## V-6 Financial Conditions of the Cement Plant

### V-6-1 History

The Marinduque Mining Industrial Corporation (MMIC) have been manufacturing copper, nickel and cement from 1949. However, MMIC transferred the cement division to the Development Bank of the Philippines (DBP) and the Philippine National Bank (PNB) due to the depression mainly in nickel business.

Island Cement Corporation (ICC) was acquired from DBP/PNB and was incorporated on October 18, 1984.
The paid-up capital as of December, 1984 is 15 million Pesos (The authorized capital is 20 million Pesos) and the share of DBP/PNB is 57% and 43% respectively.

ICC started commercial operation on January 28, 1985, and all costs and expenses related to plant preparation from September 1, 1984 to December 31, 1984 were deferred as preoperating expenses (39,362 thousands Pesos).
For reference, the change of MMIC's operation is summarized in Table 5-6-1.

Table 5-6-1 MMIC's Operation

(million Pesos)

| Year | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|
| Sales revenue | 1,648 | 2,102 | 1,610 | 1,462 | 1,671 |
| Profit (Loss) | 165 | (274) | (899) | (1,958) | (4,305) |

(Source: Annual Report of MMIC)

V-6-2 Cement Production and Sales Volume

Table 5-6-2 and Figure 5-6-1 shows the changes in volume of cement production and cement sales.
The volume of cement production and sales decreased from 1982.

Table 5-6-2 Cement Production and Sales

(ton)

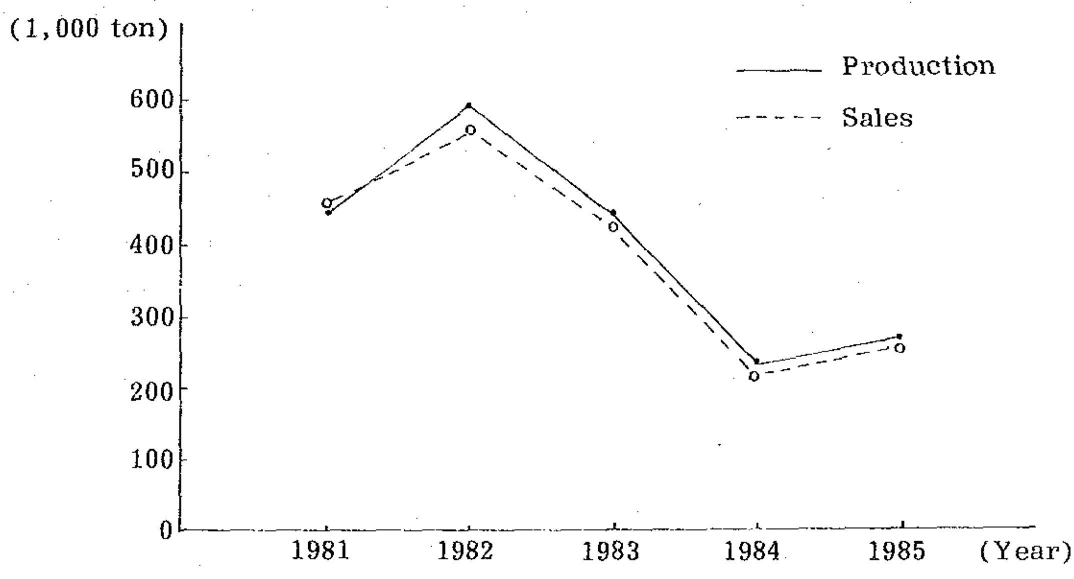
| Year | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| Cement production | 442,110 | 592,213 | 436,288 | 227,603 | 261,664 |
| Cement sales | 444,064 | 557,093 | 427,582 | 219,180 | 261,243 |

(Source: PHILCEMCOR)

Note 1 : The volume in 1981∿1984 is record by MMIC.

Note 2 : The volume in 1985 is for 11 months (Jan. - Nov.).

Fig. 5-6-1 Cement Production and Sales



## V-6-3 Sales Revenue and Profit

ICC was incorporated on October 18, 1984 and commercial operation was started on January 28, 1985.
Since the financial statement for the period ended December 31, 1985 is under preparation, Table 5-6-3 shows the monthly financial statement for 10 months ended November, 1985.

As shown in Table 5-6-3, in spite of average monthly sales revenue of 23 million Pesos, the net loss per month is nearly 6.3 million Pesos. The cumulative net loss for the year 1985 ended November is about 77.5 million Pesos, and the cumulative net loss after establishment reached 108 million Pesos.

The average production cost in 1985 is about 46.2 Peso/bag, while the ceiling price (ex-factory price) set up by the governmental authority is 42.5 Peso/bag.
The percentage of electricity cost and fuel cost in production cost is very big, and the total reaches approx. 52% of production cost (24.3 Peso/bag).
The depreciation cost of 9.2 Peso/bag (approx. 20% of production cost) also affects the profit of ICC.

On the other hand, ICC already considered the countermeasure to decrease the fuel cost by converting the fuel from oil to coal.
Since 20 years have passed since the establishment of 2 kilns, the increase of repair expenses and the shortage of spare parts may affect plant operation.
These problems will be difficult to solve through ordinary effort by management.

Considering the above, the renovation to decrease production cost, especially electricity cost and fuel cost, and efforts to expand cement market in order to raise operation rate are most advisable to improve ICC's financial position.

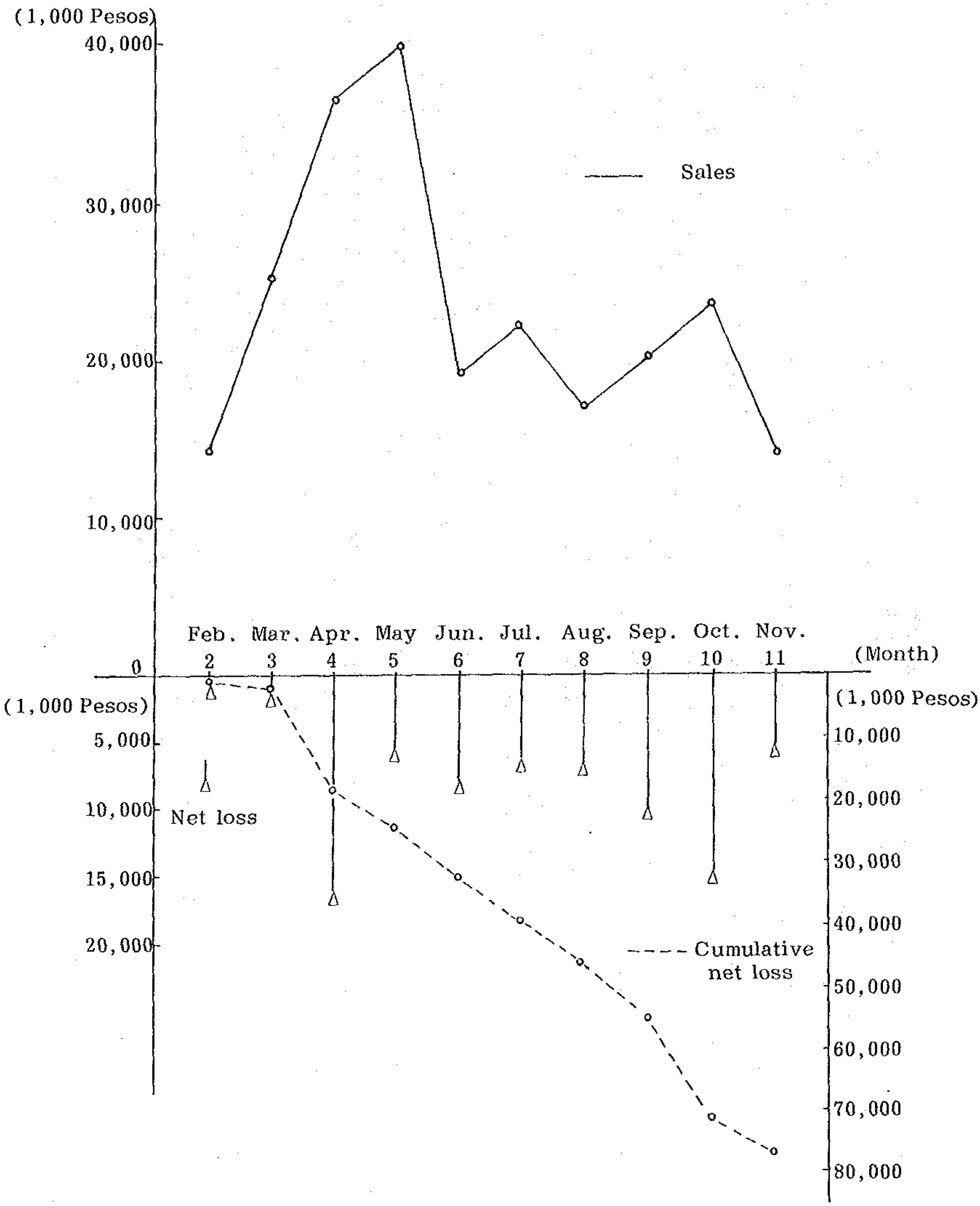
Table 5-6-3 Monthly Statement of Income
(Feb. ~ Nov., 1985)

(1,000 Pesos)

| Month | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sales revenue | 14,214 | 25,391 | 36,592 | 39,702 | 19,232 | 22,206 | 17,082 | 20,298 | 23,692 | 14,236 | 232,644 |
| Cost of sales | Δ12,807 | Δ24,228 | Δ35,497 | Δ37,530 | Δ18,419 | Δ23,292 | Δ18,203 | Δ20,836 | Δ22,770 | Δ14,356 | Δ226,941 |
| Operating income | 1,407 | 1,163 | 1,095 | 2,172 | 813 | Δ1,086 | Δ1,121 | Δ538 | 922 | Δ120 | 5,703 |
| Operating expenses | Δ290 | Δ450 | Δ882 | Δ818 | Δ642 | Δ1,414 | Δ418 | Δ572 | Δ712 | Δ260 | Δ6,252 |
| Depreciation etc. | Δ1,982 | Δ1,982 | Δ16,604 | Δ7,278 | Δ8,501 | Δ4,102 | Δ4,657 | Δ4,008 | Δ5,504 | Δ5,155 | Δ61,182 |
| Operating loss | Δ865 | Δ1,269 | Δ16,391 | Δ5,924 | Δ8,330 | Δ6,602 | Δ6,196 | Δ5,118 | Δ5,294 | Δ5,535 | Δ61,731 |
| Other income | 107 | 52 | 42 | 17 | 52 | 204 | 94 | 90 | 141 | 105 | 888 |
| Other expenses | 0 | Δ23 | Δ23 | Δ168 | 0 | 0 | Δ449 | Δ467 | Δ724 | Δ523 | Δ2,378 |
| Net loss | Δ758 | Δ1,240 | Δ16,372 | Δ6,075 | Δ8,278 | Δ6,398 | Δ6,551 | Δ5,495 | Δ5,877 | Δ5,953 | Δ63,221 |
| Extraordinary loss | | | | | | | | Δ1,839 | | | Δ1,839 |
| Prior month adjustment | | | | | | | | Δ3,042 | Δ9,419 | | Δ12,461 |
| Cumulative net loss | Δ758 | Δ1,998 | Δ18,370 | Δ24,445 | Δ32,723 | Δ39,345 | Δ45,896 | Δ56,272 | Δ71,568 | Δ77,521 | Δ77,521 |
| Decifit, beginning | | | | | | | | | | | Δ30,585 |
| Net loss (Total) | | | | | | | | | | | Δ108,106 |

(Source: ICC)

Fig. 5-6-2 ICC, Sales and Profit (Jan. ~ Nov., 1985)



## V-6-4 Production Cost

Based upon ICC's financial statements, the production cost and the unit cost per 1 ton of cement are summarized in Table 5-6-4.

Table 5-6-4 Production Cost

| | Production Cost | Unit Cost | | % |
|---|---|---|---|---|
| | (1,000 Peso/Year) | Peso/bag | Peso/t-cement | |
| [Direct Cost] Raw materials | 26,718 | 4.04 | 101.0 | 8.8 |
| Fuel | 74,225 | 11.46 | 286.5 | 24.8 |
| Grinding media | 684 | 0.10 | 2.5 | 0.2 |
| Fire brick | 7,657 | 1.18 | 29.5 | 2.6 |
| Lubricant oil | 2,732 | 0.42 | 10.5 | 0.9 |
| Electric power | 83,745 | 12.86 | 321.5 | 27.8 |
| Paper bag | 25,436 | 4.17 | 104.3 | 9.0 |
| Repair expenses | 4,898 | 0.75 | 18.7 | 1.6 |
| (Sub-total) | (226,095) | (34.98) | (874.5) | (75.7) |
| [Fixed Cost] Labor cost | 8,344 | 1.29 | 32.3 | 2.8 |
| Depreciation | 59,760 | 9.23 | 230.8 | 20.0 |
| Operating expense | 5,334 | 0.69 | 17.2 | 1.5 |
| (Sub-total) | (73,438) | (11.21) | (280.3) | (24.3) |
| TOTAL | 299,533 | 46.19 | 1,154.8 | 100.0 |

Note 1: Production cost is sum of 11 months (Jan. - Nov., 1985).
Note 2: Unit cost (Peso/bag, Peso/t-cement) is average cost of 11 months (Jan. - Nov., 1985).

As shown in Table 5-6-4, the sum of fuel cost and electricity power cost is about 52% of production cost. Furthermore, the depreciation cost accounts for about 20% of production cost.

## V-6-5 Depreciation

Aggregate cost of property, machinery and equipment was based on the transfer price from DBP/PNB to ICC.

The aggregate cost as of August 31, 1984 was allocated proportionately to the various asset accounts on the basis of the carrying cost in the books of MMIC.

Depreciation is computed by means of the following straight-line method based on the estimated lives of the assets.

| Item | Depreciation method | Salvage value |
|---|---|---|
| Machinery and equipment | 15 year straight line | 1% |
| Civil and building | 20 year straight line | 1% |
| Vehicle | 5 year straight line | 1% |

Table 5-6-5 Depreciation (as of November 30, 1985)

| Fixed Asset Items (as of Nov.30, 1985) | Original Amount (PNB/DBP Transfer Cost) | Year of Depreciation (Estimated Life) | Salvage Value (Estimated 1%) | Amount of Depreciation (per Year) | Amount of Depreciation | Remaining Amount |
|---|---|---|---|---|---|---|
| BUILDING AND STRUCTURES: | | | | | | |
| Administration Building | ₱ 7,814,394 | 20 Years | ₱ 78,144 | ₱ 386,812 | ₱ 556,288 | ₱ 7,258,107 |
| Staffhouses & Dwellings | 43,884,649 | 20 " | 438,846 | 2,172,290 | 3,266,984 | 40,617,665 |
| Mill Buildings | 141,556,489 | 20 " | 1,415,565 | 7,007,046 | 12,299,819 | 129,256,670 |
| Utilities & Serv. Buildings | 38,840,764 | 20 " | 388,408 | 1,922,618 | 3,087,346 | 35,753,418 |
| Other Structures | 7,553,344 | 20 " | 75,534 | 373,890 | 593,922 | 6,959,422 |
| Brick Plant Building | 4,045,912 | 20 " | 40,459 | 200,273 | 200,319 | 3,845,593 |
| Coal Plant Buildings | 20,390,344 | 20 " | 203,903 | 1,009,322 | 1,604,556 | 18,785,789 |
| MACHINERIES & EQUIPMENT: | | | | | | |
| Mobile Equipment & Tramline | 11,467,767 | 5 Years | 114,678 | 2,270,618 | 3,150,990 | 8,316,777 |
| General Machinery & Equipment; | | | | | | |
| Office Equip.-Furn. & Fixt. | 1,590,063 | 5 " | 15,901 | 314,832 | 441,567 | 1,148,496 |
| Household Appliances-Furn. & Fixtures | 1,417,918 | 5 " | 14,179 | 280,748 | 406,261 | 1,011,657 |
| Miscellaneous Plant & Equipment | 8,367,835 | 15 " | 83,678 | 552,277 | 2,119,747 | 6,248,087 |
| Hollow Blocks Machineries | 5,186,056 | 15 " | 51,861 | 342,280 | 350,947 | 4,835,109 |
| Mill Plant Machineries | 328,744,897 | 15 " | 3,287,449 | 21,697,163 | 24,460,733 | 304,284,163 |
| Coal Plant Machineries | 264,861,634 | 15 " | 2,648,616 | 17,480,868 | 18,882,534 | 245,979,100 |
| Mining Machinery & Equipment | 14,099,932 | 5 " | 140,999 | 2,791,787 | 2,840,112 | 11,259,819 |
| Brick Plant Machineries | 30,831,267 | 15 " | 308,313 | 2,034,864 | 2,180,064 | 28,651,204 |
| AREA DEVELOPMENT: | | | | | | |
| General Development | 10,645,330 | 20 Years | 106,453 | 526,944 | 838,556 | 9,806,774 |
| Land Improvement & Appurtenances | 33,956,944 | 20 " | 339,569 | 1,680,869 | 2,657,483 | 31,299,461 |
| UTILITIES & OTHER SYSTEM | 89,364,689 | 20 " | 893,647 | 4,423,552 | 9,158,542 | 80,206,147 |
| LAND | 55,533,559 | - | - | - | - | 55,533,559 |
| TOTAL | ₱ 1,120,153,787 | | ₱ 10,646,202 | ₱ 67,469,053 | ₱ 89,096,770 | ₱ 1,031,057,017 |

V-6-6 Financial Position of ICC

(1) Balance sheet

Tables 5-6-6 and 5-6-7 show the balance sheet as of November, 1985.

Table 5-6-6 Balance Sheet (as of Nov. 1985)

| ASSETS | (1,000 Pesos) |
|---|---|
| Current Assets | |
| Cash | 373 |
| Account receivable | 17,717 |
| Inventories | 74,862 |
| Deferred charge | 12,701 |
| Advance to (from) affiliated companies | 8,976 |
| (Total current assets) | (114,629) |
| Property, Plant & Equipment | |
| Land | 55,534 |
| Machinery & equipment | 652,092 |
| Building & improvement | 308,688 |
| Transportation equipment | 11,535 |
| Office equipment, furniture & fixture | 3,119 |
| Utilities & other system | 89,365 |
| Construction in progress | 1,934 |
| (Sub-total) | (1,122,267) |
| Less: Accumulated depreciation | - 89,128 |
| (Total property, plant & equipment) | (1,033,139) |
| Preoperating Expenses | 31,726 |
| TOTAL | 1,179,494 |

Table 5-6-7 Balance Sheet (as of Nov. 1985)

| LIABILITIES & STOCKHOLDER'S EQUITY | (1,000 Pesos) |
|---|---|
| Current Liabilities | |
| Liabilities on outstanding L/C | 2,740 |
| Account payable | 19,546 |
| Accrued expenses & other liabilities | 32,702 |
| (Total Current Liabilities) | (54,988) |
| Advance from *AICDC | 8,333 |
| Liability to DBP/PNB | 1,209,279 |
| Stockholder's Equity | |
| Capital stock | 15,000 |
| Authorized - 20,000,000 shares | |
| Issued & outstanding - 15,000,000 shares | |
| (₱1 per value) | |
| Deficit | -108,106 |
| TOTAL | 1,179,494 |

* AICDC: A.I. Construction and Development Corporation

(2) Financial review

(i) On December 14, 1984, ICC appointed AICDC as the sole and exclusive distributor of ICC's cement plant products in exchange for a grant by AICDC of a non-interest bearing advance amounting to 15 million Pesos for working capital to operate the plant.
The advance is repayable by 18 monthly payments (833,000 Pesos/month), and the remaining balance as of November, 1985 is 8,333,000 Pesos.

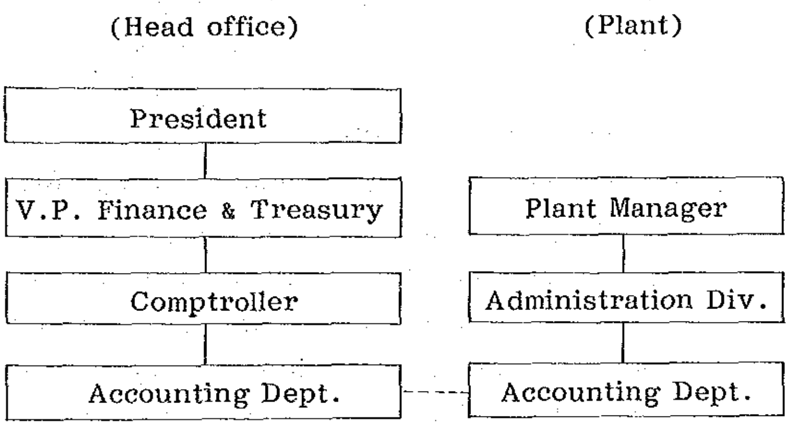
(ii) Liability to DBP/PNB, amounting to 1209 million Pesos, represents the ICC's liability arising from the transfer of the ICC plant complex located at Antipolo, Rizal.
The terms of this liability, such as interest rate and other conditions have not yet been finalized as of March, 1985. This liability is treated by DBP/PNB as a non-interest bearing receivable from ICC.
If ICC is obliged to start repayment of the liability, ICC's financial position will be further depressed.

V-6-7 Organization for Financial Management

Management System

The financial management is carried out at plant (Antipolo) and head office (Manila) under the organization shown in Fig. 5-6-3.

