material used and its delivered price, the cost of kiln fuel, and, if power is purchased, its tariff and estimates of the amount consumed in producing one ton of cement. (Diversities in these cost-elements are illustrated from experience in the operation of a number of cement factories in India.)

The rest of the items in the cost structure are more or less the same from factory to factory in India and can be assessed without difficulty.

Depreciation will naturally depend on the estimated total capital cost of the works. It is normally assessed at an average rate of 6-3/4 per cent.

Chart II.4-1

Break-down of Production Costs for a Hypothetical Cement Plant in India

Annual targeted output: Clinker, [illegible] tons

Calculated Cement, [illegible] tons

(Wet-process plant)

	Item	Quantity in tons	Parts/tons of calculated cement	Proportional cost in $	Percentage of that cost of bagged cement
(i)	Raw Materials				
	(a) Lime Stone	264,000	1.25)		
	(b) Clay	50,000	0.24)		
	(c) Bauxite	-	-)	2.08	13.5
	(d) Laterite	10,000	0.05)		
	(e) Gypsum	8,000	0.05	0.46	3.0
(ii)	Kiln Fuel (Coal)	60,000	0.30	2.90	18.8
(iii)	Power Fuel	20,000	0.10	1.22	7.9
(iv)	Repairs and Stores	-	-	1.06	6.9
(v)	Labour and Establishment			1.25	8.1
(vi)	Royalties			0.19	1.2
(vii)	Rents and taxes			0.59	3.8
(viii)	Provident fund			0.11	0.7
(ix)	Packing (excluding cost of jute bags, but including packing cost)			0.50	3.2
(x)	Depreciation			1.44	9.6
(xi)	Overheads			0.59	3.8
(xii)	Selling Expenses			0.42	2.7
	Estimated ex-works price of naked cement			12.81	
	Present day cost of jute bags			2.60	16.8
	Ex-works price of bagged cement			15.41	100.0
	or			0.77 per bag of 50 kg	

Chart II.4-1 is a hypothetical cost estimate, broken down into various cost items, for a cement factory with an installed capacity of [illegible]00,000 tons a year (using the wet process). It is a close approximation to the average cost of production in a cement works in India today.

The major items are as follows:

Raw materials, which includes mining labour costs and the cost of transporting the raw materials to the factory. Royalties paid to the Government for the use of the raw material - a form of tax - are given a separate heading.

Kiln fuel, which includes the cost of handling and pulverizing the coal, as well as losses in rail transit and through spontaneous combustion during storage - a common occurrence in India, where the coal normally available to the cement industry is low in caloric value (4,500 to 5,000) and high in ash (up to 30 per cent).

Repairs and stores, which includes the cost of fire bricks, grinding media, lining plates, spares for replacement and maintenance, including spare parts manufactured in the workshop (cost of labour and material), and stores used in the servicing and amenity departments.

Labour and establishment, which includes salaries, wages, and cost of living allowances to all employees, including supervisors, in the process departments, amenities, civil engineering department, laboratory, office, stores, motor transport department, hospital, creche, sanitation department, club etc.

Overheads, which covers expenses both at the works and the head office and includes such items as postage, telegrams, telephone, insurance, travelling expenses, workmen's compensation, retirement gratuities, and annual bonus to employees.

Selling expenses, which includes the cost of establishing sales organizations, advertising, after-sales services, stockists' commission, etc.

In India, a factory's sale price is usually fixed by the Government, on the basis of an enquiry by the Tariff Commission. For new factories, a special higher price is allowed. It is easy, therefore, to calculate gross profit on a specific turnover of cement production. After allowing for a managing agency's commission and making provision for taxes, the net profit can be calculated to determine the profitability of the scheme. A five year tax rebate is granted to new factories. In the case of existing works, however, the problem is quite different. In deciding the ex-works prices for various groups of factories, the Government at present allows a return of 12.6 per cent on capital employed (including loans). Out of this the industry has to pay:

(a) interest on loans;

(b) bonus to employees (now regarded almost as a part of wages and expected to be paid regardless of the size of the profit);

(c) managing agency's remuneration;

(f) [illegible] to statutory development reserve;

(g) company taxes.

This leaves a net return of less than 6 per cent on the capital employed, available for paying dividends on equity shares and for setting aside as a reserve.

In India today, the building of new factories is financed as follows:

(a) by equity capital, subscribed by the public and by the promoters of the company and their friends, and normally underwritten by the Life Insurance Corporation of India and local banks;

(b) through bank loans, which may be of two kinds - foreign exchange from loans by foreign governments or from international lending sources, counter-guaranteed by the Indian Finance Corporation and/or the Industrial Credit and Investment Corporation of India, or domestic currency from scheduled banks in India; and

(c) through the mortgaging of stocks and shares.

The ratio of bank loans to equity capital has been steadily rising and now stands at almost 1:1. The mortgaging of stocks and shares normally provides about 60 to 70 per cent of the working capital.

5. Summary of Discussion

During the group and panel discussions, a number of questions were tackled, including inter alia capital requirements, minimum plant size, methods of projecting demand, implications of special demand, and clinker grinding plants.

With respect to capital requirements, it was noted that accurate estimates are difficult because of variations induced by such factors as the scale of output, and differences in local conditions and requirements, such as the presence or absence of a power plant, housing for personnel, railway extensions, civil engineering difficulties, etc. The meeting felt that capital requirements could usually be broken down into fixed capital and circulating capital.

Fixed capital may be defined as including the cement plant proper, or the complete cement plant, in which case it covers besides the plant proper, the laboratory, workshops, storage and internal transport facilities. In respect of the complete plant, as defined above it was agreed that estimates of fixed investment allowing a reasonable margin or error, could run from $35 to $50 per ton, depending mainly on the scale of operation, in the 100,000 to 400,000 ton range of annual capacity. In this connexion, the meeting was of the opinion that while the cost of cement-producing equipment and machinery can be estimated fairly accurately, greater variations are to be expected in the cost of civil engineering. The latter varies from place to place and may add greatly to investment, especially in areas subject to earthquakes or with unfavourable climatic conditions. Other factors that were mentioned as affecting investment included differences in domestic freight rates, import duties and the need for additional storage facilities because of seasonal demand. Additional investment might also be required if a factory had to supply its own power. On the other hand, lower investment figures than those given above might be possible in special cases where the terrain and location are favourable and the level of mechanization of the plant is very low.

It was also emphasized that additional capital may be needed for what is usually referred to as social overheads, such as housing and amenities for workers and personnel, railway and road extensions, etc. Such costs may add [illegible] 50 per cent to the above estimates for fixed investment.

Circulating capital requirements were felt to be between 10 and [illegible] per cent of the fixed investment. However, the figure could vary from country to country, depending on the storage needs for cement and clinker owing to seasonal demand for cement, as well as storage requirements for fuel, spare parts and other material. The local credit custom is another important factor.

As regards projection of demand, one useful method was felt to be historical statistical extrapolation. However, in the case of developing countries, where future structural changes are expected, this method may indicate only the lower boundary of demand. It should be supplemented therefore by projections based on various correlations between cement consumption and gross national product and income, as well as projections based on population growth and growth of per capita cement consumption. In cases where countries did not possess sufficient data for projection purposes, it was suggested that data from other countries with similar conditions might be used as the next best alternative. It was noted that, in certain countries, the problem is not so much on the side of demand, which is usually plentiful, as on that of supply, which may be limited by a shortage of foreign exchange.

An important point was raised with respect to cement factories built to answer a special demand, such as the building of a dam, hydro-electric power plant, canal, etc. It was felt that ultimately each case would have to be decided on its own merits. However, should the project extend over a long period, it might be possible to establish an economically feasible plant that would pay its own way. It was also noted that such large projects usually generate development in the area in which they are undertaken, and that after the completion of the project enough demand for cement may be created to sustain the economic operation of the plant. In cases where the importation of cement is more economical, the economic feasibility of importing clinker for grinding at the site should be explored as a possible alternative.

In respect of the minimum scale of plants in developing countries, a distinction was made between countries where a cement industry has already been established and developed and those with no existing facilities for cement production. As far as the latter group of countries was concerned, it was agreed that an annual capacity of 100,000 tons could be regarded as the minimum size, while 200,000 tons was suggested as a minimum for countries where the cement industry is already well-established and relatively advanced. It was also noted that in very special circumstances, where the cost of imported cement is high and the internal freight rate is also high, it might be found feasible to establish plants of less than the minimum size, particularly in isolated areas where the demand is limited. The meeting warned against hasty decisions in such cases and urged thorough investigation of all the alternative sources of a low-cost cement supply.

With respect to the economic feasibility of clinker-grinding at centres of demand, it was agreed that such operations might be advisable if certain conditions obtained; first, if transport costs were lower for clinker than for cement, which is not usually the case, second, if the cost of power was lower at the centre of consumption, and third, if the clinker was mixed with another component such as slag or pozzolan, supplies of which were accessible to the grinding site. Attention was drawn to the fact that in a wet climate, the transportation of clinkers can add serious complications to the proper grinding of wet clinkers.

III. INPUT REQUIREMENTS AND PLANT LOCATION

1. Raw Materials (H. Carlsen)

An investigation is necessary in order to ascertain the feasibility of the project and to provide information on which to base the choice of the best type of process and the proper design of the plant.

1. Requirements for the source of the raw materials

(a) Proper chemical composition. Modules (LSF, M_S, M_A).

(b) Adequate amounts.

(c) Low price as quarried (overburden).

(d) Convenient location.

(e) Favourable physical properties.

2. Types of raw materials

(a) Limestone (calcium carbonate).

Undesirable impurities (dolomite, phosphates, high silicates content.

Harmless impurities (small silicates content).

"Cement rock".

Hard limestone. Coral deposits. Chalk. Sea shells. Marl.

(b) Clay. Plasticity. Moisture when dug and as slurry.

Shale. Coal shale. Volcanic ash.

(c) Other materials.

Iron ore. Quartz sand. Gypsum. Water.

3. Preliminary prospecting for raw materials

(a) Study of existing sources of information such as geological reports and maps, and records of previous manufacturing of cement, lime or other calcareous building materials.

(b) The first visit to a deposit. Sampling of rock from outcrop for chemical analyses. Rough estimate, without premature conclusions, of the possible amount of materials.

Chart [illegible]

Drilling in Formation with Inclined beds

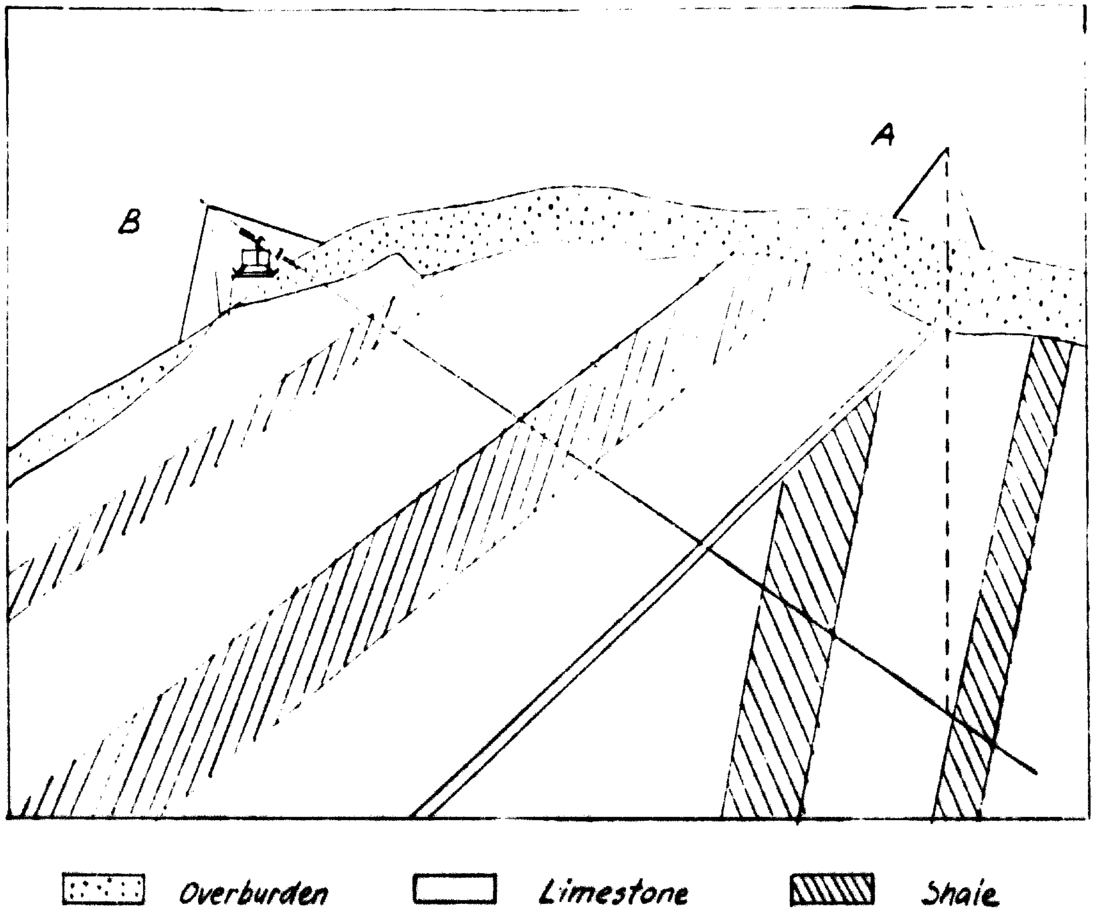
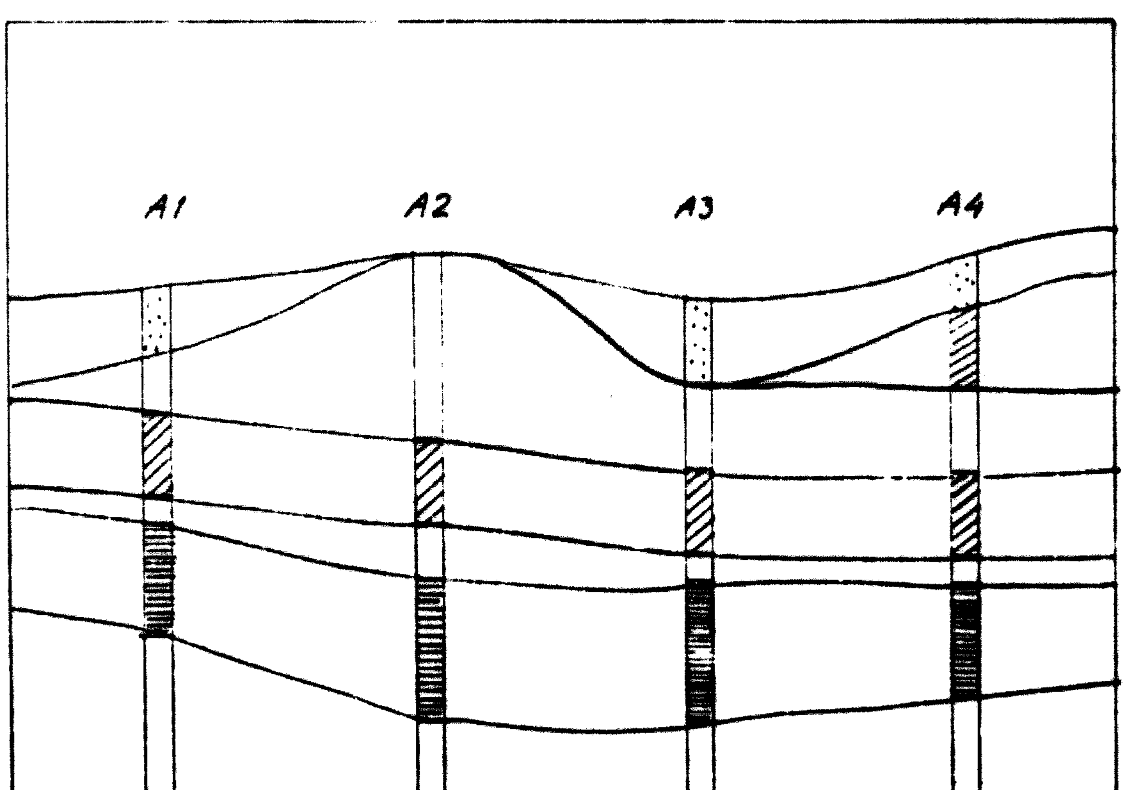


Chart III.1-[illegible]

Raw materials. Cut-diagram of Deposit



4. <u>Systematic investigation</u>

(a) Establishment of the purpose, [illegible].

(b) Provision of the necessary technical assistance. [illegible] to carry out the prospecting, [illegible].

(c) Importance of maps on which to record [illegible] study of the deposit. Aerial maps [illegible].

(d) Sampling methods. Surface sampling, pit digging, [illegible] drilling (Chart III.1-1.).

(e) The diamond core drill. Sampling of cores and sl[illegible]. [illegible] practical know-how necessary for operating the drill and obtaining [illegible] recovery.

(f) The proper use of the diamond drill. Vertical or inclined holes. Use of forms for accurate logging of all information related to the core drilling. Splitting of core samples. Filing of cores.

(g) Examination of the samples. Preparation of average samples for chemical analyses. Combination of results from core and sludge analyses. Titration (calcium carbonate) and complete analyses.

(h) Preparation of vertical-cut diagrams showing results of the examinations. Calculation of amounts of material in the deposit (Chart III.1-[illegible]). Filing of the information for later use in the planning of quarry operations.

5. <u>Further examination</u>

(a) Taking of larger samples for further examination, with a view to selecting the production scheme and determining the dimensions of the production units. Shipping of samples to machinery manufacturer (wet samples in air-tight containers). Size of samples (usually 50 kg. for limestone and 25 kg. for other materials).

(b) Wet versus dry process. Sizing of mills, kilns etc..

6. <u>Cost of the investigation</u> (Table III.1-1)

(a) Costs of core drilling, pit digging, technical assistance.

(b) Total costs in relation to the value of the investigation.

Table III.1-1

COST OF RAW MATERIAL INVESTIGATION

Costs will vary considerably, depending on the nature and location of the deposit. The following figures should therefore be taken as an example only.

Cost of investigation of a deposit, including drilling of 20 boreholes each 50 metres deep	US dollars
1 month's visit of consultant engineer, including journey and expenses	3,000
6 months' visit of drilling engineer, including journey and expenses	10,000
Labour for sampling, drilling etc. 3 men for 6 months	6,000
Maps	1,000
Core drill equipment (purchased)	10,000
Core boxes and storage facilities	1,000
Diamond bits and spare parts	2,000
Water, lubricants, fuel	2,000
Analyses	3,000
Transport, shipment of samples etc.	2,000
Total	40,000
Total expenses per metre	US $ 40.
Total expenses per foot	US $ 12.

. Power Supply ([illegible]. Lundqvist)

Variations in the demand of a cement factory for electric power are small, which is advantageous both when the factory produces its own power and when power is purchased. Unfortunately, the waste heat cannot so far be economically utilized for power production, nor is the heat demand suitable for the installation of back-pressure steam turbines, which are the most economical power source of all.

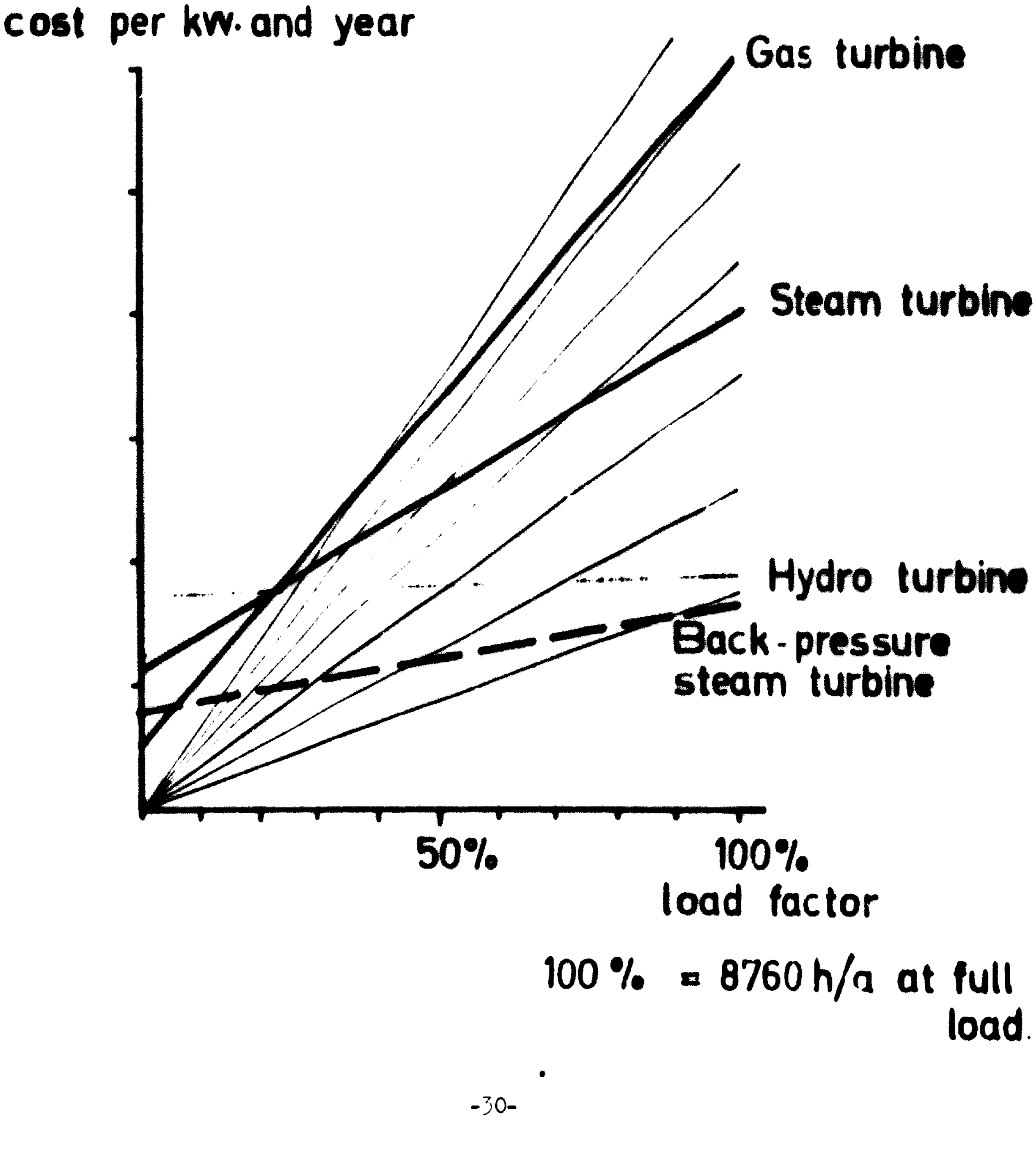
Generally speaking, electric power is produced at much lower cost in large central power stations than in a small industrial power plant. Thus, when a grid of sufficient extent is available, it is usually more economical to buy power. Several reasons may, however, justify a factory in building its own power station, to supply its own needs and perhaps those of other neighbouring industries as well. One such reason may be the high cost of transmitting power from the central power station.

It is always necessary to investigate and compare the costs of power supplied in various ways. Only then is it possible to decide how the supply is to be arranged. Equations are given for the calculation of power costs, and examples are quoted of industrial power tariffs. (See Charts III.2-1, III.2-2, and III.2-3).

The most important features of an industrial power station are reliability and simplicity. It is always a great advantage to select standard equipment, as regards size, steam conditions, alternator voltage, etc.. This means not only a less expensive plant of well proven design, but better facilities for obtaining spare parts, and easier service. It is recommended, therefore, that when tenders for power plant equipment are invited, the equipment should not be specified in too great detail but the data and design decided upon in close co-operation with consultants and manufacturers.

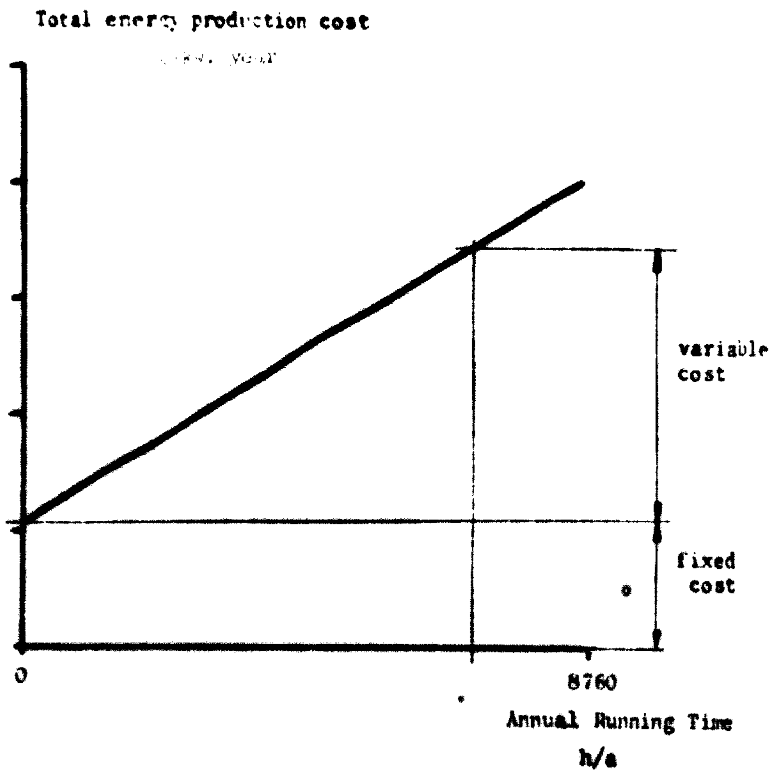
Chart III.1-1

Example of the relation between power production costs for various power sources
(Note: Fuel costs and unit size influence the total cost considerably)



Chart

Power production costs



$K = A + D_f + T(d_r + w \cdot b)$

K = total cost, e.g.

A = annuity

D_f = fixed operation cost

T = yearly running time, hours

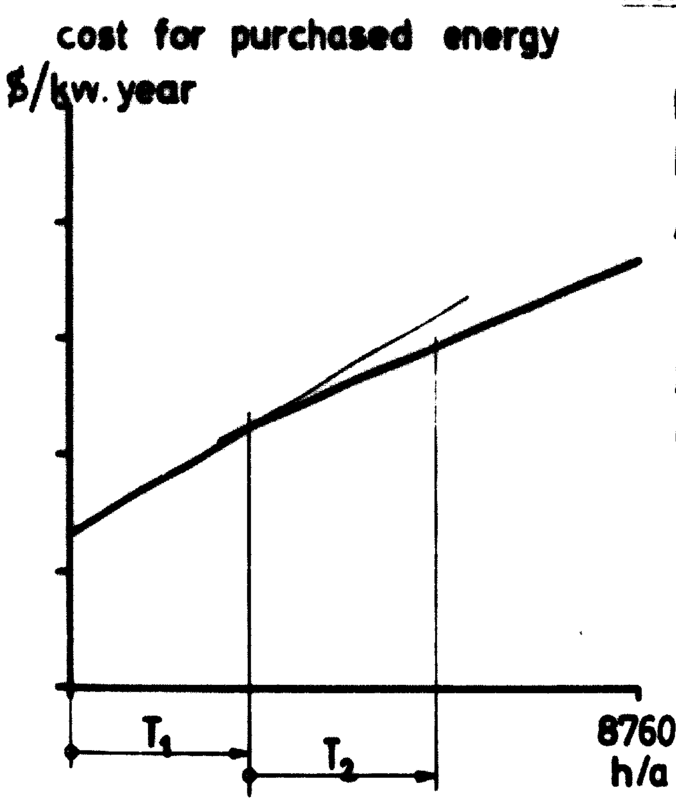
d_r = variable operation cost,

w = specific heat consumption, kcal/kwh.

b = fuel cost, \$/kcal

Chart III.-3

Tariffs for purchased power



$K = A + B \cdot N + C \cdot T_1 + D \cdot T_2$

K = total cost, e.g. \$ year

A = fixed cost (\$/year) within a certain load range (e.g. 1000-5000 kw, 5000-10000 kW etc.)