Fig. 5-6-3 Organization for Financial Management




At plant, accounting staffs manage mainly production cost, plant properties and sales volume of cement products.
On the other hand, accounting staffs in head office manage mainly sales revenue.
Monthly financial statements such as departmental summary of manufacturing expenses, statement of income and balance sheets are prepared at head office by totalizing data from plant.
Furthermore, comptroller and director of finance and treasury control whole financial position of ICC.
The management system is organized and operated systematically and efficiently through cooperation between head office and plant site.

## V-7 Marketing Capacity

As described in III-2-2, the exclusive right to sell ICC's cement was assigned to AICDC (A.I. Construction and Development Corporation) after ICC's managerial separation from Marinduque Group in 1984. Mainly owing to the said separation and subsequent decrease in ICC's plant operation rate, ICC's sales decreased especially in 1984.

However, in 1985, ICC's sales increased by 30% compared with 1984, while the sales of the whole cement industry decreased both in 1984 and 1985.

In addition, AICDC is planning to establish such bulk distribution center as described in III-2-2(3) so that they may economize the packing charges and widen their market.

When the above is taken into account together with the nature of the firm AICDC that they are dealing with other various kinds of construction materials than the cement, it can be said that there will be found no special weak point in ICC's marketing capability even after the above managerial separation.

At ICC's Antipolo plant, cement shipping operation is orderly executed by Shipping Section based on the Sales Order issued by Cement Marketing Dept. of ICC's Makati Office and Withdrawal Authority Slip emanating from AICDC, and the Shipping Section is operated in close coordination with AICDC's Traffic Office, Packhouse Section, Quality Control Dept. etc. to ensure that authorized quantities of cement are loaded as to the quality of cement.

Therefore, such traditional sales share as described in III-2-2, namely, 12% of the domestic sales of the whole cement industry will be maintained from now on.

## V-8 Administration of the Plant (Manning Plan)

Before 1983 when Antipolo plant was managed by MMIC the number of total employee was about 900.
But when ICC was newly established in 1983, after consulting with its employee ICC reduced the number of its employee to about 360 i.e. to 40% of original one.

The number of the employee was 361 as of September 1985 as shown in the attached manning table, it was further reduced and became 348 as of December 1985.

Therefore the manning plan is remarkably rationalized as compared with the time of MMIC and no surplus part exists but the following matters are pointed out.

- Abundant maintenance staff (110) is retained. This is desirable to promote the good maintenance of the plant.

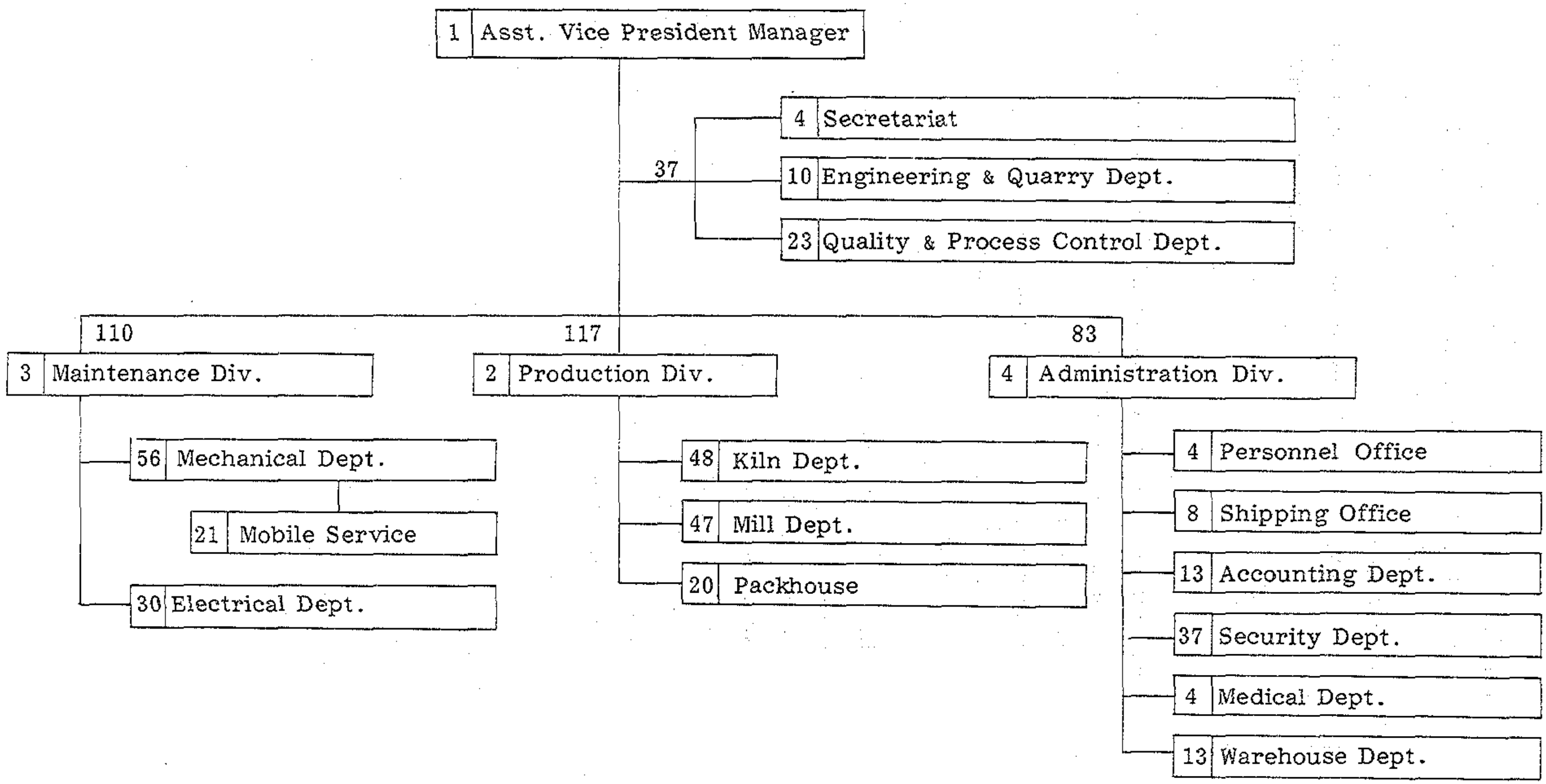
- The fact that the indirect department has many employees is due to its many security staffs (37 persons).
  It seems to be necessary for ICC to have such number of security staff for self defence against special condition of the area.

- At present, many cement plants clearly separate operation from maintenance. But in Antipolo plant, the operation staffs are engaging routine maintenance and the information brought by them are useful for maintenance. In this point it can be said that the operation and the maintenance are well balanced each other.

- It is said that when 2 kilns are operated simultaneously the employee is to be increased by 25 but their disposition is not clear.

Fig. 5-8-1 Manning Organization Chart of Antipolo Plant

Total Personnel: 348 persons as of Dec. 1985.



Manning organization chart and manning plan of Antipolo plant are shown in Fig. 5-8-1 and Table 5-8-1 respectively.

Table 5-8-1 Manning Plan of Antipolo Plant
as of December 1985

| | No of Personnel |
|---|---|
| Assistant Vice President, Secretariat and Technical Staff | |
| Assistant Vice President | 1 |
| Secretariat | 4 |
| Engineering and Quarry Dept. | 10 |
| Quality and Process Control Dept. | 23 |
| Sub-total | 38 |
| Administration Division | |
| Office | 4 |
| Personnel Office | 4 |
| Shipping Office | 8 |
| Accounting Dept. | 13 |
| Security Dept. | 37 |
| Medical Dept. | 4 |
| Warehouse Dept. | 13 |
| Sub-total | 83 |
| Production Division | |
| Office | 2 |
| Packhouse | 20 |
| Kiln Dept. | 48 |
| Mill Dept. | 47 |
| Sub-total | 117 |

Maintenance Division

| | |
|---|---|
| Office | 3 |
| Mechanical Dept. | 56 |
| Mobile Services | 21 |
| Electrical Dept. | 30 |
| Sub-total | 110 |
| | |
| Grand Total | 348 |

The classification by rank is shown as follows.

| | |
|---|---|
| Senior (S) | 13 |
| Junior (J) | 14 |
| Keyman (K) | 27 |
| Rank and File (R) | 294 |
| Total | 348 |

The details by works and by rank of each department as of September 1985 are shown as follows.

(1) Assistant Vice President, Secretariat and Technical Staff

- Office

| | | |
|---|---|---|
| Assist. Vice President | (S) | 1 |
| Executive Secretary | (K) | 1 |
| Performance Analyst I | (R) | 1 |
| Executive Driver | (R) | 1 |
| Janitor/Messenger | (R) | 1 |
| Sub-total | | 5 |

- Engineering and Quarry Department

| | | |
|---|---|---|
| Superintendent | (S) | 1 |
| Civil Engineer | (J) | 1 |
| Draftsman | (R) | 2 |
| Leadman | (K) | 1 |
| Carpenter | (R) | 2 |
| Painter | (R) | 2 |
| Plumber | (R) | 1 |
| Leadman House Keeping | (R) | 1 |
| Safety Officer | (J) | 1 |
| Sub-total | | 11 |

- Quality and Process Control Department

| | | |
|---|---|---|
| Superintendent | (S) | 1 |
| Physical Analyst I | (K) | 1 |
| Physical Analyst II | (R) | 1 |
| Chemical Analyst | (K) | 1 |
| Chemist | (R) | 1 |
| Laboratory Analyst I | (R) | 1 |
| Laboratory Analyst II | (R) | 3 |
| Process Control Foreman | (J) | 1 |
| Mixture Control Foreman | (K) | 3 |
| Blending Silo Operator | (R) | 3 |
| Sampler | (R) | 3 |
| Bag Weight Tester | (R) | 2 |
| Research & Development Foreman | (J) | 1 |
| R and D Analyst | (R) | 2 |
| Sub-total | | 24 |
| | | |
| Total | | 40 |

(2) Administration Division

- Office

| | | |
|---|---|---|
| Administration Manager | (S) | 1 |
| Secretary | (R) | 1 |
| Radio Operator | (K) | 1 |
| Guest House Helper | (R) | 1 |
| Sub-total | | 4 |

- Personnel Office

| | | |
|---|---|---|
| Assistant I | (S) | 1 |
| Assistant II | (K) | 1 |
| Clerk I | (R) | 1 |
| Administration Superintendent | (R) | 2 |
| Sub-total | | 5 |

- Shipping Office

| | | |
|---|---|---|
| Supervisor | (J) | 2 |
| Head Checker | (K) | 2 |
| Clerk | (R) | 4 |
| Sub-total | | 8 |

- Accounting Department

| | | |
|---|---|---|
| Chief Accountant | (S) | 1 |
| Supervisor | (J) | 2 |
| Book Keeper | (R) | 4 |
| Analyst | (R) | 2 |
| Head Clerk | (K) | 1 |
| Clerk | (R) | 6 |
| Sub-total | | 16 |

- Security Department

| | | |
|---|---|---|
| Chief Security | (S) | 1 |
| Clerk | (R) | 1 |
| Guard Inspector | (K) | 3 |
| Security Guard II | (R) | 13 |
| Security Guard III | (R) | 13 |
| Sub-total | | 31 |

- Medical Department

| | | |
|---|---|---|
| Head Nurse | (J) | 1 |
| Shift Nurse | (K) | 2 |
| Dental/Medical Attendant | (R) | 1 |
| Clerk | (R) | 1 |
| Sub-total | | 5 |

- Warehouse Department

| | | |
|---|---|---|
| Warehouseman | (S) | 1 |
| Supervisor | (J) | 1 |
| Head Storekeeper | (K) | 1 |
| Inventory Control Head | (K) | 1 |
| Storekeeper | (R) | 3 |
| Clerk | (R) | 2 |
| Checker | (R) | 4 |
| Sub-total | | 13 |
| | | |
| Total | | 82 |

(3) Production Division

- Office

| | | |
|---|---|---|
| Division Manager | (S) | 1 |
| Secretary | (R) | 1 |
| Sub-total | | 2 |

- Packhouse

| | | |
|---|---|---|
| Foreman | (J) | 2 |
| Operator | (R) | 2 |
| Packerman | (R) | 10 |
| Cement Silo Tender | (R) | 2 |
| Dust Collector Tender | (R) | 2 |
| Forklift Operator | (R) | 2 |
| Sub-total | | 20 |

- Kiln Department

| | | |
|---|---|---|
| Superintendent | (S) | 1 |
| Shift Foreman | (K) | 2 |
| Burner Master | (R) | 3 |
| Assist. Burner | (R) | 3 |
| E.P. Tender | (R) | 3 |
| Slurry Pump Tender | (R) | 3 |
| F.E./P.M. Tender | (R) | 3 |
| Cooler Tender | (R) | 3 |
| Conveyor Tender | (R) | 3 |
| Euclid Driver | (R) | 3 |
| Traxcavator Operator | (R) | 3 |
| Coal Plant Operator | (R) | 3 |
| Coal Mill Tender | (R) | 3 |
| IBC/Coal Storage Tender | (R) | 3 |
| Payloader Operator | (R) | 6 |
| Dump Truck | (R) | 3 |
| Sub-total | | 48 |

- Mill Department

| | | |
|---|---|---|
| Superintendent | (S) | 1 |
| Foreman (Mill) | (K) | 3 |
| Crusher Operator | (R) | 2 |
| Conveyor Tender | (R) | 6 |
| Bin Tender | (R) | 1 |

| | | |
|---|---|---|
| Conveyor Tender | (R) | 1 |
| Mill Operator (Raw Mill) | (R) | 2 |
| Miller (Raw Mill) | (R) | 1 |
| O.H Crane Operator | (R) | 3 |
| Feeder Tender (Raw) | (R) | 3 |
| Slurry Pump Tender | (R) | 3 |
| River Pump Tender | (R) | 3 |
| Mill Operator (Finish Mill) | (R) | 1 |
| Miller (Finish Mill) | (R) | 2 |
| O.H Crane Operator | (R) | 3 |
| Feeder Tender (Finish) | (R) | 3 |
| Dust Collector Tender | (R) | 4 |
| Compressor Tender | (R) | 3 |
| Mustang Operator | (R) | 2 |
| Traxcavator Operator | (R) | 1 |
| Sub-total | | 48 |
| | | |
| Total | | 118 |

(4) Maintenance Division

- Office

| | | |
|---|---|---|
| Division Manager | (S) | 1 |
| Secretary I | (R) | 1 |
| Janitor/Messenger | (R) | 1 |
| Sub-total | | 3 |

- Mechanical Department

| | | |
|---|---|---|
| Superintendent | (S) | 1 |
| Foreman | (J) | 2 |
| Leadman | (K) | 3 |
| Leadman | (R) | 1 |
| Minwright I | (R) | 14 |
| Minwright II | (R) | 12 |
| Welder I | (R) | 6 |

| | | |
|---|---|---|
| Welder II | (R) | 3 |
| Machinist I | (R) | 3 |
| Machinist II | (R) | 4 |
| Oiler Crusher | (R) | 2 |
| Oiler Burning | (R) | 3 |
| Oiler F.M | (R) | 3 |
| Oiler Packing | (R) | 2 |
| Tool Keeper | (R) | 1 |
| Sub-total | | 60 |

- Mobile Services

| | | |
|---|---|---|
| Foreman | (J) | 1 |
| Mechanic I | (R) | 5 |
| Mechanic II | (R) | 5 |
| Service Driver | (R) | 2 |
| Driver I (Shuttle) | (R) | 3 |
| Dump Truck Driver | (R) | 4 |
| Forklift Operator | (R) | 1 |
| Auto-Electrician | (R) | 1 |
| Batteryman | (R) | 1 |
| Tireman | (R) | 1 |
| Welder | (R) | 1 |
| Serviceman | (R) | 1 |
| Sub-total | | 23 |

- Electrical Department

| | | |
|---|---|---|
| Superintendent | (S) | 1 |
| Foreman | (J) | 2 |
| Inspector Euercon Officer | (K) | 1 |
| Leadman | (K) | 2 |
| Instrument Technician II | (R) | 3 |
| Instrumentation Control Technician | (R) | 1 |
| Diesel Engine Operator | (R) | 3 |
| Switchboard Operator | (R) | 3 |
| Rewinder I | (R) | 1 |

| | | |
|---|---|---|
| Rewinder II | (R) | 2 |
| Electrician I | (R) | 7 |
| Electrician II | (R) | 7 |
| Mechanic | (R) | 1 |
| Telephone Technician | (R) | 1 |
| Sub-total | | 35 |
| | | |
| Total | | 121 |
| | | |
| Grand Total | | 361 |

# SECTION VI TECHNICAL DIAGNOSIS OF THE EXISTING FACILITIES OF ICC

## VI-1 Local Conditions of Raw Material Quarries

### VI-1-1 Raw Mateiral Quarries

As for the main raw materials for the cement manufacture in the ICC plant, the following materials are supplied from respective quarries all located in the surrounding hills of the cement plant:

- limestone
- high-silica clay (dacite)
- low-silica clay (diorite)

The locations of the above raw material quarries and the areas of relevant mining claims etc. are shown in the attached drawing G-01.
As corrective/additive materials, pyrite cinder, pozzolana and gypsum are purchased from outside suppliers.
Table 6-1-1 shows chemical compositions of the samples of all the above-mentioned materials collected by repeated grab sampling from respective storages in the cement plant during the site survey.
Local conditions of the main raw material quarries (limestone and clays) are briefly explained below.

#### VI-1-1-1 Limestone Quarry

(1) Location and topography

The limestone quarry is located at around one kilometer in a straight line to the east of the cement plant. The distance of limestone haulage via existing roads is about 1.8km.

Table 6-1-1 Island Cement Corporation
List of Mining Claims

| Name of Claims | No. of Claims | Area in Hectares | Inventory Proven Reserve in Metric Tons Beginning January 1986 | Status of Claims |
|---|---|---|---|---|
| Limestone | | | | |
| Carsec IV | 1 | Present Quarry | 5,335,000 | Issued with Leased Contract |
| Carsec VI | 1 | 1.8 | 3,200,000 | Issued with Leased Contract |
| Celia V | 1 | 63 | 23,800,000 | Issued with Leased Contract |
| Winfield | 2 | 16 | 23,700,000 | Under Lease Application |
| Omega | 3 | 24 | | Under Lease Application |
| Camel | 1 | 8 | | Under Lease Application |
| Gruen 1 and 2 | 2 | 16 | Not yet evaluated | Under Lease Application |
| Falcon | 1 | 8 | Not yet evaluated | Under Lease Application |
| TOTAL | | | 56,035,000 | |
| High Silica Clay (Dacite) | | | | |
| Mango | 2 | Present Quarry | 4,340,000 | Issued with Leased Contract |
| Santol | 3 | 24 | 3,300,000 | Under Lease Application |
| Durian | 3 | 24 | Not yet evaluated | Under Lease Application |
| Piña | 3 | 24 | Not yet evaluated | Under Lease Application |
| Atis | 2 | 16 | Not yet evaluated | Under Lease Application |
| Chico | 2 | 16 | Not yet evaluated | Under Lease Application |
| Joaquin | 3 | 24 | Not yet evaluated | Under Lease Application |
| Constantine | 3 | 24 | Not yet evaluated | Under Lease Application |
| TOTAL | | | 7,640,000 | |
| Low Silica Clay (Diorite) | | | | |
| Bulova I | 1 | Present Quarry | 1,100,000 | Issued with Leased Contract |
| Bulova II & III | 2 | 16 | Not yet evaluated | Issued with Leased Contract |
| Island II | 1 | 64 | Not yet evaluated | Issued with Leased Contract |
| TOTAL | | | 1,100,000 | |

The limestone deposit now being quarried forms a 100~150m high hill called Mt. Gipit, stretching in a nearly north-south direction with the width of less than 200m in the north, expanding toward the south to more than 500m.

(2) Quarrying method

The limestone is being quarried in the northern part of Mt.Gipit, by the multi-level bench-cut mining method using a pneumatic crawler drill for drilling blast holes and a diesel power shovel for loading onto dump trucks.
Haulage of limestone to the cement plant is done by several dump trucks of 15.5 tons load each, requiring about 24 min. for one cycle of haulage.
All the quarrying and hauling operations of the raw materials (limestone, high-silica clay and low-silica clay) are carried out by a quarry contractor.

(3) Characteristics of limestone

Refer to VI-1-2-1 Characteristics of Raw Material.

(4) Quantity of reserves

The quantity of proven reserves of limestone in the present quarry (name of the mining claim: "Carsec IV") is 5,335,000 tons as of January, 1986, according to ICC.
The limestone zone extends further to the north of the present quarry, and covers a much wider area as shown in the attached drawing G-01.
The quantities of proven reserves of limestone in the other mining claims which were issued with a leased contract for ICC or which are under lease application by ICC are as listed in Table 6-1-1.

The total quantity of proven reserves of limestone reaches around 56 million tons, which is sufficient to feed the cement plant, that produces 780,000 ton of clinker annually, for 54 years.

VI-1-1-2 High-Silica Clay (Dacite) Quarry

(1) Location and topography

The high-silica clay quarry is located at around 2.5km in a straight line (3.4km via existing roads) to the northeast of the cement plant, and is situated at the western foot of a hill with generally gentle slopes.

(2) Quarrying method

The quarrying is done by ripping with a bulldozer or by blasting, depending on the conditions. The quarried clay is loaded onto a dump truck of 15.5 tons load by a wheel loader.

(3) Charasteristics of high-silica clay

Refer to VI-1-2-1.

(4) Quantity of reserves

The quantity of proven reserves of high-silica clay in the present quarry (name of the mining claim "Mango") is 4,340,000 tons as of January, 1986, according to ICC.
An additional quantity of proven reserves of 3,300,000 tons is reported in the mining claims ("Santol I, II and III," which are under lease application by ICC) to the south-east of the present quarry.

The total quantity of proven reserves of 7.6 million tons is sufficient to feed the cement plant, that produces 780,000 ton of clinker annually, for 60 years.

VI-1-1-3 Low-Silica Clay (Diorite) Quarry

(1) Location and topography

The low-silica clay quarry is located at around 700m in a straight line (900m via existing roads) to the south-west of the cement plant, and is situated on the eastern slope of a hill stretching in a north-south direction.

(2) Quarrying method

The quarrying is done mainly by ripping with a bulldozer and eventually by blasting. The quarried clay is loaded onto a dump truck of 15.5 tons by a wheel loader.

(3) Characteristics of low-silica clay

Refer to VI-1-2-1.

(4) Quantity of reserves

The quantity of proven reserves of low-silica clay in the present quarry (name of the mining claim "Bulova I") is 1,100,000 tons as of January, 1986, according to ICC.
For the other mining claims ("Bulova II and III" and "Island II," which were already issued with a leased contract for ICC) the quantity of reserves are not yet evaluated.

## VI-1-2 Quality of Raw Materials

### VI-1-2-1 Characteristics of Raw Materials

The characteristics of raw materials which are being used at Antipolo plant of ICC and will be used after the renovation are studied based on the various test results shown in VI-1-2-2 as well as the test results by ICC and described as below.

(1) Limestone

The limestone is buff-to grey-coloured, fine to medium-grained, medium-hard and compact rock.
The limestone contains 52 to 47% of CaO as principal component and the content of MgO, which becomes harmful if contained in cement more than 5%, is 1.3 to 0.4% and allowable. The content of $SiO_2$ is rather high showing 4 to 8%.
The content of other minor component such as $Na_2O$, $K_2O$, $P_2O_5$ and $C\ell$ are 0.3, 0.2, 0.05 and 0.00% respectively in the sample collected during the site survey and seems in allowable range. As a whole the limestone shows favourable properties as cement raw material.
The chemical analysis carried out by ICC shows that the monthly average in 1985 of main component of limestone are in the following range.

| | |
|---|---|
| CaO | 47.4 ∿ 51.7% |
| MgO | 0.4 ∿ 1.3% |
| $SiO_2$ | 4.6 ∿ 8.1% |
| $A\ell_2O_3$ | 2.1 ∿ 3.4% |
| $Fe_2O_3$ | 0.8 1.6% |

(2) High silica clay (Dacite)

Dacite is weathered to some extent. The contents of $SiO_2$, $Al_2O_3$ and $Fe_2O_3$ are about 60, 16 and 6% respectively. The contents of $Na_2O$ and $K_2O$ in the sample collected during the site survey are as low as 0.9 and 0.8% respectively.
Dacite shows favourable properties as high silica clay for cement production.
The chemical analysis carried out by ICC shows that the monthly average in 1985 of main component of high silica clay are in the following range.

| | |
|---|---|
| $SiO_2$ | 55.3 ∿ 61.0% |
| $Al_2O_3$ | 16.7 ∿ 19.9% |
| $Fe_2O_3$ | 5.7 ∿ 10.7% |
| CaO | 3.6 ∿ 6.5% |
| MaO | 0.4 1.2% |

(3) Low silica clay (Diolite)

Diolite is weathered into brownish grey, rather fragile and clayey rock facies.
The content of $SiO_2$, $Al_2O_3$ and $Fe_2O_3$ are about 53, 19 and 9% respectively. $Na_2O$ and $K_2O$ content in the sample collected during the site survey are 0.9 and 2.2% respectively which are somewhat high.
As a whole diolite is favourable as low silica clay for cement production. The chemical analysis carried out by ICC shows that the monthly average in 1985 of main component of low silica clay are in the following range.

| | |
|---|---|
| $SiO_2$ | 50.1 ∿ 53.7% |
| $Al_2O_3$ | 19.4 ∿ 22.6% |
| $Fe_2O_3$ | 6.1 ∿ 10.7% |
| CaO | 5.8 ∿ 8.2% |
| MgO | 0.4 ∿ 1.6% |

(4) Ferrous material

As ferrous material pyrite cinder is purchased. It contains 12.6% of $SiO_2$ and 77.6% of $Fe_2O_3$ and is good ferrous material for cement production.

(5) Gypsum

Chemical gypsum is being used. It's combined water and $SO_3$ content are 19.2 and 44.5% respectively and these figures show that the gypsum is good as cement retarder.
The content of water soluble $P_2O_5$ is a little high which will probably retard setting time of cement and the care must be taken in this point.

(6) Pozzolana

Pozzolana is procured from a supplier. According to ICC its $SiO_2$ , $Al_2O_3$ and $Fe_2O_3$ contents are about 50, 20 and 9% respectively. Its insoluble residue is 57%.
Judging from the strength of pozzolan cement produced of it, the quality of the pozzolana seems good.

(7) Industrial water

Although its total hardness of 144 ppm and evaporation residue of 260 ppm are a little higher, its quality is acceptable and is being used.

(8) Coal

At present imported coal (Chinese and Australian) and local coal are used.
According to ICC they are bituminous coal of following properties.

| | | local | imported |
|---|---|---|---|
| Calorific value (Gross) | kcal/kg | 5,500 ∿ 5,700 | 5,900 ∿ 6,500 |
| Volatile matter | % | 26 ∿ 27 | 31 ∿ 34 |
| Fixed carbon | % | 45 ∿ 48 | 44 ∿ 50 |
| Ash | % | 21 ∿ 22 | 16 ∿ 22 |

(9) Summary

(i) Raw meal

Raw meal of ordinary portland cement can be produced of the raw materials mentioned above i.e. limestone, dacite, diorite and pyrite cinders. These raw materials do not contain harmful impurities which will cause coating trouble in preheaters of dry process with NSP system.

Grindability of raw meal is 14.5 kWh/t expressed by Work index (WI) and seems somewhat hard. This is due to low grindability of limestone, but will not cause any trouble. Grindability of raw meal is almost the same as that of raw meal used in the cement plants in Japan.

(ii) Others

As to pozzolana, coal, gypsum and industrial water, refer to the comment described before.

### VI-1-2-2 Test Results of Raw Materials and Products

The samples of raw materials, products and industrial water collected by the survey team at the site were sent to Japan and tested.

The test results of these samples including those of products are described in this article.

(1) Sample

| | | |
|---|---|---|
| Limestone | random sample | 10 kg |
| Dicite | random sample | 2 kg |
| Diorite | random sample | 2 kg |
| Pyrite cinder | random sample | 1 kg |
| Pozzolana | random sample | 1 kg |
| Gypsum | random sample | 1 kg |
| Cement | | |
| Ordinary portland cement | spot sample | 10 kg |
| Pozzolan cement | spot sample | 10 kg |
| Indutrial water | spot sample | 2 litre |

(2) Chemical analysis

(i) Testing method:

Raw material:

| | | |
|---|---|---|
| $SiO_2$, $Al_2O_3$, $Fe_2O_3$, $SO_3$ | : | Gravimetric analysis |
| $CaO$, $MgO$, $C\ell$ | : | Volumetric analysis |
| $Na_2O$, $K_2O$ | : | Flame photometric analysis |
| $P_2O_5$ | : | Colorimetric analysis |

(ii) Results of chemical analysis

The results of chemical analysis are shown in Table 6-1-2.

Table 6-1-2 Chemical Analysis of Raw Materials

(wt% in dry basis)

| | LOI | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO |
|---|---|---|---|---|---|---|
| Limestone | 41.8 | 4.0 | 0.9 | 0.3 | 51.7 | 0.6 |
| Dacite | 7.0 | 66.3 | 13.8 | 4.9 | 2.8 | 2.0 |
| Diorite | 3.2 | 54.9 | 17.7 | 8.8 | 7.0 | 3.2 |
| Pyrite cinder | 2.9 | 12.6 | 1.4 | 77.6 | 1.4 | 0.6 |
| Pozzolana | 8.0 | 49.5 | 20.7 | 8.2 | 9.9 | 1.9 |

| | $SO_3$ | ($Na_2O$) | ($K_2O$) | ($P_2O_5$) | (Cℓ) | Total |
|---|---|---|---|---|---|---|
| Limestone | 0.1 | 0.32 | 0.22 | 0.05 | 0.000 | 99.4 |
| Dacite | 0.2 | 0.95 | 0.81 | 0.12 | 0.020 | 97.0 |
| Diorite | 1.1 | 0.88 | 2.17 | 0.25 | 0.006 | 95.9 |
| Pyrite cinder | 1.9 | 0.59 | 0.30 | 0.06 | 0.000 | 98.4 |
| Pozzolana | - | 1.02 | 0.81 | - | - | - |

Table 6-1-3 Chemical Analysis of Gypsum

(wt.% in dry basis)

| | Combined water | Insol. residue | CaO | $SO_3$ | W-$P_2O_5$ | T-$P_2O_5$ | Total |
|---|---|---|---|---|---|---|---|
| Gypsum | 19.2 | 1.0 | 32.3 | 44.5 | 0.10 | 0.13 | 97.0 |

(3) Burnability test of raw mix

In order to investigate the burnability of the raw meal of ordinary portland cement prepared from the proposed raw materials of ICC, the burnability test was carried out in comparison with the burnability of the raw meal used in cement plants, in Japan.

(i) Raw materials

The chemical composition of ICC's raw materials used for the test are shown in Table 6-1-4.

Table 6-1-4 Chemical Composition of ICC's Raw Material Samples used for Burnability Test

| Sample | Chemical Composition (wt.% on dry basis) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | L.O.I | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_3$ | Total | $Na_2O$ | $K_2O$ |
| Limestone | 41.8 | 4.0 | 0.9 | 0.3 | 51.7 | 0.6 | 0.1 | 99.4 | 0.32 | 0.22 |
| High Silica | 7.0 | 66.3 | 13.8 | 4.9 | 2.8 | 2.0 | 0.2 | 97.0 | 0.95 | 0.81 |
| Low Silica | 3.2 | 54.9 | 17.7 | 8.8 | 7.0 | 3.2 | 1.1 | 95.9 | 0.88 | 2.17 |
| Pyrite Cinder | 2.9 | 12.6 | 1.4 | 77.6 | 1.4 | 0.6 | 1.9 | 98.4 | 0.59 | 0.30 |

(ii) Raw meal preparation

Each one combination of raw mix was prepared from ICC's raw materials and ther raw materials used in cement plant in Japan.
The moduli of clinker are shown in Table 6-1-5.
The method adopted for the preparation of raw meal is as follows. At first, each raw material was crushed by a laboratory jaw crusher and then ground to the fineness of less than 1.2mm by a roll crusher. After mixing to the required proportion described in Table 6-1-6, it was ground to the required fineness as shown in Table 6-1-7, by a vibrating mill.

Table 6-1-5 Raw Material Combinations

| Combination | Moduli of clinker | | |
|---|---|---|---|
| | SM | IM | HM |
| ICC | 2.2 | 1.6 | 2.06 |
| Japan | 2.5 | 1.6 | 2.06 |

Note: HM(Hydraulic modulus) = $\frac{CaO}{SiO_2 + Al_2O_3 + Fe_2O_3}$

SM(Silica modulus) = $\frac{SiO_2}{Al_2O_3 + Fe_2O_3}$

IM(Iron modulus) = $\frac{Al_2O_3}{Fe_2O_3}$

Table 6-1-6 Mixing Proportion of ICC's Raw Material

| Combination | Proportion of raw materials (wt.% on dry basis) | | | |
|---|---|---|---|---|
| | Limestone | High-silica | Low-silica | Pyrite cinder |
| ICC | 79.95 | 3.59 | 15.55 | 0.91 |

Table 6-1-7 Fineness of Raw Meal

| Combination | Fineness wt.% (Residue on 88μ sieve) |
|---|---|
| ICC | 10.7 |
| OCC | 10.4 |

(iii) Burning of raw meal

After adding required quantity (about 18%) of water, the raw meal was pelletized to a size of 10mm in diameter (weight: about 3g) and dried at 110°C in an electric drying oven until all the moisture was evaporated.
The pellets, 3 pieces of each raw meal, were put in platinium crucibles and burnt in an electric furnace maintained at 1,500° C. The burning time was three levels of 10, 20 and 30 minutes.

(iv) Free lime of clinker

The chemical composition and moduli of the burnt clinker, and free lime of the clinkers are shown in Table 6-1-8 and 6-1-9, respectively.

Table 6-1-8 Chemical Composition and Moduli of Clinker

| Combination | Chemical Composition (wt.%) | | | | | Moduli | | |
|---|---|---|---|---|---|---|---|---|
| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Total | SM | IM | HM |
| ICC | 21.98 | 5.86 | 3.54 | 64.57 | 95.95 | 2.34 | 1.66 | 2.06 |
| Japan | 22.94 | 5.88 | 3.26 | 66.00 | 98.08 | 2.51 | 1.80 | 2.06 |

Table 6-1-9 Percentage of Free CaO Content of Clinker

| Burning Temp | 1500°C | | |
|---|---|---|---|
| Burning Time | 10 min | 20 min | 30 min |
| ICC | 2.1 | 0.9 | 0.5 |
| Japan | 1.8 | 0.5 | 0.2 |

Note: The free lime content of clinker corresponds to the quantity of uncombined CaO. If the free lime content of clinker, prepared and burnt under the same conditions, is higher than the others, the burnability of the clinker is judged to be inferior as compared with the others.

(4) Grindability test on raw materials

Since closed circuit grinding system will be adopted during the actual operation after the renovation, the grindability test was performed according to "Testing method of grindability work index" which consists of closed circuit system. The test result was examined by comparing with those of raw materials used in cement plants in Japan.

(i) Mixing proportion of raw material

The same raw materials and the mixing proportion adopted for the burnability test were used for the grindability test. (Refer to Table 6-1-6)

(ii) Testing method

The grindability work index was measured by a test ball mill.
Specification of the test mill and grinding media are as follows:

Test mill

| | |
|---|---|
| inside diameter | 305 mm |
| inside length | 305 mm |
| revolution | 70 revolution per min. |
| grinding media: | bearing balls of steel |

| diameter | quantity |
|---|---|
| 36.5 mm | 43 pcs |
| 30.2 mm | 67 pcs |
| 25.4 mm | 10 pcs |
| 19.1 mm | 71 pcs |
| 15.9 mm | 94 pcs |

Test procedure:

(a) Measure the particle size distribution of the raw mix sample crushed to as fine as less than 3,360 micron and determine under size(%) of $P_1$(micron) and 80% particle size F(micron).

Note: 1. In this test $P_1$(micron) is 88 micron.

2. 80% particle size: In case that the under size of a particle size is 80% of pulverulent body which has particle size distribution, this particle size is called 80% particle size.

(b) Fill the prepared sample into a measuring cylinder, measure the weight of 700 mℓ volume and charge this quantity into the test mill with the grinding media and then operate the mill for 100 revolutions.

(c) After 100 revolutions, screen all the ground material carefully by $P_1$(micron) sieve and measure over size A(g).

(d) Calculate Gbp from under size of $P_1$(micron), i.e. (W-A)(g) and estimate the revolutions of next trial by which the circulating rate of next trial reaches 250%.

(Note: Gbp: Under size of $P_1$(micron) produced by one revolution of test mill (g) )

(e) Add the newly prepared sample, which is the same weight as the under size of $P_1$ (micron), i.e. (W-A)(g), to the over size A(g) and charge it into the test mill.

(f) Operate the mill by the revolutions estimated in step (d).

(g) Repeat the procedure of step (d) to (f), until the circulating rate reaches steady rate at about 250%. Calculate the average value of Gbp from the last three trials.

(h) Measure the particle size distribution of under size product of $P_1$ (micron) sieve obtained in item (g) and calculate 80% particle size of P(micron).

Calculation formula of Work Index (Wi)

$$Wi = \frac{44.5}{(P_1)^{0.23} \times (Gbp)^{0.82} \times \left(\frac{10}{\sqrt{P}} - \frac{10}{\sqrt{F}}\right)} \times 1.102 \text{ (kWh/t)}$$

(iii) Result of test

The test results of grindability are shown in Table 6-1-10.

Table 6-1-10 Work Index (Wi) of Raw Materials

| Sample No. | Type of Raw Material | Proportion of Raw Materials | Wi (kWh/t) |
|---|---|---|---|
| ICC | Limestone | 79.95 % | 14.5 |
| | Dacite | 3.59 | |
| | Diorite | 15.55 | |
| | Pyrite cinder | 0.91 | |

(iv) Consideration

The grinding work index (Wi) is the index based on Bond's "The third party of comminution" and principally represents the grinding resistance of material. Since this experimental work index (Wi) shows good correlation with the work index (Wio) obtained by actual plant operation, the grindability can be examined based on the index.

The characteristics of this method lies in the adoption of closed circuit system by adding a new feed to the over size of $P_1$ (micron) sieve to repeat the grinding and therefore the results are close to the actual operation figures.

The test results of ICC's raw mix is shown in Table 6-1-11 together with those of raw mix used in the cement plants in Japan.

Table 6-1-11 Work Index (Wi) of ICC's and Japanese Raw Mix

| Raw Material | Wi (kWh/t) |
|---|---|
| ICC raw mix | 14.5 |
| Raw mix of Japan A | 9.3 ∿ 9.8 |
| Raw mix of Japan B | 10.2 |
| Raw mix of Japan C | 12.2 |
| Raw mix of Japan D | 8.5 |
| Raw mix of Japan E | 12.9 |
| Raw mix of Japan F | 9.2 |
| Raw mix of Japan G | 9.4 ∿ 11.2 |

Judging from the test results shown above, the grindability of ICC's raw mix is somewhat lower than those of raw mix used in the cement plants in Japan. It seems due to the reason that ICC's limestone is a little harder but this figure won't cause any trouble in grinding process.

(5) Test results of cement samples

(i) Chemical analysis

(a) Testing method: The method stipulated in JIS

(b) Test results

The test results are shown in Table 6-1-12.

Table 6-1-12 Chemical Analysis of ICC's Cement

(wt.% in dry basis)

| | LOI | Insol.res. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_3$ |
|---|---|---|---|---|---|---|---|---|
| OPC | 0.8 | 0.2 | 20.6 | 5.7 | 3.4 | 64.7 | 1.7 | 2.0 |
| PC | 2.3 | 6.1 | 19.3 | 5.8 | 3.2 | 58.7 | 1.5 | 2.3 |

| | (MnO) | ($K_2O$) | ($Na_2O$) | Total | LSF | HM | SM | IM |
|---|---|---|---|---|---|---|---|---|
| OPC | 0.062 | 0.59 | 0.26 | 99.1 | 0.95 | 2.13 | 2.26 | 1.68 |
| PC | 0.063 | 0.54 | 0.21 | 99.2 | 0.91 | 2.02 | 2.14 | 1.81 |

Note: OPC : Ordinary portland cement
PC : Pozzolan cement

(ii) Physical test

(a) Testing method:

- JIS R5201 Physical test of cement
- Particle size distribution: Air jet sieve method
- Soundness: ASTM C151 Autoclave method

(b) Test results

The test results are shown in Table 6-1-13.

Table 6-1-13 Physical Test of ICC's Cement

| | Specific gravity | Fineness | | | | Setting ** | | |
|---|---|---|---|---|---|---|---|---|
| | | Blaine | Residue(%) * | | | Water | I.S. | F.S. |
| | | (cm²/g) | 30μ | 50μ | 100μ | (%) | (h-m) | (h-m) |
| OPC | 3.14 | 3,170 | 34.6 | 15.4 | 1.6 | 26.4 | 2-10 | 3-15 |
| PC | 2.96 | 3,290 | - | - | - | 27.8 | 3-30 | 4-20 |

| | *** Soundness (%) | Bending Strength (kg/cm²) | | | Compressive Strength (kg/cm²) | | |
|---|---|---|---|---|---|---|---|
| | | 3 day | 7 day | 28 day | 3 day | 7 day | 28 day |
| OPC | 0.16 | 29.0 | 48.0 | 67.0 | 121 | 225 | 397 |
| PC | 0.06 | 28.0 | 41.0 | 58.0 | 111 | 176 | 304 |

Note: * Air jet sieve method
** Vicat needle method
*** ASTM C151 Autoclave method

Since the strength test of OPC and PC were conducted by JIS, the figures are converted to ASTM and shown in Table 6-1-14.

Table 6-1-14 Compressive Strength of ICC's Cement

(converted to ASTM)

| | Compressive Strength ($kg/cm^2$) | | |
|---|---|---|---|
| Age | 3 days | 7 days | 28 days |
| Conversion factor | 1.36 | 1.11 | 0.89 |
| OPC | 165 | 250 | 353 |
| PC | 151 | 195 | 271 |

Consideration

1. OPC
   Its particle size distribution is somewhat wide, but its strength is acceptable.

2. PC
   Although mixing ratio of pozzolana is 25%, its strength is 23% lower than that of OPC and seems rather low.

(6) Test results of industrial water

Industrial water being used by ICC was taken and its quality was analyzed.

(i) Testing method:

JIS K 0101 Testing method of industrial water

(ii) Test results

The test results are shown in Table 6-1-15.