B = fixed cost (\$/kw, year), N = load (kw)

C = price per kWh up to T_1 h/a (example T_1 = 3000 h/a)

D = price per kwh. in the range T_1 - 8760 h/a

$0 < T_2 < (8760 - T_1)$

3. <u>Other Inputs (Mr. Jón [illegible]. Vestdal)</u>

The Portland cement industry can only flourish where the necessary raw materials are available. These raw materials are lime and clay, or similar minerals, or waste (for instance ash and slag), from which a raw mixture can be obtained of the following composition: 65 per cent lime (CaO), 23 per cent silica (SiO_2), 2.5 per cent iron oxide (Fe_2O_3) and 5 per cent aluminium oxide (Al_2O_3), all in respect of calcined materials. The raw mixture may vary considerably in composition but only within certain limits The raw material usually contains other compounds, which are generally useless, though harmless, in PC production. It may, however, contain harmful compounds such as phosphor. An exact chemical analysis is therefore, essential. If some compound in the raw material is superfluous, processing may be advisable.

For an accurate chemical study of the composition of the raw material, the taking of samples must be carried out as carefully as possible.

The amount of raw material needed to produce 100,000 tons of cement may be estimated at 180,000 tons. To cover an annual production of this figure, for 50 years, a raw material supply of 9,000,000 tons is necessary.

Mineralogical and geological information which may be in the possession of public or private bodies may be of very great help in the preliminary investigations

Water is also needed for the production of PC.

Electric power requirements vary to some extent from one factory to another, but in an average cement factory, producing 100,000 tons annually, about 2,000 kw. will be needed. Generally, 120 kwh. per ton of cement is calculated for electric power used for all normal purposes. Peak hour consumption can be reduced, if convenient in respect to cost, by enlarging some of the machinery.

Fuel of one kind or another is required for the production of PC, the quantity depending on the process used, wet or dry, and also on the construction of the kiln. All types of fuel can be used, the most usual being fuel oil, coal or natural gas. Normally, for the production of 100,000 tons cement, 14,000 tons of fuel oil are needed when the wet process is used, and 27 per cent less when the dry process is used. The quantity of coal and natural gas needed is correspondingly higher and proportional to the calorific value.

Natural gypsum stone is used in the last stage of cement production, 5,000 tons for 100,000 tons of cement.

The decision as to the location of the factory needs careful study, taking into account the sources of the raw materials, the cost of transporting the cement to the various market areas, sites for heavy machinery and constructions, suitability of the ground, availability of manpower, and other factors. A medium-size factory needs an area of 60,000 m² for a plant site.

The manning of the factory calls for a staff with the necessary knowledge of, and experience with, heavy machinery, electrical equipment, analysis of raw materials, the raw mixture and the finished product, and the uses of Portland cement. A medium-sized factory needs at least 150 workers, skilled workers and operational staff.

[illegible]. <u>Location (K.V. Talcherkar)</u>

In deciding upon a suitable location for a Portland cement factory, the following factors must be taken into consideration:

The consumption of Portland cement within the economic radius (usually 150 km.), at present and as forecast for the future.

The proximity of other cement works, and their present production, known reserves of raw material within mining leases already acquired, and programmes for future expansion.

(In India, at present, these two considerations have little bearing on deciding a location, since the producer gets a fixed ex-works price and the consumer pays a controlled ex-destination price fixed by the State Trading Corporation, an Indian government organization.)

The proximity of raw material deposits. (An illustration is given of a cement factory in India which, after some years of operation, had to move its housing colony in order to get at the limestone.)

The proximity of a railhead. In deciding on this factor, a compromise has to be made between the cost of long road haulage of raw materials and the high cost of building a railway siding.

The proximity of coal fields or other fuel sources. (An account is given of the Indian Government's policy of promoting the use of fuel oil by subsidizing it in areas which are difficult to serve by rail.)

The proximity of water sources.

The proximity of electric supply.

There may be other special considerations, such as the proximity of a steel works, which may provide slag for use in the manufacture of Portland blast furnace cement, or of a fertilizer plant, which produces as a waste product calcium carbonate sludge that can also be used in the production of Portland cement. In both these cases, it may be convenient to locate a cement works nearby, in order to utilize these materials in the manufacture of cement.

There are other purely technical considerations which may have a bearing on the exact physical location of the factory site. These include the lie of the land, the nature of the soil and its load-bearing value, the presence of subsoil water, the prevailing wind direction which may influence the location of the housing colony, etc..

The final selection of the location must be a compromise between all these factors. However, some will weigh more than others in making the decision.

After the location has been chosen, the next most important step is to decide the factory's initial capacity. On this, the following factors will have a bearing:

The availability of finance.

[illegible] ([illegible] single unit and [illegible] capacity [illegible] considered adequate.)

[illegible] invested in the first instance.

[illegible] are available in the vicinity and [illegible].

[illegible] plant available from indigenous sources (a factor that [illegible] applies in India).

Constant and variable factors in the cost structure, when compared with total production.

In India, at least one large cement-manufacturing concern considers that a plant should have an initial capacity of 400,000 tons a year in order to give a reasonable return on the capital employed in the light of the present tax structure and other restrictions imposed in the country.

[illegible]. Summary of Discussion

The discussion ranged over questions of impurities in raw materials, raw material reserves, fuel and power requirements, additives, and alternative types of power plants.

In connexion with raw materials, the various effects of impurities such as magnesium, manganese, gypsum and alkalis, were discussed. In respect of magnesium, it was noted that the presence of 4 or 5 per cent MgO would add to the raw materials' burnability, but if there was more than 5 per cent, the cement produced would have the unfavourable characteristic of expansion when used in concrete. It was pointed out that in a number of countries, the standard specification permits up to 5 per cent MgO in the clinker. The presence of a high MgO content further results in lower strength cement, but that can be compensated for by maintaining a higher lime saturation factor in the raw mix, or by finer grinding. It was emphasized that when the presence of MgO in the clinker exceeds 5 per cent, the degree of cement expansion should be determined in the laboratory by the autoclave test.

With respect to manganese, which is found mostly in blast furnace slag, it was observed that a content of 1 to 1.5 per cent MnO_2 would facilitate burning, even with a high lime saturation factor, and that generally speaking an impurity of up to 2 per cent would not be harmful. Attention was also drawn to the fact that it is necessary to adjust the usual analytical procedure when manganese is present.

With regard to gypsum, it was pointed out that this is not commonly found in raw materials. However, when present in limestone or clay it may amount to 1 to 2 per cent of the raw feed as SO_3, and have to be disposed of in burning. The problem of reducing gypsum content was discussed extensively, and it was noted that the design of the kiln and the burning process must be adjusted to allow for the reduction of SO_3 to SO_2.

In connexion with alkalis, it was agreed that the problem does not arise with old kilns. It has arisen in modern kilns however, because of the introduction of chain systems and pre-heaters that have the additional function of collecting dust. The problem is not so serious in the wet process, because the alkalis are concentrated in the finest dust, and as such are collected easily in the last sections of the electric filter. However, in the dry process, where the alkalis are evenly distributed in the dust, the problem becomes more serious, as the [illegible] quantities of alkali-rich dust [illegible] [illegible] economic. It was pointed out that solutions would have to be [illegible] individually, and mention was made of the possibility of [illegible] [illegible] the dust as one rather complicated solution.

In respect of reserves of raw materials, it was [illegible] [illegible] [illegible] sixty years' reserves are required. Attention was drawn to the [illegible] [illegible] planning for future expansion in the output of a cement plant and its [illegible] the calculation of the reserves required. It was noted, for example, that if doubling the capacity of a plant is envisaged in the near future, thirty-five years' reserves may be regarded as feasible. Further, it was maintained that the number of years of raw material reserves may also be regarded as equal to the number of years required to amortize a plant fully; in special circumstances, this may be less than the number of years mentioned above.

It was pointed out by some participants that the power figure of 110 to 1[illegible]0 kwh. per ton of cement was rather high, and that in a number of developing countries lower figures, ranging from 70 to 100 kwh. per ton, are obtained. Such figures, it was further maintained, are due mainly to the type of raw material and the low level of mechanization.

A number of participants held that the figures suggested for fuel consumption (1,[illegible] kcal/kg. for the wet process and 725 for the dry) were rather low, and that in developing countries the average ranged between 1300 to 1400 kcal/kg. for the wet process and 900 to 1000 kcal/kg. for the dry process. These high actual figures, it was pointed out, are due to the fact that a higher water content than the theoretical norm is used in the slurry, in order to simplify processing.

The use of additives, such as soda ash and water glass, as a means of reducing the water content of slurry and thus lowering fuel consumption was also discussed. It was maintained that the use of additives was economically feasible if the gain on fuel was twice as high as the cost of the additives used. It was agreed that tests in the plant were necessary.

With respect to power, a number of participants argued that in small cement plants, in developing countries, two or three small diesel engines should be installed because of lower installation costs. They further advised against the use of second-hand converted jet engine power plants in developing countries, mainly because they have not yet been sufficiently tried out. Others maintained that these power plants offer several advantages to the developing countries, including lower initial cost, ease of erection and smaller housing requirements. In this connexion, it was pointed out that since small cement plants usually expand rapidly, it may be found economically advisable to plan for the installation of larger steam or gas turbine plants at the start, even though they may have to operate for a few years at a lower run factor.

Chart IV.1-1

Types of Production Processes

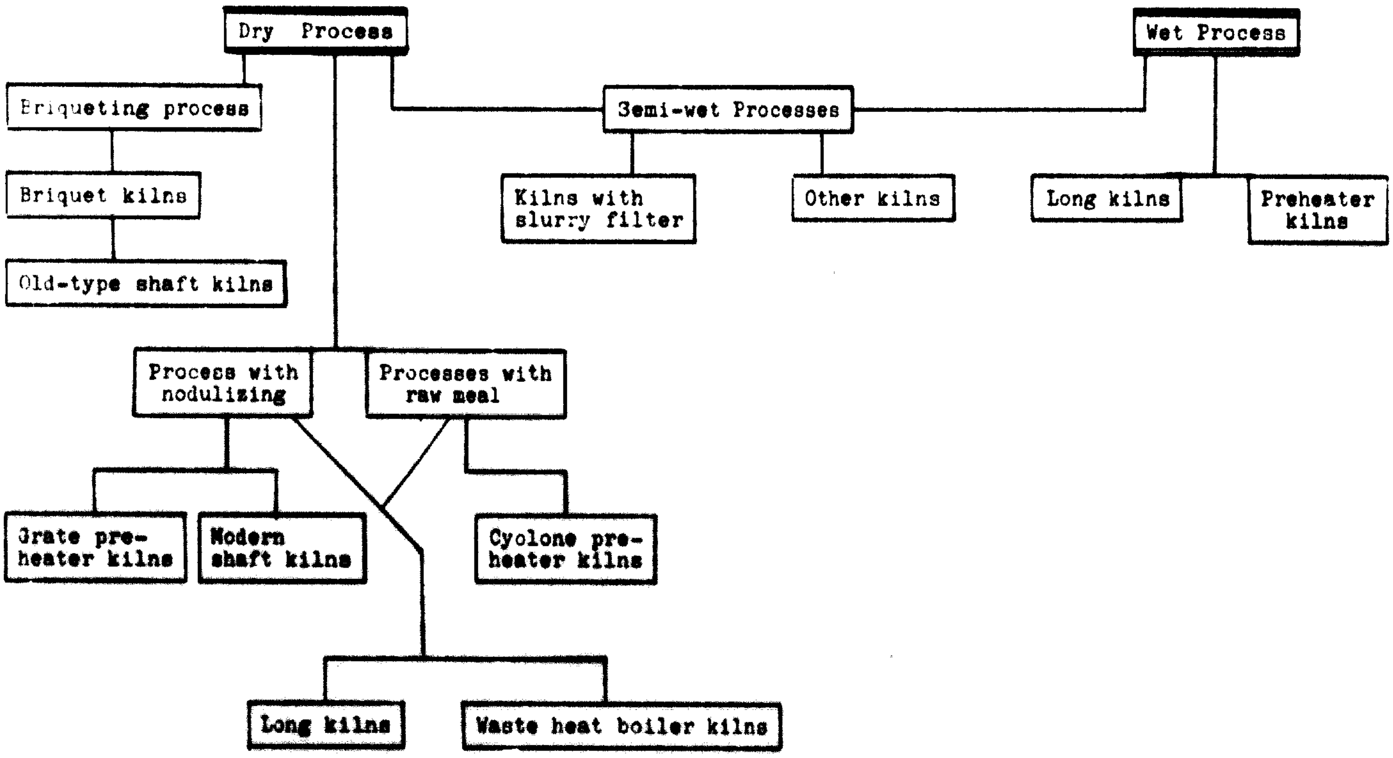


Table IV.1-2

Minimum Figures Obtainable in Practice

	Wet Process kcal/kg.cl.	Nodule Process kcal/kg.cl.	Dry Meal Process kcal/kg.cl.
Heat of reaction	400	400	400
Loss of heat in exit gases	80	40	130
Loss of heat in evaporation and heating of steam	440	130	5
Radiation losses	100	60	60
Cooler losses	60	95	130
Totals	1080	725	725

<u>Assumptions:</u>

Percentage of water in raw meal	-	0	7-8% max.
" " " " slurry	32	(12%)	-
Exit gas temperature	130°C	100°C	300°C

Oil firing.

Dust loss = 0

Difference in calories corresponds to heat consumption for dehydration of raw materials with water content of	-	21%	28%

IV. PRODUCTION PROCESSES AND EQUIPMENT

1. Types of Production Processes (H.E. Hastrup)

The lecture opens with a review of the various processes that may be adopted for the manufacture of Portland cement. There are three principal processes, known as the dry process, the semi-wet process and the wet process respectively. A brief account is given of these processes and the types of machinery used. (Charts IV.1-1, IV.1-2)

A description follows of various factors influencing the choice of process, the most essential being the chemical and physical properties of the raw materials. The raw materials may be roughly classified according to suitability as follows:

Dry Process

Suitable:

(a) Natural cement raw materials, especially those with a minimum water content of 7.8 per cent.

(b) Hard and soft limestone and schist, etc., especially if they can be quarried separately and are of a homogeneous composition.

(c) Marls of a fairly homogeneous composition, the water content of which is not too high.

(d) Blast furnace slag, etc.

Less suitable:

(e) Washable materials with a high content of silica in the form of stones etc.

(f) Very sticky raw materials with a relatively high water content (clays).

Unsuitable:

(g) Raw materials that have to be cleaned by the flotation process.

Wet Process

Suitable:

(h) All the materials listed under (a) to (f) but without the limitations indicated, especially if the amount of water necessary in the kiln slurry does not appreciably exceed 35 per cent.

Table IV.1-1

INVESTIGATION OF RAW MATERIALS

(The questionnaire to be filled in for each quarry)

Factory:

Country:

Distance of quarry, as the crow flies, from factory:

Amount of rain per year: mm.

Specially rainy seasons:

Summer temp.:

Winter temp.:

Especially dry seasons:

Water table: m. below quarry floor

Altitude:

Water supply:

Capacity:

Capacity of ropeway:	ts/hr. for	hrs/day:	length of ropeway:	km
" " railway:	ts/day		" " track:	km
" " lorries:	ts/vehicle	ts/day.	" " road:	km

Raw materials to be included in raw mix: (to be underlined)

I	II	III
Limestone	Mica schist	Bauxite
Travertine	Kaolin	Fly ash
Dune sands	Quartzite	Earth
Coral limestone	Clay	Pyrites ash
Chalk	Shale	Laterite
Shell debris	Marl	Sand
Archaean limestone	Sandstone	Slag

Quarried in the quarry in question:

Is quarrying by: Digging, blasting, ripping?

Digger, capacity: cu.m

Are materials stratified or solid?

Layer thickness: cm: dip: %

Are layers firm or loosely coherent?

Are there joints between layers? Thickness of joint: cm

Do joints contain other materials? If so, which?

Thickness of overburden: m: Consistency:

Is surface underneath overburden smooth? Are there pockets? % of deposit

Is overburden used in raw mix? Is it transported separately?

Is any part of quarry quarried separately? Is this part transported separately?

Type of crusher used: Type of feeding device used:

Difficulties encountered in crushing: or in feeding:

What type of crusher ought to be used?

Can minus 25 mm fraction be extracted by feeder/feed table from silo?

What difficulties have been experienced so far in connexion with extraction? (preferably see miller personally this question)

What max. water content gives no trouble in crushing? % water

" " " " " " " " extraction? % water

Are dryers available, and what difficulties have been experienced, and how far are materials dried?

What is the fineness to which materials are crushed in existing mill installation, and what is the power consumption (kwh/t.)?

A 50-kg. sample of the main component and 25 kg. of each of the other components should be sent to supplier.

A map of the quarry, indicating situation in relation to factory and height contours would be desirable - and possibly a sketch showing cross section of quarry face and layer sequence, etc.

(i) Washable chalk and clay, as well as materials [illegible] with a high natural water content, especially if the amount of [illegible] the slurry does not appreciably exceed 35 per cent.

Less suitable, but possible:

(j) Raw materials calling for cleaning by the flotation process.

It will appear from the foregoing that the great majority of raw materials lend themselves to the production of cement by the wet process, while [illegible] somewhat different in the case of the dry process, where the water content, the stickiness and the homogeneity of the materials, in particular, play an important role. The importance of carrying out thorough investigations before making the final decision in respect of process is stressed. (See Table IV.1-1 for suggested questionnaire.)

Other factors that are decisive for the selection of either the dry or the wet process are the access to water and the grindability of the raw materials in the wet and the dry state, grindability being of special importance to the wet process if the raw materials are washable, because only then can appreciable savings in grinding be obtained.

The greatest advantage of the dry process over the wet process is the lower fuel consumption normally obtainable. Between the best wet-process plants and the best dry-process plants there is a difference of about 350 calories in favour of the dry process, although under adverse conditions, with very wet and washable raw materials, this gain may be lost, partly through the additional heat required for drying such materials and partly in the grinding. Attention is drawn to the part played by the choice of process in relation to the quality of the cement and the run factor of the plant and it is noted that if a dry-process plant is to produce equally good results in these two respects as a wet-process plant, great importance must be attached to the employment of well-qualified personnel and the setting-up of an efficient organization.

As far as installation costs are concerned, it is difficult to say anything in favour of either process; if a dust precipitator is required for dedusting the exit gases in a dry-process plant, and if the raw materials are relatively homogeneous, the difference in price will hardly be great.

Lastly, a review is given of the distribution of the three processes in various countries. In Europe, where regulations for the prevention of dust nuisance require the installation of dust precipitators in connexion with wet-process kilns, and where, generally speaking, skilled technical staff is readily available, the dry process has, in recent years, found wide application, except in Northern and North-Western Europe where the occurrence of washable chalk and clay makes the wet process better suited. (Table IV.1-2)

In the developing countries, where there is often a shortage of skilled technical personnel, and in countries such as the United States of America where fuel prices are of minor consequence, the wet process still predominates.

Table IV.1-[illegible]

Percentage Distribution of World Capacity, Dry Process and Wet Process, 1 January 1960

(centrally planned economies not included)

	Wet Process %	Dry Process %	Shaft Ki[ln] %
Africa	69	25	6
Asia	60	38	2
Australia	78	16	6
Central and South America	70	29	1
North America	60	39	1
Europe	45	43	12
Averages for world as a whole	56	39	5

Number of Kilns put in Operation within the OEEC countries

	Wet Process	Dry Process	Shaft Ki[ln]
1955	14	14	3
1956	7	20	17
1957	13	17	6
1958	9	16	2
1959	11	16	7
1960	10	17	2
1961	14	33	6
1962	18	30	5
Totals for 1955-1962:	96	163	39
Number of Kilns put in operation in USA in 1950-1963:	134	94	-

Production Equipment ([illegible]. Bellwinkel)

This lecture deals with the various types of production equipment and is extensively illustrated by drawings and charts. Alternative types of equipment for particular uses are discussed and special attention is paid to the rotary kiln plant versus the modern automatic shaft kiln, with the comparative investment costs and input requirements being given and discussed at length. ([illegible] Table IV.[illegible]-1.) The major topics covered in the lecture are as follows:

1. Preparation of Raw Material

   (a) Crushers.

   (b) Wash mills.

   (c) Dryers.

   (d) Raw mills.

   (e) Homogenizing silos.

2. Burning Process

   (a) Wet-process rotary kiln.

   (b) Dry-process rotary kiln.

   (c) Cooler for rotary kilns.

   (d) Kiln firing.

   (e) The shaft kiln.

   (f) Evolution of rotary and shaft kilns.

3. Further processing of the clinker

   (a) Cement mills.

   (b) Conveyors.

   (c) Loading and packing of cement.

4. Layout, enlargement and costs of cement works

   (a) Comparison of rotary and shaft kiln plants.

5. Quarry Equipment (O.V. Borgkvist)

The lecture touches upon problems relating to the quarrying of limestone and clay only, these being the two most important raw materials.

Quarrying is defined as consisting of a number of operations, including the stripping of the overburden, the loosening of the rock itself, loading, hauling, and primary crushing.

Table IV. -1

[illegible] - [illegible] Installation (West Germany 1964)

[illegible]	[illegible]7,000 DM.	7
[illegible]	1[illegible]7,500	7
[illegible]	45[illegible],000	1[illegible]
Grinding and drying plant	385,000	13
[illegible] homogenizing [illegible]	[illegible]46,000	8
[illegible]	481,500	1[illegible]
[illegible]	[illegible]5,000	[illegible]
Grinding [illegible] ([illegible])	5[illegible]3,000	18
[illegible]	3[illegible] 500	1
Cement [illegible] silo	[illegible]8,000	3
[illegible]	115,000	4
[illegible]	[illegible]1,500	1
[illegible]	[illegible],000	1
Grinding mill	[illegible],000	[illegible]
Pipes and [illegible]	16,000	1
	[illegible],915,000 DM.	[illegible]00

Heat and Energy Requirements for Shaft and Rotary Kilns

Heat Consumption

Shaft kiln	700 - 900 kcal/kg. cl
Rotary kiln, dry process	750 - 900
Rotary kiln, wet process	1200 - 1500

Specific energy requirement

Shaft kiln	15 - 20 kwh/t. clink
Rotary kiln, dry process	12 - 25
Rotary kiln, wet process	14 - 2[illegible]

Costs of Installation in Mill.DM. (1964)

	Shaft kiln plant		Rotary kiln plant	
	300 t.	600 t.	300 t.	600 t.
Machine installations incl. refractories	4.7	7.7	5.3	8.5
Electrical equipment	1.1	1.6	1.0	1.6
Buildings, stores and silos	3.6	5.9	3.6	6.0
Installation	1.5	2.5	1.5	2.5
	10.9	17.7	11.4	18.6

Specific Energy Requirement - kwh/t. cement
(shaft)

Crushing installations	
Raw Mill	5 kwh/t.
Homogenization	20
Kiln	5
Cement mill	20
Transport, etc.	30
	10
	[illegible]0 kwh/t.

The lecture deals with the influence [illegible] of the type of deposit, the [illegible] of the stone, the topography of the quarry area, [illegible] factory site, and climatic conditions in the [illegible].

1. <u>Limestone</u>

(a) Stripping of Overburden

After some general remarks, the lecture discusses the [illegible] draglines, bowlscrapers, bulldozers and stackers.

(b) Loosening of Rock

After some general remarks, the lecture discusses the use of drilling in combination with blasting from the point of view of the equipment [illegible]. The use of handhold drills, light and heavy waggon drills, and heavy drilling [illegible] discussed, as is the use of mobile and stationary compressors. A review is given of equipment for direct digging in the quarry front, such as shovels and bucketwheel excavators, and of equipment for ripping.

(c) Loading

After some general remarks on the problem of loading, the use of diesel-driven and electrically-driven shovels, front end loaders and tractors is discussed and some views put forward as to their capacity.

(d) Hauling

The use of ordinary highway trucks and dumpers is discussed, and the use of trains, ropeways, rubber conveyors and pumps.

(e) Primary Crushing

The effect of secondary blasting is discussed and stress is laid on the use of crushers with big gaps. An example is given of the distribution of working costs and their variation with the size of primary crusher.

(f) Dressing

Low-grade stone can sometimes be made exploitable by the use of certain methods. Mention is made of sorting, picking, screening and flotation.

2. <u>Clay</u>

Most of the equipment used in clay pits is basically the same as that used in quarries. The lecture touches upon some more specialized equipment, such as front-end loaders, bucket-chain excavators, and grab [illegible] (floating wash mills).

[illegible]. Electrical [illegible] (V. [illegible])

The lecture opens with a short review of the development of driving methods for cement-making machinery, and goes on to discuss the following topics in detail:

1. Electric Motors

(a) D.C. motors versus A.C. motors.

(b) Types of A.C. Motors:

Asynchronous induction motors - slip-ring and squirrel-cage,
Synchronous motors,
Synchronous induction motors,
Variable-speed A.C. motors.

(c) Special requirements for winding insulation and for bearings.

(d) Various types of motor enclosures.

(e) Efficiency and power factor in relation to load on motor.

2. Electrical Protection of Motors

(a) Knife switches and fuses.

(b) Automatic circuit-breakers.

3. Starters for A.C. Motors

(a) Oil-cooled starters.

(b) Liquid starters.

(c) Starters and rotor regulators.

4. Interlock between Short-circuiting Device, Starter and Circuit-breaker

(a) Sequence interlock between circuit-breakers.

5. Types of Motors to be Recommended for Different Cement-Making Machines

(a) Crushers.

(b) Mills.

(c) Compressors. Shaking conveyors (with heavy fly-wheels).

(d) Rotary kilns.

(e) Fans.

(f) Transport machinery.

(g) Feed [illegible].

. <u>Distribution of Electric [illegible]</u>

(a) [illegible] electrical [illegible]:
[illegible] are [illegible] lines [illegible]

( ) [illegible] electric [illegible]:

[illegible]
Smaller motors.

(c) Distribution [illegible] power centre:

Small plants - low tension [illegible]
[illegible] plants - high tension [illegible]

( ) Types of high tension and low tension boards.

Control panels.

(e) Secondary low tension distribution boards.

(f) Dimension of cables.

(g) Protection of cables.

(h) Exact plans showing location of cables.

7. <u>Total Demand on Power Supply</u>

(a) Losses in Motors and Distribution System.

(b) Power factor adjustment:

Condensers of synchronous mill motors.

8. <u>Additional Electrical Equipment</u>

(a) Electrostatic Dust Collectors.

9. <u>Control Panels and Cable Connexions for Sequence Interlock, Remote Control and Instruments Automation</u>

10. <u>Lighting Installation</u>

(a) 380 V. low tension motors or separate lighting transformer.