Table 6-1-15 Chemical Analysis of ICC's Industrial Water

| | pH (14°C) | SS (mg/ℓ) | Total hardness (mg/ℓ) | Calcium hardness (mg/ℓ) | Magnesium hardness (mg/ℓ) | $Cl^-$ (mg/ℓ) |
|---|---|---|---|---|---|---|
| Sample | 8.1 | 20 | 144 | 108 | 36 | 4.8 |
| Standard | 6.5∿8.0 | | 120 | | | 80 |

| | $SO^{--}$ (mg/ℓ) | Electric conductivity (μs/cm) | Evaporation residue (mg/ℓ) |
|---|---|---|---|
| Sample | 7.8 | 260 | 260 |
| Standard | | | 250 |

Note: Standard: Standard quality for industrial water supply

## VI-2 Conditions of the Processing, Offsite and Auxiliary Facilities

The plant is located 40km from Manila in the suburb of Antipolo. The No.1 kiln line was completed and started operation in December 1966 and the No.2 kiln line in November 1969. The machinery and equipment of both lines are mostly of the same type. The content, present condition and feature of the facilities are described below and a flow sheet is attached.

### VI-2-1 Raw Material Receiving

The limestone, and clay high silica, low silica, pyrite cinder) are transported from the mountain on trucks to the storage yard individually. Since the limestone are in lumps of over 1m, they are first crushed in a jaw type primary crusher, then are crushed in a secondary impact type crusher. The capacity of this facility is jaw crusher 400 tons/hour, impact crusher 450 tons/hour and belt conveyor 900 tons/hour. Other related pieces of equipment such as receiving hopper and apron feeder are 450 tons/hour.

If the lumps of limestone discharged from trucks are relatively small, the hopper outlet will not clog and limestone will easily be discharged enabling the feeder to operate fully at 450 tons/hour. However, the average operation for last year was 235 tons/hour, and during our survey limestone was not received at all.

An accurate opinion cannot be made since the actual operation could not be observed, but if there is no problem on the respective pieces of equipment, the system should operate at 400 tons/hour.

Clay is received and conveyed to the storage after being crushed only in the primary crusher. The rated capacity for each equipment is as follows; apron feeder 100 tons/hour, crusher 75 tons/hour and belt conveyor 200 tons/hour, but the operation during last year averaged 75 tons/hour. Gypsum is received in this system and conveyed to the gypsum storage.

The aforementioned facility is suitable for two lines of 1,300 ton-clinker/day each, totalling 2,600 ton-clinker/day. When the plant is to be operated at 2,600 ton/day, ICC should recondition the feeder, grizzly and crusher to achieve their full existing capacity.

Specification of equipment

Limestone crushing section

a010 Receiving Hopper

| | | |
|---|---|---|
| Type | : | Reinforced concrete constuction |
| Dimension | : | 6.5mW x 5mL x 2.9mH |
| Capacity | : | 73 tons |

a021 Apron Feeder

| | | |
|---|---|---|
| Type | ; | Extra Heavy Duty Type |
| Dimension | : | 1,600 mmW x 4,920L |
| Capacity | : | 450 t/h (max) |
| Motor | : | 7.5 kW |

a031 Jaw Crusher

| | | |
|---|---|---|
| Model | : | Allis Chalmers A-1 |
| Dimension | : | 48" x 60" |
| Capacity | : | 400 t/h |
| Motor | : | 190 kW |

a041 Belt Conveyor No.1

| | | |
|---|---|---|
| Dimension | : | 1,000W x 25,879L |
| Inclination | : | 14°06' |
| Capacity | : | 450 t/h |
| Motor | : | 19 kW |

a050 Impact Crusher

| | | |
|---|---|---|
| Model | : | K8 18F |
| Dimension | : | 1,100 x 1,900 |
| Feed size | : | 250 mm (max) |
| Production size | : | 25 mm |
| Capacity | : | 400 t/h |
| Motor | : | 370 kW |

a060 Belt Conveyor No.2

| | | |
|---|---|---|
| Dimension | : | 1,200W x 60,896L |
| Capaciyty | : | 900 t/h |
| Motor | : | 55 kW |

a070 Belt Conveyor No.3

| | | |
|---|---|---|
| Dimension | : | 1,200W x 77,524 |
| Capacity | : | 900 t/h |
| Motor | : | 37 kW |

Silica crushing section

a100 Receiving Hopper

| | | |
|---|---|---|
| Type | : | Reinforced Concrete Construction |
| Dimension | : | 5.5mW x 3.5mL x 2.9mH |
| Capacity | : | 43 t |

a110 Apron Feeder

| | | |
|---|---|---|
| Type | : | Extra Heavy Duty Type |
| Dimension | : | 1,200W x 4,500L |
| Capacity | : | 100 t/h (max) |
| Motor | : | 2.2 kW |

a120 Hammer Crusher

| | | |
|---|---|---|
| Dimension | : | 42" x 52" |
| Capacity | : | 75 t/h |
| Motor | : | 220 kW |

a130 Belt Conveyor No.1

| | | |
|---|---|---|
| Dimension | : | 700W x 52,994L |
| Inclination | : | 9°15' |
| Capacity | : | 200 t/h |
| Motor | : | 11 kW |

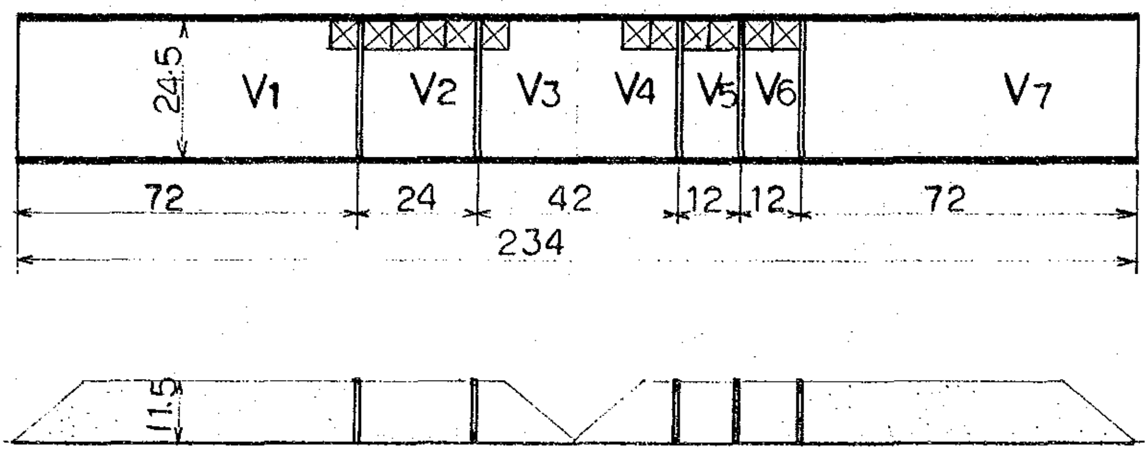
a140 Belt Conveyor No.2

| | | |
|---|---|---|
| Dimension | : | 700W x 143,500L |
| Capacity | : | 200 t/h |
| Motor | : | 15 kW |

VI-2-2 Storage

The storage is 24.5m wide, 234m long and 11.5m high (height of concrete wall) and the raw materials are stored as shown in the following drawing.

Unit : M




| | | Material | Volume | Material meaurement tonnage | Capacity |
|---|---|---|---|---|---|
| $V_1$ | : | Limestone | 17,800m$^3$ | ρ = 1.6 | 28,500 tons |
| $V_2$ | : | Pyrite Cinder | 5,100m$^3$ | ρ = 1.3 | 6,600 tons |
| $V_3$ | : | Hi-Silica | 6,500m$^3$ | ρ = 1.6 | 10,400 tons |
| $V_4$ | : | Low-Silica | | | |
| $V_5$ | : | Gypsum | 2,500m$^3$ | ρ = 1.05 | 2,600 tons |
| $V_6$ | : | Pozzolan | 2,500m$^3$ | ρ = 1.3 | 3,250 tons |
| $V_7$ | : | Clinker | 17,800m$^3$ | ρ = 1.4 | 25,000 tons |

A ratio of high silica clay 73 to low silica ratio (high silica 7,600 tons low silica 2,800 tons).

Specification of equipment

| | | | | |
|---|---|---|---|---|
| b011<br>b012 | Overhead crane | | 2 units | |
| | Type | : | Overhead Travelling in door use | |
| | Lifting capacity | : | 10 ton | |
| | Span | : | 25 m | |
| | Lifting height | : | 18 m | |
| | Bucket | : | 3 $m^3$ | |
| | Motor | : | Travelling | 30 kW |
| | | : | Traversing | 3 kW |
| | | : | Lifting | 40 kW |

VI-2-3 Raw Material Grinding

Each raw material is picked up by an overhead crane and fed to its respective hopper from where it is discharged and mixed by a weighing feeder located under the hopper then conveyed to the mill.

Water is added to the mixed material at mill inlet and ground by the wet system, the wet grinding mill is a combination of a rod mill and a tube mill in series. The gound material is pumped to a slurry tank and after blending, pumped into the slurry basin from where it is pumped to the kiln.

The flow of material is a normal process for a wet kiln, and the water content of the slurry is controlled at 33-38% from the viewpoint of heat consumption and handling.

At this plant water content is controlled at 34% which is an appropriate standard.

From the viewpoint of quality and operation, it is important that composition and water content of the slurry should be controlled constantly. However, the present raw material mixing facility and water adding facility are not satisfactory. The weighing feeder of each raw material is a constant speed type so if the condition of raw material changes, the amount of discharge will change. If an accurate mixing is to be performed with this equipment, the gate opening should be frequently adjusted to assure a good control. At present such adjustment is not performed so water content is influenced by their error in mix control and it is estimated that water contents varies as follows:

Weighing error : 1∿5%
Water variation : 33∿39%

Specification of equipment

b021 ∼ b026 Raw Material Receiving Hopper 6 units

| | | |
|---|---|---|
| Type | : | Reinforced Concrete Construction |
| Dimension | : | 6mW x 6mL x 4.5mH |
| Capacity | : | 50 m |

b031 b034 Limestone Weighing Feeder 2 units

| | | |
|---|---|---|
| Type | : | Apron Feed |
| Dimension | : | 1,000W x 6,150L |
| Capacity | : | 40 t/h - 120 t/h |
| Motor | : | 5.5 kW |

b032 High Silica Weighing Feeder No.1

| | | |
|---|---|---|
| Type | : | Belt Feeder |
| Dimension | : | 600W x 3,850L |
| Capacity | : | 10 t/h - 30 t/h |
| Motor | : | 2.2 kW |

b035 High Silica Weighing Feeder No.2

| | | |
|---|---|---|
| Type | : | Belt Feeder |
| Dimension | : | 1,000W x 5,500L |
| Capacity | : | 10 t/h - 30 t/h |
| Motor | : | 2.2 kW |

b033 Low Silica Weighing Feeder No. 1

| | | |
|---|---|---|
| Type | : | Belt Feeder |
| Dimension | : | 600W x 3,850L |
| Capacity | : | 6 t/h - 18 t/h |
| Motor | : | 2.2 kW |

b036 Low Silica Weighing Feeder No. 2

| | | |
|---|---|---|
| Type | : | Belt Feeder |
| Dimension | : | 1,000W x 5,500L |
| Capacity | : | 6 t/h - 18 t/h |
| Motor | : | 2.2 kW |

b040 Belt Conveyor No. 1

| | | |
|---|---|---|
| Dimension | : | 600W x 35,500L |
| Capacity | : | 150 t/h |
| Motor | : | 3.7 kW |

b050 Belt Conveyor No. 2

| | | |
|---|---|---|
| Dimension | : | 600W x 20,000L |
| Capacity | : | 130 t/h |
| Motor | : | 5.5 kW |

b060 Belt Conveyor to No. 1 Mill

| | | |
|---|---|---|
| Dimension | : | 600W x 13,463L |
| Capacity | : | 150 t/h |
| Motor | : | 3.7 kW |

b070 Belt Conveyor to No.2 Mill

| | | |
|---|---|---|
| Dimension | : | 600W x 5,000L |
| Capacity | : | 130 t/h |
| Motor | : | 5.5 kW |

b081 Rod Mill 2 units
b082

| | | |
|---|---|---|
| Type | : | Side drive |
| Dimension | : | $\phi$10 ft x $^{L}$13 ft |
| Capacity | : | 117 t/h |
| Motor | : | 450 kW |

b091 Compeb Mill 2 units
b092

| | | |
|---|---|---|
| Type | : | Center drive |
| Dimension | : | $\phi 11\frac{1}{2}$ ft x $^{L}$45 ft |
| Motor | : | 2,200 kW |

b111 Slurry pump 2 sets x 2 units
b112

| | | |
|---|---|---|
| Capacity | : | 120 $m^3$/h, 40 mH |
| Motor | : | 95 kW |

b121 Slurry Tank 6 units ¢ Blending Tank 3 units
～
b129

| | | | | |
|---|---|---|---|---|
| Type | : | Reinforced Concrete Construction | | |
| Dimension | : | 10m x 9mH (effective height) | | |
| Stirring system | : | Slurry tank | : | mechanical blending |
| | | Blending tank | : | mechanical & air blending |
| Capacity | : | 700 $m^3$ x 9 | = | 6,300 $m^3$ |

15) Slurry Basin 2 units

| | | |
|---|---|---|
| Type | : | Reinforced Concrete Construction |
| Dimension | : | $\phi$30m x 6mH (effective depth) |
| Capacity | : | 4,000 $m^3$ × 2 = 8,000 $m^3$ |

## VI-2-4 Clinker Burning

Slurry stored in the slurry basis is pumped to the kiln feed tank located on the top stage of the kiln end tower. A bucket scoop type feeder is installed within the tank and the feed amount is controlled by regulating the rotation of the bucket. In order to raise the accuracy of feeding the slurry in the tank is controlled to a prefixed level and if the slurry exceeds this level, it overflows back into the slurry basin.

The kiln diameter is 4,850mm at inlet and discharge ends and 4,400mm at center, while the length is 180m. The amount of output per unit inner volume is 18 kg/m$^3$h (1,300 t/d base) which is a common standard for this type of kiln.

The problems are as described in paragraph (V-1-2), the treatment of dust (presently disposed), insufficient cooling of No.1 cooler and high heat consumption. From latter half of last year, old tires are being charged from kiln end to reduce fuel consumption. This is practiced in Japan and is a very effective operation.

Specification of equipment

No.1 Kiln line

c011 Slurry Feeder 1 unit

| | | |
|---|---|---|
| Type | : | Variable Speed Ferris Wheel Type |
| No. of bucket | : | 12 |
| Width of bucket | : | 400 mm |
| Capacity | : | 120 t/h (max) |
| Motor | : | 5.5 kW |

Paddle Mixer 1 unit

| | | |
|---|---|---|
| Type | : | Twin Screw Type |
| Dimension | : | $\phi$600 x 5,000L x 2 rotor |
| Capacity | : | 120 t/h |
| Motor | : | 11 kW |

c021 Exhaust Fan 1 unit

| | | |
|---|---|---|
| Type | : | Double Suction Turbo Type |
| Gas temperature | : | 220°C |
| Static pressure | : | 240 mmAq |
| Capacity | : | 7,500 $m^3$/min |
| Motor | : | 550 kW |

c031 Electric Precipitator 1 unit

| | | |
|---|---|---|
| Type | : | Dry Gas Type |
| Gas temperature | : | 300°C (max) |
| Capacity | : | 7,500 $m^3$/min (max) |
| Dimension | : | 13,000W x 8,130L |

c041 Chain Conveyor 3 units
c051
c061

| | | |
|---|---|---|
| Dimension | : | 150W x 15,100L |
| Capacity | : | 10 t/h |
| Motor | : | 0.75 kW |

c071 Bucket Elevator 1 unit

| | | |
|---|---|---|
| Dimension | : | 360W x 28,400H |
| Capacity | : | 10 t/h |
| Motor | : | 2.2 kW |

c081 Chain Conveyor No.4

| | | |
|---|---|---|
| Dimension | : | 150W x 15,100L |
| Motor | : | 1.5 kW |

c091 Rotary kiln

| | | |
|---|---|---|
| Type | : | Allis Chalmers Wet Process |
| Diameter | : | $\phi$4,850 x $\phi$4,400 x $\phi$4,850 |
| Length | : | 180 m |
| Capacity | : | 1,300 t/d |
| Motor | : | 190 kW x 2 units |

c101 Cooling Air Seal Fan

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static Pressure | : | 75 mmAq |
| Capacity | : | 150 $m^3$/min |
| Motor | : | 3.7 kW |

c110 Clinker Cooler

| | | |
|---|---|---|
| Type | : | Allis Chalmers Travelling Grate Type |
| Dimension | : | 2,574W x 23,075L |
| Capacity | : | 54.2 t/h |
| Motor | : | 7.5 kW |

c120 Chain Conveyor under Cooler

| | | |
|---|---|---|
| Type | : | Drag Chain Type |
| Length | : | 26,805L |
| Motor | : | 3.7 kW |

c130 Clinker Breaker

| | | |
|---|---|---|
| Type | : | Swing Hammer Type |
| Speed | : | 347 r/m |
| Capacity | : | 55 t/h |
| Motor | : | 37 kW |

c140 Cooler Fan No.1

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static pressure | : | 380 mmAq |
| Capacity | : | 354 $m^3$/min |
| Motor | : | 37 kW |

c150 Cooler Fan No.2

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static pressure | : | 350 mmAq |
| Capacity | : | 300 $m^3$/min |
| Motor | : | 37 kW |

c160 Cooler Fan No.3

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static pressure | : | 320 mmAq |
| Capacity | : | 330 $m^3$/min |
| Motor | : | 37 kW |

c170 Cooler Fan No.4

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static pressure | : | 250 mmAq |
| Capacity | : | 1,300 $m^3$/min |
| Motor | : | 95 kW |

c180 Cooler Fan No.5

| | | |
|---|---|---|
| Type | : | Double Suction Turbo Type |
| Static pressure | : | 150 mmAq |
| Capacity | : | 2,000 $m^3$/min |
| Motor | : | 95 kW |

c190 Cooler Exhaust Fan

| | | |
|---|---|---|
| Type | : | Double Suction Turbo Type |
| Static pressure | : | 100 mmAq |
| Gas temperature | : | 150 C |
| Capacity | : | 4,000 $m^3$/min |
| Motor | : | 110 kW |

c201 Cooler Precipitator

| | | |
|---|---|---|
| Type | : | Multicyclone |
| Capacity | : | 4,000 $m^3$/min |
| Dimension | : | 1,000W x 7,500L |
| Capacity | : | 70 t/h |
| Motor | : | 3.7 kW |

c210 Pan Conveyor

| | | |
|---|---|---|
| Type | : | Pan Drag Chain Type |
| Dimension | : | 1,000W x 7,500L |
| Capacity | : | 70 t/h |
| Motor | : | 3.7 kW |

c220 Bucket Conveyor

| | | |
|---|---|---|
| Dimension | : | 700W x 22,000L |
| Capacity | : | 100 t/h |
| Motor | : | 7.5 kW |

c230 Belt Conveyor

| | | |
|---|---|---|
| Dimension | : | 500W x 99,509L |
| Inclination | : | 13°25' |
| Capacity | : | 70 t/h |
| Motor | : | 11 kW |

c240 Belt Conveyor

| | | |
|---|---|---|
| Dimension | : | 600W x 49,100L |
| Capacity | : | 140 t/h |
| Motor | : | 3.7 kW |

No.2 Kiln line

c012 Slurry Feeder

| | | |
|---|---|---|
| Type | : | Variable Speed Ferris Wheel Type |
| No. of bucket | : | 12 |
| Width of bucket | : | 400 mm |
| Capacity | : | 120 t/h (max) |
| Motor | : | 5.5 kW |

c022 Exhaust Fan

| | | |
|---|---|---|
| Type | : | Double Suction Turbo Type |
| Gas temperature | : | 220°C |
| Static pressure | : | 240 mmAq |
| Capacity | : | 7,500 $m^3$/min |
| Motor | : | 550 kW |

c032 Electric Precipitator

| | | |
|---|---|---|
| Type | : | Dry Gas Type |
| Gas temperature | : | 300°C (max) |
| Capacity | : | 7,500 $m^3$/min (max) |

c042 Chain Conveyor

| | | |
|---|---|---|
| Dimension | : | 200W |
| Capacity | : | 20 t/h |
| Motor | : | 11 kW |

c082 Chain Conveyor

| | | |
|---|---|---|
| Dimension | : | 150W x 15,100L |
| Capacity | : | 10 t/h |
| Motor | : | 0.75 kW |

c092 Rotary Kiln

| | | |
|---|---|---|
| Type | : | Allis Chalmers Wet Process |
| Diameter | : | Φ4,850 x Φ4,400 x Φ4,850 |
| Length | : | 180 m |
| Capacity | : | 1,300 t/d |
| Motor | : | 190 kW x 2 units |

c102 Cooling Fan

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static pressure | : | 75 mmAq |
| Capacity | : | 180 $m^3$/min |
| Motor | : | 3.7 kW |

c300 Clinker Cooler

| | | |
|---|---|---|
| Type | : | Grate Type Quenching Cooler |
| Dimension | : | 3,982W x 20,614L |
| Capacity | : | 54.2 t/h |

c310 Clinker Breaker

| | | |
|---|---|---|
| Type | : | Swing Hammer Type |
| Capacity | : | 54.2 t/h |

c320 Cooler Fan No.1

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static pressure | : | 320 mmAq |
| Capacity | : | 330 $m^3$/min |
| Motor | : | 95 kW |

c330 Cooler Fan No.2

| | | |
|---|---|---|
| Type | : | Single Suction Turbo Type |
| Static pressure | : | 250 mmAq |
| Capacity | : | 3,800 $m^3$/min |
| Motor | : | 300 kW |

c340 Cooler Precipitator

| | | |
|---|---|---|
| Type | : | Multicyclone |
| Capacity | : | 3,800 $m^3$/min |

c350 Cooler Exhaust Fan

| | | |
|---|---|---|
| Type | : | Double Suction Turbo Type |
| Gas temperature | : | 220°C |
| Static pressure | : | 150 mmAq |
| Capacity | : | 4,700 $m^3$/min |
| Motor | : | 220 kW |

| | | | |
|---|---|---|---|
| c360<br>c370<br>c380 | Bucket Conveyor | | 3 units |
| | Dimension | : | 700W |
| | Capacity | : | 100 t/h |

c390 Belt Conveyor

| | | |
|---|---|---|
| Dimension | : | 500W x 99,809L |
| Inclination | : | 13°25' |
| Capacity | : | 70 t/h |
| Motor | : | 11 kW |

Coal Crusher line 2 units

d010 Chain Conveyor

| | | |
|---|---|---|
| Type | : | Chain Scraper Type |
| Dimension | : | 710W x 4,930L |
| Capacity | : | 65 t/h |
| Motor | : | 7.5 kW |

d020 Belt Conveyor

| | | |
|---|---|---|
| Dimension | : | 500W x 109,725L x 29,300H |
| Capacity | : | 70 t/h |
| Motor | : | 15 kW |

d051 Chain Scraper Conveyor
d052

| | | |
|---|---|---|
| Dimension | : | 1,010W x 4,545L |
| Capacity | : | 3 ∿ 30 t/h |
| Motor | : | 7.5 kW |

d061 Coal Mill

d062

| | | |
|---|---|---|
| Type | : | Vertical Roller Mill |
| Grinding bowl dia. | : | 1,900 mm |
| No. of roller | : | 2 pair |
| Motor | : | 230 kW |

d071 Burning Fan

d072

| | | |
|---|---|---|
| Type | : | 2 stage Turbo Fan |
| Static pressure | : | 240 mmBar |
| Capacity | : | 800 $m^3$/min |
| Motor | : | 450 kW |

VI-2-5 Cement Grinding

Clinker and gypsum are picked up by an overhead crane in the storage and charged into respective hoppers from where the materials are first weighed by a weigh feeder located under the hopper and then conveyed to the mill.

When producing pozzolan cement, only one mill is operated because there is no hopper for pozzolan and one hopper among the four hoppers for the two mills is diverted to a pozzolan hopper. Two pozzolan hoppers are now under construction.

The average output for last year was 62∿63 tons/hour, but the mills have a potential capacity of 70 tons/hour.

They are equipped with s Sturtevant type separator and a bag filter for dust collection.

The standard of cement is specified as 90∿94% passing a 200 mesh sieve and Blaine specific surface of 3,000 $cm^2/g$.

The cement is pumped to the cement silo with a kniyon pump so power cost is high.

e011 Receiving Hopper 4 units
~
e014

| | | |
|---|---|---|
| Type | : | Reinforced Concrete Construction |
| Dimension | : | 6mW x 6mL x 4.5mH |
| Capacity | : | 50 $m^3$ |

e021 Weighing Feeder for Clinker 2 units
e022

| | | |
|---|---|---|
| Type | : | Apron Feeder |
| Length | : | 4,570 mm |
| Capacity | : | 27∿81 t/h |
| Motor | : | 3.7 kW |

e031 Weighing Feeder for Gypsum 2 units
e032

Dimension : 600V x 3,850L
Capacity : 1.1∿3.3 t/h
Motor : 2.2 kW

e041 Belt Conveyor 2 units
e042

Dimension : 500W x 11,000L
Capacity : 85 t/h
Motor : 1.5 kW

e051 Belt Conveyor 2 units
e052

Dimension : 500W x 23,137L
Capacity : 85 t/h
Motor : 3.7 kW

e061 Cement Mill 2 units
e062

Type : Allis Chalmers Center Drive
Dimension : $\phi$13 ft x 33 ftL
Capacity : 73 t/h
Motor : 2,500 kW

e071 Bucket Elevator 2 sets x 2 units
~
e074 Type : Continuous discharge
Dimension : 970 x 1,450 x 24,950H
Capacity : 200 t/h
Motor : 30 kW

| | | | |
|---|---|---|---|
| e081 | Separator | 2 sets x 2 units | |
| ? | | | |
| e084 | Type | : | Sturtevant S-18 |
| | Dimension | : | φ5,490 x 9,040H |
| | Motor | : | 190 kW |
| e091 | Bag Filter | 2 sets x 2 units | |
| ? | | | |
| e094 | Type | : | Bag Shaking Type 864-LT-P |
| | Dimension | : | 5,316W x 6,400L |
| | Filter area | : | 965 $m^2$ |
| | Capacity | : | 775 $m^3$/min |
| e101 | Exhaust Fan | | 2 units |
| e102 | | | |
| | Type | : | Double Suction Turbo Type |
| | Static pressure | : | 250 mmAq |
| | Capacity | : | 1,550 $m^3$/min |
| | Motor | : | 130 kW |
| e111 | Kniyon Pump | | 2 units |
| e112 | | | |
| | Type | : | Fuller 250 H & M |
| | Capacity | : | 80 t/h |
| | Motor | : | 110 kW |
| e121 | Rotary Air Compressor | 2 sets x 2 units | |
| ? | | | |
| e124 | Type | : | Single Stage Screw Type |
| | Model | : | KS 20L |
| | Capacity | : | 45 $m^3$/min |
| | Motor | : | 180 kW |

## VI-3 Conditions of the Facilities for Storage and Shipping of Cement

There are eight 1,300 tons cement silos totalling 10,400 tons. Four silos (Nos. 1, 2, 3, 4) are for bagged cement, three silos (Nos. 5, 6, 7) are for both bagged and bulk cement and No.8 silo is for bulk cement.

The cement discharged from the four silos is conveyed by a chain conveyor to three packers and there are two lines of this system.

As described in V-1-4 the packing results of last year was very poor. Even if the packer is in good condition, cement must be continuously supplied to the packer bin or else the packer cannot realize its full capacity. There are many ways to control cement supply to a series of packer bin from one conveyor, but the most common method is to automatically discharge the necessary quantity for the packer from the silo, convey to the top of the packer bin by a trough chain conveyor, supply to each bin by over flow and stop the supply when the bins are full. In this plant, the discharge from the silo is regulated manually by opening and closing the valve and the conveyors are also operated manually. Therefore, the supply of the packer bin is unstable and the packer is often idle which seems to be the main reason for the low efficiency. Furthermore, from the information obtained at the site, the conveyor capacity is 110 tons/hour which is less than the capacity of three packers of 144 tons/hour (48 tons/hour x three sets). It is not known why the capacity is not balanced from the beginning. Before renovation, it is necessary to upraise the capacity of conveyor and screen, which should be possible by increasing the speed of the equipment, and to study an automatic operation system.

The loading line for each packer is independent with separate approach route, so it is difficult to change the line when a packer breaks down during operation, which will cause trouble during busy shipping hours. The packing room is dusty with dust piled up everywhere creating a very bad environment. There are three 350 $m^3/m$ dust collectors, but it does not seen that they are operating effectively.

Specification of equipment

| | | | |
|---|---|---|---|
| f011 ~ f018 | Cement Storage | | 8 units |
| | Type | : | Reinforced Concrete Construction |
| | Dimension | : | $\phi$10,000 x 15,000H (Effective height) |
| | Capacity | : | 1,300 t x 9 |
| f021 ~ f023 | Roots Blower | | 3 units |
| | Pressure | : | 2,800 mmAq |
| | Capacity | : | 35 $m^3$/min |
| | Motor | : | 30 kW |
| f031 ~ f032 | Flow Conveyor | | 2 units |
| | Dimension | : | 350W(case) x 31,250L |
| | Capacity | : | 110 t/h |
| | Motor | : | 15 kW |
| f041 ~ f042 | Bucket Elevator | | 2 units |
| | Type | : | Continuous Discharge Type |
| | Dimension | : | 730 x 1,140 x 17,800H |
| | Capacity | : | 110 t/h |
| | Motor | : | 11 kW |
| f051 ~ f052 | Vibrating Screen | | 2 units |
| | Type | : | Single Deck |
| | Dimension | : | 1,520W x 3,050L |
| | Capacity | : | 110 t/h |
| | Motor | : | 7.5 kW |
| f061 ~ f062 | Chain Conveyor | | 2 units |
| | Dimension | : | 350W x 19,650L |
| | Capacity | : | 110 t/h |
| | Motor | : | 11 kW |

f071 ~ f076 Packer 6 units

| | | | |
|---|---|---|---|
| | Type | : | Four Tube Automatic Bagging |
| | Capacity | : | 1,200 bags/h |

f081 ~ f086 Belt Conveyor 6 units

| | | | |
|---|---|---|---|
| | Type | : | Flat Belt |
| | Dimension | : | 700W x 3,000L |
| | Motor | : | 1.5 kW |

f091 ~ f092 Chain Conveyor 2 units

| | | | |
|---|---|---|---|
| | Dimension | : | 150W x 18,900L |
| | Capacity | : | 10 t/h |
| | Motor | : | 1.5 kW |

f101 ~ f103 Bag Filter 3 units

| | | | |
|---|---|---|---|
| | Dimension | : | 2,600W x 6,100L |
| | Compartment | : | 4 |
| | Filtering area | : | 350 $m^2$ |

f111 ~ f113 Exhaust Fan for Bag Filter 3 units

| | | | |
|---|---|---|---|
| | Type | : | Single Suction Turbo |
| | Static pressure | : | 250 mmAq |
| | Capacity | : | 350 $m^3$/min |
| | Motor | : | 30 kW |

# SECTION VII STUDY ON THE PROCESS OF ICC

## VII-1 Present Process Scheme

The cement production process of this plant is already described in Chapters V & VI, therefore, in this Chapter, only the critical points in the present process are described.

### VII-1-1 Raw Material Supply

The deposits of the present raw materials are sufficient both in quantity and quality posing no problems for future expansion.
Mining and transportation to the plant are operated by sub-contractor working/shift/day, 6 days/week.
The raw material receiving facility of the plant has a potential capacity of over 400 tons/hour (rated capacity 450 tons/hour) but the present operation is quite low and in order to receive raw material for production of 2,600 tons clinker/day, a complete overhaul of the facility is necessary. The present raw material storage capacity is sufficient.

### VII-1-2 Raw Material Grinding

Raw material blending accuracy and water content control of the wet mill variate widely.
The capacity of the wet grinding mill is sufficient, but specific ball wear is high and maintenance is taking time.
The wear of grinding media and maintenance are large in a wet grinding mill.

### VII-1-3 Burning

Heat consumption is 1,400 - 1,500 kcal/kg-cl which is very high.
Old tires are burned (10 - 30 tons/day) to reduce fuel cost, also kiln dust is a problem and is presently being disposed.
Coal grinding and burning is by a direct system, so primary air volume is excessive, raising heat consumption and making heat control difficult. The construction of the present kiln burner has defects which makes it difficult to regulate flame condition resulting in difficult temperature control of the burning zone.
Since the cooling air volume control in the cooler is bad, secondary air temperature is very low, therefore, burning heat efficiency is very poor.
Owing to frequent shutdown, brick life is shortened as well as raising total maintenance cost.

### VII-1-4 Cement Grinding

Clinker storage has a maximum capacity of 25,000 tons which is equivalent to approximately 10 day stock.
Since there is no special pozzolana feed facility, feed facility is present being installed. Pozzolan cement is presently ground by using feed facilities of the two mills and operate only one mill.

### VII-1-5 Packing and Shipping

There are six packers, by the packed operation of all packers is only one half of the rated capacity. The equipment and instrumentation of the packing facility should be reviewed.

## VII-2 Possibility of Conversion of the Present Process Scheme into Dry Process Utilizing the New Suspension Preheater System

No technical problems exist in the renovation of this plant. The problem would be that during construction period, only one kiln (No.2 kiln) will be operating and when changing over to dry process (NSP) operation, the entire plant must be shutdown during changeover resulting in a decrease of yearly production.

### VII-2-1 Capacity After Renovation

The capacity after renovation shall be equivalent to the present capacity of 2,600 tons/day considering demand forecast, therefore after renovation, only No.1 kiln may be operated and No.2 kiln may be shutdown.

### VII-2-2 Kiln to be Converted

At present, the No.1 kiln line is frequently shutdown owing to cooler trouble, and the No.2 kiln is mostly operated, therefore, the conversion of No.1 kiln is proposed.

### VII-2-3 Proposed System

The burning system proposed for conversion is the NSP type which is the most up-to-date system with the best heat efficiency and burning operation condition.

The proposed system is to improve the present SP system by installing a calciner between the top cyclone and the bottom cyclone to burn the raw meal to raise decarbonation before feeding to the kiln. There are several types of such precalcining system which are all known as the NSP system.

In the NSP system, 4 - 5 stages of cyclones are arranged vertically, and raw meal fed in the top cyclone passes through the lower cyclones and calciner then collected in the bottom cyclone to be fed into the kiln. The kiln exhaust gas and calciner burned gas flows upward while exchanging heat with the raw meal and is discharged from the top cyclone throuth an exhaust fan, and by this heat exchange, the raw meal is decarbonated to over 90% (SP, 40 - 45%) .

Normally, the ratio of fuel fired in precalciner and in kiln is 6:4, but for SP modified NSP system, which is limited by the size of cyclone and kiln, the amount of fuel burned in kiln is higher than that in precalciner, also the heat consumption tends to be higher than an original NSP system. In the present renovation, the capacity is set at 2,600 tons/day, but the size of the kiln will permit the construction of a 4,000 - 4,500 tons/day NSP system which has better heat efficiency.

In a capacity of 2,600 tons/day, the amount of fuel necessary for burning in the kiln is larger than that in precalciner being about 60% of the total fuel owing to the large kiln diameter.

## VII-2-4 Outline of Renovation for Each Department

### VII-2-4-1 Raw Material Receiving Department

Raw material receiving department is not planned to be renovated, but the daily maintenance should be improved to assure receiving operation of over 400 tons/hour with the present facility.

### VII-2-4-2 Raw Material Grinding

In order to reduce construction cost, the present facility will be used as much as possible, but in the raw material department, only the slurry silo can be modified and used and other facilities cannot be used. The basic conditions and outline of the renovation are as follows:

- Mill shall be a vertical mill.

| | |
|---|---|
| Mill capacity | 220 tons/hour (dry base) |
| • Raw material silo | 12,300 $m^3$ (about 3 days supply) |
| Storage silo | 700 $m^3$ x 9 = 6,300 $m^3$ |
| | convert present slurry tank |
| Blending silo | 6,000 $m^3$ install one silo |

- Existing No.1 electrostatic precipitator will be used for kiln electrostatic precipitator. Dust generated during raw mill shutdown period (stabilizer & electrostatic precipitator dust) will be stored in a special dust tank (convert one of the present slurry tank).

  In order to maintain uniform raw material composition, raw material will be charged successively into eight storage silos (plus one dust tank) and stored raw material will be discharged simultaneously from all silos to homogenize the composition. The main flow of raw material will be as follows:

  mill → cyclone → storage silo → blending silo → weigher → NSP kiln.

- Since the composition of kiln electrostatic precipitator dust will differ between mill operating period and shutdown period, the following methods shall be taken.

  Mill operating period: mix with raw meal and charge into storage silo.

  Mill shutdown period (kiln operating): stabilizer and electrostatic precipitator dust is stored in the dust tank from where a constant volume is discharged and fed into the blending silo.
- In order to improve the blending accuracy of raw mateiral fed to the mill, all existing two mills will be replaced.

VII-2-4-3 Burning

The present Nos. 3, 4 & 5 roll platform of the present No.1 kiln will be used, but the kiln will be shortened to about 71m by cutting 5m of the kiln from the No.3 roller towards the discharge end and 8m from the No.5 roller towards the inlet end. All other rollers and foundations will be disassembled and removed. The NSP tower will be newly constructed immediately behind the No.5 roller, and other renovations will be as follows:

- Five stage cyclones will be installed in the NSP tower to improve heat efficiency.
- Present No.1 cooler will be disassembled and removed.
- A cooler and cooler EP will be newly installed.
- A new burning control room will be installed by extending the present burning control room floor.
- The coal mill be remodeled to an indirect system by utilizing one existing mill. Pulverized coal will be pumped through two routes, one to the kiln burner and the other to the calciner in the NSP tower.
- A new type kiln burner to burn of coal or oil will be installed together with a primary fan.
- An electric room will be installed next to the raw meal silo.
- A stabilizer will be installed for kiln operation when raw mill is shutdown.

### VII-2-4-4 Cement Grinding

Renovation will not be made in the cement grinding department, because an output of 70 tons/hour can be achieved by good maintenance and repair.

### VII-2-4-5 Packing and Shipment

Capacity of the system from silo discharging to packer bin feeding will be raised to 150 tons/hour maximum and operation of this system will be automated.

# SECTION VIII STUDY ON ELECTRIC POWER SOURCE TO THE ANTIPOLO PLANT

## VIII-1 Electric Power Supply System in the Philippines

The electric power resources are being exclusively developed by National Power Corporation (NPC) of the public sector which has constructed many thermopower and hydropower generating stations. On the other hand, electricity is being distributed to consumers by Manila Electric Company (MERALCO) of the private sector, several Electric Cooperatives and NPC itself. MERALCO is exclusively supplying electricity to consumers in her franchise area of Metro Manila and its vicinity. Electric Cooperatives are established to supply electricity and to increase electrification in certain areas. NPC is also supplying electricity to consumers mainly in rural areas not covered by other electric suppliers.

### VIII-1-1 National Power Corporation (NPC)

National Power Corporation (NPC) was established in 1936 by the Philippine government to develop electric power resources, both hydro- and geothermal power, in the Philippines. NPC is continuing to develop the scope of business operation according to the national development plans, and also is studying on possibilities of development of all kinds of electric power resources in the country. NPC, moreover, has set up transmission lines covering the whole country and is supplying electricity generated by the corporation to MERALCO and other Electric Cooperatives. NPC was operated under the supervision of Ministry of Energy (MOI) but after reorganization in November 1984 by the Presidential Executive Order No.982, the management of NPC is controlled by its president and five senior vice-presidents who are in charge of their respective department.
The number of NPC employees were 11,523 and sales revenue were 14,390 million pesos at the end of 1984.

### VIII-1-2 Manila Electric Company (MERALCO)

Three parties; Manila Electric Railroad and Lighting Company, Manila Surburban Railway Company and La Electricista, were merged to establish Manila Electric Company (MERALCO) in 1919. MERALCO later spun off the bus transportation department and also sold all power generating facilities to NPC by 1977, while is developing the transmission network to satisfy the increasing power demand in the franchise area.

MERALCO presently purchases electricity from NPC and supplies it to consumers within the area around Metro Manila. In 1984, MERALCO's energy sales reached about 84 billion kWh which is about 51% of the total amount of NPC's wholesales electricity.

### VIII-1-3 Electric Cooperatives

National Electrification Administration was established in 1969 to promote rural electrification in provinces and to assist in setting up Electric Cooperatives which supply electricity to consumers in their service areas. Big cooperatives are Visayan Electric Co., Davao Lighting and Power Co., Panay Electric Co., Zamboanga City Electric Co., Negros Occidental Electric Cooperative, Surigao Electric Cooperative, Cotabato Electric Cooperative, etc., therefore electricity is available in all provinces in the country through these cooperatives and other suppliers.

## VIII-2 Electrical Installation

### VIII-2-1 Power Generating Plant

The capacity of power generating plants of NPC at the end of 1984 was 5,196MW, and installation capacity by plant type and by region are shown respectively in Table 8-2-1 and Table 8-2-2.

Table 8-2-1 Installation Capacity of Power Generation by Plant Type

(Unit: MW)

| Plant Type \ Fiscal Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Oil-based thermal | 1,454 | 2,365 | 2,430 | 2,537 | 2,537 | 2,603 | 2,298 |
| Hydro | 731 | 928 | 940 | 940 | 1,267 | 1,564 | 1,654 |
| Geothermal | 3 | 223 | 446 | 501 | 559 | 784 | 894 |
| Coal | - | - | - | 50 | 50 | 50 | 350 |
| Total | 2,188 | 3,516 | 3,816 | 4,028 | 4,449 | 5,001 | 5,196 |

Source: 1984 Annual report of NPC

Table 8-2-2 Installation Capacity of Power Generation by Region

(Unit: MW)

| Region \ Fiscal Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Luzon | 1,902 | 2,994 | 3,226 | 3,281 | 3,636 | 3,906 | 4,101 |
| Visaya | 73 | 93 | 103 | 224 | 263 | 478 | 510 |
| Mindanao | 213 | 429 | 487 | 523 | 550 | 617 | 585 |
| Total | 2,188 | 3,516 | 3,816 | 4,028 | 4,449 | 5,001 | 5,196 |

Source: 1984 Annual report of NPC

## VIII-2-2 Transmission Lines

As to the voltage used for transmission lines in the Philippines, three voltages of 230kV, 115kV and 69kV are utilized in the Luzon island as shown in the attached drawing E-01 Luzon Grid Map of Power Supply and two voltages of 138kV and 69kV are used for both Visaya Grid and Mindanao Grid respectively.

Since NPC strongly promoted electrification in the country, the total length of transmission lines with more than 69kV was developed at a yearly growth rate of about 16% during the last seven years as shown in Table 8-2-3 and Table 8-2-4.