(b) Hand lamps with extra low tension (50 V.) for work inside machines.

11. <u>Maintenance of Electrical Outfit</u>

(a) Testing outfit.

(b) Personnel:

[illegible]

[illegible]

( ) [illegible]:

[illegible] recommended by maker.

Fuses.

[illegible] stock of ball bearings, carbon brushes, brush holders for motors.

Contacts and no-volt coils for circuit-breakers.

Resistance elements and contact pieces for starters and regulators.

Spare motors and circuit-breakers.

Cables and splicing outfit.

( ) Regular cleaning of motors with blower.

(e) Greasing and oiling according to maker's instructions.

(f) Replacement of worn carbon brushes and repair of commutators and slip-rings.

In conclusion, the lecture emphasizes the importance of the electrical outfi[t] to the efficiency of the cement plant as a whole. The efficiency of the plant depends largely upon uninterrupted production, hence the advisability of installing recognized high-class material designed to work under difficult conditions; initial costs should not be the first consideration when decisions are made. All possible precautions should be taken to protect workers against accidents. The safety of the lighting installations is important, as are telephone installation and protection against lightning.

5. Summary of Discussion

After discussing the comparative merits of the wet and dry processes, the participants concluded that in developing countries, unless adverse raw materials and high fuel costs are against it, the wet process is to be preferred in the initial stages of cement-industry development, on the grounds that the operation of wet-process plants is simpler and it is easier to obtain better quality cement In this connexion, reference was made to the possibility of shifting at a later stage from the wet process to the dry process as the developing countries gained more experience. There was some discussion of the problems associated with such shift, and some participants expressed doubts, maintaining that most developing [illegible] ... that the [illegible] ... countries such as India, [illegible] ... the [illegible] ... eventually [illegible]

The participants also discussed the semi-[illegible] process, in [illegible] content of the slurry is reduced to between [illegible] per cent [illegible] filters. In order to economize on fuel [illegible] exceptional cases, it is possible to reduce the water content [illegible] noted, however, that because of the additional cost of [illegible] filters, the process may only be found economical when the water content of the slurry is very high (about [illegible] per cent) and fuel costs are also high. [illegible] the rather higher skills required for this process, from the point of view of the developing countries.

In connexion with the use of shaft kilns, it was noted that in Germany about [illegible] per cent of cement production comes from shaft kilns, the remaining [illegible] per cent being produced in about 170 rotary kilns. The majority of the shaft kilns are of modern design with a unit capacity of 100 to 180 tons per day. Fuel consumption is about the same or slightly better than in rotary dry process for capacities of about 150 tons per day. However, for larger capacities, of about [illegible] tons per day, fuel consumption would increase slightly. Good quality coal e.g. anthracite, is used in most cases but lower quality coal such as lignite has been used without any serious effect on the quality of the cement. Work is being done on the use of liquid or gas fuel in shaft kilns but it is still in an experimental stage. Thus, in areas where these fuels are cheap and abundant, the shaft kiln would be at a disadvantage.

Skill requirements for the operators of shaft kilns would be about the same as for the rotary dry process, i.e., somewhat higher than for the rotary wet process. Shaft kilns are easy to start up after shut-downs and capacity output and acceptable quality are usually obtained within a few hours. Control of the quality of the clinker produced may, however, be somewhat more difficult than in the rotary processes, since in the latter it is possible to adjust the burning process to possible minor deviations in the raw meal mix, which is not possible in shaft kilns.

It was generally agreed that the shaft kiln is only to be recommended for small plants, i.e., in the range of 100 to 300 tons per day. Above 100,000 tons per year, the rotary process is definitely preferable. Moreover, since cement consumption has a tendency to increase rapidly once production has started in an area, this capacity is often reached sooner than expected. However, a shaft kiln plant can also be complemented later on with rotary kilns.

As regards the choice of preheater system for the dry process, it was pointed out that each case requires individual study. Sometimes a final solution can only be reached after a long period of actual operation. As always, equipment that has been insufficiently tried out should be avoided. Data on the performance of new systems can be found in current professional journals such as <u>Zement-Kalk und Gips</u>.

[illegible]

[illegible]

[illegible] of open circuit versus closed circuit grinding [illegible] raised. [illegible] the latter is generally more complicated and requires more power for ordinary cement; on the other hand, consumption of grinding bodies is less. In the plant [illegible] only one mill the closed system may be preferable, since it is more readily adjustable to specific requirements regarding particle size distribution, [illegible] in the manufacture of special cements.

As regards the problem of clinker storage, it was agreed that clinker can be stored in the open, even under very humid conditions. A cake will form on top of the clinker and protect the rest. However, it is preferable for at least part of the storage to be under cover, so that the caked clinker can be mixed with fresh clinker material, and a uniform average quality be maintained. In larger plants, the use of conveyor systems has advantages over the overhead crane system for the transportation of clinker, the crane and the necessary construction work being rather expensive.

In connexion with quarrying, various methods for the removal of overburden were discussed. Water jets were mentioned as one such method, and it was noted that a good drainage system is essential in such cases. Large bulldozers, such as the Caterpillar D.8 and 9, have been used successfully for ripping in recent years in the winning of limestone. However, this method is only possible for medium-strength limestone found in laminated strata not exceeding one metre in depth.

The choice of explosives was also discussed, and ammonium nitrate was compared with conventional explosives. Mention was made of the successful use of ammonium nitrate combined with fuel oil. It was pointed out, however, that its use would have to depend on its cost as compared with other explosives. It was also noted that split-second blasting has been found more efficient than simultaneous blasting.

Various methods of handling material in the quarry were discussed. A question was raised regarding the maximum distance that clay slurry can be pumped (as one method of transport) and it was noted that there is actually no technical limit. However, there is one possible disadvantage to this method, i.e. the existence of more water in the slurry than is required in the process.

In regard to electrical equipment, some discussion arose on the advantages of a high tension ring with main feeding transformers located at different load centres. It was pointed out that a breakdown in any of the transformers or feeding circuits can be isolated without affecting the supply to other transformers connected on the ring. It was noted that this system is economical only in the case of large units.

[illegible]

[illegible]

[illegible] that these [illegible] still [illegible] although their cost of operation and maintenance [illegible] high. However, it is expected that they will be [illegible] in the near future.

The question of the economic feasibility (as distinct from the legal necessity) of installing dust-collecting equipment was discussed [illegible] it may [illegible] as much as 15 per cent of investment [illegible] and large, it is not economic in wet-process plants where dust-[illegible] 5 per cent of production. In the dry process, however, it may be [illegible], especially when the percentage of dust-loss is high, depending on the type of raw material. There was some discussion of the problems that arise in marketing this product as a potash fertilizer, owing to variations in purity and the relative inconvenience of its use to the farmer.

Reference was also made to the production of special cements and it was [illegible] that the chief additional requirements are additional silos and packing equipment. In some cases additional raw material may also be needed the amount varying from one type of special cement to another. Thus for white cement, pure limestone and kaolin are needed, whereas in the case of rapid-hardening cement, the raw material used is the same but the grinding is finer.

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[illegible] ESTABLISHMENT [illegible] PLANTS

a. Studies Pri[illegible] (R. [illegible]urand)

The introduction to the lecture assumes that satisfactory [illegible] have been obtained from a previous technical and financial survey that a company has been formed and that the site and capacity of the plant [illegible] The lecture goes on to consider means of securing the equipment and services desired.

1. Proposal and Quotations

For the proposed plant the following equipment and services are [illegible] (table V.1-1):

A. Machinery for cement production.

B. Equipment for power supply.

C. Auxiliary machinery.

D. Civil engineering work.

E. Erection and starting-up service.

The question of the availability of suppliers of equipment and services is discussed

Special mention is made of the information (and samples) needed by the suppliers of the main machinery for cement production to enable them to design machinery according to the requirements (table V.1-2). A comparison is made between the quotations required by a company with a highly developed technical organization (quotations from several classes of supplier, own calculations and execution of civil engineering work, etc.) and the quotations required by a newly-formed company without any technical organization at all (turn-key job). Mention is made of the normal extent of quotations for equipment and service from a main supplier to a company in a developing country, and the possibility of collaboration with firms of consulting engineers.

2. Main points of contract

The extent of the order. Possible limitations on the acquisition of technic desirable auxiliary equipment, owing to the limited funds available. The inadvisability of installing machinery and control equipment more complicated than the skill of the workmen available at the site allows.

3. Times of delivery

The delivery time of machinery for [illegible] production should correspond to the time of completion of the civil engineering work. Orders for auxiliary equipment should be placed in time to fit into the programme laid down [illegible] the [illegible] buildings and machinery and the starting-up of the plant.

4. Forms of payment

Reference is made to various forms of payment, in particular:

A. Cash against shipping documents, paid out of company's available [illegible].

B. Credit obtained locally (commercial banks, development banks, etc.).

C. Credit obtained from international organizations (World Bank, [illegible]).

D. Credit granted by suppliers (possibly guaranteed by government of suppliers' country) (table V.1-3).

Table V.1-1

CEMENT PLANT INSTALLATION

A. **Machinery for Production** (crushing section to Packing Plant)

(a) Main Machinery, (crushers, grinding mills, kiln, other special equipment).

(b) Stationary handling equipment, (cranes, pumps, conveyors).

(c) Electrical equipment for (a) and (b) (motors, switchgear, control panels, distribution boards).

B. **Power Supply**

(a) Power Plant (hydaulic, thermal, Diesel) and/or

(b) Transformer station with main distribution installation, cables, etc.

C. **Auxiliary Equipment**

(a) Quarry equipment (for drilling, loading, stripping, etc.).

(b) Rolling equipment for transportation (heavy trucks, medium and light trucks, mobile cranes, passenger cars, etc.).

(c) Equipment for workshop.

(d) Equipment for laboratory.

(e) Water supply.

(f) Fuel storage.

(g) Sundries (office equipment, telephones, etc.).

[illegible]

[illegible]

[illegible]

[illegible]

(a) [illegible]

(b) [illegible]

[illegible]. Various

Freight, duties, administration, interest, etc.

Table V.1-2

INFORMATION NECESSARY FOR DESIGN OF MAIN MACHINERY FOR PRODUCTION OF CEMENT

A. General Layout

Topographical map of plant site, giving railway, roads, etc.

Temperature, altitude, wind direction, water precipitation, etc.

B. Crushing Section, Raw Mill Section

Samples of all the raw materials to be utilized.

Information about natural humidity in raw materials.

C. Raw Meal or Slurry Storage

Information about the qualities of cement to be produced.

D. Kiln Section and Fuel Preparation

Desired Capacity of Plant.

Samples of fuel or technical characteristics of same.

E. Cement Mill Section

Qualities of cement to be produced, (types, finenesses), and desired output of each.

[illegible]

[illegible]

[illegible]

[illegible]

Characteristics of power supply (voltage [illegible])

Any Special Information

Table V.1.5

TERMS OF PAYMENT

A. Cash payment to supplier, paid out of company's available funds.

Example: 30 per cent at time of ordering,

30 per cent 6 months after order,

30 per cent successively against shipping documents (for instance 10 to 15 months after order),

10 per cent after fulfilment of production guarantees.

B. Cash payment to supplier financed locally.

Local financing from commercial banks, development banks, etc.

C. Cash payment to supplier, with credit from international organisations.

Examples: International Bank for Reconstruction and Development (World Bank),

International Finance Corporation,

Inter-American Development Bank.

D. Credit granted by supplier.

Such forms of credit are generally supported by government agencies of the supplier's country.

[illegible] (E. [illegible])

[illegible] or before even calling in tenders for all the various machinery, [illegible] etc., which [illegible] to make up a cement factory ready [illegible] necessary to determine the extent and content of the order or [illegible]. [illegible], the various parts that constitute a cement factory must be [illegible].

The lecture first reviews the main sections of a cement factory, divided up into the following major items:

(1) Production machinery:

(a) Main machinery,
(b) Auxiliary machinery,
(c) Reduction gears,
(d) Motors with secondary distribution equipment,
(e) Sundries.

(2) Quarry equipment.

(3) Rolling equipment.

(4) Equipment for the machine shop.

(5) Laboratory equipment.

(6) Main power distribution and power supply.

(7) Transport of equipment to plant site.

(8) Water supply.

(9) Fuel supply.

(10) Civil engineering work, including: internal and external roads, levelling, sewerage and drainage.

(11) Opening of quarry.

(12) Erection work.

(13) Starting-up and running-in.

All these items may be included in a single order, which constitutes the "turn-key job", or they may be divided up into as many orders as items, or even more.

The lecture then considers the feasibility of the various ways of ordering from the economical, financial, and practical aspects.

The lecture reviews ways in which some of these items may be ordered and supplied by local sub-suppliers to the main supplier, or directly by local suppliers and contractors.

In conclusion, a short review is given of the main sections [illegible] which constitute the order or the contract between the [illegible] supplier.

[illegible]. <u>Relationship to Supplier (K.V. Talch[illegible])</u>

Clearly, the complex work involved in the basic investigations which are so important in establishing a Portland cement factory, must be entrusted:

(a) to a special team of experts within the organization; or

(b) to a reputable firm of consulting engineers or

(c) to (a) in the initial stages, and later, when the project has advanced to a more concrete stage, to (b).

In a developing country, it is doubtful whether a cement-machinery manufacturer from outside would be in a position to carry out the work alone, even at a disproportionately high cost.

The team of experts should consist of the following:

<u>A senior geologist</u>, with staff and equipment, experienced in conducting detailed limestone exploration. (If such services are available from internal agencies, this member of the team may be dropped.)

<u>A cement technologist</u>, with wide experience in the cement industry - preferably a chemical engineer or a plant manager. Normally, he would be the leader of the team.

<u>A financial expert</u>, conversant with company law and the procurement of finance, capable of assessing the profitability of the scheme and allied financial matters.

<u>An administrative manager</u>, capable of dealing with State and Central governments in processing the project, securing industrial licences and mining leases, acquiring land, etc.

Such a team of experts can, with suitable assistance from the plant machinery suppliers, bring a project to successful completion. However, after the basic investigations have been completed, if they are not competent to carry it out, the task of ordering the plant and its installation can be entrusted to a local firm of consulting engineers.

According to experience in India, a firm of consulting engineers that will undertake the whole job, including the basic investigations, is difficult to find, but the combination suggested in (c) may be possible. (Experience is quoted of a large cement manufacturing concern in India with the necessary competent staff.)

When the preliminary investigations have been completed and plant specifications drawn, the next step is to invite tenders. Developing countries should get competitive tenders from international suppliers of repute. In many [illegible] plan [illegible] matter.

[illegible] will probably [illegible] to have the local [illegible] and experience [illegible] labour, local officials, and other allied matters. [illegible] the [illegible] between the company setting up the [illegible] and the [illegible] supplier has to be drawn up carefully, defining the [illegible] each party.

As a matter of interest to some of the representatives of developing countries at the meeting, a brief account is given of the way in which India has tackled the [illegible] of progressively manufacturing cement-making machinery. Statistics are given of present manufacturing capacity, its limitations, and future prospects.

Lastly, the respective advantages and disadvantages of "package deals" and "turn-key jobs" in setting up a Portland cement factory in a developing country are discussed, and the conclusion is drawn that in view of the complex problems and peculiar local conditions prevailing in these countries at the present time, it is unwise to conclude "package deals" with foreign cement-machinery manufacturing concerns. Instead, the work should be shared between the promoters of the company, the local consultants, and the machinery suppliers.

4. Guarantee and Starting-up (U.H. Bauditz)

The lecture opens with the assumption that a previous lecture has dealt with the setting-up of a sales contract between the supplier and the buyer of a cement plant, and with the relationship between supplier and buyer in general.

He goes on to discuss that part of the contract which deals with the quality of the machinery, and the guaranteed output of the principal machinery, such as the crushing plant, the mills, the kiln and the packing plant, and the fulfilment of these guarantees, as well as the measures to be taken in case the guarantees cannot be fulfilled.

In this connexion, mention is made of the technical personnel required for this purpose, and of the conditions for placing such personnel at the disposal of the buyer, as well as the obligations and rights of the said personnel.

Reference is also made to methods of selecting local personnel from the point of view of quantity and quality, and to the way in which co-operation can be established between the local personnel and the supplier's staff during the starting-up period.

As regards the starting-up proper, the lecture reviews the taking of the measures on which the date of starting-up is based, and the preparations which must be made in order to ensure as smooth and frictionless a start as possible, so that the plant can be put into normal operation as quickly as possible.

It goes on to discuss the importance of training the buyer's technical staff from the long-term point of view, in conformity with the agreement between the two parties. The supplier may also undertake to place highly qualified technical [illegible] or [illegible] of the [illegible] provide sufficiently skilled [illegible]

It then touches on the question of [illegible] supplier and the customer, in relation to technical advice [illegible] if necessary, the sending out of [illegible] specialists [illegible]

It notes that a continuation of the technical [illegible] and customer, after the starting-up period, [illegible] (special production problems, development work, preparation [illegible] special types of cement, special consumer problems, etc.) may [illegible] helpful, and even good economy, until the new cement plant has set up its own technical organization, and very often afterwards also. (Co-operation [illegible] without contract).

Lastly, the lecture takes up the whole question of supply [illegible] the plant.

5. <u>Civil Engineering Work (K. Sten Larsen)</u>

The lecture opens with an introduction specifying the types of work which may be regarded as included in "civil engineering work". The list comprises factory buildings proper, such as pits, basins, silos, foundations for machinery, stock buildings, floor buildings, superstructures and bridges for transport of materials; also ground levelling, road construction, sewage and water supply; and lastly, offices, laboratory, canteen and, possibly, living quarters.

Attention is called to the fact that since the expenditure on civil engineering work constitutes a rather large proportion of the cost of putting up a cement factory, the estimate of this expenditure should be included in the financial assumptions.

Next, an account is given of the details necessary for preparing an estimate of the civil engineering work, such as the nature of the ground at the proposed site, with special reference to the depth at which sufficient carrying capacity is found, and the carrying capacity at that depth; the necessity, if any, of pile-driving; the level of the water table; climatic conditions; prevailing wind velocity; and the possibility of earthquakes.

Investigations must also be made into the type of building methods which will be feasible on the site in question and the possibilities of obtaining materials, contractors and labour locally

Mention is made of various building methods, such as brickwork, reinforced concrete (including special types), prestressed concrete, precast units, steel structures made by local firms or purchased from outside and assembled at the site, lightweight sheeting for cladding, etc.

It is on the basis of these particulars, together with the information obtained from the supplier of the machinery regarding the relative placing of the productive machinery in respect of level and spacing, the loads involved, their space equipment. The sizes and shapes of [illegible], hoppers, stores, roofing over, if any, [illegible] knowledge of the roads, sewage, etc., and buildings which are not factory buildings [illegible] that the technical advisers prepare their proposals.

Examples are given of the way in which it is possible, without actually having any detailed project to hand, to compare prices of various building methods and thus make an approximate estimate.

A brief account is then given of the buildings normally required at a cement factory, and the special features of such buildings mentioned.

Lastly, mention is made of the details which must be given to the building contractor to enable him to submit a quotation or an estimated price, viz. drawings, specifications and conditions. Various types of quotation are discussed

(1) A firm price based on exactly specified conditions and detailed drawings;

(2) Unit prices based on preliminary drawings and preliminary lists of quantities, adjustments being made according to the final quantities of materials and the work done;

(3) Payment as per account rendered, with percentage fees previously agreed upon.

6. The Site (N. Thorsen)

The purpose of this lecture is to discuss the organization and procedure on the site of a cement plant during the construction period.

The manner in which the construction work is contracted varies from one plant to another, depending on the owner's choice. In certain cases, owners prefer to entrust the complete construction and erection work to a single main contractor. If this method is used, the owner need maintain only a small organization at the site and he obtains the benefit of undivided responsibility, since the co-ordination of all the work on the site, as well as the cost and completion on time, becomes the sole responsibility of the main contractor.

The opposite method is to engage several smaller contractors under separate contracts covering the various sections of the plant. In this case, co-ordination becomes the responsibility of the owner and it is necessary for him to keep a larger organization on site.

Good results can be obtained from either method, as long as the various functions on the construction site are organized accordingly.

Prior to the start of construction work on the site, it is necessary to plan carefully all the work to be performed during the entire construction period. Such planning includes the establishment of the following information:

(1) Construction and erection programme;

(2) Ordering programme for all materials and machinery;

(3) Programme for issue of drawings [illegible]

(4) Evaluation of staff and labour requirements [illegible] period

(5) Layout drawings for the site, including location [illegible] facilities required for the construction [illegible].

The above information is consolidated in standard [illegible] adequate types. As an example, Chart V.6-2 depicts a typical [illegible] programme with estimated payments curve, which serves the owner and the contractor for budget purposes. This form can later be used for [illegible] reports, and in this case a curve showing the value of work done [illegible] up. This latter curve must follow the curve for estimated payments [illegible] is on schedule, and these two curves therefore provide an easy instrument for the quick assessment of progress on the job at the end of each month.

It is perhaps easiest to follow the various functions on site by studying the contractor's site organization chart; a typical example is depicted in Chart V.6-1. This example covers a site on which the work is carried out by a main contractor.

In order to secure efficient operation, it is important to work out a Standard Operating Procedure (S.O.P.), giving a brief description of the organization on the site and outlining the responsibilities and functions of the various department heads. The S.O.P. should also contain instructions regarding staff and labour (time-keeping, contracts, accounts, welfare), ordering, stores, construction equipment, insurance, etc.

At the end of each month, progress reports are worked out and presented on the forms shown in Chart V.6-2.

In addition, interim weekly reports and forecasts are made. Regularly - at least once every week - staff meetings are held, in order to review the work done in the past week and discuss the forecast for the week ahead. If sections of the work are behind schedule the measures to be taken in order to get back on schedule are reviewed.

The ordering schedule is reviewed periodically and check-lists indicating the status of individual orders are established weekly or monthly, as need be, with a view to following the flow of materials from the moment an order is placed until it has arrived at the stores on site. This phase is a very important one, since a slip in the ordering may hold back entire sections of the work.

The contractor may employ one or several sub-contractors and it is also important to hold regular site meetings with them, separately or jointly, in order to co-ordinate their work.

Through his representatives on the site, the owner follows the day-to-day work of the contractor, and joint problems are discussed at meetings held daily or weekly as need be.

Chart V.6-1

Main Contractor's Site Organization Chart

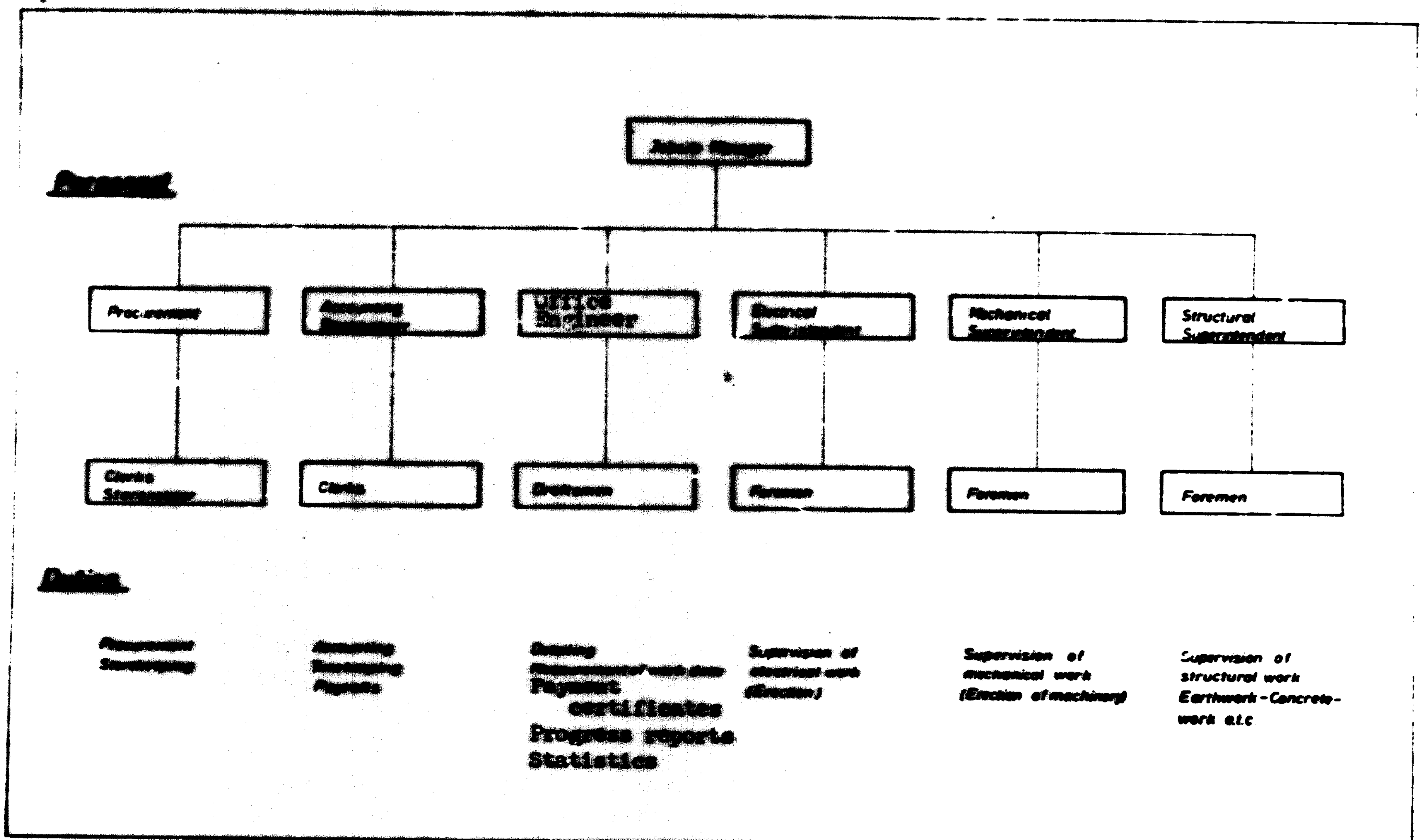
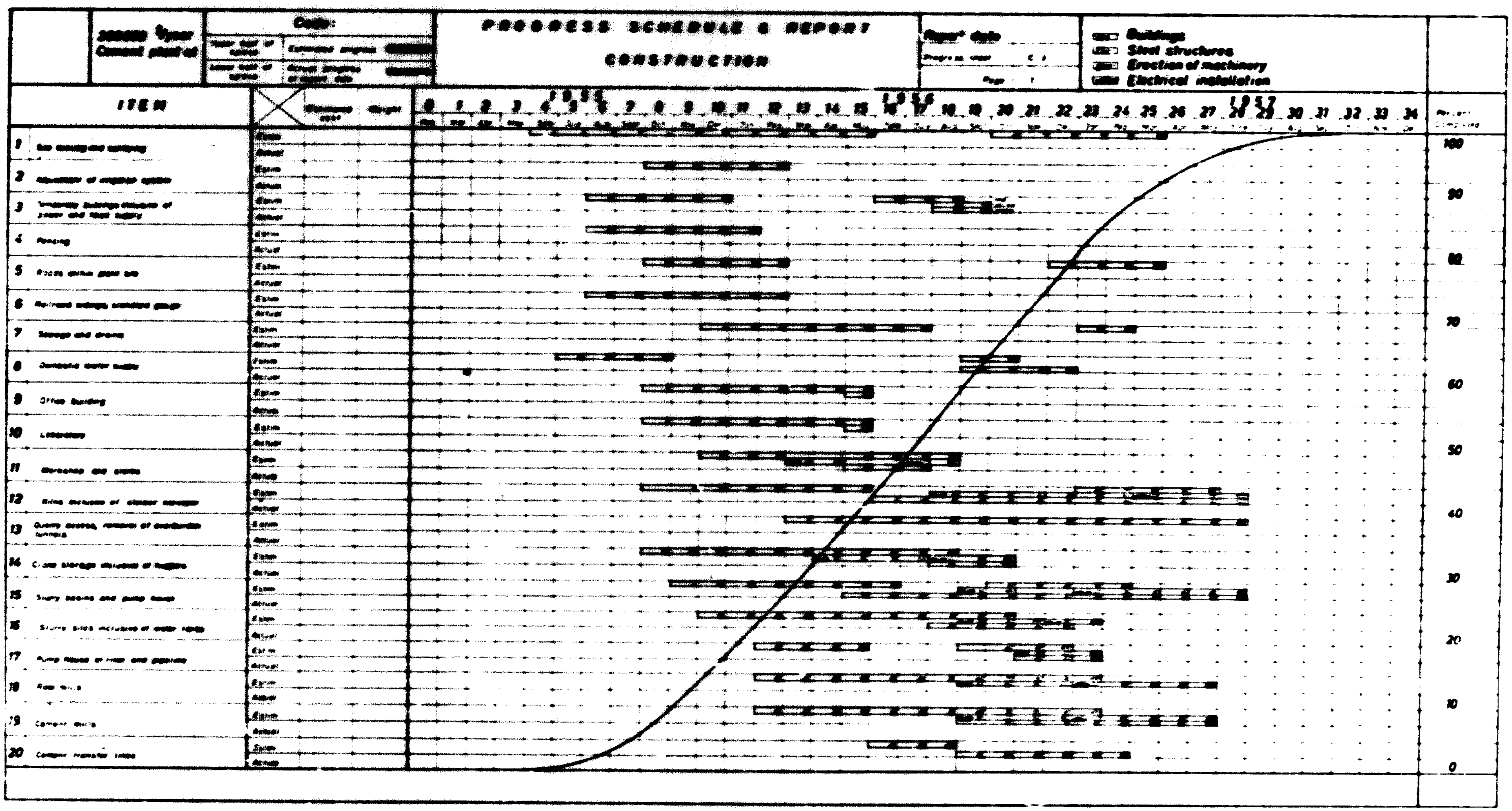


Chart V. 6-2

Estimating Payments



[illegible] his [illegible] to check that the [illegible] the agreed schedule on arrival at the site [illegible] at the owner's stores and later issued to the [illegible] erection work proceeds.