Table 8-2-3 Length of Transmission Lines

(Unit: circuit km)

| Voltage \ Fiscal Year | 1978 | 1879 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| 230 kV | 1,251 | 1,493 | 1,883 | 2,363 | 2,461 | 3,164 | 3,500 |
| 138 kV | 764 | 995 | 1,090 | 1,359 | 1,469 | 2,067 | 2,395 |
| 115 kV | 459 | 484 | 484 | 484 | 484 | 484 | 484 |
| 69 kV | 2,288 | 2,638 | 2,890 | 3,513 | 3,934 | 4,396 | 4,600 |
| Total | 4,762 | 5,610 | 6,347 | 7,719 | 8,348 | 10,111 | 10,979 |

Source: 1984 Annual report of NPC

Table 8-2-4 Installation Capacity of Substations

(Unit: MVA)

| Voltage \ Fiscal Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| 230 kV grid | 2,709 | 3,098 | 3,598 | 4,128 | 4,411 | 5,709 | 6,204 |
| 138 kV grid | 618 | 879 | 1,017 | 1,267 | 1,493 | 1,977 | 2,137 |
| 115 kV grid | 1,537 | 1,737 | 1,787 | 1,857 | 1,857 | 1,907 | 1,907 |
| 69 kV grid | 776 | 893 | 921 | 1,150 | 1,170 | 1,170 | 1,170 |
| Total | 5,640 | 6,607 | 7,323 | 8,402 | 8,931 | 10,763 | 11,418 |

Source: 1984 Annual report of NPC

Power supply voltage to small consumers in the Philippines is A.C. 115/230V, 60Hz, excluding certain rural areas using A.C. 125/215V.

## VIII-3 Power Demand and Supply

### VIII-3-1 Energy Generation

Energy generation in the Philippines recorded 18,666 x $10^6$ kWh at end of 1984. Both energy generation by plant type and by region are shown in Table 8-3-1 and Table 8-3-2 respectively.

Table 8-3-1 Energy Generation by Plant Type

(unit: $10^6$kWh)

| Plant Type \ Fiscal Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Oil-based thermal | 9,702 | 10,368 | 9,507 | 9,494 | 10,016 | 11,514 | 8,536 |
| (percent, %) | (78) | (74) | (63) | (59) | (58) | (61) | (46) |
| Hydro | 2,792 | 2,868 | 3,502 | 3,724 | 3,751 | 2,964 | 5,167 |
| (percent, %) | (22) | (21) | (23) | (23) | (21) | (16) | (28) |
| Geothermal | 3 | 657 | 2,077 | 2,770 | 3,586 | 4,093 | 4,540 |
| (percent, %) | ( 0) | ( 5) | (14) | (18) | (21) | (22) | (24) |
| Coal | 0 | 0 | 0 | 0 | 60 | 111 | 423 |
| (percent, %) | ( 0) | ( 0) | ( 0) | ( 0) | ( 0) | ( 1) | ( 2) |
| Total | 12,497 | 13,893 | 15,086 | 15,988 | 17,413 | 18,682 | 18,666 |
| (percent, %) | (100) | (100) | (100) | (100) | (100) | (100) | (100) |

Source: 1984 Annual report of NPC

Table 8-3-2 Energy Generation by Region

(unit: $10^6$kWh)

| Region \ Fiscal Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Luzon | 11,222 | 12,504 | 13,115 | 13,666 | 14,398 | 15,294 | 14,655 |
| Visaya | 230 | 240 | 321 | 503 | 777 | 1,057 | 1.177 |
| Mindanao | 1,045 | 1,146 | 1,650 | 1,819 | 2,238 | 2,331 | 2,834 |
| Total | 12,497 | 13,893 | 15,086 | 15,988 | 17,413 | 18,682 | 18,666 |

Source: 1984 Annual report of NPC

## VIII-3-2 Conditions of Energy Consumption

### VIII-3-2-1 Energy Consumption by Region

Energy consumption by region in the Philippines is shown in Table 8-3-3.

Table 8-3-3 Energy Consumption by Region

(unit: $10^6$kWh)

| Fiscal Year \ Region | Luzon | Visaya | Mindanao | Total |
|---|---|---|---|---|
| 1983 | 13,908 | 933 | 2,248 | 17,089 |
| 1984 | 13,245 | 1,020 | 2,741 | 17,006 |

Source: 1984 Annual report of NPC

### VIII-3-2-2 Energy Consumption by Consumer

As for energy consumption by consumer, a typical example of MERALCO, which is a franchise holder in Metro Manila and its vicinity, is shown in Table 8-3-4. As shown in the table, energy consumption, which had increased smoothly, decreased in 1984 by 8.7% from the previous year. The reason for the decrease was that the domestic economic activities in the Philippines slowed down in the year.

The energy consumption in industrial fields in 1984 declined by 14.1% from the preceeding year, slightly off the consumption of 2,764 x $10^6$ kWh in 1977. This fact exactly indicates how the industrial production activity decreased in 1984.

Table 8-3-4 Energy Consumption by Consumer Catergory

(unit: $10^9$kWh)

| Fisical Year / Consumer | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Industrial (percent, %) | 3.3 (40.2) | 3.1 (37.3) | 3.0 (35.7) | 3.2 (34.8) | 2.8 (33.3) |
| Commercial (percent, %) | 2.6 (31.7) | 2.7 (32.5) | 2.8 (33.3) | 3.0 (32.6) | 2.7 (32.1) |
| Residential (percent, %) | 2.2 (26.8) | 2.4 (28.9) | 2.5 (29.8) | 2.9 (31.5) | 2.9 (34.6) |
| Others (percent, %) | 0.1 (1.3) | 0.1 (1.3) | 0.1 (1.2) | 0.1 (1.1) | - ( - ) |
| Total (percent, %) | 8.2 (100) | 8.3 (100) | 8.4 (100) | 9.2 (100) | 8.4 (100) |

Source: 1984 Annual report of MERALCO

The numbers of energy consumers purchasing from MERALCO are shown by category in Table 8-3-5.

Table 8-3-5 Energy Consumers by Category

(unit: $10^3$)

| Fiscal Year / Consumer | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Industrial | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 |
| Commercial | 111.5 | 114.1 | 120.7 | 128.9 | 132.4 |
| Residential | 822.4 | 881.9 | 962.2 | 1,078.9 | 1,163.8 |
| Others | 0.9 | 0.9 | 1.1 | 1.3 | 1.5 |
| Total | 938.0 | 1,000.2 | 1,087.4 | 1,212.6 | 1,301.3 |

Source: 1984 Annual report of MERALCO

VIII-3-2-3 Monthly Energy Consumption

Monthly energy consumption supplied by MERALCO in 1983 and 1984 are shown in Table 8-3-6.

Table 8-3-6 Monthly Energy Consumption

(unit: $10^6$kWh)

| Month \ Year | 1983 | 1984 |
|---|---|---|
| January | 651 | 622 |
| February | 855 | 817 |
| March | 826 | 774 |
| April | 901 | 869 |
| May | 921 | 853 |
| June | 989 | 873 |
| July | 880 | 835 |
| August | 900 | 852 |
| September | 917 | 824 |
| October | 884 | 816 |
| November | 871 | 812 |
| December | 891 | 853 |
| Average | 874 | 817 |

Source: 1984 Annual report of NPC

## VIII-3-2-4 Maximum Power Demand

Maximum power demand of each electric grid in the Philippines are respectively shown in Table 8-3-7.

Table 8-3-7 Maximum Power Demand Transition

(unit: MW)

| Network \ Fiscal Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Luzon grid | 1,780 | 1,926 | 2,074 | 2,225 | 2,364 | 2,478 | 2,374 |
| Cebu grid | 33 | 22 | 35 | 66 | 88 | 105 | 98 |
| Negros grid | 5 | 6 | 7 | 26 | 30 | 46 | 48 |
| Bohol grid | 3 | 3 | 4 | 5 | 7 | 8 | 8 |
| Leyte grid | 1 | 1 | 2 | 2 | 16 | 45 | 50 |
| Panay grid | - | 10 | 19 | 25 | 21 | 25 | 38 |
| Agus grid | 174 | 195 | 264 | 298 | 371 | 394 | 433* |
| Santos grid | - | - | 9 | 13 | 16 | 16 | - |

Source: 1984 Annual report of NPC

Note 1.* : Both grids of Agus and Santos were interconnected in May, 1984.

## VIII-4 Development of Power Resources

Electrification in the Philippines has been proceeding remarkably due to increase of energy generation capacity which showed a growth rate of about 237% from 1977 to 1984. Main power resource development projects under construction at end of December, 1984 are listed in Table 8-4-1.

Table 8-4-1 Main Development Projects of Power Resources

(as end of 1984)

| Region | Plant Name | Type | Output (MW) | Q'ty |
|---|---|---|---|---|
| Luzon | Phil. Nuclear | Nuclear | 620 | 1 |
| Visaya | Cebu Coal | Coal | 55 | 1 |
| | Iloilo Burgi | Thermal | 8 | 4 |
| | Zamboanga Burgi | Thermal | 8 | 4 |
| | Pulangui | Hydro | 85 | 3 |
| Mindanao | Agus I | Hydro | 40 | 2 |
| | Agus IV | Hydro | 50 | 3 |
| | Agus V | Hydro | 27.5 | 2 |

Source: 1984 Annual report of NPC

## VIII-5 Forecast of Power Demand

### VIII-5-1 Energy Consumption

According to the NPC's report on energy consumption forecast made in January, 1986, which has not been authorized yet, average annual growth rate is estimated to be about 6% for five years from 1986 to 1990 and about 6.2% for five years from 1991 to 1995. Forecast of energy consumption by region is shown in Table 8-5-1.

Table 8-5-1 Forecast of Energy Consumption by Region*

(unit: $10^6$kWh)

| Year \ Region | Luzon | Visaya | Mindanao | Total |
|---|---|---|---|---|
| 1985 | 12,900 | 1,030 | 2,828 | 16,758 |
| 1986 | 13,030 | 1,066 | 3,090 | 17,186 |
| 1987 | 13,291 | 1,325 | 3,596 | 18,212 |
| 1988 | 13,823 | 1,661 | 4,103 | 19,587 |
| 1989 | 14,514 | 2,000 | 4,380 | 20,894 |
| 1990 | 15,385 | 2,157 | 4,896 | 22,438 |
| 1991 | 16,308 | 2,330 | 5,267 | 23,905 |
| 1992 | 17,286 | 2,519 | 5,344 | 25,149 |
| 1993 | 18,323 | 2,669 | 5,829 | 26,821 |
| 1994 | 19,422 | 2,837 | 6,349 | 28,608 |
| 1995 | 20,587 | 3,037 | 6,630 | 30,254 |

Source: NPC

Note 1.*: Figures mean sales amount.

## VIII-5-2 Maximum Demand

According to the NPC's unofficial paper on forecast of maximum demand on sales level made in January, 1986, the forecast of maximum demand is as shown in Table 8-5-2.

Table 8-5-2 Forecast of Power Demand

(unit: MW)

| Year \ Region | Luzon | Visaya | | | | Mindanao |
|---|---|---|---|---|---|---|
| | | Cebu | Negros | Leyte | Bohol | |
| 1985 | 2,375 | - | - | - | - | 579 |
| 1986 | 2,399 | - | 46 | - | - | 628 |
| 1987 | 2,447 | 133 | 48 | 73 | 11 | 719 |
| 1988 | 2,545 | 153 | 80 | 78 | 11 | 813 |
| 1989 | 2,672 | 174 | 122 | 79 | 11 | 865 |
| 1990 | 2,833 | 198 | 126 | 80 | 11 | 962 |
| 1991 | 3,003 | 219 | 131 | 81 | 11 | 1,025 |
| 1992 | 3,183 | 239 | 140 | 85 | 12 | 1,079 |
| 1993 | 3,374 | 254 | 147 | 90 | 12 | 1,125 |
| 1994 | 3,576 | 266 | 156 | 98 | 13 | 1,214 |
| 1995 | 3,791 | 278 | 168 | 108 | 14 | 1,264 |

Source: NPC

## VIII-5-3 Energy Generation by Plant Type

According to the NPC's unofficial report on forecast of the energy generation made in January, 1986, the energy generation by plant type is estimated as shown in Table 8-5-3.

Judging from the table, NPC estimates that the biggest yearly growth rate by plant type during the ten years from 1986 to 1995 is in coal-based energy generation which amount will be about 3.9 times in ten years. On the other hand, the nuclear power plant will start in operation in 1986 and amount of nuclear energy generation will increase to about 2.6 times in ten years.

Table 8-5-3 Forecast of Energy Generation by Plant Type

(unit: $10^6$kWh)

| Year \ Plant | Hydro | Geo-thermal | Coal | Nuclear | Oil-based | Total |
|---|---|---|---|---|---|---|
| 1986 | 5,725 | 5,255 | 1,922 | 1,315 | 4,842 | 19,059 |
| 1987 | 6,545 | 4,749 | 1,767 | 2,564 | 4,767 | 20,392 |
| 1988 | 6,945 | 5,152 | 1,816 | 3,132 | 4,835 | 21,880 |
| 1989 | 6,959 | 5,401 | 1,984 | 3,415 | 5,256 | 23,015 |
| 1990 | 6,960 | 5,453 | 2,159 | 3,415 | 6,583 | 24,570 |
| 1991 | 6,960 | 6,194 | 2,777 | 3,415 | 6,681 | 26,027 |
| 1992 | 6,960 | 6,221 | 3,457 | 3,415 | 7,350 | 27,402 |
| 1993 | 8,128 | 6,235 | 4,350 | 3,415 | 6,771 | 28,899 |
| 1994 | 8,128 | 6,390 | 5,261 | 3,415 | 7,533 | 30,727 |
| 1995 | 8,128 | 6,417 | 7,459 | 3,415 | 6,972 | 32,391 |

Source: NPC

For reference, the forecast of energy generation connected to the Luzon Grid is shown in Table 8-5-4.

Table 8-5-4 Forecast of Energy Generation to Luzon Grid

(unit: $10^6$kWh)

| Year \ Region | Hydro | Geo-thermal | Coal | Nuclear | Oil-based | Total |
|---|---|---|---|---|---|---|
| 1986 | 2,559 | 4,597 | 1,626 | 1,315 | 4,343 | 14,440 |
| 1987 | 2,750 | 4,013 | 1,298 | 2,564 | 4,121 | 14,746 |
| 1988 | 2,750 | 4,073 | 1,344 | 3,132 | 4,013 | 15,312 |
| 1989 | 2,750 | 4,125 | 1,509 | 3,415 | 4,281 | 16,080 |
| 1990 | 2,750 | 4,158 | 1,671 | 3,415 | 5,009 | 17,003 |
| 1991 | 2,750 | 4,882 | 1,696 | 3,415 | 5,277 | 18,020 |
| 1992 | 2,750 | 4,892 | 1,795 | 3,415 | 6,213 | 19,065 |
| 1993 | 2,904 | 4,890 | 2,992 | 3,415 | 6,014 | 20,215 |
| 1994 | 2,904 | 4,895 | 3,608 | 3,415 | 6,584 | 21,406 |
| 1995 | 2,904 | 4,895 | 5,351 | 3,415 | 6,155 | 22,720 |

Source: NPC

## VIII-5-4 Number of Consumers

MERALCO estimated the yearly growth rate of number of consumers in the franchise area as shown in the following table. The actual result in 1985, however, seems to be lower than the figure in the table due to the decline of domestic economy.

Table 8-5-5 Forecast in Number of Consumers

(unit: $10^3$)

| Category / Year | Industrial (groth rate,%) | Commercial (groth rate,%) | Residential (groth rate,%) | Others (groth rate,%) | Total (groth rate,%) |
|---|---|---|---|---|---|
| 1985 | 3.7 (3.5) | 139.0 (5.0) | 1,313.2 (12.8) | 2.1 (40.0) | 1,458.0 (12.0) |
| 1986 | 3.9 (4.5) | 146.2 (5.2) | 1,397.2 (6.4) | 2.3 (9.0) | 1,549.7 (6.3) |
| 1987 | 4.1 (5.0) | 154.1 (5.4) | 1,482.4 (6.1) | 2.5 (8.0) | 1,643.2 (6.0) |
| 1988 | 4.3 (5.5) | 162.8 (5.6) | 1,568.4 (5.8) | 2.7 (7.0) | 1,738.2 (5.8) |
| 1989 | 4.6 (6.0) | 172.2 (5.8) | 1,654.7 (5.5) | 2.9 (6.0) | 1,834.3 (5.5) |
| 1990 | 4.9 (6.5) | 182.5 (6.0) | 1,737.4 (5.0) | 3.0 (5.0) | 1,927.8 (5.1) |

Source: MERALCO

## VIII-6 Electricity Charges

### VIII-6-1 Electricity Charges of NPC

There is a big difference in electricity charges among regions in the Philippines as shown in Table 8-6-1. The main reason is that there are some differences in energy generation cost by plant type. The electricity charge is cheapest in the Mindanao region where the energy generation is mainly by hydropower, and to the contrary it is highest in the Visaya region where the energy generation is mainly by small-sized diesel generators.
Difference in charges between the two regions amounted to about 2.67 times in 1984.

Table 8-6-1 Average Electricity Charge of NPC

(unit: Pesos/kWh)

| Region \ Fiscal Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Luzon | 0.1816 | 0.2278 | 0.3640 | 0.4480 | 0.4670 | 0.6152 | 0.9741 |
| Visaya | 0.2949 | 0.3080 | 0.4062 | 0.4982 | 0.5444 | 0.7245 | 0.9980 |
| Mindanao | 0.1100 | 0.1366 | 0.1651 | 0.1800 | 0.1859 | 0.2996 | 0.3732 |
| Average in whole islands | 0.1723 | 0.2212 | 0.3422 | 0.4166 | 0.4299 | 0.5790 | 0.8754 |

Source: 1984 Annual report of NPC

## VIII-6-2 Electricity Charge System

### VIII-6-2-1 Electricity Charge System of NPC

There is much difference among regions in the electricity charges of NPC as shown in Table 8-6-1, and the electricity charges rapidly rose to the higher level recently. The reason is that NPC is adopting a system where electricity charges are mainly calculated based on the actual cost of energy generation as stated below.

(1) Sales charge

Sales charge is determined monthly after making fuel cost adjustment, monthly foreign currency exchange rate adjustment, etc. The unit sales price is in principal calculated by the following formula;

$$SUP = BUP + FCA + SCA + FEA$$

where,
SUP : Sales unit price in Peso/kWh
BUP : Basic unit price in Peso/kWh
FCA : Fuel cost adjustment in Peso/kWh
SCA : Steam cost adjustment in Peso/kWh
FEA : Foreign currency exchange rate adjustment in Peso/kWh

Unit sales price of electricity as of December, 1985 is listed in the following table.

Table 8-6-2 Details of Electricity Unit Sales Price (as of Dec., 1985)

(Unit: Peso/kWh)

| | BUP | FCA | SCA | FEA | Total |
|---|---|---|---|---|---|
| Unit sales price | 1.0586 | 0.0055 | 0.0059 | 0.1796 | 1.2496 |

Source: NPC

(2) Basic unit price

Basic unit price of electricity is determined to cover the cost of energy generation by NPC, and due to the high increase of fuel cost, a certain amount of the fuel cost adjustment was transferred to the basic unit price on July 26, 1984 resulting in the figure in Table 8-6-2.

(3) Fuel cost adjustment

The fuel cost adjustment charge is for adjustment of cost difference between the actual and the base price of fuel used by NPC to generate electricity. The base price of fuel in each grid is listed in the following table.

Table 8-6-3 Base Price of Fuel for Energy Generation

| Application | | Unit | Base Price |
|---|---|---|---|
| Fuel oil | Luzon grid | Peso/$10^6$BTU | 108.2064 |
| | Cebu grid | Peso/ℓ | 4.7842 |
| | Negros grid | Peso/ℓ | 3.6276 |
| | Bohol grid | Peso/ℓ | 4.8450 |
| | Panay grid | Peso/ℓ | 4.8527 |
| | Mindanao grid | Peso/ℓ | 4.8683 |
| Steam | Luzon grid | Peso/kWh | 0.2526 |
| Coal | Cebu grid | Peso/ℓ * | 455 |

Source: NPC

Note 1. *: Base price is applied to equivalent coal with calorific value of 5555 kcal/kg.

In addition, the cost transition of fuel purchased by NPC is shown at 1977 prices in Table 8-6-4 for reference. The transition, moreover, of the average electricity unit charge at 1977 prices is shown in Table 8-6-5.

As shown in the tables, the escalation rate of electricity unit charge is equivalent to 95.9% of that of fuel cost.

Table 8-6-4 Transition of Fuel Unit Cost
(as costs of 1978) (Unit: Peso/ℓ)

| Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Fuel unit price | 0.6181 | 0.6567 | 0.9037 | 1.0129 | 0.9527 | 0.9997 | 1.1437 |
| Index (%) | 100 | 106.2 | 146.2 | 163.9 | 154.1 | 161.7 | 185.0 |

Source: 1984 Annual report of NPC

Table 8-6-5 Average Electricity Unit Charge
(as costs of 1978)

| Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Electricity unit charge | 0.1723 | 0.1883 | 0.2464 | 0.2652 | 0.2482 | 0.3039 | 0.3057 |
| Index (%) | 100 | 109.3 | 143.0 | 153.9 | 144.1 | 176.4 | 177.4 |

Source: 1984 Annual report of NPC

(4) Steam cost adjustment

The steam cost adjustment charge is to adjust the difference between the actual and the base price of steam used by NPC to generate electricity in the same way as for the fuel cost adjustment. The amount of steam cost adjustment was 0.006 pesos per kilowatthour in 1983 and 0.013 pesos per kilowatthour in 1984.

(5) Foreign currency exchange rate adjustment

The foreign currency exchange rate adjustment is to adjust the difference between the actual and the base cost of energy generation, caused by variation of actual fuel cost due to the floating currency exchange rate.

This adjustment was made by reducing or increasing at the rate of 0.33% of basic unit price for each full 0.1 peso decrease below or increase above 14 pesos to one U.S.dollar. Currency exchange rate to U.S.dollar and foreign currency exchange rate adjustment are shown in Table 8-6-6.

Table 8-6-6 Currency Exchange Rate and FEA Adjustment

| Month | Exchange rate (Peso/U.S.$) | FEA rate (%) | FEA charge* (Peso/kWh) |
|---|---|---|---|
| 1984 November | 20.320 | 20.79 | 0.2201 |
| December | 20.455 | 21.12 | 0.2236 |
| 1985 Janauary | 19.536 | 18.15 | 0.1921 |
| February | 18.620 | 15.18 | 0.1607 |
| March | 18.847 | 15.84 | 0.1677 |
| April | 18.895 | 15.84 | 0.1677 |
| May | 18.942 | 16.17 | 0.1712 |
| June | 18.944 | 16.17 | 0.1712 |
| July | 19.138 | 16.83 | 0.1782 |
| August | 19.163 | 16.83 | 0.1782 |

Source: MERALCO
Note 1. *: Figures are calculated based on figures in Table 8-6-2.

(6) Other adjustment

(i) Power factor adjustment

When the consumer's average monthly power factor is less or more than 85% (lagging), this power factor adjustment is applied to the demand charge by reducing or increasing at the rate of 1% for each full 1% decrease below or increase above 85%. (A power factor of above 95% is considered as 95% in the adjustment.)

(ii) Primary voltage discount

Electricity charge is given a discount equal to the following table in accordance with the primary voltage of consumers.

Table 8-6-7 Voltage Discount

| Receiving voltage | Discount rate (%) |
|---|---|
| less than 69kV | 0 |
| 69kV | 2.5 |
| 115/138kV | 3.0 |
| 230kV and more | 3.5 |

Source: NPC

VIII-6-2-2 Electricity Charge System of MERALCO

The electricity charge system of MERALCO is basically the same as that of NPC, but the electricity charge to industrial consumers is especially much higher than that of NPC due to the subsidiary policy to small consumers in the area.

The MERALCO's electricity charge system is complicated being different for user categories such as general service, residential service, hospital, street lighting, general power, etc. For example, the electricity charge system for general power with monthly consumption of more than 40kWh is described below.

(1) Generation charge

The generation charge is determined by adding the franchise tax and the subsidizing amount to the electricity cost purchased from NPC. Actual generation charge is shown in the following table.

Table 8-6-8 Generation Charge

(Unit: Peso/kWh)

| Month | Generation charge |
|---|---|
| 1984 December | 1.9850 |
| 1985 January | 1.8525 |
| February | 1.8100 |
| March | 1.9900 |
| April | 1.8320 |
| May | 1.8210 |
| June | 1.8980 |
| July | 2.0750 |
| August | 2.0550 |
| September | 1.9750 |
| October | 2.0820 |
| November | 2.1950 |
| December | 2.3450 |

Souce: MERALCO

(2) Distribution charge

The distribution charge is the sum of the figures respectively computed as below.

(i) Demand charge

12.60 peso per kW

(ii) Energy charge

The following rate is applied to energy under the assumption that the billing demand power continues during the following hours.

| | |
|---|---|
| For first 200 hours | 0.25 peso/kWh |
| For next 200 hours | 0.23 peso/kWh |
| For next 100 hours | 0.22 peso/kWh |
| For next 100 hours | 0.21 peso/kWh |
| For excess kWh | 0.20 peso/kWh |

(3) Foreign currency exchange rate adjustment

As stated in the clause VIII-6-2-1(5), the electricity charge is adjusted according to the foreign currency exchange rate. This adjustment is applied to the distribution charge in case of MERALCO.

(4) Other adjustment

(i) Power factor adjustment

The following rates are applied to calculate the billing amount of energy consumption according to the consumer's actual monthly power factor.

Table 8-6-9 Power Factor Adjustment Rate

| Monthly power factor | Adjustment rate |
|---|---|
| 0.95 ∿ 1.00 | 0.951 |
| 0.90 ∿ 0.95 less | 0.965 |
| 0.85 ∿ 0.90 less | 0.981 |
| 0.80 ∿ 0.85 less | 1.000 |
| 0.75 ∿ 0.80 less | 1.023 |
| 0.70 ∿ 0.75 less | 1.050 |
| 0.65 ∿ 0.70 less | 1.0835 |
| 0.60 ∿ 0.65 less | 1.1255 |
| 0.55 ∿ 0.60 less | 1.1785 |
| 0.50 ∿ 0.55 less | 1.2485 |
| 0.50 less | 1.3335 |

Source: MERALCO

(ii) Primary metering discount

This discount is applied to the consumer when he owns a substation and the energy is measured at the voltage level of the supply side. The discount rate is 3.42% of the distribution charges.

(iii) Bulk sales discount

This discount is applied to the energy consumption which exceeds the amount corresponding to that consumed with the monthly maximum demand for 200 hours. The formula for calculation is as follows.

(a) For number of hours exceeding 200 but not over 400:

$$\text{Discount}(\%) = 0.0695 \times (\text{Hr}-200) \times (1-\frac{200}{\text{Demand}})$$

(b) For number of hours exceeding 400:

$$\text{Discount}(\%) = [13.9+0.0257(\text{Hr}-400)] \times (1-\frac{200}{\text{Demand}})$$

Note: Hr= (Energy consumption) ÷ (Demand)

VIII-6-3 Forecast of Electricity Charge

Since the electricity charge in the Philippines consists of a system covering the entire costs of energy generation as previously stated, therefore fuel oil price and foreign currency exchange rate directly affect the electricity charge. It is, therefore, very difficult to forecast the future electricity charge because of unstable economic conditions surrounding the Philippines. MERALCO, however, prepared the following forecast on future electricity charge.

Table 8-6-10 Forecast of Average Electricity Charge

| Category \ Year | Unit | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|
| Industrial (growth rate %) | Peso/kWh | 2.1800 (100) | 2.6824 (123.0) | 3.0525 (113.8) | 3.2082 (105.1) | 3.3176 (103.4) | 3.4274 (103.3) |
| Commercial (growth rate %) | Peso/kWh | 2.1222 (100) | 2.6098 (123.0) | 2.9712 (113.0) | 3.1274 (105.3) | 3.2405 (103.6) | 3.3537 (103.5) |
| Residential (growth rate %) | Peso/kWh | 0.9477 (100) | 1.2826 (135.3) | 1.6468 (128.4) | 1.9542 (118.7) | 2.2639 (115.8) | 2.5986 (114.8) |
| Average (growth rate %) | Peso/kWh | 1.6941 (100) | 2.1233 (125.3) | 2.4829 (116.9) | 2.6924 (108.4) | 2.8768 (106.8) | 3.0713 (106.8) |
| Purchase (growth rate %) | Peso/kWh | 1.2496* (100) | 1.5009 (120.1) | 1.7830 (118.8) | 1.9416 (108.9) | 2.0833 (107.3) | 2.2332 (107.2) |
| Foreign currency exchange rate | Peso/$ | 18.45** | 22.93 | 24.25 | 25.65 | 27.13 | 28.69 |

Source: MERALCO

Note 1. *: The figure comes from NPC (Refer to Table 8-6-2)

2. **: Average figure from January to June, 1985 as per Central Bank.

## VIII-7 Power Conditions Surrounding the Plant

### VIII-7-1 Number of Consumers

The transition of number of electricity consumers in Teresa and Antipolo areas in the vicinity of the ICC Antipolo plant are shown in the following table.

Table 8-7-1 Number of Electricity Consumers Surrounding the Plant

(unit: Nos.)

| Area | Category \ Year | 1981 | 1982 | 1883 | 1984 | 1985 |
|---|---|---|---|---|---|---|
| Antipolo | Industrial | 27 | 31 | 28 | 30 | 31 |
| | Commercial | 651 | 688 | 777 | 748 | 779 |
| | Residential | 5,683 | 6,613 | 7,569 | 8,301 | 8,785 |
| | Other | 31 | 35 | 36 | 38 | 39 |
| | Total | 6,392 | 7,367 | 8,410 | 9,117 | 9,634 |
| Teresa | Industrial | 3 | 7 | 7 | 7 | 9 |
| | Commercial | 98 | 121 | 139 | 143 | 163 |
| | Residential | 1,364 | 1,463 | 1,537 | 1,597 | 1,730 |
| | Other | 0 | 2 | - | - | 6 |
| | Total | 1,465 | 1,593 | 1,683 | 1,747 | 1,908 |

Source: MERALCO

### VIII-7-2 Feeder Load

The Antipolo plant can presently receive electricity on the distribution voltage of 34.5kV through either the Teresa substation or the Dolores substation, and historical loads through the both substations for the past five years are shown respectively in Table 8-7-2.

Table 8-7-2 Load of Feeder to the Plant

(unit: MVA)

| Feeder \ Year | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| Teresa (41XJ circuit) | 12.85 | 14.34 | 14.94 | 14.34 | 11.95 |
| Dolores (45XM circuit) | 6.57 | 5.98 | 7.17 | 6.57 | 4.78 |

A capacity of the substation is 50MVA for the Teresa substation and 10MVA for the Dolores substation.

## VIII-7-3 Number of Power Interruption

The number of power interruption frequency rate and comulative interruption time which occured on the distribution feeder to the Antipolo plant are listed in Table 8-7-3. The average number of interruption is very big as shown in the table which shows 24.68~38.29 hours for cumulative interruption time and 30.73~47.94 times for interruption frequency rate which are the average number of times experienced by each consumer in 1985.

Table 8-7-3 Interruption Frequency and Hours

| | | 1981 | 1982 | 1983 | 1984 | 1985 | Average |
|---|---|---|---|---|---|---|---|
| Teresa (41XJ) | IFR * (Nos.) | 10.17 | 29.00 | 34.71 | 33.05 | 30.73 | 27.53 |
| | CIT ** (Hours) | 8.12 | 25.75 | 34.72 | 29.73 | 38.29 | 27.32 |
| Dolores (45XM) | IFR * (Nos.) | 37.00 | 50.80 | 43.22 | 41.67 | 47.94 | 44.13 |
| | CIT ** (Hours) | 21.50 | 35.81 | 37.53 | 23.35 | 24.68 | 28.57 |

Source: MERALCO

Note 1.*: Interruption frequency rate in average number of times experienced by each consumer.

**: Commulative interruption time in hours.

## VIII-8 Present Condition of Power Consumption in Antipolo Plant

### VIII-8-1 Receiving Facilities

There are five sets of transformer with a capacity of 5,000kVA as power receiving facilities in the Antipolo plant as shown in the attached drawing E-02. Judging from the present power consumption, these facilities seem to be sufficient for production increase up to 3,500 tons clinker per day.

### VIII-8-2 Power Generating Facilities

Power generating facilities with the following outlined specification exist as emergency power generators during MERALCO's power failure. Each generator is interconnected to each other as shown in the attached drawing E-02 Single Line Diagram.

Table 8-8-1 Outline Specification of Generator

| Generator | No. 1 | No. 2 | No. 3 | No. 4 | Total |
|---|---|---|---|---|---|
| Rated output (kVA) | 875 | 750 | 750 | 5,712.5 | 8,087.5 |
| Voltage (V) | 4,160 | 460 | 460 | 4,160 | - |
| Power factor (%) | 80 | 80 | 80 | 80 | - |
| Rotation speed (rpm) | 720 | 720 | 720 | 514 | - |
| Excitor output (kW) | 9.75 | 10 | 7.5 | 25 | - |
| Excitor voltage (V) | 150 | 135 | 125 | 125 | - |

Source: ICC

The No.1 generator is mainly operated as emergency power supplier during power interruption, while other generators are used for trial operation after adjustment.

Specific fuel consumptions excluding that for operation of less than 30 minutes are shown in the following table. These specific fuel consumptions are reasonable, judging from the small size of the generator capacity.

Table 8-8-2 Actual Results of Specific Fuel Consumption by Generator

| Month | Operating Time (Hours) | Energy Generation (kWh) | Hourly Output (kW) | Fuel Consumption (ℓ) | Specific Fuel Consumption (ℓ/kWh) |
|---|---|---|---|---|---|
| 1983 May | 17.95 | 5,568.1 | 310.2 | 1,561.7 | 0.280 |
| June | 7.25 | 3,112.5 | 429.3 | 954.1 | 0.307 |
| July | 39.72 | 18,635.0 | 469.2 | 6,572.3 | 0.353 |
| August | 20.25 | 9,683.5 | 478.2 | 3,292.7 | 0.340 |
| September | 32.28 | 16,132.6 | 499.8 | 6,012.0 | 0.373 |
| October | 0.50 | 199.8 | 399.6 | 109.6 | 0.548 |
| November | 13.00 | 6,505.2 | 500.4 | 2,028.0 | 0.312 |
| December | 0 | 0 | 0 | 0 | 0 |
| 1984 January | 0.78 | 243.1 | 311.7 | 240.1 | 0.988 |
| February | 0 | 0 | 0 | 0 | 0 |
| March | 36.43 | 18,782.1 | 515.6 | 6,320.2 | 0.337 |
| April | 10.00 | 2,215.2 | 221.5 | 900.0 | 0.406 |
| May | 16.07 | 4,023.8 | 250.4 | 2,273.2 | 0.565 |
| June | 0.78 | 109.3 | 140.0 | 122.6 | 1.122 |
| July | 7.70 | 3,741.4 | 485.9 | 1,155.0 | 0.309 |
| August | 0.92 | 281.6 | 306.1 | 148.5 | 0.527 |
| Average | 12.73 | 5,577.4 | 438.1 | 1,980.6 | 0.355 |

Source: ICC
Note: Results since September, 1984 are excluded from the above table because of a lack of records on energy generation.

VIII-8-3 Electric Consumer

The departmentwise electric consumers in the Antipolo plant are as shown in the following table.

Table 8-8-3 Capacity of Electric Consumer

| Department | Nos. of consumer | | | Installation capacity (kW) | | |
|---|---|---|---|---|---|---|
| | High voltage | Low voltage | Total | High voltage | Low voltage | Total |
| Raw material receiving | 3 | 13 | 16 | 780 | 167.7 | 947.7 |
| Material storage | 0 | 21 | 21 | 0 | 340.8 | 340.8 |
| No.1 Raw mill | 4 | 12 | 16 | 2,840 | 40.4 | 2,880.4 |
| No.2 Raw mill | 3 | 12 | 15 | 2,745 | 40.5 | 2,785.5 |
| No.1 Burning | 4 | 31 | 35 | 1,270 | 890.9 | 2,160.9 |
| No.2 Burning | 4 | 48 | 52 | 1,445 | 1,200.1 | 2,645.1 |
| No.1 Finish mill | 6 | 17 | 23 | 3,270 | 136.0 | 3,406.0 |
| No.2 Finish mill | 6 | 17 | 23 | 3,270 | 133.7 | 3,403.7 |
| Compressor room | 1 | 7 | 8 | 180 | 361.0 | 541.0 |
| Blending silo | 2 | 5 | 7 | 190 | 34.4 | 224.4 |
| Slurry basin | 3 | 7 | 10 | 285 | 97.5 | 382.5 |
| Water pump | 0 | 5 | 5 | 0 | 319.0 | 319.0 |
| No.1 Packing | 0 | 25 | 25 | 0 | 248.2 | 248.2 |
| No.2 Packing | 0 | 23 | 23 | 0 | 216.0 | 216.0 |
| Coal | 4 | 6 | 10 | 1,360 | 40.5 | 1,400.5 |
| Total | 40 | 249 | 289 | 17,635 | 4,266.7 | 21,901.7 |

Source: ICC

(Note) High voltage : 4,160 V

Low voltage : 440 V

Judging from the above table, the installation capacity is reasonable because the specific installation capacity per clinker production is calculated at 202.2 kW/t/h-clinker which is nearly the same as the figure, 175∼200 kW/t/h-clinker, of Japanese cement plant with almost the same production capacity.

### VIII-8-4 Power Consumption

#### VIII-8-4-1 Power demand

The records of power demand at the Antipolo plant are shown in Table 8-8-4. The reason why the power demand in 1985 decreased from previous years is that only one finish mill was operated due to stagnation of cement demand in the country.

Table 8-8-4 Actual Records of Power Demand

(Unit: kW)

| Month \ Year | 1983 | 1984 | 1985 |
|---|---|---|---|
| Janauary | 15,000 | 11,280 | 6,720 |
| February | 14,040 | 14,160 | 9,600 |
| March | 14,640 | 17,040 | 9,600 |
| April | 15,840 | 14,880 | - |
| May | 16,800 | 9,240 | 12,360 |
| June | 16,440 | 11,880 | 9,360 |
| July | 14,400 | 12,960 | 9,360 |
| August | 15,960 | 12,000 | 9,240 |
| September | 13,680 | - | 9,240 |
| October | 15,960 | - | 6,240 |
| November | 15,960 | - | 6,840 |
| December | 15,600 | - | 9,600 |
| Average | 15,360 | 12,930 | 8,920 |

Source : ICC

Table 8-8-5 Departmentwise Unit Power Consumption

(Unit: kWh/t-cement)

| Month / Dept. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | * Nov. | Arith-matic average | Typical example in Japan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Raw Material receiving | 0 | 1.98 | 1.84 | 1.96 | 1.86 | 2.16 | 2.20 | 2.19 | 2.04 | 2.37 | 0.03 | 2.07 | 33.7 |
| Raw material grinding | 41.51 | 48.19 | 41.37 | 34.81 | 43.83 | 40.13 | 44.83 | 42.47 | 42.77 | 41.23 | 39.48 | 42.11 | |
| Burning | 30.12 | 25.61 | 23.35 | 23.80 | 24.62 | 24.57 | 28.95 | 24.61 | 25.01 | 26.60 | 0 | 25.72 | 25.4 |
| Coal | 4.62 | 6.63 | 5.49 | 5.63 | 6.10 | 6.17 | 7.45 | 7.35 | 6.28 | 6.40 | 0 | 6.21 | 4.9 |
| Finish mill | 49.22 | 53.60 | 52.93 | 51.35 | 53.41 | 55.66 | 54.27 | 56.12 | 52.51 | 51.83 | 54.30 | 53.09 | 46.9 |
| Packing | 3.86 | 2.58 | 2.06 | 2.19 | 2.17 | 2.01 | 1.99 | 2.00 | 2.07 | 2.38 | 2.16 | 2.33 | 1.1 |
| Utility ** | 21.52 | 13.32 | 6.76 | 8.30 | 5.54 | 7.49 | 7.13 | 7.22 | 5.30 | 7.96 | 4.05 | 9.05 | 1.6 |
| Administration | 4.21 | 0.97 | 0.44 | 0.40 | 0.28 | 0.34 | 0.39 | 0.58 | 0.37 | 0.52 | 0.67 | 0.85 | |
| Total | 155.06 | 152.88 | 134.24 | 128.44 | 137.81 | 138.53 | 147.21 | 142.54 | 136.35 | 139.29 | 100.70 | 141.43 | 113.6 |

Source: ICC

Note 1. * : Results of Nov. are excluded from calculation of average figures.
2. ** : Utility Dept. includes electric consumers in sections of water pump, material storage and workshop.

### VIII-8-4-2 Power consumption

The actual results of departmentwise unit power consumption per cement in 1985 are shown in Table 8-8-5. Judging from the table, the total unit power consumption compared with the recent typical record of Japanese cement company with almost the same production capacity is higher by about 27kWh per ton cement that means about 25% higher rate.

We consider that the main reasons are that the power consumption used in water treatment and compressor house sections are very high due to the existing wet process, and the power consumption for raw material and clinker grinding is also high.

## VIII-8-5 Number of Power Interruption

The number of power interruption frequency on MERALCO's distribution lines were listed in Table 8-7-3. On the other hand, the power interruption frequency of Antipolo plant in 1985 was 5.25 times per year and the cumulative duration was about 9 hours on monthly average as shown in the following table. These figures are too big to neglect for a cement plant which operation cost are strongly affected by intermittent operation due to power interruption.

Table 8-8-6 Power Interruption Frequency and Duration

| | Power interruption frequency | Cumulative duration (hours) |
|---|---|---|
| 1985 January | 1 | 1.93 |
| February | 4 | 7.40 |
| March | 1 | 2.07 |
| April | 10 | 12.85 |
| May | 1 | 0.07 |
| June | 5 | 46.45 |
| July | 12 | 14.05 |
| August | 6 | 5.97 |
| September | 6 | 1.27 |
| October | 10 | 10.90 |
| November | 3 | 0.62 |
| December | 4 | 4.35 |
| Average | 5.25 | 8.99 |

Source:ICC

## VIII-8-6 Actual Amount of Electricity Charge

The actual results of power consumption in the Antipolo plant are as stated previously and the actual monthly records of payment for electricity are shown in Table 8-8-7.

As shown in the table, the electricity charge rose rapidly in the latter half of 1985 due to the fluctuation of foreign currency exchange rate as already explained in VIII-6 Electricity Charge.