[illegible] inspectors, the owner makes regular checks of the contractor's work; there are [illegible] checks of quality, for instance the quality of [illegible], etc.

Payment to contractors is usually made monthly, in accordance with the value of the work done. Measurement of work done may be carried out jointly by representatives of the owner and the contractor.

During the planning, the contractor makes an analysis of labour requirements during the construction period, and if sufficient skilled labour is not available locally, it is necessary to make arrangements well ahead of time for the transfer to the site of labour from other areas. In this connexion, it may be necessary to build temporary accommodation for part of the labour force, including canteen facilities, etc.

In most countries, labour codes lay down general conditions of employment as well as minimum wages. Since the wages paid during the construction period may reflect on wages to be paid later on, during the operation of the completed plant, it may be in the owner's best interest to take advice regarding wage levels, employment benefits, etc.

It is also important for the contractor to consider carefully his relationshi with local labour unions, in order to secure a good labour relationship during the work period.

During the construction and erection of most cement plants, it is adisable to bring several specialists to the site. These specialists may often be foreign, an it is necessary to apply for working permits, etc., well ahead of time and also to work out corresponding conditions of employment.

It can be in the owner's interest to have a temporary construction camp built under a separate contract at an early stage, prior to the start of construction of the cement plant proper, since this facilitates the start on site for the owner's staff and for the contractor.

Local materials are used for the civil engineering work to the greatest possible extent. This applies for example to concrete aggregates. In this connexion, it may be necessary to conduct tests on the aggregates prior to construction, in order to make sure that they are of suitable quality for concrete work.

A cement plant consists of several structures spread over a relatively large area, and subsoil conditions may vary. To safeguard against difficulties during the construction period in connexion with foundation work, it is advisable for soil investigations to be carried out at an early stage, prior to construction, at the location of all major structures.

.. Local Organization at Site (H. [illegible])

The lecture opens with a definition of [illegible] These tasks include the carrying-through [illegible] including connexion-up to power source, [illegible], possibly, port.

Stress is laid on the importance of working programmes, [illegible] the available resources of equipment and labour and the [illegible] of building and erection work.

Reference is then made to the provision of labour and living quarters for the same. Mention is made of possible problems in connexion with [illegible] (foreign) labour, and leisure time at sites in isolated localities.

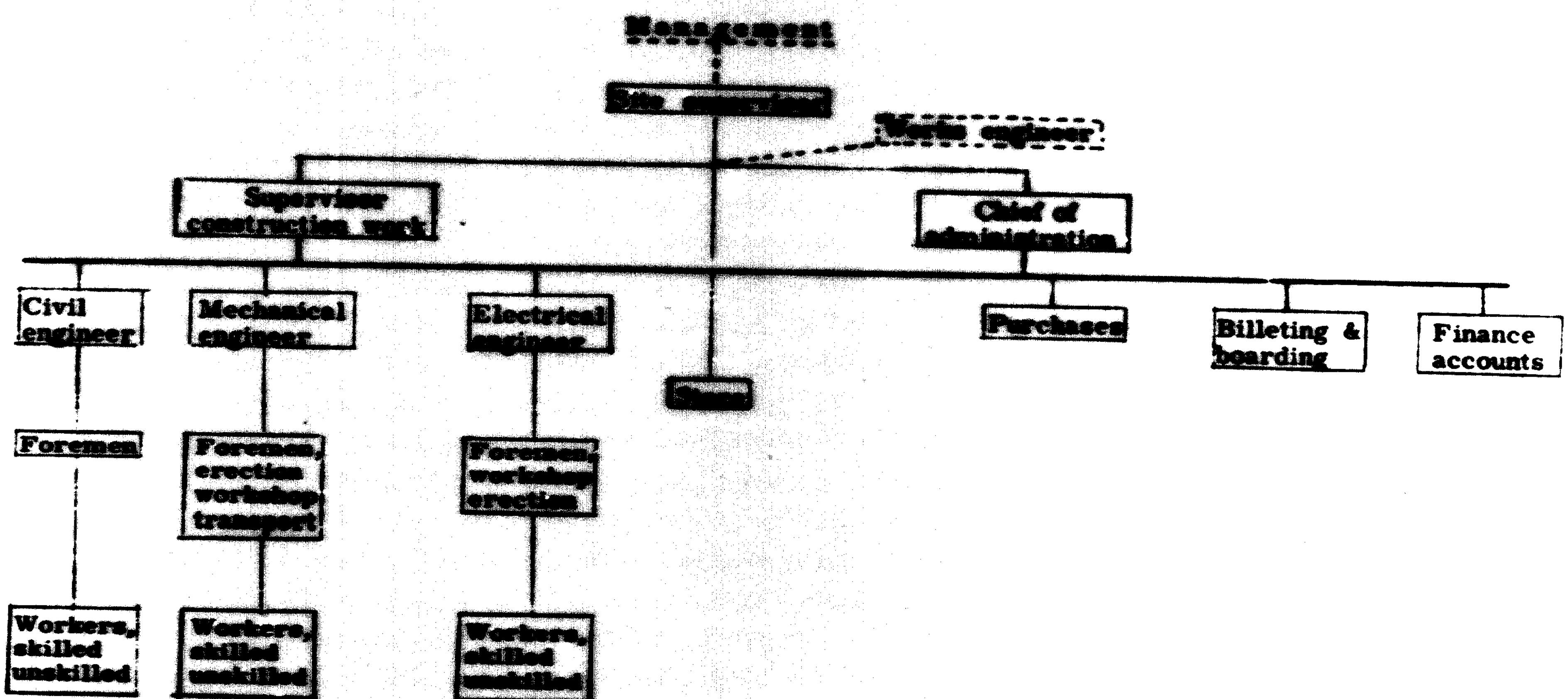
Stress is also laid on the importance of establishing good relations with the local population, organizations, authorities, etc., and on talent-scouting during the erection to find the people who are best suited to stay on at the factory after the starting-up.

The lecture then touches upon such matters as the establishment of courses for future foremen, the translation of instructions, the laying-down of wage systems, working hours and regulations to ensure peace and order at the site, the payment of wages, salaries, invoices for supplies, etc., the control of supplies, and the transport of machines and equipment from the port of discharge to the factory site.

The lecture then turns to the structure of the Organization. A brief reference is made to the necessity of delegating work and, concurrently, responsibility and authority (Chart V.7-1). Stress is laid on the necessity of a simple and unambiguous organization, in which each employee knows who his superiors and his equals are, and on the necessity of staking out exactly each foreman's field of activity.

Chart V.7-1

Local Organization at Site



. Opening-up of Quarry (O. Bergkvist)

Before [illegible] are [illegible] to open up [illegible] quarry, [illegible] that there [illegible] sufficient amount of stone [illegible] should the ground containing the stone [illegible] bought [illegible] the erection of the necessary quarry buildings [illegible] stockpiles and waste dumps, together with further [illegible] whether it be roads, railway, ropeway or belts. [illegible] that private dwellings are kept at a safe distance, [illegible] protective zone around the deposit.

The expression "opening-up of quarry" is discussed, and defined as being composed of two stages, one preparatory and one productive. The first stage includes a good deal of detailed surveying, clearing and stripping, building of roads and haulage ways, and, at the end, the successively increasing production of stone. This stage should be started in good time, so that the productive phase of the quarrying can be ready when the factory starts its operations. The productive stage must be carefully designed as any short-comings may affect the output of the factory seriously. The factory owner should be aware that quarrying is one of the most important phases in the production of cement, and should not, as is often the case, be left out in the cold.

The layout of the quarry operations is affected by the type of deposit, the character of the stone, the topography of the quarry area, the hauling distance, the factory size, and the climate, and also by the type of organization of the labour force and the number of working shifts. These factors are often closely interwoven and several equally good solutions are possible.

In order to show how some of these factors can influence the layout, nine different quarry layouts are discussed.

9. Summary of Discussion

It was the opinion of the meeting that it is generally not advisable to rely on a single contractor for the purchase and installation of equipment and the execution of the project. It was further suggested that the owners should form a local organization preferably with the assistance of a consultant, who should be carefully selected to co-ordinate the activities of the various contractors entrusted with different aspects of the project. Attention was drawn to the danger of carrying sub-contracting to extremes, when it might become difficult to place responsibility.

The question of penalties for non-fulfilment of contract was raised, and it was noted that in most cases penalties are considered symbolic, since they may not exceed 10 per cent of the value of the contract. It was also noted that the establishment of a cement plant involves certain industrial risks and it was maintained by one participant that such risks should be shared by the supplier and the buyer.

Mention was also made of personnel training and it was agreed that it would be advisable for suppliers to arrange first for the training of personnel in an advanced country, in addition to training them in their own plants. One participant noted that in his own country, the reverse procedure was followed:

[illegible] first, followed by additional training in [illegible] [illegible]. The results had been found to be most satisfactory.

It was noted that the share of civil engineering in total investment usually amounts to about [illegible] per cent. The question was raised of the deterioration of concrete chimneys as a result of high temperatures and it was pointed out that the situation can always be rectified by using a brick lining to prevent the difference between the inside and outside temperature of the concrete sides of the chimney from exceeding 100°. The question of the distortion by means of crane runways was also raised and it was noted that as long as the columns supporting a gantry are kept independent of the retaining walls, little or no damage will result.

VI. OPERATION AND MANAGEMENT OF CEMENT PLANTS

[illegible]. Factory Management (A. Sch[illegible]nn)

Factory management is a comprehensive term, calling for technical [illegible] and insight as well as knowledge and understanding of human [illegible].

The factory management is responsible for the optimum utilization of the resources in the form of manpower, machinery and materials, that are available for the attainment of the production target.

The factory management exercises its functions with the aid of a group of selected men, drawing up a plan of organization which clearly shows the desired distribution of labour.

Prior to the working out of the plan of organization, a production diagram (see Chart VI.1-1) will have to be studied, so that the factory can be divided into spheres of activity which form natural separate entities. In so doing, the following factors will have to be taken into account:

(1) The technical limits;

(2) The topography of the site;

(3) The fixing of the working hours (day work or shift work);

(4) The size of the labour force;

(5) The character of the work.

Each sphere of activity is headed by a foreman. The foremen's work is co-ordinated by engineers. The channels of command appear from the attached diagrammatical plan of the organization (see Chart VI.1-2).

Table VI.1-1 is a job description, which defines for each staff member:

(1) His place in the organization, vertically and horizontally.

(2) The limits of his sphere of activity, technically and topographically.

(3) His responsibility, comprising:

(a) operational responsibility;

(b) responsibility for the operation and maintenance of machinery;

(c) responsibility for orderliness and cleanliness;

(d) reporting of operational data, etc.;

Chart VI.1-1

Production Diagram

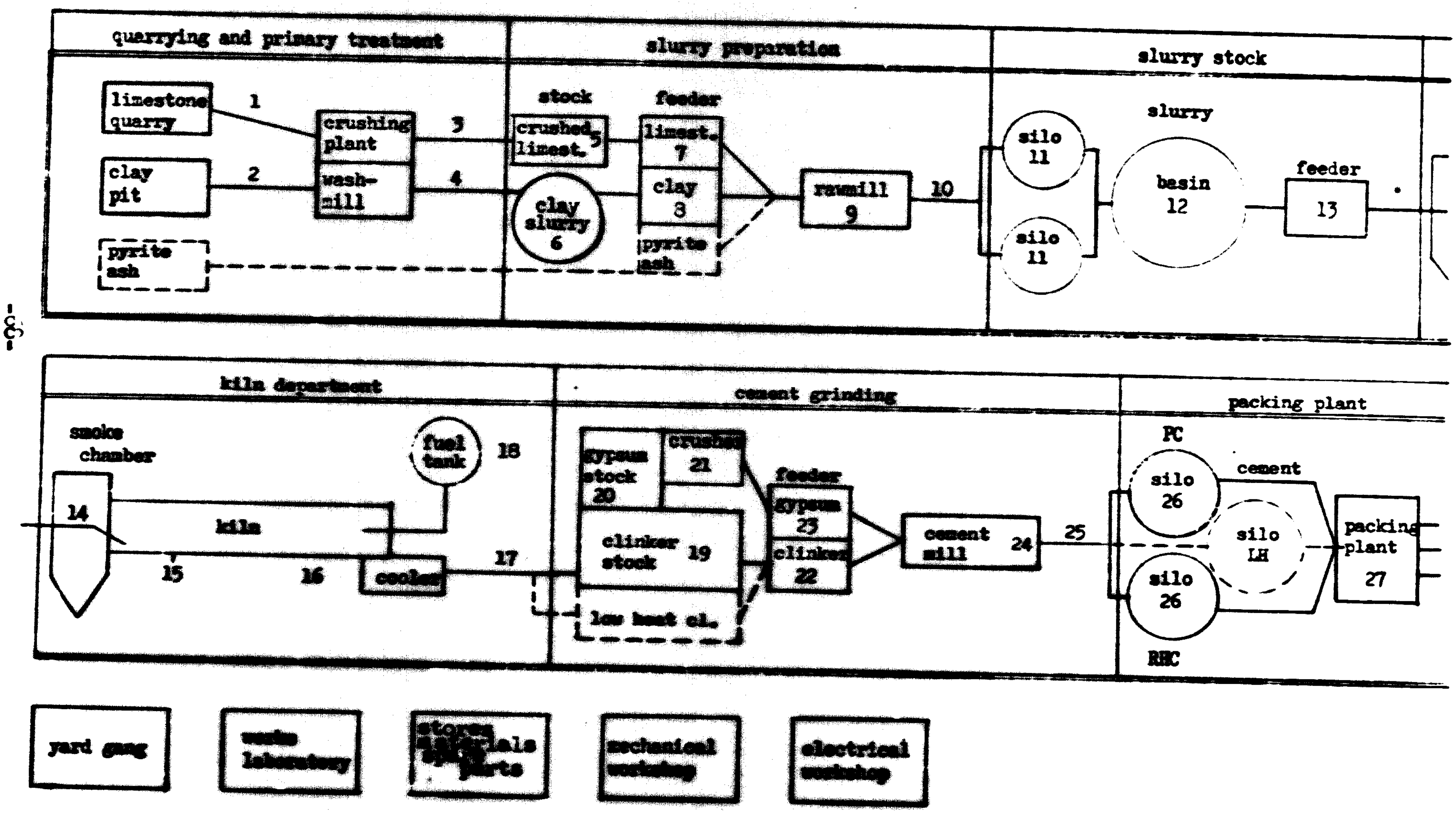
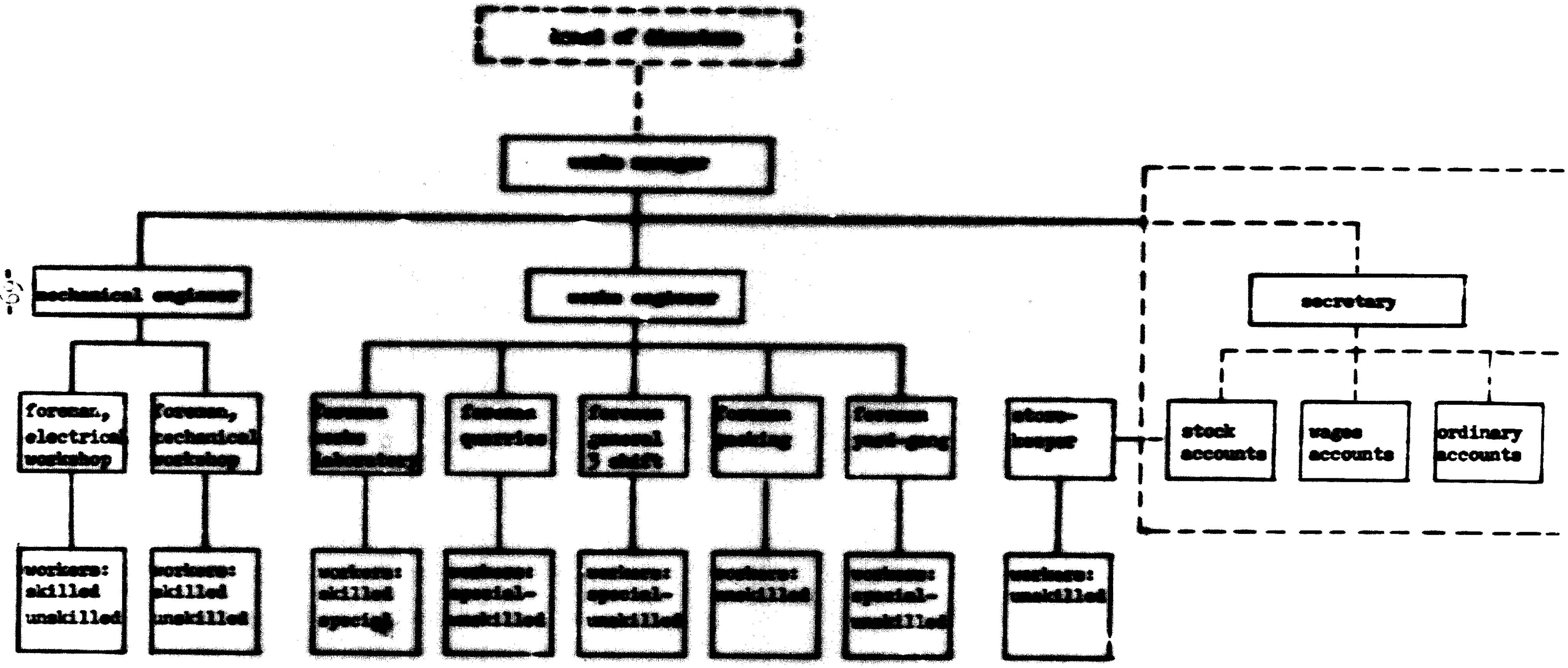


Chart VI.1-2

Plan of Organization



(e) records of receipts and consumption of materials;

(f) requisitioning of materials and equipment;

(g) labour legislation;

(h) health and safety regulations;

(i) instruction and training of workers.

When the technical apparatus - the skeleton - has been established, the ne step is to fill out the skeleton with men. In doing so, that which can be established and predicted logically gives place to the uncertain and incalculab the human factor, where reactions will depend on the temperament, ambition and ability of the individual.

In this field, intuition and flexibility are called for, as well as a know of human nature, and the faculty of knowing "when" and "why", if the organizati is to work smoothly.

Certain fundamental principles may, however, be pointed out:

(1) The channels of command of the organization plan should always be followed.

(2) Full responsibility and, consequently, the brunt of failure must be delegated.

(3) The development of personality should be promoted by the delegation o authority.

(4) Downward contact should always be maintained - without dictatorially displaying superior knowledge, but acting inspiringly.

(5) Exhaustive information should be given.

This human aspect of the functions of the organization throughout all its links indicates that, in selecting foremen and leaders, account must be taken no only of technical skill but also human qualifications.

Technical skill can be acquired through tuition and training courses, and m be demanded of engineers and certain foremen before the start of the factory.

Technical maturity and experience have to be acquired during the routine operation of the factory, and must be consciously promoted in order to adapt the foremen and also to train and instruct the labour force.

Each foreman and engineer should receive tuition in the fundamental princip of carrying out a leader's functions (see Table VI.1-2). This instruction in th task of supervision should include:

(1) The organization of the concern.

(2) The handling of personnel.

(3) [illegible]

(4) [illegible]

(5) [illegible]

(6) [illegible]

Only [illegible] experience [illegible] indispensable to [illegible] enterprise.

Each leader [illegible] technical [illegible] field, in order to [illegible] his [illegible] organization.

It is, however, the duty of the top management to provide for [illegible] of growth, direct development, and delegate responsibility and authority in accordance with the technical and human [illegible] of the staff.

Table VI.[illegible]

Job Description

1. Place in the Organization, indicating:

(a) The person who is his direct superior, from whom he is to receive instructions and orders, and to whom he is to report, i.e., the vertical ranking.

(b) The persons who are his equals, whom he is to inform or by whom he is to be informed, about questions of mutual importance in respect of the operation and repairs, i.e., the horizontal ranking.

(c) The category of workers (skilled, specialist and unskilled) who are at his disposal, and whom he is to instruct and supervise.

2. Sphere of Activity, indicating:

(a) The departments of which he is in charge. The boundary of the adjacent field of activity must be clearly defined. By way of example, it may be noted that the sphere of activity of the quarry foreman ceases where the crushed limestone is delivered to the store, and where the washed clay is delivered to the clay slurry silo.

The shift foreman's sphere begins with the limestone store and clay slurry silo, and ends with the delivery of cement into the cement silos.

3. Delegation of Responsibility, comprising:

(a) Responsibility for the appropriate operation of the departments within the sphere of activity, according to the regulations in force.

[illegible]

[illegible]

[illegible] operational data, labour [illegible] regulations.

(e) Responsibility for the careful recording of [illegible] and operational [illegible] materials spent, which is important for productive accounting and statistics.

(f) Responsibility for the requisitioning in time of materials and equipment in co-operation with the storekeeper.

(g) Responsibility for the observance of agreements with labour organizations in respect of working hours, wages, etc.

(h) Responsibility for the observance of statutory health and safety provisions, including the instruction of newly employed workers with regard to the special conditions and dangers of the working place.

(i) Responsibility for the instruction and training of workers in their special jobs within the sphere of activity.

Table VI.1-2

Curriculum of Instruction in the Supervision of Work

1. The organization of the concern, including: a grasp of the structure and function of the plan of the organization, with a description of the various jobs and the distribution of competence.

2. The handling of personnel, including: working psychology, work instruction, and the giving of orders.

3. The practical supervision of work, with special reference to: the planning of the work of the department, and co-operation with other departments.

4. Operational economy, including: understanding of accountancy, development of ability to assess the economy, costs and wastage of the department.

5. Labour legislation, including: information about the organization of the labour market, labour agreements, conflicts, etc.

6. Safety and welfare, including: factory legislation and internal safety precautions.

[illegible]

The [illegible] of [illegible] concern is [illegible] [illegible] [illegible] responsible for [illegible] [illegible] [illegible] obtained [illegible].

The functions of [illegible] productive enterprise consist of [illegible] administration. Of these the last-mentioned is [illegible] following headings:

Financial accounting;

Cost accounting and calculation;

Purchase;

Wages;

Salaries;

Dispatch;

Personnel;

Internal Control.

A detailed outline of the administrative organization is given in Chart VI.2-1. The advantage of placing the accounts department directly under the top management is commented upon in detail.

In general, the purpose of financial accounting is to record all financial transactions with the external connexions of the concern, while the cost accounting section attends to the recording of all internal transactions. The accounts department has the further task of supplying the management with information to enable it to ensure that the concern as a whole and each department have developed in accordance with the plans and budgets established.

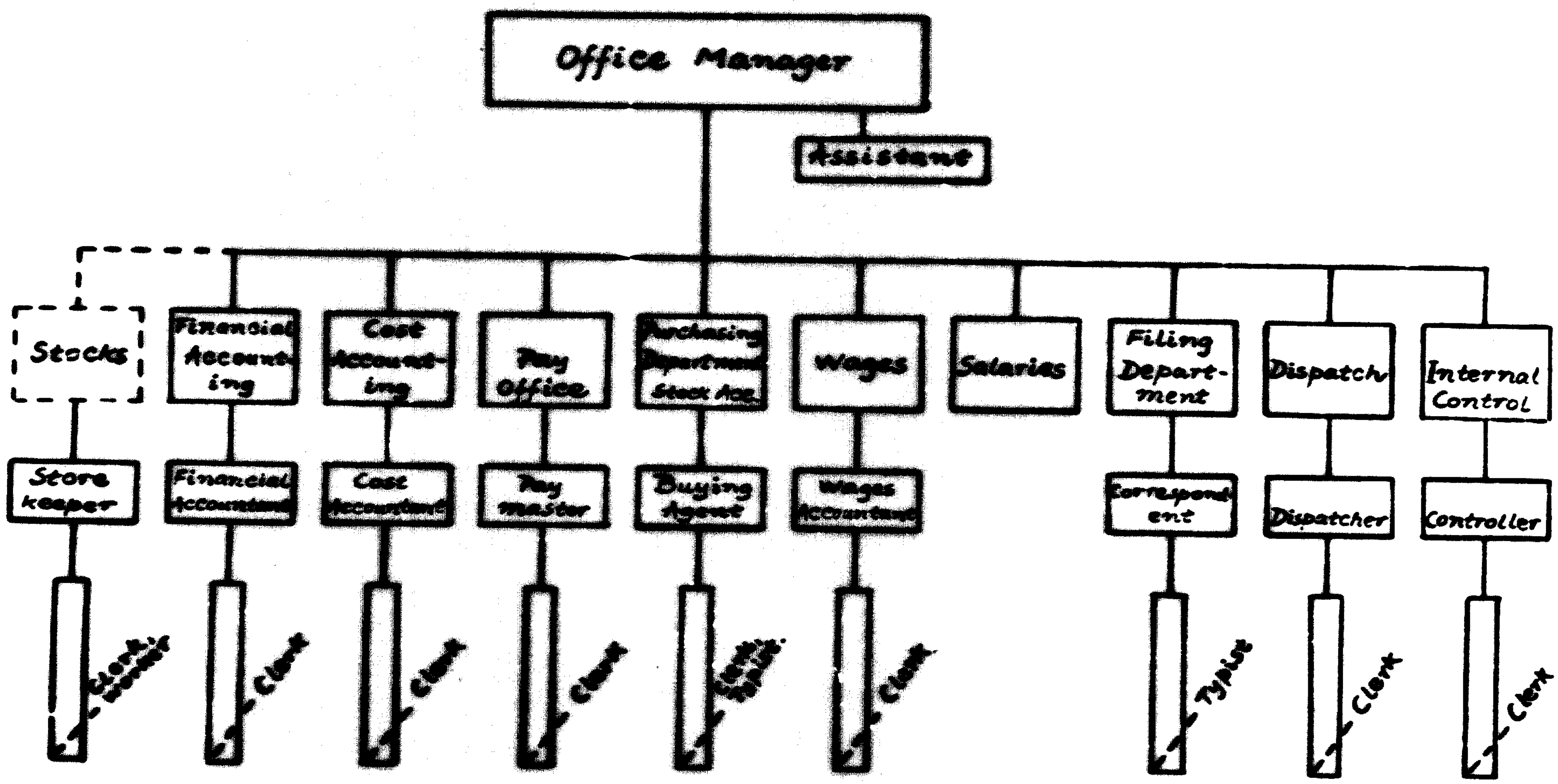
An accounting system is proposed for a hypothetical P.C. works, using the dualistic system, in which financial transactions are entered by ordinary booking, while control of the production is presented in tabular form. The financial accounting department of a concern must help to prepare balance sheets and profit and loss accounts, and, in order to do so it must receive information from the cost accounting section, on alterations of stocks, etc.

Forms are given in Tables VI.2-1 and VI.2-2 for reports from the financial accounting section, and reports from the cost accounting section.

The lecture then presents and expounds an accounting plan comprising ten classes based on the decimal system (Table VI.2-3). It follows with comments on principles regarding account classes, groups, and account numbers. The system of six-digit account numbers is illustrated in Chart VI.[illegible].

Chart VI.2-1

Detailed Outline of the Administrative Organization



Since the [illegible]

Table [illegible].2-[illegible]

Report from the Financial [illegible]

Period	Year	Description	Schedule

Text	Account Number	ACCOUNTS		
		Precalculation	FINAL CALCULATION	
			GROUP	MAIN GROUP
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
	Total			

[illegible] VI. -

[illegible] with Clinker Production

[illegible]	[illegible]	DEPARTMENT	SCHEDULE

[illegible]		Prec[illegible]lation: tons		Final C[illegible]lation tons	
		Amount	Unit price	Amount	Unit pri[illegible]
P[illegible]tion [illegible]	Fuel				
	S[illegible]bsi[illegible] m[illegible]trs.				
	Power				
	Wages				
	Materials				
Repair [illegible]	Wages				
[illegible]	Ma[illegible]ls				
Re[illegible] to	Wages				
machinery	Materials				
TOTAL [illegible]	[illegible]				

Analysis Prec[illegible]lation		Unit price	Quantity Total	Quantity Per ton	Amount Total	Amount Per ton
Fuel						
Subsidiary materials						
Power						

Analysis Final Calculation		Unit Price	Quantity Total	Quantity Per ton	Amount Total	Amount Per ton
Fuel						
Subsidiary materials						
Power						

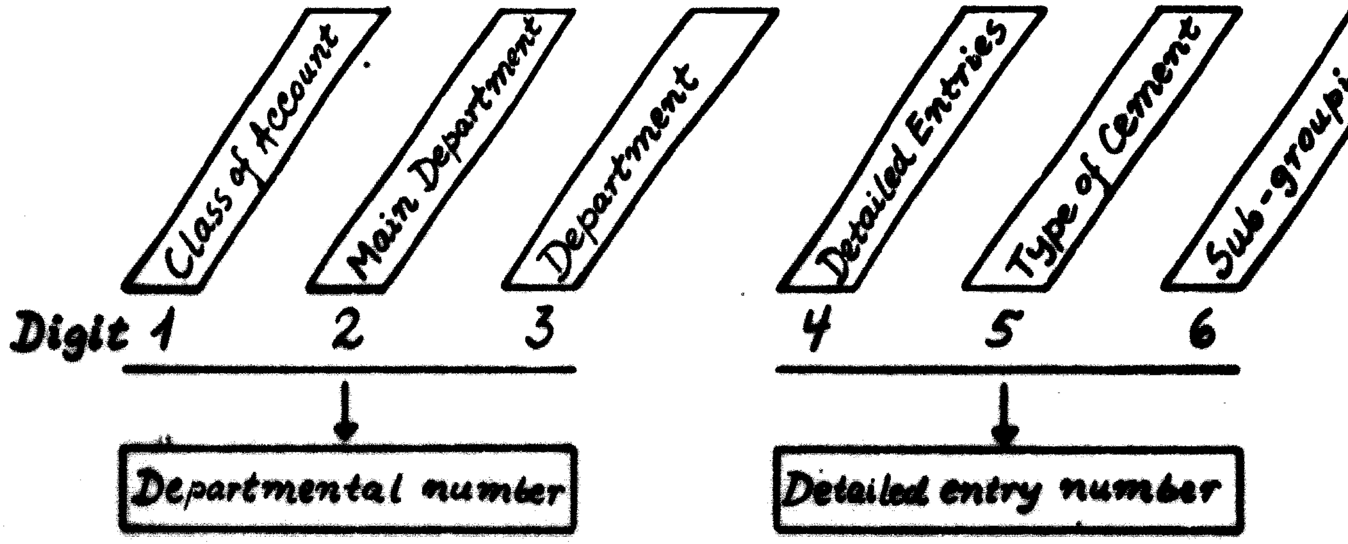
Table VI.2-3

Chart of Accounts
worked out on the Decimal System

	FINANCIAL ACCOUNTS			COST ACCOUNTS - COST SHEETS					FINANCIAL ACCOUNTS	
	Liabilities	Assets	Expenses	Expenses taken over	Stock Control	Auxiliary Departments	Main Departments	Internal Statements	Income	Closing of Accounts
	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9
0	00	10	20	30	40	50	60	70	80	90
1	01	11	21	31	41	51	61	71	81	91
2	02	12	22	32	42	52	62	72	82	92
3	03	13	23	33	43	53	63	73	83	93
4	04	14	24	34	44	54	64	74	84	94
5	05	15	25	35	45	55	65	75	85	95
6	06	16	26	36	46	56	66	76	86	96
7	07	17	27	37	47	57	67	77	87	97
8	08	18	28	38	48	58	68	78	88	98
9	09	19	29	39	49	59	69	79	89	99

Chart VI.2-2

System of 6-Digit Account Numbers



1st digit - account class:
A number of affiliated accounts corresponding to the treatmen

2nd digit - main department:
The second digit represents the main department.

3rd digit - department:
Acts as a sub-department under the main department.

4th digit - the detailed entry:
By detailed entry is understood the type of cost to which the expenses are referred.
- 0 = Operation.
- 2 = Repair of buildings and rails.
- 4 = Repair of machinery, electrical plant and furnitu
- 6 = Kiln linings.

5th digit - type of cement:
The fifth digit may be used to indicate the type of cemen

6th digit - sub-grouping:
Sub-grouping means the numbering of accounts taking place within the individual departments.

4. The Works Manager's Task (A. Schønnemann)

The cement works with one rotary kiln outlined in Chart VI.3-1 forms the basis of the lecturer's considerations in connexion with the tasks of the works manager.

It is the object of the factory to produce and sell ordinary Portland cement, rapid-hardening cement and a special cement - low-heat cement.

The two first-mentioned types of cement are manufactured on the basis of the same slurry, which makes it possible to use the same machinery and storage facilities up to and including the cement mill installation. After that, silos have to be provided for each type of cement and, depending on the magnitude of the production, separate packing facilities.

The manufacture of low-heat cement calls for separate storage space and an additional feeding device for spent pyrites, storage space for special clinker, and a separate cement silo. The installations for the production, storage and burning of slurry may be common, in view of the fact that the manufacture of special cement in the factory under review will require complete reorganization of the productive plant.

The average magnitude of the kiln output has to be fixed with a view to the rated capacity of the kiln, relining and repair work, and estimated marketing possibilities for the different types of cement.

The longer the period of operation at optimum output from each individual productive unit, the rotary kiln in particular, the greater the possibility of good quality and economy.

In order to be able to cope with daily fluctuations and seasonal variations in the sales, buffer stocks will have to be established. Day-to-day variations may be compensated for in the cement silos, while seasonal variations are made up for in the clinker stocks.

Economy and quality are the works manager's fields of activity and responsibility, calling for planning, calculation, and the control of processes and products in each individual department.

The foundation of factory management is systematic mapping-out of the factors that determine the result, technically, economically and in respect of quality, in each individual department and in the factory as a whole. A favourable development in one department may not necessarily bring about a favourable development in the subsequent department.

This systematic mapping-out should cover the items listed in Table VI.3-1 for each department, with the necessary basic data being entered on forms specially prepared for the purpose. These statistical data are collected and processed in special offices, which pass on the resulting information to the works manager. This information may be divided into characteristic groups, as indicated in Table VI.3-2.

Chart VI.3-1

Production Diagram

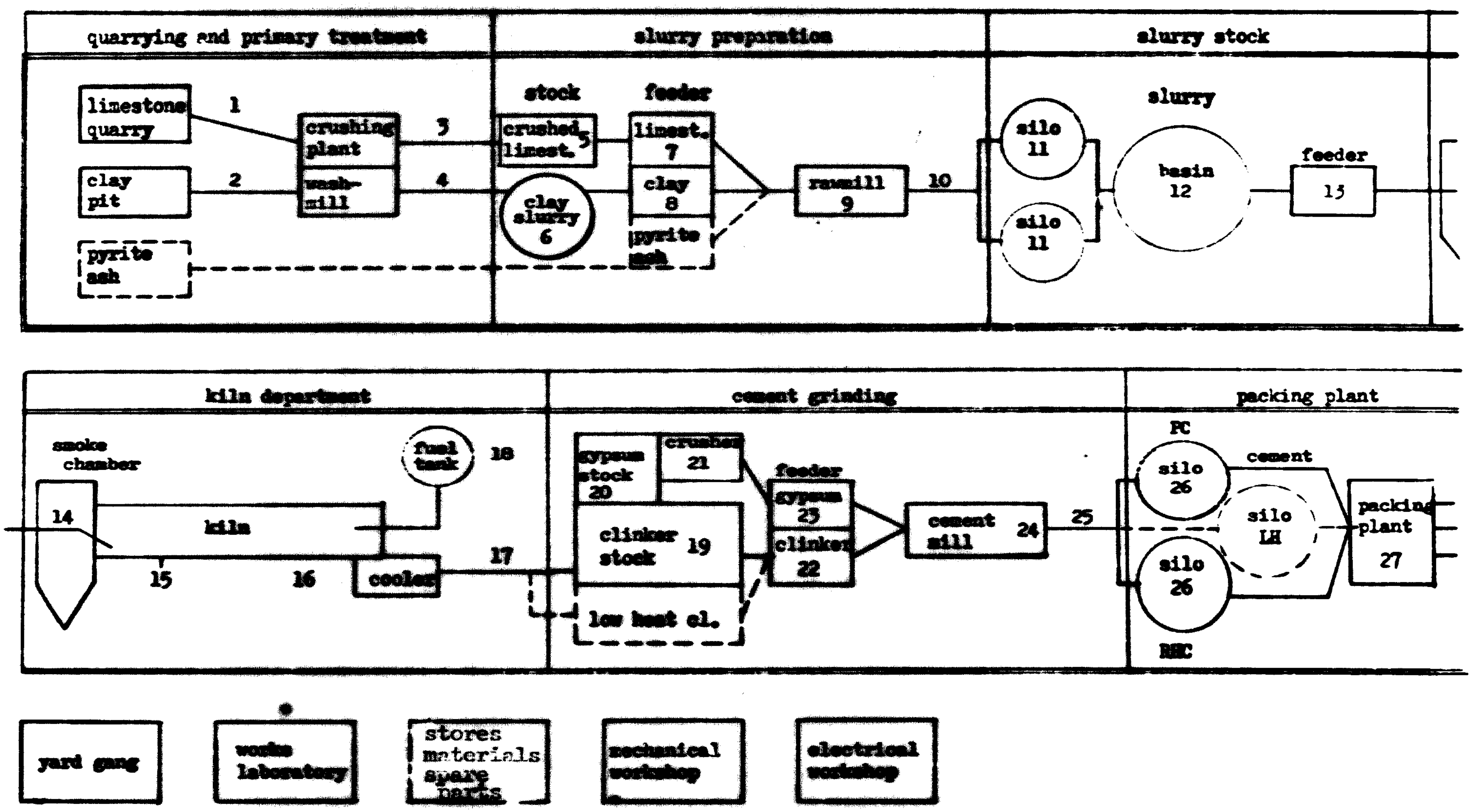


Table VI.3-1

Review of the Technical Records which ought to form part of the Works Manager's [illegible]-cut of Production and Quality Determining Factors

Manhours (production and repairs).

Production aids (lubricants, grinding media, diesel oil, etc.).

Repair materials (spare parts, etc.).

Operating hours of machines.

Power consumption (kwh.).

Coal and oil consumption (clinker burning).

Quantities consumed of limestone, clay, slurry, clinker, gypsum, cements, bags, water, etc..

Quantities produced of limestone, clay slurry, clinker, cements, etc..

Quantities sold (cements).

Stock accounts of limestone, clay, slurry, clinker, gypsum, cements, bags, coal, oil, grinding media, etc..

Process-governing and controlling factors (such as temperatures, amperage, oxygen content, water content, etc.).

Quality-governing and controlling factors (such as chemical analyses, fineness determinations, cement strengths, etc.).

Table VI.3-2

Groups within Internal Technical Reporting System

Technical basic data are collected from the works departments, where they are entered on special forms which are passed on to special clerical departments where the basic information is processed statistically. After this, the works manager is able to:

(1) Intervene immediately, where the question is one of process control (mill operation, clinker burning, etc.).

(2) Provide for short-term regulation (adjustment) and co-ordination from day to day (adaptation of raw material quantities to storage capacities and kiln output; the fitting-in of minor repair work; adjustment of raw mixture composition; adaptation of cement grinding to silo capacity and sales, etc.).

(3) Prepare long-term planning (overhaul of large units of machinery; major repair jobs, such as relining of the kiln, alteration to or renewal of internal kiln fittings, or the like; change-over of operation from one type of cement to another with a view to sales, clinker stocks, etc.).

(4) Make a technical evaluation of the appropriate utilization of personnel and machinery on a short or a long view, maintenance being also included in the evaluation.

(5) Make a financial evaluation of the result obtained.

Table VI.3-3

The Expediency of Technical Data and Records should be Tested by Answering the Following Questions:

(1) Will the information make possible an evaluation calling for immediate action, in the case of deviation from the normal, or intervention on a long view if an undesirable tendency is in course of development - whether technically, economically or in respect of quality?

(2) Is the advantage gained by a more efficient process control or management in reasonable proportion to the expenditure incurred by the production of the information?

(3) Will the information be received early enough for adjustments to be made in time?

(4) If not, will the information help to prevent the repetition of errors already made?

Chart VI.3-2 is a diagrammatical outline of an internal reporting system. Such a system may be more or less comprehensive, according to the [illegible] judgement.

Nowadays, the recording and processing of the data collected may be done by electronic computers, in combination with more or less complete automation. Electronic data-processing should, however, only be introduced after thorough consideration, since the necessary apparatus and installations are very expensive both to buy and to operate. Moreover, detailed knowledge is required of all the factors that influence the control of processes and quality, as well as reliable and accurate measuring and recording of the basic data material. If these prerequisites are not present, the complicated automation and data-processing equipment will give confusing information, instead of contributing towards better economy, higher output and a more uniform quality.

The works laboratory system, the function of which is to control production, is normally headed by a chief chemist, who has at his disposal three laboratories, namely, the analytical laboratory, the shift laboratory, and the cement-testing laboratory. Chart VI.3-3 shows diagrammatically how the routine checking and control performed by the laboratory system may be organized. The chart also indicates the samples and investigations which may be required, as well as where and how often such samples should be taken, how often the investigations should be made, and, finally, how the work should be distributed among the various laboratories.

The amount of operating control needed is that which will make it possible to obtain the desired quality, in the proper quantities, at the proper times, and at the lowest possible cost.

The expediency of the operating control's data and recordings in this sense may be tested by answering the questions asked in Table VI.3-3.

When used with prudence, operating control is of vital importance in the expedient direction of processes and qualities, and thus becomes the basic means whereby the works manager is able to run the factory in a satisfactory manner - technically, financially and in regard to quality.

Chart VI.3-2

Diagram of Internal Reporting

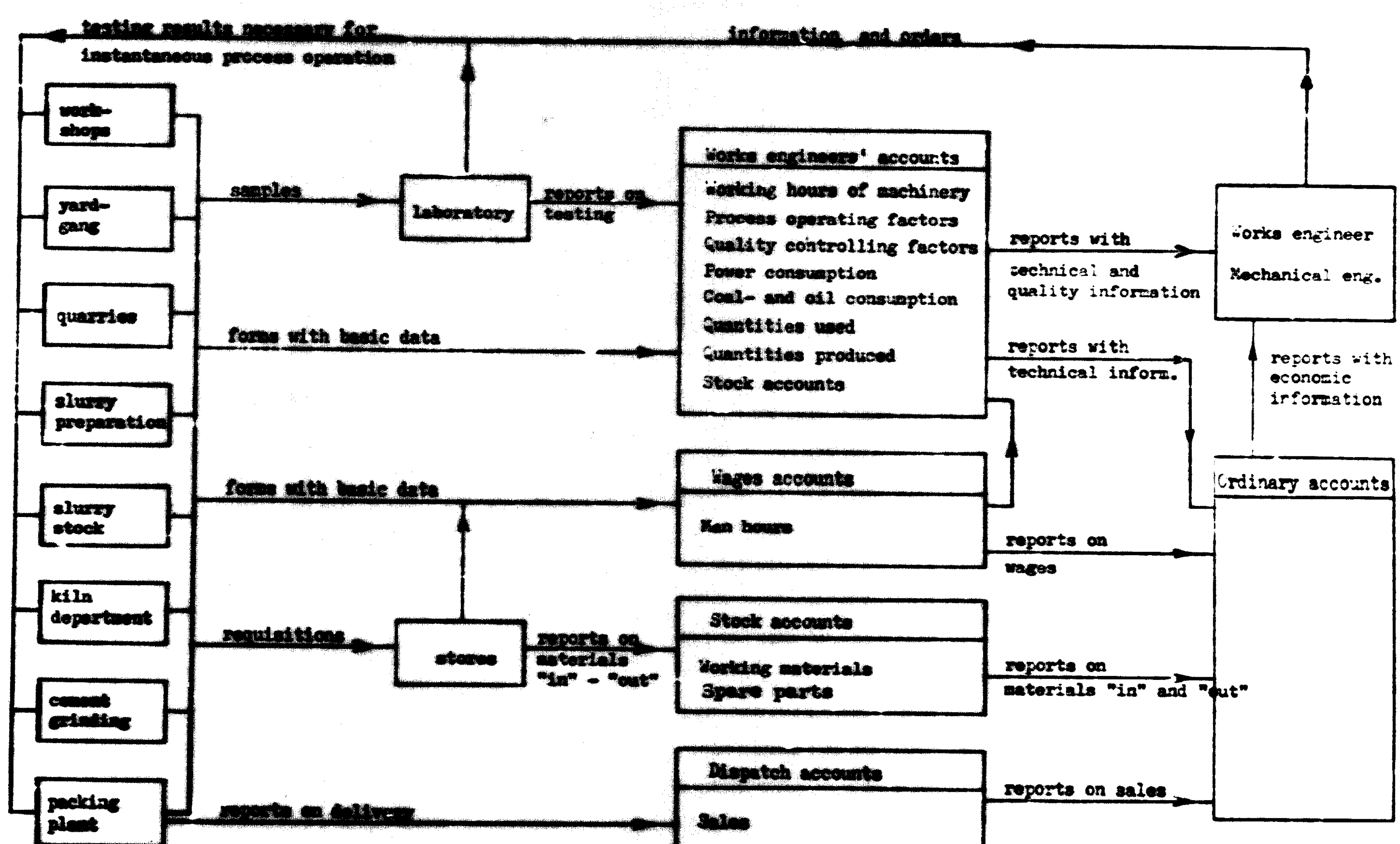
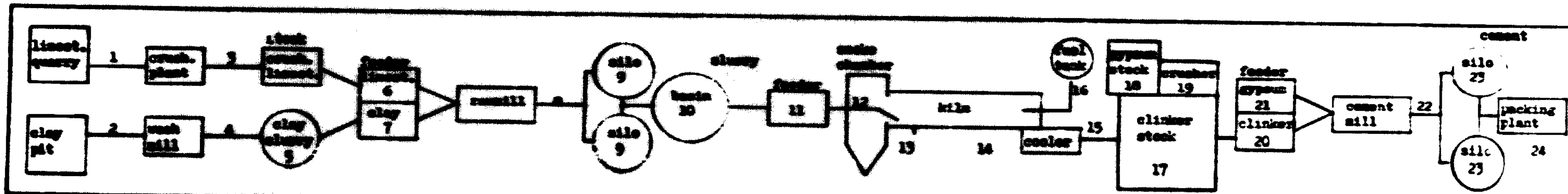


Chart VI. -)

Production Control - Programme for Routine Testing in the Laboratory



position	sample taken from	type of sample	frequency of sampling	frequency of testing	moisture content	titration	fluidity	literweight	free lime	SO_3	complete chemical analysis	calorific value	temperature	Orsat analysis	fineness - sieving	fineness - Blaine	soundness Chatelier	setting - time	strength	hourly feed	daily output	stock - daily	remarks
					A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C	A S C				
1	limest.quarr.	limestone	occasionally	occasionally	S	A					A												
2	clay pit	clay	occasionally	occasionally	S	A					A										x		
3	crusher	limestone	monthly	monthly°	S	A					A										x		
4	wash mill	clay slurry	hourly	daily°	S	S	S	S							S						x	x	
				weekly°		A					A				S						x		
5	clay silo	clay slurry	daily	daily	S	S	S	S															
6	limest.feeder	limestone	———	hourly																		x	
7	clay feeder	clay slurry	———	hourly																x			
8	rawmill	slurry	hourly	hourly	S	S	S	S												x			
9	slurry silo	slurry	each silo	each silo	S	S	S	S							S						x		
10	slurry basin	slurry	———	daily																		x	
11	slurry feeder	slurry	6 x daily	6 x daily	S	S									S					x		x	
				weekly°		A					A												
12	sm. chamber	exitgas	3 x daily	3 x daily										S									
13	after chains	sack'es	2 x daily	2 x daily	A										S								
14	burning zone	temperature	———	2 x daily									S										
15	clinkercooler	clinker	hourly	hourly°				A															
				daily°					A												x		
				weekly°					A	A	A												
16	fuel tank	fuel oil	daily	monthly°						A		A											
17	clinker stock	clinker	———	daily																		x	
18	gyps.stock	gypsum	each cargo	each cargo	A					A												x	
19	gyps.crusher	gypsum	monthly	monthly																		x	
20	clinkerfeeder	clinker	———	hourly											S						x		
21	gyps.feeder	gypsum	———	hourly																x			
22	cement mill	cement	hourly	4 x shift°											S	S		S		x			
				daily°					A	A					C	C	C	C			x		
				2 x weekly°					A	A	A				C	C	C	C	C				
23	cement silo	cement	———	daily																		x	
24	packing plant	cement	daily	daily					A	A					C	C	C	C			x		
				2 x weekly°					A	A	A				C	C	C	C	C				

° - average sample. Samples are collected and prepared for analysis by "S".

A - analytical laboratory.
S - shift laboratory.
C - cement laboratory.

Stock Accounts (F. Møller)

Stock accounting is a field which deserves a central position in the total financial planning of the firm; only if the management holds this work in respect will it be possible to induce the staff concerned to make a wholehearted effort.

The object of the stock of goods is to act as a buffer between purchase and consumption or between production and sale, and, from this point of view it can be divided into a working stock and an emergency stock (see Chart VI.4-1).

The size of the working stock depends on the most advantageous quantities that can be bought at a particular time, and these can be estimated by comparing the following two groups of costs:

(a) the costs incurred by carrying a stock;

(b) the costs incurred by making purchases.

The relationship between the costs of carrying a stock and the costs of ordering can be illustrated graphically, as shown in Chart VI.4-2.

The size of the emergency stock can be determined by taking the following factors into account:

(a) the accuracy with which the rate of consumption has been calculated;

(b) the probability of changes in the rate of consumption;

(c) the probability of changes in the time of delivery;

(d) the cost of having run out of the article;

(e) the cost of carrying an emergency stock.

Efficient control of the stock is based on an organization comprising at least:

(a) a planning function;

(b) a purchasing function;

(c) a goods-reception function;

(d) a war housing and issuing function;

(e) an accounting and checking function; (See Chart VI.4-3)

In Chart VI.4-4 the materials which occur normally in a PC works are classified, and attention is drawn to factors of special interest for the control of stocks of the individual groups of articles.

In stocks of "own products", the finished products call for the greatest effort, because the possibility of shortages occurs there in particular. Chart VI.4-5 shows a draft form for the daily reporting of the issue department.

Chart VI.4-1

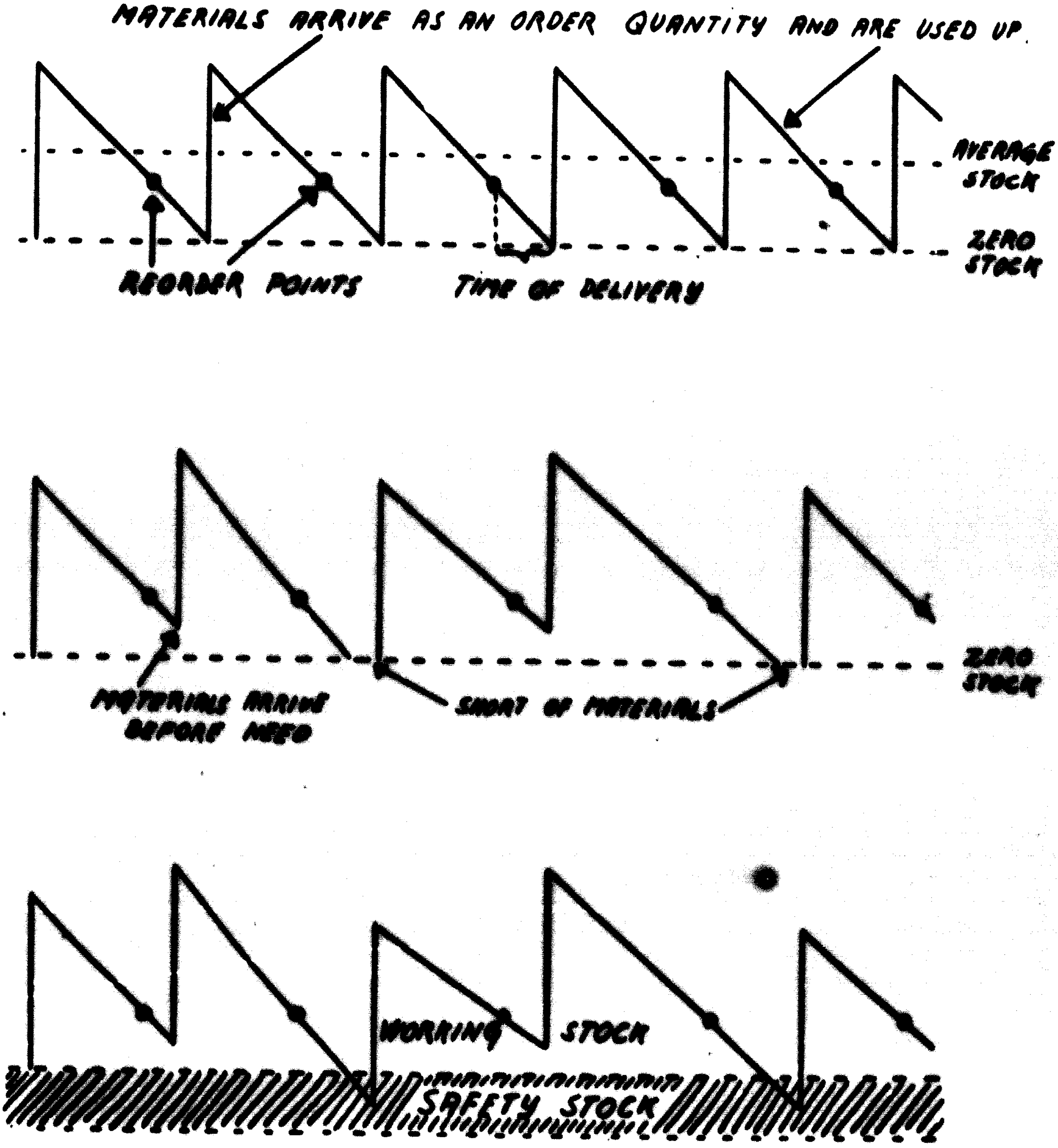

MATERIALS ARRIVE AS AN ORDER QUANTITY AND ARE USED UP.
AVERAGE STOCK
ZERO STOCK
REORDER POINTS
TIME OF DELIVERY
ZERO STOCK
MATERIALS ARRIVE BEFORE NEED
SHORT OF MATERIALS
WORKING STOCK
SAFETY STOCK

Chart VI.4-2

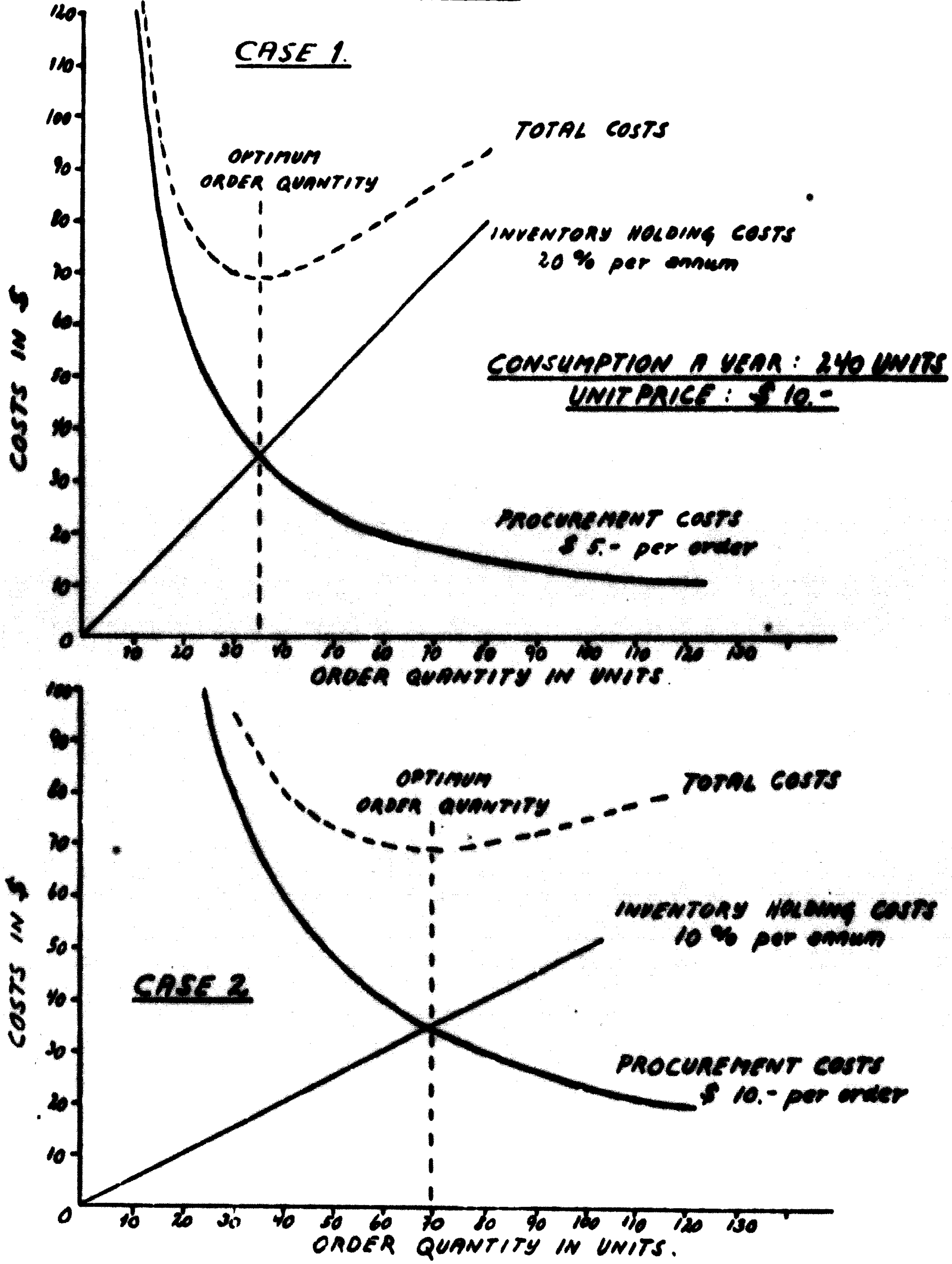
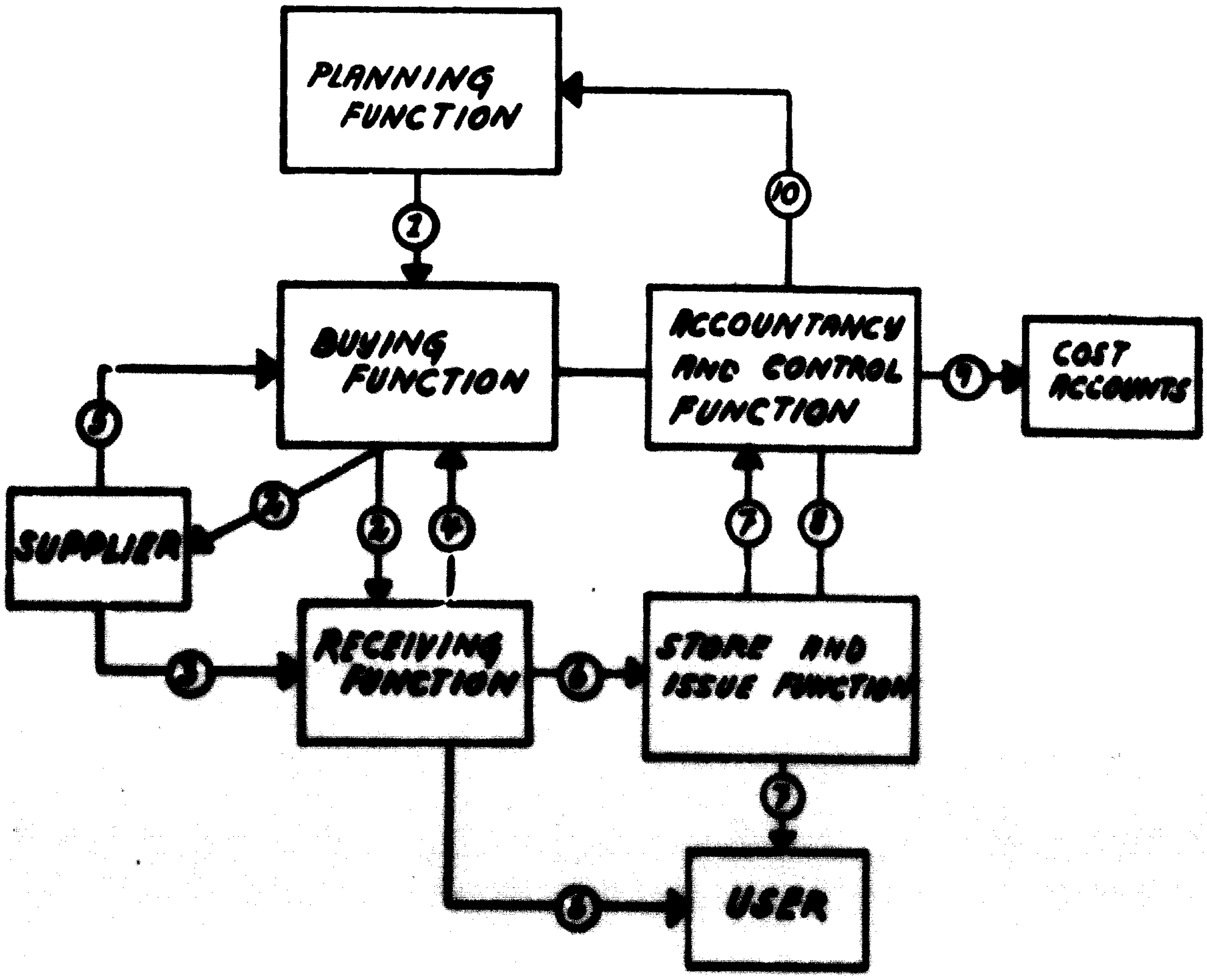

CASE 1.
TOTAL COSTS
OPTIMUM ORDER QUANTITY
INVENTORY HOLDING COSTS 20 % per annum
CONSUMPTION A YEAR : 240 UNITS
UNIT PRICE : $ 10.-
PROCUREMENT COSTS $ 5.- per order
COSTS IN $
ORDER QUANTITY IN UNITS
CASE 2.
OPTIMUM ORDER QUANTITY
TOTAL COSTS
INVENTORY HOLDING COSTS 10 % per annum
PROCUREMENT COSTS $ 10.- per order
COSTS IN $
ORDER QUANTITY IN UNITS.

Chart VI.4-3



1) Reports on estimated requirements.

2) Order (copy to the Receiving Function).

3) Delivery of materials.

4) Reports on materials received.

5) Supplier's invoice.

6) Issue directly to user or transfer to the Store Function.

7) Issue against requisition, which is sent for bookkeeping.

8) Continuous comparison of book records with actual stocks.

9) Priced issues are sent to cost accounts.

10) Reports on variances between actual and planned results.

Chart VI. 4-4

Classification of Materials and Goods in a PC Industry

OWN PRODUCTS

1. Natural raw Materials.
   - 1.0. Limestone from own quarry
   - 1.1. Clay from own pit
2. Intermediate products.
   - 2.0. Slurry
   - 2.1. Clinker
3. Finished products
   - 3.0. Bulk cement in silos
   - 3.1. Packed cement

PURCHASED MATERIALS & GOODS

4. Fuel.
   - 4.0. Coal
   - 4.1. Fuel oil
5. Purchased raw materials.
   - 5.0. Gypsum
   - 5.1. Other process materials
6. Packing.
   - 6.0. Paper bags
   - 6.1. Other packing
7. Spare parts and ordinary consumption goods.
   - 7.0. Special spares for quarry equipment
   - 7.1. " spares for cement making machinery
   - 7.2. " spares for electrical equipment
   - 7.3. " spares for rolling stock
   - 7.4. Common spare parts
   - 7.5. Fire-bricks (Refractories) and grinding bodies
   - 7.6. Iron, steel, pipes, fittings etc.
   - 7.7. Diesel oil, gasoline and lubricant
   - 7.8. Tools and various consumption goods
   - 7.9. Construction materials

Chart VI.4-5

CONTROL OF STOCKS OF CEMENT

	CEMENT TYPE I		CEMENT TYPE II		
	BULK	PACKED	BULK	PACKED	
Opening stock	2,750	25			
Cement ground	290				
Packed as per counters	- 250	250			
1. TOTAL	2,790	275			
EXPORT by boat					
EXPORT by railway		10			
EXPORT by car					
INLAND by boat		25			
INLAND by railway	25				
INLAND by car	50	210			
OWN USE	5				
2. TOTAL ISSUE	80	245			
Closing stock (1-2)	2,710	30			
Measured stock		26			
Difference		4			
Booked waste		1			
Uncontrolled waste		3			

MAY 13, 1964	signature	signature
Date	Worked out by	Checked by

[illegible] of great economic importance, since they [illegible] of the total consumption [illegible]. They are most [illegible] bought under long-term contracts concluded between the suppliers and the [illegible].

The stock of packing materials is a function which may normally be placed under the [illegible] department.

The spare parts stock gives rise to the greatest number of problems, for in a factory with an annual output of about 200,000 tons of cement, the category covers about 6,000 different items with a total value of about half a million dollars, or about $[illegible].50 per ton of cement produced. They are articles with a very low rate of turnover, being generally in stock for about two years before being consumed. Furthermore, they must be stored under safe conditions so as to be serviceable at any time. Finally, for specially made spare parts, the time of delivery is relatively long.

There are great advantages in being able to identify all spare parts and articles for consumption by means of a descriptive code number. Table VI.4-1 shows how a code numbering system may be devised, based partly on the application of the article and partly on its nature.

In order to illustrate the attention which should be paid to the initial and repeat ordering of spare parts, the lecture quotes an example from practice, whereby the supervisors of the repair shop, the mechanical workshop, the stock and the purchasing department, of a certain concern, meet once a week to review the past week's consumption and discuss, in a spirit of co-operation, the repeat orders which ought to be placed and their size.

The savings that can be obtained by efficient stock control are of a dual nature. In the first place, capital which may be tied up in unnecessary stocks is released for use on more productive purposes. Secondly, the annual costs of carrying stocks are reduced.

Table VI.4-1

<u>Coding of an article according to its use</u>

Example:	Travelling wheel, model Q.b.286 etc. for stirring device for slurry basin	
Code number:	1 - 35 - 271	
Analysed as follows:		
Class	1 - xx - xxx	Special spares for cement making machinery
Department	1 - 3x - xxx	Slurry Department
Main Machinery	1 - 35 - xxx	Slurry basin
Machine	1 - 35 - 2xx	Stirring device
Item number	1 - 35 - 271	Travelling wheel, model Q.b.286 etc.

<u>Coding of an article according to its nature</u>

Example:	Round steel bar, SM-0.30% carbon, 0.750 ins dia.	
Code number	6 - 24 - 315	
Analysed as follows:		
Class:	6 - xx - xxx	Iron, steel, pipes, fittings etc.
Sub-Class	6 - 2x - xxx	Iron and carbon steel
Group	6 - 24 - xxx	Round bar
Series	6 - 24 - 3xx	SM-0.30 carbon
Dimension	6 - 24 - 315	0.750 ins dia.

5. Quality Specifications (per Hansson)

Cement, like all other technical products, must be made and sold in accordance with specifications. In these it should be clearly stated what properties are required of the cement. The specifications should protect the consumer as well as the manufacturer.

The various requirements in the specification can be divided into two groups:

Requirements which must be fulfilled by all cements, regardless of their intended use, such as:

(a) Soundness,

(b) Setting time,

(c) Strength.

Special requirements, such as:

(d) Chemical composition,

(e) Fineness,

(f) Heat of hydration,

(g) Sulphate resistance.

a. Soundness

From the point of view of the durability of a concrete construction, it is essential that the cement should not cause excessive expansion after the concrete has hardened. If it causes such expansion, it is unsound and must be rejected.

Several methods are available for controlling the soundness. All of them are accelerated methods, i.e. the specimens are treated at an elevated temperature in order to bring about the harmful reactions in a few hours. Normally, the expansion does not develop until after months or perhaps years. The most common methods are the boiling test, the le Chatelier test, and the autoclave test.

b. Setting time

As soon as the cement mortar or concrete is mixed, the cement starts to react with the water. A gradual change of consistency takes place. When a certain degree of stiffness is reached, the concrete cannot be placed any more. The so-called "setting-time" gives an indication of the length of time the concrete remains in a state in which it can be placed.

In order to determine the setting-time, the methods mainly used are the Vicat method and the Gillmore method. Both use apparatuses based on the same principle - the penetration of neat cement paste by a needle. The set is said to have begun when the needle cannot penetrate the paste completely, and to have ended when the paste has become so hard that the needle makes only a very small mark on its surface.

c. Strength

To determine the strength, a large number of different methods are used. In principle, they can be classified in the following way:

Mortar tests in which specimens are made of a cement:sand mortar and tested for tensile strength, flexural strength, and compressive strength.

Concrete Tests in which specimens are made of concrete and tested for compressive strength.

As the various methods generally give very different results, it is difficult to compare cement from different countries. In recent years, an attempt has been made to produce an international method. On the basis of proposals from two European associations, Cembureau and Rilem, the International Organization for Standardization has proposed a method which seems to have become widely accepted. According to this, prisms 4x4x16 cm. are tested for flexion and compression.

d. Chemical composition

Generally, magnesia and sulphate contents are limited. This limitation serves as a sort of soundness test. No other limitations as to chemical composition should be necessary in the specifications.

e. Fineness

Limits are given in some countries, but the requirement is rather unnecessary.

f. Heat of hydration

A limitation is necessary only when the cement is used in very large structures. Tests are complicated.

g. Sulphate resistance

When the cement is used in structures exposed to ground or water containing large amounts of sulphates, special precautions must be taken.

[illegible]. <u>The Control Laboratory H. Eriksen</u>

The purpose of the control laboratory [illegible] ensure [illegible] quality in the product (cement), for example, high strength, normal setting-time and low expansion, and the [illegible] operation of the plant, with high production and low [illegible], for example, a high running-factor for kilns, low fuel and power consumption, and longer life for machinery, grinding media and brick lining in kilns.

The functions of controlling the process and the finished product are usually united in a single laboratory (see Chart VI.6-1). The various tasks of the laboratory include: sampling, under which the lecture discusses sampling points (see Chart VI.6-2), sampling methods, spot samples, average samples and automatic samplers, the examination of samples (see Chart VI.6-3), instructions to the production units e.g. quarry, mill, kilns, etc., and service to customers.

A typical staff for such a laboratory would consist of about ten persons: one chief chemist, one assistant chemist, two analysts, one operator for physical tests, and four shift operators.

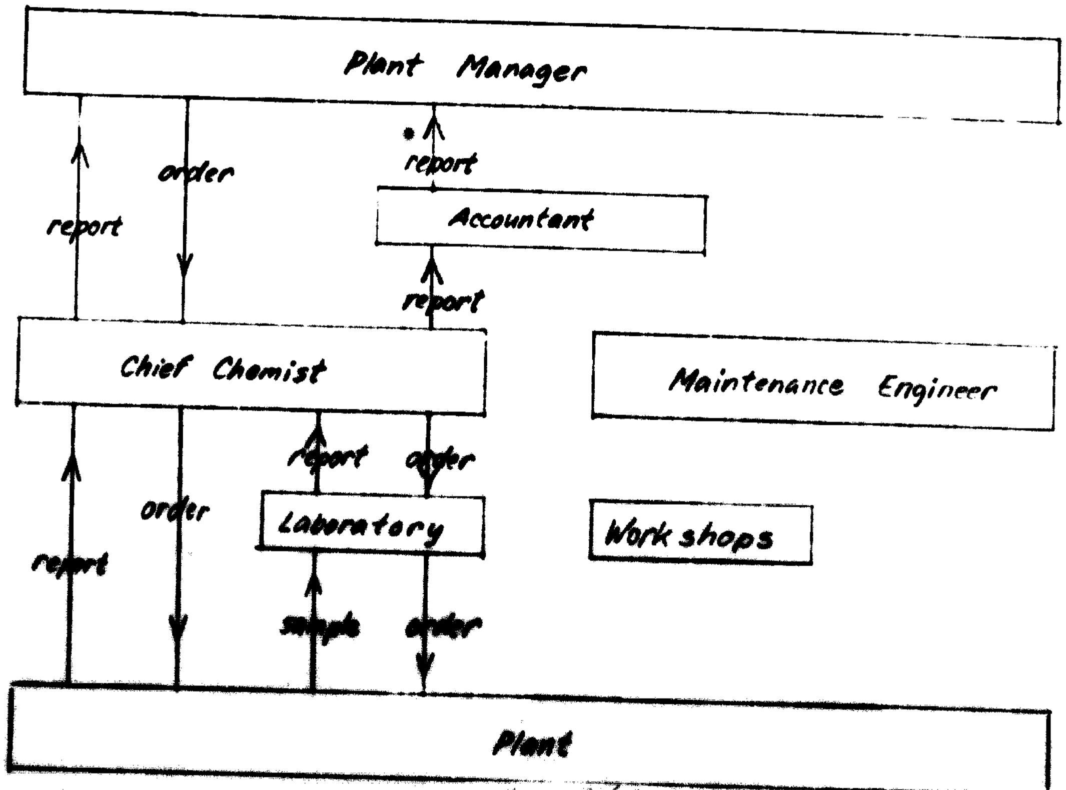
A typical laboratory floor plan is shown in Chart VI.6-4. The chemical section would contain gas burners, electric furnaces, analytical balances, instruments for optical analyses, etc.. X-ray analysers are used in some newer plants. There would also be exhaust fans for acid vapours. The physical section would contain sieving machines, Vicat apparatus for checking cement setting-time, molds for test specimens of cement mortar and concrete, strength-testing machines, Blaine apparatus, autoclave, sand and aggregates for the preparation of test specimens, a thermostatic room with constant moisture, and water tanks for the storage of test specimens. The equipment needed for a laboratory depends to some extent on the type of process used by the factory and the specifications of the cement produced.

All the data from the laboratory's examinations are recorded systematically on forms or in books.

The information from the laboratory is utilized to disclose and correct the source of irregularities, as for example expansion caused by too high a lime saturation of the raw mix, and to prevent irregularities by keeping important factors at the desired values. The properties of the cement and the efficiency of the plant may also be improved by adjustments designed on the basis of the statistical information obtained from the data recorded by the laboratory.

Chart VI.6-1

Control Laboratory Report Diagram



Control Laboratory Chart VI.6-2 Sampling Points

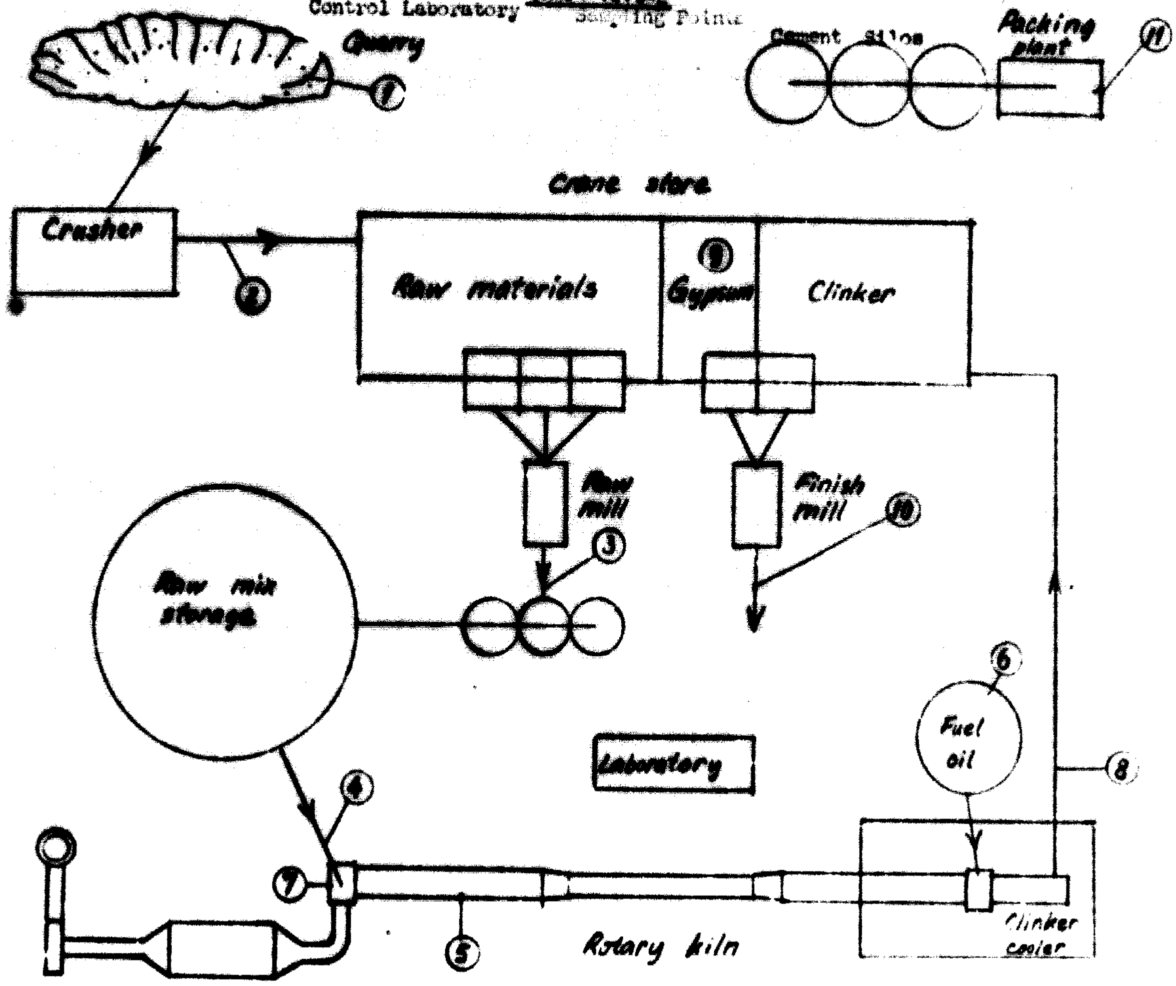


Chart VI.6-3

Control Laboratory Control Scheme

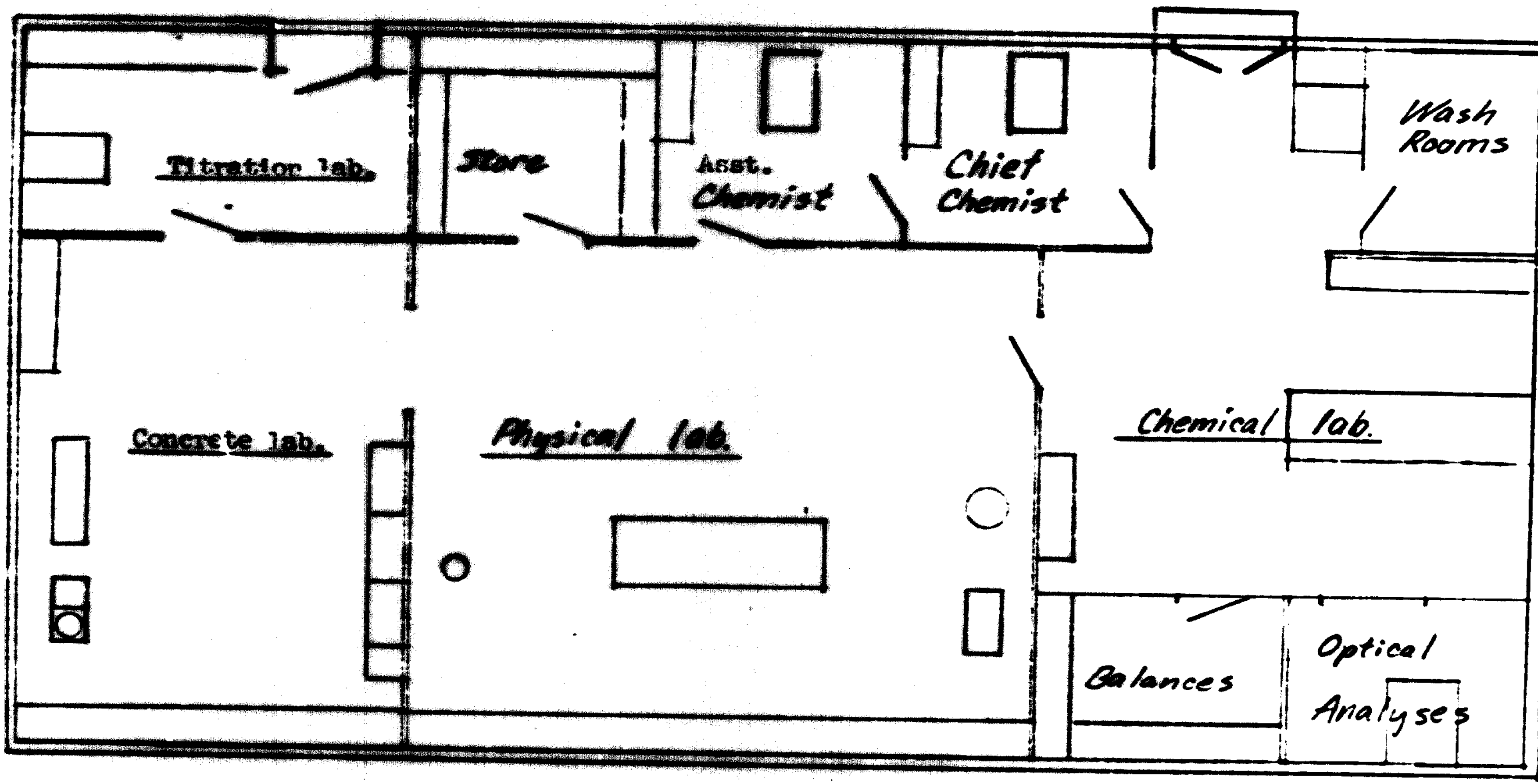
Pos.	From	Material	Sampling Frequency	Titration	Moisture	Viscosity	Fineness	Complete Analysis	Calorific Heat Value	Orsat Analysis	Temp.			
1	Quarry	Limestone	Occasional	x				x						
2	Crusher	Limestone	Daily	x			x							
3	Raw Mill	Raw Mix	Hourly	x	x	x	x	daily						
4	Kiln Feeder	Feed	Hourly	x	x									
5	Kiln	Nodules	4 Hours		x		x				x			
6	Fuel store	Oil/coal	Occasional		x coal	x oil	x coal		x					
7	Smoke Box	Smoke Gas	Daily							x				

Pos.	From	Material	Sampling Frequency	Litre weight	Free Lime	SO_3	Setting Time	Fineness: Blaine Surface	Fineness: Sieve residue	Fineness: Flour	Strength	Expansion: le Chat.	Expansion: Autoclave	Complete Analysis
8	Cooler	Clinker	Hourly	x	shift	daily								daily
9	Store	Gypsum	Occasional			x								
10	Finish Mill	Cement	Hourly		daily	daily	x	x	x	x	daily	daily	daily	daily
11	Packing	Cement	Daily		x	x	x	x	x	x	x	x	x	x

x determination on each sample

Chart VI.6-4

Central Laboratory — Floor Planning



[illegible] Summary of discussion

A number of questions relating to management and labour were discussed as well as laboratory tests and quality control.

In respect of management, the qualifications required of a works manager gave rise to some discussion. It was pointed out that while he must be knowledgeable regarding the technical as well as the financial implications of cement production, one of his most important qualifications is an innate ability to understand human relations and their management. With respect to the qualifications required in a developed, as compared with a developing, country, it was maintained that the basic elements would be the same, although, in a developing country, because of different conditions, the manager might have to carry greater power and responsibility, chiefly because of more limited opportunities to delegate power.

The problem of achieving horizontal co-ordination at different levels was also discussed and generally agreed to be one of the most difficult to solve. It was noted that solutions to this problem have been sought in a number of ways, including daily as well as periodic conferences of foremen, and similar gatherings for reviewing financial and production aspects, as well as the general condition of the plant, in relation to each department and to the cement plant as a whole. The "training within industry" (TWI) method was mentioned as one method of tackling this problem. Another approach that has been adopted in advanced countries is school training for foremen in organization and human problems for a period of two weeks in the first year, followed by one week in the following year. This method had proved very useful in solving managerial problems.

As regards labour relations, stress was laid on the differences between the developed and the developing countries, chiefly in respect of the relative scarcity of labour in the former, although emphasis was also placed on the scarcity of skilled labour in the latter and the abundance of unskilled labour. The question of job evaluation and its relation to the fixing of wage rates was also discussed, as being of particular interest to developing countries starting their first cement plant. In this connexion, it was pointed out that in a number of developing countries wage rates have been fixed by the governments. In connexion with job evaluation, reference was made to rate-fixing according to certain prescribed criteria such as skills and training, degree of responsibility, etc.. There was some discussion of the various problems and complications involved in this approach as regards labour organizations and state control.

The question of the arrangement of vacations in cases where the plant is designed to operate continuously was also discussed. It was noted that it has been solved in some plants by training extra men from the plant to hold continuous operation jobs and replace permanent crews during their vacations. In such cases, the stand-by crew would be paid at higher rates, equal to those of the crew they replaced while working as substitutes.

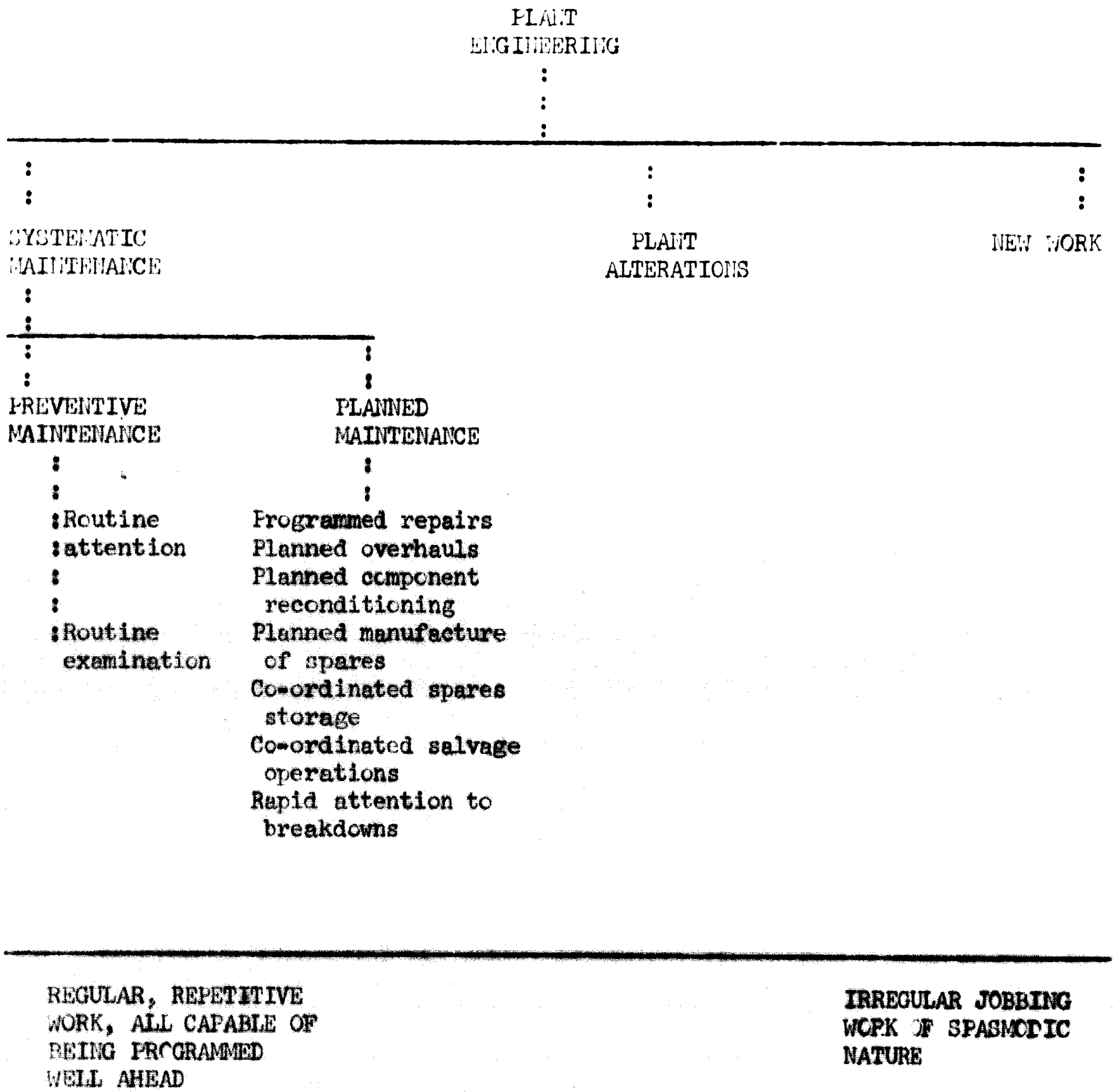
Questions relating to plant safety were discussed, and mention was made of health hazards resulting from dust, particularly in developing countries with dry climates. It was noted that periodical medical check-ups are being introduced, and that health problems may force the relocation of some workers. One preventive measure used in some plants was the introduction of masks.

The meeting discussed the problem of surplus labour in [illegible] developing countries at length, and it was noted that [illegible] developing countries have developed a surplus of labour [illegible] unskilled labour, which has to be retained as part of the [illegible] alleviating to some extent the unemployment problem [illegible]. [illegible] was noted that in one such country, cement plants have [illegible] to branch out into auxiliary labour-intensive activities, such as the [illegible] of cement blocks and concrete products.

The chemical composition and requirements of cement and methods for testing cement and concrete were also discussed. Tests of fineness, ignition loss, and insolubility were considered to be superfluous, in so far as the quality of cement in use is concerned. Two methods of testing were mentioned in connexion with the heat of hydration, the adiabatic method proper, and the heat of solution method. The former was agreed to be time-consuming and expensive, and it was suggested that the heat of solution method should be used instead, as being simpler and cheaper, although less accurate.

Chart VII.1-1

The functions of a Plant Maintenance Department



VII. MAINTENANCE AND EXPANSION[1]

1. Maintenance (K.V. Talcherkar)

The importance of plant maintenance cannot be over-emphasized. This is especially true of developing countries which may have experienced great initial difficulties in securing finance, foreign exchange, a suitable site and an imported plant, in order to start production. Failure to keep up full production because of the absence of good maintenance is particularly disappointing in such circumstances.

Good maintenance is not obtained automatically merely by having adequate staff, spares and stores. It has to be planned and executed in a well-organized manner.

The types of job handled by maintenance engineers can be classified under two main headings: plant alteration, or new work, and plant maintenance.

The lecture goes on to discuss the scope of each. For plant maintenance, three popular systems are in vogue: "lifting" maintenance, breakdown or haphazard maintenance, and systematic or "examining" maintenance, which can be further subdivided into preventive maintenance and planned maintenance.

The functions of a plant maintenance department are illustrated in Chart VII.1-1. The lecture examines these functions in detail, with illustrations drawn from the actual experience of cement factories in India. The importance of routine examination is also explained in detail. The full process consists of the drawing-up of detailed specifications, the routine examination itself, the systematic recording of the findings of the examination, and action on those findings as required. The lecture describes the type of personnel needed to carry out each stage of the process.

Table VII.1-1 shows a typical specification sheet, Table VII.1-2 shows a typical weekly programme of routine examination, and Table VII.1-3 is a typical examiner's report.

Maintaining collated reports on the different machinery units right from the start will eventually produce a very valuable record which can be extremely useful at a later stage when a systematic programme of machinery replacement is being planned. Similarly, persistent breakdowns and defects will show up clearly on the record. The particular unit involved can then be subjected to a further careful examination, leading perhaps to a change of design.

The introduction of such "examining" maintenance may lead to a sudden rise in maintenance costs at first, but in the long run it will prove substantially cheaper and more productive than the haphazard methods often used.

1/ The summary of the discussion of the contents of Chapter VII is incorporated in that of Chapter VIII.

Table VII.1-1

Specification Sheet

Works: "A"

Group: Mechanical Examiner

Plant Item: Crushed Limestone Conveyor

Spec.	Frequency	Details	Availability
M82/1A	Monthly	Record motor load in amps., Examine belt for cracks, tears or missing pieces at edges. Any other obvious defect seen without stopping conveyor. Do any repairs that take 15 mins. or less and need no material.	A
M82/1B	6 months Est 2-1/4 hrs.	As for M82/1A. Record any idlers not rotating. Feel idler bearings for overheating. Stop conveyor at convenient place and examine belt fastener for security.	B
M82/1C	Annual Est 14 hrs.	As for M82/1B, then stop conveyor. Lift top half of gearbox and examine condition of gears and bearings. Estimate residual life of V belts. Examine all idler lubricators to see they are not blocked. Measure belt tension (slack on idle side must not droop more than 1[illegible]" between idlers). If too much slack, cut portion of belt and rejoin.	C

Note: "Availability" means the conditions under which the examiner can carry out the inspection.

Availability "A" - Job which can be done at any time without stopping the machine.

" "B" - Job which can be done at any time without stopping the machine, but requiring the permission of the departmental head and perhaps a short stoppage not affecting production.

" "C" Job which will require prior planning and stoppage of the machinery unit. Normally it will be synchronized by the plant engineer with other similar jobs.

Table VII.1-2

Examiner's Weekly Programme

Name

Week ending

Spec. No.	Item	Availability	Time	P[illegible]
M 82/1B	Crushed L. Conveyor	B		
M 79/3A	Primary Crusher	A		
M 15/20	Limestone tub No. 10	C	Tuesday afternoon	
"	" 11	C		
"	" 12	C	"	
"	" 13	C	"	
"	" 14	C	"	
M/133/3B	O.H. Crane Workshop	A		
M/7/1A	No. 1 Kiln drive	A		
M 7/1A	No. 2 Kiln drive	A		
M 63/3C	Used bag stitching machine	C	Friday morning	

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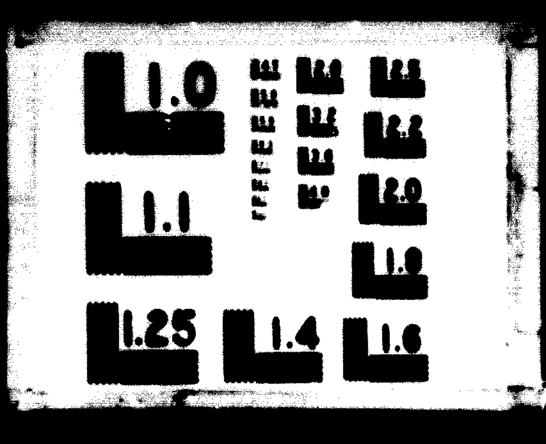


Table VII.1-3

Engineer's Report | Name | Date

Spec. No.	Item	Report	Office use only: Repair card	Office use only: Spares orders	Office use only: Plant history
1.M /1B	Crushed Limestone Conveyor	2 idlers seized, 4th and 5th from feed end.	Later	[illegible]	Yes
2.M70/3[illegible]	Primary Crusher	Primary drive guard loose.	173[illegible]	No	No
3.M15/2C	No. 10 Tub.	O.K.	-	-	-
4.M15/2C	No. 11 Tub.	Sole bar bent.	No	No	Note for annual overhaul
5.M15/2C	No. 12 Tub.	O.K.	-	-	-
6.M15/2C	No. 13 Tub.	Axle box badly worn.	No	8308	No
7.M15/2C	No. 14 Tub.	O.K.	-	-	-
8.M1133/3B	O.H. Crane Workshop	Long traverse wheel flanges wearing, whole crabbing.	Report to E.C.	No	Yes
9.M7/1A	No.1 Kiln Drive	O.K.	-	-	-
10.M7/1A	No.2 Kiln Drive	Gear box oil level very low.	17399	-	-
11.M63/3C	Used bag stitching Machine.	Tensioners out of use. Repaired.	No	No	Yes

2. Modernization of Old Plants (K.V. Talcherkar)

A stage is reached in the life of any industrial concern at which, [illegible] either to technological changes that have taken place since its establishment or simply to wear and tear, the plant ceases to be economic and modernization becomes necessary in order to improve productivity and face competition from other more modern and efficient factories.

If the move to modernize is prompted by technological advances, the stage may occur even before the economic life of the plant has run out. In the case of the cement industry, however, the end product, Portland cement, has remained unchanged for decades, and the need for modernization usually arises out of the deterioration of the old machinery to a point at which it becomes uneconomic to spend any more money on repairs. Modern cement-making plants are far more efficient than their old counterparts and the replacement of the latter invariably results in increased productivity, reduced costs, and larger profit margins.

The useful life of a cement plant is often assessed at thirty years, if kept in good repair. By and large, however, it is safe to assume that a plant installed twenty to twenty-five years ago is in need of modernization, and a progressive concern will plan for this as part of its long-term programme.

A modernization programme usually presents the following main problems: the question of financing the programme, loss of production during its execution, and technical problems connected with the co-ordination of old and new units.

Raising funds for plant modernization is not easy; the cost of such a project may be from four to eight times larger than the original cost of the units to be replaced. Such large capital expenditure cannot normally be covered by the statutory depreciation funds set aside for the purpose on the basis of the original block value. Most Indian industries have had to face this problem during the post-war period of inflation. For some time past, the Government of India has accepted the principle of allowing a separate rehabilitation fund to be set aside from profits before tax.

In spite of this marginal assistance, the cement industry has had to use large amounts from its reserves and/or profits. In one case such utilization of reserves became the issue of a dispute with a cement works labour union which contended that the additional profit should have been dispensed to them as an extra bonus. The case was fought right up to the Supre Court before the company's contention was upheld, and then only after volumes of evidence had been submitted by experts regarding the increased replacement costs of machinery, equipment and buildings.

In order to distribute the capital expenditure over a larger production, major modernization and rehabilitation projects are usually undertaken side by side with the extension of old plants. One of the most common reasons for reluctance on the part of cement factory owners or company directors to engage in modernization schemes is the fear of inevitable losses of production during their execution which will add to the already high capital expenditure involved. Engineering ingenuity and skilful planning can reduce these losses to a minimum but the best way of eliminating them is to carry out plant extension schemes side by side with modernization.

[illegible] layout. The [illegible] completely retained until [illegible] ready [illegible]. Wet-process [illegible] very often [illegible] production [illegible]. Increased [illegible] efficiency and [illegible] [illegible] by more efficient air-quenched [illegible].

There has been a recent trend in Western Europe and the United States towards modernizing the old wet-process long kilns by converting them to short dry-process kilns. Such conversions are particularly suitable for suspension-type pre-heaters, since the entire vertical structure, including the cyclonic pre-heaters, can be erected before the kiln is cut off. Spectacular increases in production, in many cases 50 to 70 per cent, have been obtained from such converted kilns, with the added advantage of greatly improved efficiency as regards fuel.

Improved plant layouts which will contribute to higher productivity and lower labour costs should be introduced whenever space permits.

The technical and operational problems that are encountered during the execution of such modernization schemes are, of course, colossal. They tax the ingenuity of the engineers and operational staff to the outmost, for the management always expects the work to be carried out with the least possible interruption of production. The time taken to complete such jobs is usually longer than to erect a new plant or to extend a new plant when plans have already been made for the extension in the initial stages.

In India, some of the cement works commissioned over forty years ago have been modernized and extended to five times their original capacity. Table VII.2-1 reproduces figures from the actual records of three Indian cement works, to illustrate what well-planned programmes of modernization and expansion (possible carried out in stages) can achieve in terms of all-round improvement of productivity. The large reduction in manpower was due essentially to the replacement of the old manual quarry operations by complete mechanization. The retrenchment was made as painless as possible for the workers by offering them attractive benefits under a voluntary retirement scheme.

[illegible] VII. -1

Incr[illegible]

Works:	[illegible]	B	C
Original annual capacity in tons	500,000	[illegible],000	[illegible],000
Modernized and extended capacity in tons	580,000	500,000	4[illegible],000
Manpower			
before	2,300	1,400	1,[illegible]00
after	1,600	1,500	[illegible]86
Man hours/ton			
before	21.80	17.60	[illegible]4.50
after	9.44	8.36	10.80
Power consumption/ton			
before	133 units/ton	110	12[illegible]
after	106 " "	93	98

VIII. MARKETING PORTLAND CEMENT

1. Marketing and Distribution (C.A. Bang Petersen)

Since marketing and distribution are more suited to discussion without an introductory lecture than most of the other subjects dealt with by the seminar, the lecturer confines himself to suggesting topics for group and panel discussion.

Portland cement works can sell directly to consumers, or through distributors keeping stocks of cement, or through a combination of the two methods. Direct sale would be ex-works only, with consumers coming with their own lorries to pick up the cement. Credit systems or arrangements might also be discussed.

In connexion with the holding of stocks of cement by distributors, the meeting might discuss technical requirements for stock sheds, bearing in mind tropical conditions. Another point of interest might be the quality of the bags (jute, paper, plastic), the ply of paper used and the price of bags. The export of cement is a related point.

An interesting question for discussion is the sale of cement in bulk versus cement in bags. In Denmark, cement in bulk is distributed in specially built silo lorries, which belong to the cement works. Within a certain distance from the distribution centre, PC is delivered at a price which includes transport and pumping to the consumer's silo. In Copenhagen, this distance is 5 km., in other towns about 10 km. Outside this inner zone, there are several other zones, the distance between the limits progressing from 5 to 10 km. The price rises at a rate of 1-1 1/2 kr. per ton per 10 km. increased distance. In Scandinavia, the maximum distance in practice is about 100-150 km. Above that, two persons are needed on the lorry, or overtime will have to be worked, so costs increase. Consequently, in cases of great distances there is an extra charge. There is also an extra charge on lots of less than 5 tons, of about 10 kr. per ton. This is to encourage the customers to provide the necessary silo capacity for receiving greater quantities of cement with each shipment. For purposes of comparison, the cost of PC in bulk within the inner zone can be taken to be about 4 to 5 per cent less than in bags. The cost of transporting PC in bags is very cheap in Denmark because the cement is usually hauled as a return cargo. A price of 17-20 kr. per ton per 250-300 km. can be mentioned as an example.

Another point is whether the silo lorries should belong to the cement company, to the consumer, or to an independent transport firm. The saving on bags may pay for the rather expensive silo lorries, or part of it may be used to reduce the selling price. Very often, the technical and practical advantages of receiving cement in bulk are so important that consumers are prepared to accept the same price for cement in bulk as for bagged cement. It has been calculated that the cost of concrete production at a construction site is about 10 kr. less using bulk cement than using packed cement.

The cement may be brought to the distribution centre either by rail or by ship. In Denmark, the cost of shipping bulk cement may amount to approximately 15 kr. per ton, including depreciation on the ship.

Bulk cement is mainly supplied to major consumers or to movable silos for construction sites. Another interesting point is whether the construction site silos should be owned by the cement works or whether they should belong to the contractors.

Bulk cement can be sent by rail or by ship to distributing centres, where the bulk cement is either packed in bags or distributed in silo lorries. The Danish cement works have two vessels of about 1,000 tons loading capacity, sailing between Aalborg and Copenhagen, and two other Danish towns. The cement is unloaded either by compressed-air transporting systems or by screw conveyors. In the most recent installation, the cement is lifted about 20 metres by a screw conveyor to the top of the silos. It is especially important in view of the short sailing distances in Denmark, that unloading should be carried out as fast as possible in order to obtain the best possible utilization of the ship.

When compared to clinker mills, a distribution centre for cement has the advantage of not needing technical supervision. In the developing countries, bulk may not yet play an important in the distribution of Portland cement, but it might be considered as a future development.

Statistical information on cement sales and on the requirements of the various groups of consumers are of importance in projecting future sales of cement. The amount of information that the sales statistics should give might usefully be discussed.

Major consumers of cement include asbestos cement works, concrete products plants, ready-mix concrete stations, and, very often, large construction projects, such as dams, etc. Some of these consumers may require special cement, with regard either to physical or chemical properties or with regard to both. It will often be convenient and practical to arrange for special methods of shipment to such consumers, for instance by pipelines if they are close to the works, and by special railway waggons or containers if they are far away.

The advantages and disadvantages to the cement works of the sale of a considerable percentage of the output to such clients should be discussed.

2. The Service Laboratory (K.E.C. Nielsen)

The purpose of a service laboratory is primarily to serve cement users by carrying out routine testing in connexion with the production of concrete, and secondarily to serve cement producers by testing of cement in concrete. (Chart VIII.2-1)

Routine testing for cement users comprises the testing of aggregates (grading, impurities and specific properties of aggregates, as, for instance, specific weight, porosity and durability), the working out of mix proportions and the testing of concrete test specimens sent in from the building sites (testing of strength, permeability and other properties). As such testing is rather costly and does not give very much information about the cement market, it should be restricted as much as possible. On the other hand, such laboratory service is highly appreciated by the users, because it needs special equipment and specially trained people, which most building enterprises do not possess. Therefore, laboratory service has

Chart VIII.2-1

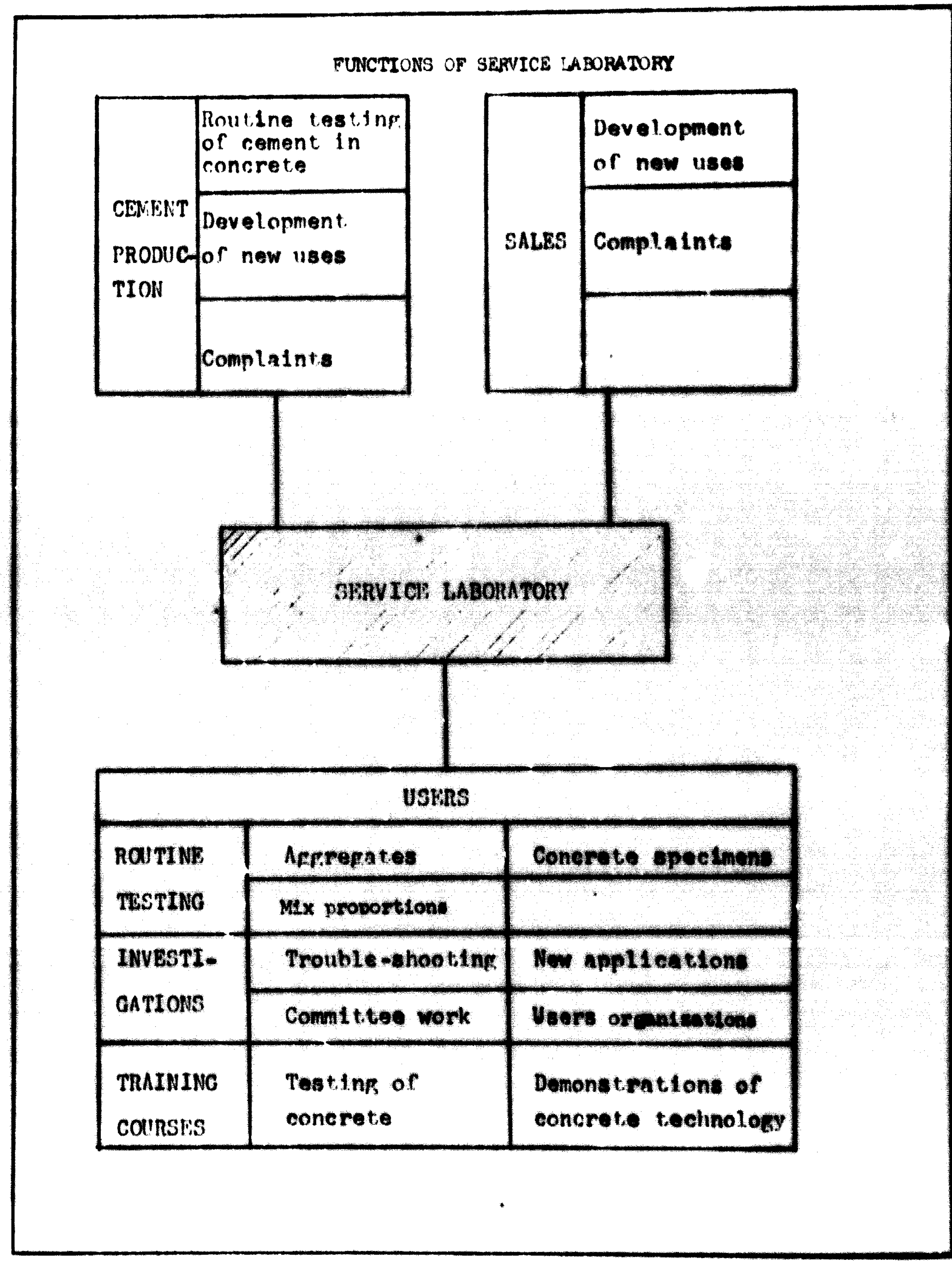
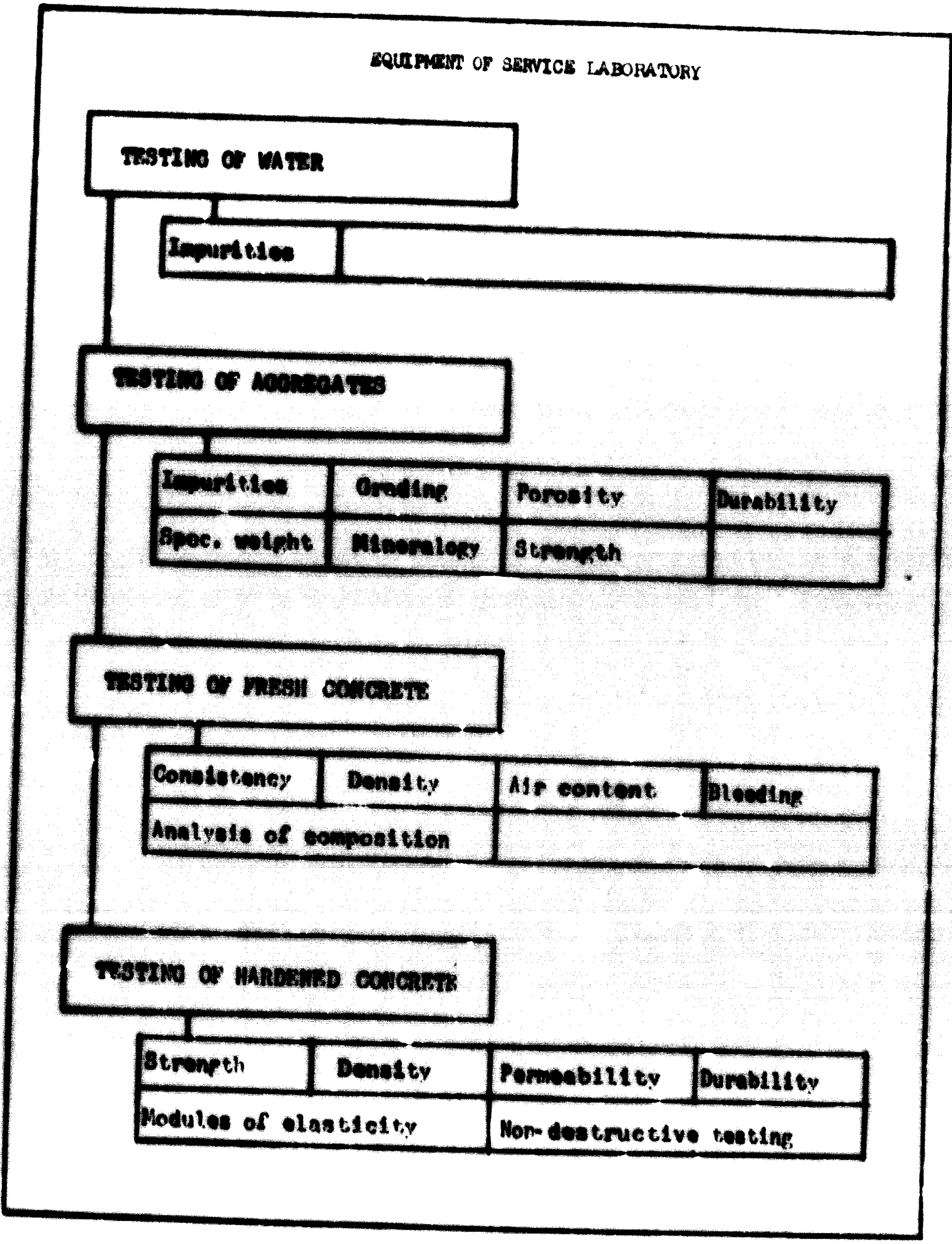


Chart VIII.2-2



high practical value, especially in countries where a concrete industry is starting up, and where there is no official or private testing institute. This applies whether the cement users are offered the service free of charge or whether they have to pay a reasonable fee. Since such testing for cement users may bring up the question of the responsibility of the industry for the advice given more clearly than is the case with other kinds of technical service, it is recommended that it should be clearly stated that the cement industry assumes no responsibility for the results or consequences of such testing. Testing which serves as an official approval of concrete should preferably be done by official testing laboratories.

The laboratories of cement factories are normally only equipped and staffed for testing and investigations relating to the production and control of cement. This means that a technical service laboratory, which is specially equipped and staffed to test concrete, should be able to serve the PC industry internally by means of special testing and investigation of the properties of cement in concrete, in connexion, for example, with complaints or with the development of new types of cement.

Depending on its qualitative and quantitative standards, the service laboratory could undertake real research projects put forward by the PC industry or by the cement consumers. It is recommended, however, that a special organization should be established if it is found necessary to undertake more extensive and fundamental research into concrete, because such research needs other equipment and staffing and has other relations with the users of PC than the technical service laboratory.

A technical service laboratory, well equipped and well staffed, will, however, in the absence of a real concrete research laboratory, be able to undertake simpler research projects (trouble-shooting) of great immediate value to cement users (problems on sites, problems in the precast concrete industry and problems connected with committee work).

Since an essential part of education in concrete technology consists of training in the testing of concrete materials and fresh and hardened concrete, and includes demonstrations of the different steps in concrete production, a service laboratory can be of great value in this connexion. Such activities must be taken into consideration when planning the service laboratory, however, because of special requirements with regard to space and equipment.

It is not possible to give any general rules for the size of a service laboratory. It depends very much on the extent of the service to be given and the possibilities for collaboration with the cement factory laboratory and official or private testing laboratories. The minimum equipment will be that needed for the routine testing of aggregates and fresh and hardened concrete, and the minimum staff will be about three people, one of whom must be highly qualified in concrete technology and testing in general. The cost of the minimum equipment will be about $15,000. (Chart VIII.2-2)

Technical Service (K. [illegible])

Technical service for the users of PC [illegible] on the field use of cement and the technology of [illegible] limited to problems connected with the batching, mixing, placing [illegible] concrete [illegible], but it often includes formwork, constructional problems [illegible] of reinforced concrete and architectural design.

[illegible]ervice can be restricted to the real user (the man who buys the cement [illegible] on the job), but in most cases it includes any persons and organizations engaged in the building industry (builders, architects, consulting engineers, contractors, craftsmen, workers, authorities, teachers and committees working [illegible] codes of practice, standards, recommendations, etc.).

The purpose of a PC industry's technical service for users is simply to promote the use of cement. This can be done through service to users when necessary to ensure that the concrete product or concrete structure will have the proper qualities at a competitive price, or when new kinds of uses are to be introduced.

Technical service to users is a valuable source of information about the cement market. This information must be fed back to the industry's sales and production departments as part of their market information. This important function of a technical service department should be taken into consideration in planning such a department, and the internal information system, comprising production, sales and technical service, should be so arranged that this feed-back works properly.

Technical service should be based on a high level of knowledge about the use of cement (concrete technology). New knowledge must be collected continuously through literature (periodicals, books, research reports, brochures, pamphlets etc.) and through participation in congresses, symposia, courses and committee work. Adjacent fields of interest and competitive materials must also be watched. New information must be filed and stored (library) in such a way that it can be found easily (information retrieval).

Technical service can be given on request (inquiry service over the phone or by letter, visits to building sites and concrete factories, and laboratory service comprising the testing of aggregates, the working out of mix proportions and the testing of concrete specimens from building sites) or unsolicited in the form of publications (articles in own or foreign publications, brochures, etc.), training courses (own arrangements or support to courses arranged by others), lectures (own arrangements or given to societies and associations) and the arrangement of visits to outstanding concrete works. Participation in official committee work is another means of distributing knowledge, and at the same time it may provide an opportunity to exercise a certain influence on new official standards, recommendations, etc., and to collect valuable information for the PC industry.

The policy of a technical service department must be such as to give users of cement confidence in the information they obtain. Hence, the information must be objective and completely free from any kind of sales talk. It is very important that inquiries from and assistance to individual users should be treated in strict confidence. The technical service department should not be connected with advertising for cement and other materials for concrete, except by serving the advertising department internally within the industry. In the same way, the technical service department should not deal with complaints regarding cement, except by serving the sales department and production department internally.

The staff of a technical service department should be of a high moral and technical standard. It is important that the manager at least should be highly estimated by the building industry and the authorities. At the same time, the staff should comprise members who are familiar with and able to deal with the many practical problems that may arise on building sites and in factories.

The costs of technical service vary very much from country to country, and it is not possible to give a general figure which will be valid in a country where a new IC industry is starting up. The costs in most Western European countries and in the United States are in the order of 0.5 to 1 per cent of the sales value of the cement produced.

4. Summary of Discussion

During the discussions on the subjects covered by Chapters VII and VIII many questions were raised, including bulk versus bagged cement, weight and material of bags, transport and storage problems, vertical integration of the cement industry and price policy.

The main advantages of bulk cement were agreed to be savings on bags, lower labour requirements, and simplicity of use. However, the silo trucks needed to transport it are rather expensive and can seldom take advantage of return freight as is sometimes the case with regular trucks transporting bagged cement. As far as the developing countries are concerned, it was emphasized that the most important factor might be savings on bags since that also implied savings in foreign exchange. The cost of bags may sometimes amount to 12 per cent of the total cost of cement in these countries. As regards the transportation of bulk cement, it was noted that it is generally preferable for the producers to own the transport fleet and silos at the start as a means of promotion. Only then can they exercise the necessary control over the quality of the cement at the early stages. When bulk distribution is on a large scale, it is impractical for the producer to own all the silos required. Another important advantage of bulk transport is the flexibility it adds to the mixing of concrete, making the size of the batch independent of the unit weight of bags. It was noted that ordinary means of transport, such as closed railroad cars, have been tried for the transportation of bulk cement, but the use of specially designed equipment was strongly recommended.

It was mentioned that, in Denmark, transportation of bulk cement is generally more economical up to a distance of 100 km. with the load carried amounting to 20 tons. For a 5-ton load the distance would, however, be reduced to only 25 km. Pneumatic transportation can only be used over very short distances, since the power consumption for compressed air is high.

It is generally safer to store cement in silos than in bags. A storage period of up to six months in silos and three months in bags has no effect on the quality.

As far as the size of storage silos at distribution centres is concerned, it was recommended that silos should be designed to cover at least one and preferably two days' consumption.

With regard to storage facilities to meet variations in demand, it was stressed that investment in the provision of excess production capacity is generally more feasible than investment in storage.

On the question of bag materials it was noted that plastics, such as polyethylene, could be used advantageously as coatings or linings but not for the bag proper. Difficulties had been caused by the trapping of air during the filling of plastic bags.

The vertical integration of a cement industry with a consuming industry may be desirable as a means of promoting the use of cement, but it may also have adverse effects on sales to competing consumers of cement.

Price discounts are generally practised when the consumer is actually doing a service to the producer, such as taking certain risks, doing promotional work, etc., which would otherwise have to be done by the producer.

It was agreed that a centralized technical service would be advantageous in countries with several producers. There was some discussion of the objectivity of technical service in connexion with the question of whether such technical service should be provided by the government, the producers or a combination of the two. The participants mentioned a number of examples, drawing on their experience. In this connexion, stress was laid on the importance of exchanging experiences of technical service at the international level.

Comparisons were made of the cost per ton of cement of technical service in various countries, and it was found that the cost was generally in the range of 1 per cent of the sale value of the cement. Attention was drawn to the difficulty involved in international comparison owing to variations in the activities included in technical service in each case.

Mention was made of advantages and problems connected with the production and sale of sand cement and masonry cement. Qualities comparable to those of ordinary cement are obtainable in sand cement and it may be applied in several cases where early strength is of minor importance. It was emphasized that users of sand cement should be informed of its special characteristics. In this connexion, it was noted that the cement content of concrete is often unnecessarily high. The properties and production of masonry cement were also discussed, in connexion with sand cement.

Attention was drawn to the prospect of using cement in soil stabilization and it was noted that in the developing countries especially, where there is a great expansion potential for roads, this use may be an important outlet for cement.

With respect to maintenance, there was some discussion of the question of producing spare parts locally on the basis of drawings made available by the suppliers of the equipment. It was pointed out that suppliers were generally reluctant to provide drawings because of the high cost involved in the development and design of the machinery. Licence arrangements were mentioned as a possibility.

ANNEXES

ANNEX I. PROGRAMME OF THE SEMINAR

[illegible] May		Arrival and Registration
4 May, Monday		
9.00	0.1	Introduction by the Director
10.00	0.2	Opening Ceremony Statements by: Prof. P. Nyboe Andersen Mr. Lars [illegible], United Nations Co-director Mr. C.A. Bang Petersen, Director
		1. The Product: Portland Cement (PC)
11.15	1.1	The History of Portland Cement (Prof., Dr. A.H.M. Andreasen)
		2. The PC Industry
14.00	2.1	Statistical Information on PC (Mr. T. Ehlers)
15.00	2.2	Trade in PC, Transport Problems (Mr. A. Mouritzen)
16.10	2.3	The PC Industry (Mr. C.A. Bang Petersen)
17.00	2.4	Building Activity and the PC Industry (Mr. I.A. Iliuschenko)
19.00		Informal Opening Dinner
5 May, Tuesday		
		3. Fundamentals of a PC Industry
9.00	3.1	Technical Conditions (Dr. Jón E. Vestdal)
10.00	3.3	Financial Assumptions (Mr. S.A. Kock-Petersen)
11.00		2-3 Discussions in Groups
14.00		2-3 Discussions in Groups (continued)
15.40		Reports on group discussions (Plenary Meeting)
16.00		Panel

6 May, Wednesday

		4. Basic Investigations	
9.00	4.1	Raw materials	([illegible])
10.00	4.2	Power Supply	(Mr. [illegible])
11.00	4.4	Types of Production Processes	(Mr. [illegible])
12.30		Lunch	
14.00	4.3	Location	(Mr. K.V. Talcherkar)
14.30	4.5	Modernization of Old Plants	(Mr. K.V. Talcherkar)
15.00	4.6	Financial Considerations	(Mr. K.V. Talcherkar)
15.30		Tea/Coffee	
15.45		4. Group Discussions	
18.00		Dinner	
20.00		Mr. C. Christiansen, Danish Foreign Office: Denmark's Help to the Developing Countries	

7 May, Thursday

		5. Studies Prior to Ordering	
9.00	5.2	Placing of Order	(Mr. E. Cugnard)
10.00	5.3	Guarantee and Starting-up	(Mr. U.H. Bauditz)
11.00	5.1	Relationship to suppliers	(Mr. K.V. Talcherkar)
11.30		5. Discussions in Groups	
12.30		Lunch	
14.00		5. Discussions in Groups (continued)	
15.20		Tea/Coffee	
15.40		4-5. Reports on Group Discussions (Plenary Meeting)	
16.00		Panel Meeting	
18.00		Dinner	

[illegible]

[illegible]. [illegible]

[illegible]		[illegible] of Order	(Mr. [illegible])
[illegible]		Local Organisation at site	(Mr. H. Winther)
1[illegible]		Excursion: Departure for prefabricated building elements factory, Larsen and Nielsen Constructor A/S at Glostrup	
		Individual Dinner in Copenhagen	
[illegible]3.30		Bus Departure from Copenhagen (free of charge)	

9 May, Saturday

		7. The Details of the Project	
8.00	7.1	Production Equipment	(Mr. A. Bellwinkel)
9.00	7.1	Production Equipment (continued)	
10.00		Questions ad 7.1	
approx. 10.40		Bus to Copenhagen	
Afternoon and evening		No programme	

10 May, Sunday

10.00	Sightseeing Tour	
	Guided visit to Frederiksborg Castle at Hillerød	
	Lunch at Marienlyst (included)	
	Guided visit to Kronborg Castle at Helsingør (Elsinore)	
approx. 16.00	Bus returning to Krogerup	
approx. 16.05	Bus departure for Copenhagen	

11 May, Monday		The Details of the Project	
8.30	7.2	Quarry Equipment	([illegible])
9.30	7.3	Electrical Equipment	(V. [illegible])
10.30	7.4	Civil Engineering Work	(K. [illegible])
11.30	8.1	The Site	(Mr. H. [illegible])
12.30		Lunch	
14.00		6-7-8.1 Discussions in Groups	
15.00		Tea	
15.20		Reports on Group Discussions (Plenary Meeting)	
15.40		Panel	
19.30		Film programme	
		(a) 19.30 Film on the construction period at Karlstrup	
		(b) 20.00 Horse on Holiday (Sightseeing in Denmark)	
		(c) 20.40 Film on transport of equipment for PC works	

12 May, Tuesday		Excursion
8.00		Bus departure
9.00		Visit to Quarry
9.30	8.2	**Lecture at Karlstrup:** Opening-up of Quarry
10.30		Visit to PC Works
12.00		Lunch at PC Works
13.00		Departure for:
13.30		Visit to Betonvarefabrikken "Sjælland A/S" (concrete production plant)
15.00		Departure for Copenhagen
15.45		Visit to Cement Machinery Workshop (Valby Maskinfabrik og Jernstøberi)
		Visit to Messrs. F.L. Smidth and Co. A/S

12 May, Tuesday (continued)		
18.[illegible]	Dinner at Restaurant, Zoological Gardens	
21.[illegible]	Bus to Krogerup	
13 May, Wednesday	9. Operation of a PC plant	
8.30 9.1	Factory Management	(Mr. A. Schønnemann)
9.30 9.2	The Works' Manager's Tasks	(Mr. A. Schønnemann)
	10. Production Control	
10.30 10.1	Quality Specifications	(Mr. P. Håkanson)
11.30 10.2	Control Laboratory (Brief Survey)	(read by C.A. Bang Petersen)
14.00	9-10 - Discussions in groups	
15.20	9-10 - Reports on group discussions (Plenary Meeting)	
15.00	9-10 - Panel	
14 May, Thursday	14. Maintenance and Expansion	
8.30 14.1-2	Maintenance and Expansion	(Mr. K.V. Talcherkar)
	12. Management of PC Works	
9.30 12.1	Management of the Concern	(Mr. B. Nielsen)
10.30 12.2	Stock Accounts	(Mr. F. Møller)
	11. Marketing	
11.30 11.1-2	Marketing and Distribution, Major Consumers - Brief Survey by C.A. Bang Petersen	
14.00	11-12 + 14 - Discussions in Groups	
15.40	11-12 - Reports on Group + 14 - Discussions - Plenary Meeting	
16.00	Panel	

15 May, Friday	13. Technical Service for Users of [illegible]	
8.[illegible]-9.30	13.1-13.2 - Technical Service The Service Laboratory	(Mr. [illegible])
10.15	Address by the Commissioner for Industrial Development, Mr. I. Abdul Rahman, followed by a Press Conference	
14.00	Discussions in Groups	
15.40	Reports on Group Discussions (Plenary Meeting)	
16.00	Panel	
16.30	1 - 14 - Panel	
17.00	Summing-up and Closing Session	
19.00	Closing Dinner	
16 May, Saturday	**D e p a r t u r e**	

[illegible] 1. [illegible] OF [illegible]

1. [illegible]

[illegible]	[illegible]	[illegible]	ADDRESS
AFGHANISTAN	[illegible], G.H.	General Director, Economic Dept.	Ministry of Mines and Industries, Afghanistan
AFGHANISTAN	Y[illegible], Sultan M.	Director, Plan and Project Dept.	Ministry of Mines and Industries, Afghanistan
ARGENTINA	Lessing, J.A.	President, Argentine Cement Association	Bartolome Mitre 226, Buenos Aires
CEYLON	Ponnamperuma, George	General Manager	Ceylon Cement Corp., P.O. Box 1382, Colombo, Ceylon
CEYLON	Poologasundram, Dr. K.	Designs and Research Engineer	Ceylon Cement Corp., P.O. Box 1382, Colombo, Ceylon
CHILE	Pinedo, R.	Cement Factory Manager	Empresas Industriales El Melon S.A., Casila 50, La Calera, Chile
COLOMBIA	Martinez, Anjel C.	Assistant Manager	Cementos Diamante S.A., CRA.10 nr.14.33, Floor 15, Bogotá, Colombia
DAHOMEY	Olory-Togbe, G.	Director	Service des Mines et de la Géologie, Cotonou, Dahomey
ECUADOR	Carrera de la Torre, L.H.	Engineer (Planning)	Caja de Riego Riofrio 314, Quito, Ecuador
ECUADOR	Paez, R.C.	Chief (Planning Division)	National Planning Board Quito, Ecuador
EL SALVADOR	Piche, [illegible]	Head of Planning Department	Instituto de Vivienda Urbana Centro Urbano Libertad, San Salvador

COUNTRY	NAME	POSITION	[illegible]
INDIA	Varma, S.I.	Industrial Advi[illegible] Government [illegible] India	[illegible] Bhav[illegible], N[illegible]
INDONESIA	Nirwhono, L.	Director State Enterprise for Industrial Project Engineering and Construction	Dept. [illegible] Industry, /Mini[illegible], Djak[illegible]
INDONESIA	Ardjanggi, S.	Director	Gresik Cement State Enterprise, Gresik, Java, Indonesia
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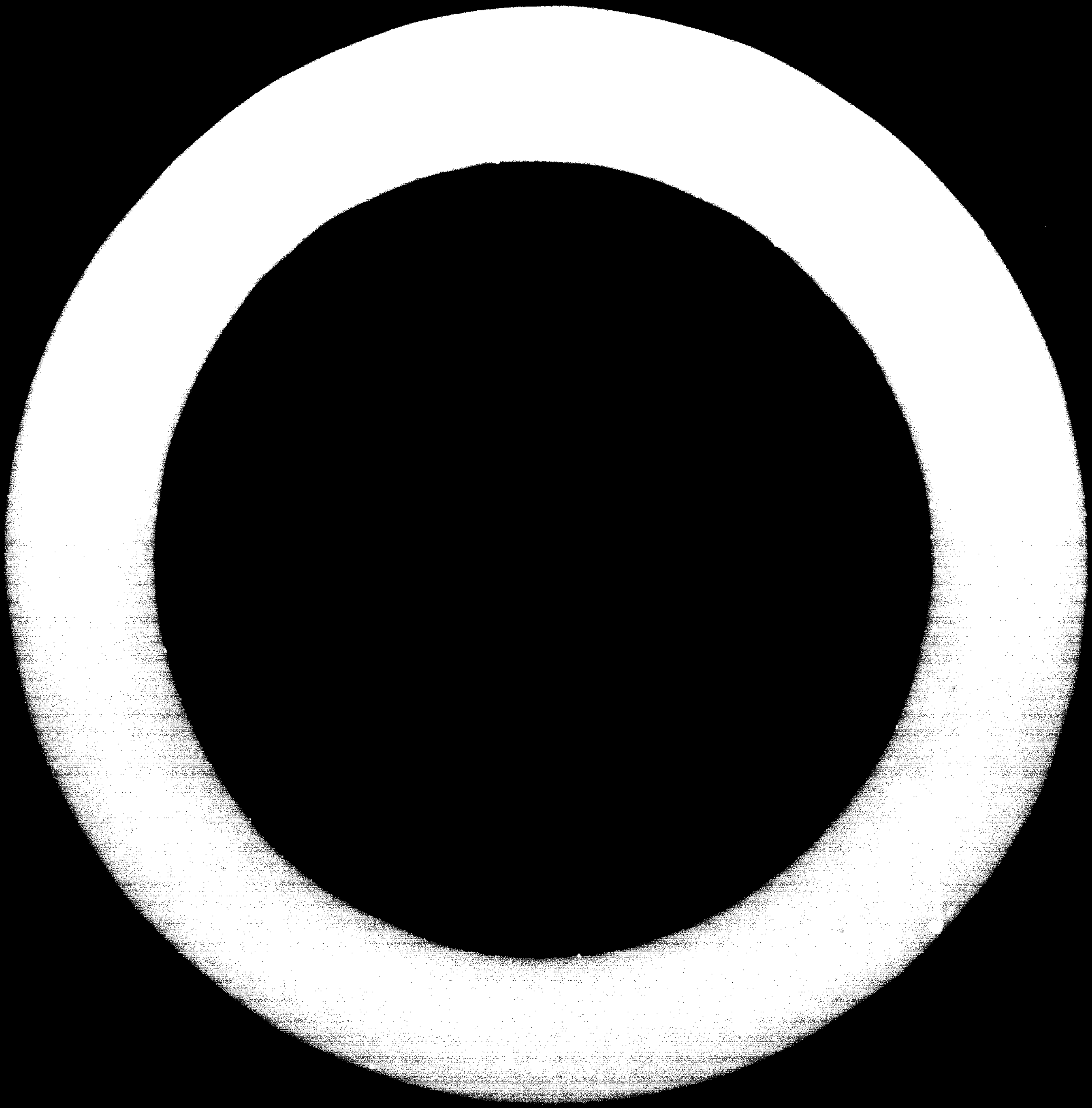

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