Table 8-8-7 Actual Monthly Payment for Electricity

| Month | | Power consumption | | Electricity charge | | Payment amount per cement (Peso/t)** |
|---|---|---|---|---|---|---|
| | | Amount (MWh) | Power factor (%) | Amount ($10^3$peso) | Unit price (Peso/kWh) | |
| 1985 | Jan. | 840 | 73.9 | 2,023.9 | 2.4095 | 373.617 |
| | Feb. | 4,632 | 84.4 | 9,547.1 | 2.0611 | 315.101 |
| | Mar. | 3,792 | 83.3 | 8,535.9 | 2.2510 | 302.174 |
| | Apr. * | - | - | - | - | - |
| | May | 5,520 | 84.8 | 11,422.9 | 2.0730 | 285.680 |
| | Jun. | 3,984 | 83.2 | 8,691.6 | 2.1816 | 302.217 |
| | Jul. | 4,008 | 82.6 | 9,343.6 | 2.3312 | 343.176 |
| | Aug. | 3,168 | 87.3 | 7,268.2 | 2.2943 | 327.030 |
| | Sep. | 4,152 | 85.5 | 9,082.0 | 2.1874 | 298.252 |
| | Oct. | 3,648 | 91.3 | 8,158.0 | 2.2363 | 311.494 |
| | Nov. | 1,272 | 97.6 | 3,105.8 | 2.4417 | 245.879 |
| | Dec. | 2,472 | 92.3 | 6,381.9 | 2.5817 | 350.853 |
| Average | | 3,665 | 86.0 | 8,155.7 | 2.2772 | 322.064 |

Source: Copy of MERALCO's billing sheet

Note 1.*: No information due to bill lost.

2.**: The figure is calculated by multiplying (unit price) by (Actual specific consumption in Table 8-8-5).

Since many kinds of adjustment are applied to the electricity charges as explained in VIII-6-2 Electricity Charge System, the actual records of the unit price of electricity for the Antipolo plant show about a 14% higher figure than the generation charge, as shown in the following table.

Table 8-8-8 Actual Adjustment on Electricity Charge

(unit: Peso/kWh)

| Month | | Generation charge (A) | Electricity unit price (B) | B/A (%) |
|---|---|---|---|---|
| 1985 | January | 1.8525 | 2.4095 | 130.1 |
| | February | 1.8100 | 2.0611 | 113.9 |
| | March | 1.9900 | 2.2510 | 113.1 |
| | April | 1.8320 | - | - |
| | May | 1.8210 | 2.0730 | 113.8 |
| | June | 1.8980 | 2.1816 | 114.9 |
| | July | 2.0750 | 2.3312 | 112.3 |
| | August | 2.0550 | 2.2943 | 111.6 |
| | September | 1.9750 | 2.1874 | 110.8 |
| | October | 2.0820 | 2.2363 | 107.4 |
| | November | 2.1950 | 2.4417 | 111.2 |
| | December | 2.3450 | 2.5817 | 110.1 |
| Average | | 2.0046 | 2.2772 | 113.6 |

Source: Refer to Table 8-6-8 and Table 8-8-7.

## VIII-9 Study on Conversion of Electricity Source to Antipolo Plant

### VIII-9-1 Conversion to NPC from MERALCO

As previously stated, the Antipolo plant is presently receiving electricity from MERALCO through the transmission line with a voltage of 34.5kV which is reduced from 115kV at the Teresa substation. The electricity charge, however, for industrial consumers in the MERALCO's franchise area is extremely higher than that of NPC's on wholesales basis as listed in Table 8-6-10.

In fact, according to MERALCO's forecast on the electricity charge in the future, the difference between NPC's and MERALCO's charge seems to continue by about 1.2∿1.3 pesos per kilowatthour. In case of the Antipolo plant, the percentage of electricity cost in the total direct cost of manufacturing cement amounts to about 30∿35% as stated in clause V-6. It is, therefore, necessary to study and prepare some countermeasures to cut down this high percentage in the manufacturing cost.

Excluding seven cement manufacturers with direct connection to NPC in the Luzon island, this problem is also the same for the other three cement companies; namely, Filipinas Cement Corporation, Rizal Cement Company and Northern Consolidated Corporation, which are located in the MERALCO's franchise area.

Therefore, in order to study direct connection to NPC, a committee that is called "NPC task force" was organized in 1984 among these four companies including ICC. The committee has hold meetings many times and has studied on this problem from several aspects. However, Northern Consolidated Corporation dropped out of the committee in October, 1984, because the proposed route of transmission line to be directly connected to NPC is far from the plant. Moreover, as MERALCO issued a letter dated May 14, 1985, in which they expressed their intension that they could not waive the right to supply electricity in the franchise area, the committee has substantially postponed the further study. In addition, since Filipinas Cement Corporation has closed the plant since September, 1985, the plan to provide a new transmission line to be connected directly to NPC by the four parties lost its footing. However, due to the fact that the difference of electricity charge between NPC and MERALCO is very large, it became necessary for ICC to study by themselves the direct connection to NPC line in order to cut down the electricity unit cost.

For that purpose, it is considered possible from a technical point of view to receive electricity through a new proposal transmission line to be connected to NPC's Dolores substation about 10km to the West of Antipolo plant, as follows.

(1) PLAN 1: To provide a new substation, in the vicinity of the plant, which reduces the voltage to 34.5kV from 115kV and to directly connect to NPC's substation through a 115kV transmission line to be newly provided.

(2) PLAN 2: To provide a new substation, in the vicinity of the plant, which reduces the voltage to 34.5kV from 230kV and to directly connect to NPC's substation through a 230kV transmission line to be newly provided.

The construction cost in PLAN 1 is clearly lower than that of PLAN 2 because of the lower voltage level. However, it is necessary to negotiate and obtain MERALCO's consent on the right waiver, as stipulated in the attached MERALCO's letter (Attachment 1) on this problem.

On the other hand, power supply with 230kV does not need to obtain MERALCO's consent because a voltage of 230kV is NPC's service voltage in the country. Taking into account of these aspects, PLAN 2 using only 230kV voltage is studied in this report.

## VIII-9-2 Study on Transmission Facility

### VIII-9-2-1 Dolores substation

In case that the Antipolo plant will receive electricity directly from NPC through 230kV, NPC's Dolores substation is most recommendable because it is situated much closer to the plant.

As shown in the attached drawing E-03 Single Line Diagram, Dolores substation connects San Jose and Malaya substations with double circuits of 230kV transmission lines. Three banks of transformers with a capacity of 300MVA are arranged in the substation at present.

The substation has enough capacity to newly connect the assumed load of ICC, because the actual load of the substation totally consumes only 250∿300MVA.

Furthermore, as shown in the attached drawing E-04, equipment at 230kV side are installed taking into account of the future extension of one circuit, and the existing control panels are equipped with switches, relays, etc. to be used after the future expansion. Therefore, only circuit breakers and their accessories are required in case of the direct NPC connection. Then Dolores substation is most economical among other substations to newly construct a direct connection line to NPC.

### VIII-9-2-2 Transmission facilities

The proposed route of transmission line between Dolores substation and the Antipolo plant is as shown on the attached drawing E-05. Outlined specification of the main equipment are selected as follows.

(1) Circuit breaker for out-going feeder

| | | |
|---|---|---|
| Quantity | : | 1 set |
| Type | : | Outdoor type gas breaker |
| Rated voltage | : | 245kV |
| Rated current | : | 1,200A |
| Rated short circuit current | : | 40kA |
| Rated interruption time | : | 3 cycle |

(2) Isolator for out-going feeder

| | | |
|---|---|---|
| Quantity | : | 2 sets |
| Type | : | Outdoor, horizontal break type |
| Rated voltage | : | 245kV |
| Rated current | : | 1,200A |
| Rated short circuit current | : | 40kA |

(3) Current transformer

| | | |
|---|---|---|
| Quantity | : | 3 sets |
| Type | : | Outdoor, single phase |
| Rated voltage | : | 245kV |
| Rated capacity | : | 40VA |
| Current ratio | : | 1,200/5A |

(4) Potential transformer

| | | | |
|---|---|---|---|
| Quantity | : | 3 sets | |
| Type | : | Outdoor, single phase | |
| Rated voltage | : | primary | $230,000/\sqrt{3}$ V |
| | | secondary | $115/\sqrt{3}$ V |

(5) Switch board

Necessary switches are equipped on the existing switch board.

(6) Arrester

| | | |
|---|---|---|
| Quantity | : | 1 set |
| Type | : | Gapless type |
| Rated discharge voltage | : | 195kV |

(7) Power line carrier telephone equipment

| | | |
|---|---|---|
| Quantity | : | 1 set |
| Type | : | Phase to phase coupling type with 2 channels |
| Rated inductance | : | 1mH |

(8) Transmission line

| | | |
|---|---|---|
| Quantity | : | 1 circuit |
| Rated voltage | : | 230kV |
| Conductor | : | 795 MCM ACSR |
| Ground wire | : | 95mm$^2$ Alumoweld steel wire |
| Insulator | : | 254mm Ball and socket type |

(9) Steel tower

| | | |
|---|---|---|
| Type and quantity | : | for angle 0° x 15 sets |
| | | for angle 5° x 7 sets |
| | | for angle 15° x 5 sets |
| | | for angle 30° x 3 sets |
| | | (for dead end) |

Note: As for the outline dimension of steel tower, refer to the attached drawing E-06.

### VIII-9-2-3 Antipolo primary substation equipment

The electric power from Dolores substation through the 230kV transmission line is planned to be delivered to Antipolo plant through the proposed substation to be provided in the vicinity of the plant to reduce a voltage to 34.5kV.

Outlined specification of the main equipment in this primary substation is planned as follows.

(1) Structure of substation

| | | |
|---|---|---|
| Type | : | Outdoor, steel frame type |

(2) Incoming circuit breaker

| | | |
|---|---|---|
| Quantity | : | 1 set |
| Type | : | Outdoor, gas circuit breaker |
| Rated voltage | : | 245kV |
| Rated current | : | 1,200A |
| Rated short circuit current | : | 40kA |
| Rated interruption time | : | 3 cycle |

(3) Isolator

| | | |
|---|---|---|
| Quantity | : | 1 set |
| Type | : | Outdoor, horizontal break type |
| Rated voltage | : | 245kV |
| Rated current | : | 1,200A |

(4) Current transformer

| | | |
|---|---|---|
| Quantity | : | 3 sets |
| Type | : | Outdoor, single phase |
| Rated voltage | : | 245kV |
| Rated capacity | : | 40VA |
| Current ratio | : | 1,200/5A |

(5) Potential transformer

| | | | |
|---|---|---|---|
| Quantity | : | 3 sets | |
| Type | : | Outdoor, single phase | |
| Rated voltage | : | primary | $230,000/\sqrt{3}$ V |
| | | secondary | $115/\sqrt{3}$ V |

(6) Arrester

| | | |
|---|---|---|
| Quantity | : | 1 set |
| Type | : | Gapless type |
| Rated discharge voltage | : | 195kV |

VIII-9-3 Construction Cost

The construction cost of the energy source conversion to NPC is estimated as follows, provided that emergency batteries and control rooms necessary for both Dolores and Antipolo primary substations are respectively available for this project.

Table 8-9-1 Energy Source Conversion Cost

(unit: $10^3$₱)

| | Equipment * | Construction ** | Contingency *** | Total |
|---|---|---|---|---|
| Dolores substation out-going feeder | 8,500 | 600 | 700 | 9,800 |
| Transmission line between Dolores/Antipolo | 14,300 | 28,050 | 2,000 | 44,350 |
| Antipolo primary substation | 24,800 | 1,500 | 2,500 | 28,800 |
| Engineering fee | 4,650 | 0 | 0 | 4,650 |
| Total | 52,250 | 30,150 | 5,200 | 87,600 |

Note 1. *: Equipment cost is on CIF basis.
2. **: Construction cost includes materials such as wooden piles, cement, fence net, etc. to be locally procured.
3. ***: The figure includes land rental fee for steel towers.

## VIII-9-4 Calculation of Electricity Charge after Conversion

### VIII-9-4-1 Premises

The following premises are taken into calculation of electricity charge after energy source conversion.

(1) Electricity unit price

Electricity unit prices in Table 8-6-2 and Table 8-8-8 will be given to the calculation for cases of before and after the energy source conversion respectively.

(2) Various adjustment on charge

Since the above-mentioned electricity unit price includes various adjustment charge, no adjustment will be made.

(3) Energy unit consumption

The average figures in Table 8-8-5 will be adopted.

(4) Cement production amount

The following three cases will be studied as for the cement production amount. The proportion of ordinary portland cement to pozzolan cement is to be 50:50.

Case I : To operate one line of the existing kilns as they are. (469,880 t/y)

Case II : To operate all the existing kilns. (939,760 t/y)

Case III : To convert one line of the existing kilns to NSP type kiln. (939,760 t/y)

VIII-9-4-2 Calculation results

The calculation results of electricity charges are shown in the following table.

Table 8-9-2 calculation Results of Electricity Charges

| | | MERALCO | NPC | Difference |
|---|---|---|---|---|
| Electricity unit price (₱/kWh) | | 2.5817 | 1.2496 | 1.3321 |
| Case I | Production (t/y) | 469,880 | 469,880 | 0 |
| | Specific power consumption (kWh/t) | 130.17 | 130,17 | 0 |
| | Payment amount ($10^3$₱/y) | 157,907.8 | 76,430.9 | 81,476.5 |
| Case II | Production (t/y) | 939,760 | 939,760 | 0 |
| | Specific power consumption (kWh/t) | 130,17 | 130,17 | 0 |
| | Payment amount ($10^3$₱/y) | 315,815.6 | 152,861.8 | 162,953.8 |
| Case III | Production (t/y) | 939,760 | 939,760 | 0 |
| | Specific power consumption (kWh/t) | 117.94 | 117.94 | 0 |
| | Payment amount ($10^3$₱/y) | 286,143.5 | 138,499.8 | 147,643.7 |

Based on the figures in the above table and taking into account of the estimated maintenance cost of 5% of the total investment cost, the payout years of the investment cost for the power source conversion are calculated as follows.

Table 8-9-3 Payout Year of Investment Cost

(Unit: months)

| | Case I | Case II | Case III |
|---|---|---|---|
| Payment Year | 13.5 | 6.8 | 7.5 |

## VIII-9-5 Conditions in Case of Power Source Conversion

In case that the power source of the Antipolo plant of ICC is converted from MERALCO to NPC, it is required to discuss on the conversion project with concerning parties and governmental agencies such as Board of Energy, National Electrification Administration, etc. and obtain their consent on the matter, prior to implementing the project because of its publicity.

This point was clearly stated in the attached paper (Attachment 2) issued by Power Development Council on January 28, 1977. According to the above paper, in the event that MERALCO's electricity charges may be more than 110% of the applicable NPC rate, the NPC direct connection can be allowed to consumers, provided that agreement among concerning parties be made.

On the other hand, according to the letter issued from MERALCO to Philcemcor on May 14, 1985, MERALCO expressed their position not to agree with cement companies including ICC in the franchise area on the direct connection to NPC.

Therefore, taking into account of these conditions, it is most recommendable to directly connect to NPC through the transmission line with a voltage of 230kV that exceeds the MERALCO's franchise voltage. Close negotiation among parties concerned will be required to proceed the project through this plan.

To the contrary, if the rule of electricity supply in the country will be amended in such a way that it does not give any impact to management of private companies by the difference of electricity charges like one between MERALCO and NPC, the investment for this project will not be needed and so from national economic point of view foreign currency for the project can be saved.

Attachment 1

May 14, 1985

Dr. Magdaleno B. Albarracin, Jr.
Philippine Cement Manufacturers Corp.
4th Flr., Cacho Gonzales Bldg.
101 Trasierra Cor. Aguirre Sts.
Legaspi village, Makati
Metro Manila

Dear Dr. Albarracin;

This refers to your letter of April 25, 1985 which we received only last May 7, 1985 requesting for power cost reduction either thru Meralco reducing its power rates of allowing direct connection to the National Power Corporation (NPC) citing the very disadvantageous position which you find yourselves in viz-a-vis the other cement plants which are connected to NPC.

Please be advised that we are not in a position to unilaterally reduce our rates. It is the Board of Energy (BOE) which is empowered to revise rates. Once the rates are set for various customer classes, whatever reduction would be provided a group of customers would have to be shouldered by the remaining customers.

On the other hand, agreeing to direct NPC connection would set a dangerous precedent which will jeopardize the cross-subsidization existing between customer classes in our franchise area. Furthermore, this will result in unnecessary duplication of facilities which may be advantageous to certain customers but introduces diseconomies in the national economy.
We understand from our previous discussions with various industry groups and with the Ministry of Trade and Industry that while the power cost obtaining in our franchise area is comparatively higher than those in the provinces, there are certain amenities enjoyed in Metro Manila such as infrastructures and nearness to market which the other industries do not enjoy. Also, the government has been providing incentives in the form of tax breaks to listressed industries such as the cement industry to finance the rehabilitation of plant facilities.

From our end, we have started last February the six-year program to gradually reduce the subsidy being shouldered by industries and other power customers. We anticipate that thru the years, aided by the improvement in the general economy and consequently the improvement in our sales mix between the subsidizing and subsidized consumption, our industrial rate would go down by more than 40 centavos per kilowatthour. The NPC is likewise conducting a study to rationalize and make the power rates of utilities distributing power competitive with those directly connected to NPC.

We trust that you would bear with us as we work out the rationalization of rates and understand our present predicament for not being able to accede to your request.

Very truly yours,

M.B. MOLE
Vice President
Customer Services Group

Attachment 2

POWER DEVELOPMENT COUNCIL
Philippine National Petroleum Center
Fort Benifacio, Makati
Metro Manila

PDC Resolution No. 77-01-02

RESOLUTION APPROVING POLICY GUIDELINES REGARDING DIRECT POWER CONNECTIONS WITH THE NATIONAL POWER CORPORATION.

WHEREAS, there is an evident need to issue policy guidelines regarding direct power connection with NPC, due to increasing demands of the industrial sector to avail of direct connections as provided for in PD 395 and the apprehension expressed by authorized franchise holders and cooperatives regarding the false protection offered by their franchise by virtue thereof;

WHEREAS, there is need to give operational meaning to the concepts of a franchise and service area coverage under which the distribution sector of the power industry presently operates, and to protect the economic and financial growth of the franchise utility and the electric cooperative;

NOW, BE IT RESOLVED, as it is hereby resolved, that the following policy guidelines be approved and adopted in relation to the matter of direct NPC connections.

1. At any given service area, priority should be given to the authorized cooperative of franchise holder in the right to supply the power requirements of existing or prospective industrial enterprises (whether BOI-registered or not) that are located or plan to locate within the franchise area or coop service area as shall be determined by the Board of Power or National Electrification Administration whichever the case may be; Provided, that the allowable franchise or coop rate shall not be more than 110% of the applicable NPC rate if NPC is already supplying these customers, or is willing to supply such customers on the assumption that the local utility, either an electric cooperative or a franchise holder, is not able to; Provided further, that price arrangement under existing contracts of direct connections shall be honored up to contract expiration

date. This price policy is to be implemented, monitored and enforced by the Board of Power and the National Electrification Administration.

2. In service areas, where the facilities of coops or private utilities are not sufficient to cope with the supply requirement of industrial enterprises immediately, the NPC, at its option, may services the power requirments of these customers directly; Provided, that in the event, the franchise holder or cooperative will later on increase their generating and/or distribution facilities to a point where they can directly service the power requirements of these customers, subject to the above policy on power rates, the NPC will relinguish this distribution function to the franchise operator or cooperative; Provided futher, that in the case where physical transferred to the utility by virtue to this relinguishment, reimbursement of costs shall be made after valuation based on generally accepted accounting principles.

3. In all cases, residential power customers, including those in real estate subdivisions must be serviced by or through a cooperative or franchise holder.

RESLOVED, FURTHER, that this resolution be submitted to the President with a draft implementing decree for his approval.

RESOLVED, FINALLY, that these policy guidelines regarding direct power connections with NPC be transmitted to the Board of Power and the National Electrification Administration, through the Chairman, for dissemination, implementation and enforcement after the council has secured Presidential clearance.

Effective this 28th day of January, 1977.

APPROVED:

ALFREDO JUINIO
Chairman

GERONIMO Z. VELASCO
Vice-Chairman

# SECTION IX STUDY ON THE IMPROVEMENT AND RECOMMENDATION FOR MANAGEMENT AFTER REHABILITATION AND MODERNIZATION OF ICC

## IX-1 Improvement of Process Operation Control

### IX-1-1 Process Operation Control

When considering the economic condition, labor condition and technical level of ICC employees, it is believed that a labor intensive type operation is more desirable than a sophisticated computerized operation control system. Because when a sophisticated control equipment breaks down, it will affect other process department as well as require a high degree of technology to repair the equipment.

In this project, a computer control or an X-ray analysis on-line control system for raw meal blending is not planned for raw material and burning departments. However, for future efficient operation of this plant, a central operation control system is adopted for the raw material and burning process.

### IX-1-2 Central Operation Control System

The processes from raw material discharge, raw material blending, drying and grinding, raw meal homogenizing, storing, precalcining, burning, cooling, clinker storing and coal grinding are controlled from the central operation control center located in the burning room.
Furthermore, the preheater exhaust gas, which is utilized for raw material drying before being treated in an EP and discharged into the atmosphere, is monitored for its oxygen and carbon monoxide at the central operation control center.

Other processes such as raw materials, receiving and crushing, clinker grinding also packing and shipping are controlled separately. For individual operation also during inspection and repair, a local operation switch is provided alongside the equipment.

IX-1-3 Instrumentation

Instruments and sensor terminals necessary for central process control are located within each process and may be monitored and control remotely. Furthermore, the minimum necessary measures to upgrade the system such as standardized instrument signals will be provided.

IX-1-4

However, as described in article V-3-1, a process control is necessary, regardless of whether renovation is executed or not, furthermore, since the cement mill system and packing process will be utilized, the control process recommended in article V-3-1 should be performed.

## IX-2 Improvement of Quality Control

As stated in V-3-2 the cement produced in this plant is keeping steady quality and its 28 day's compressive strength is good and occupying higher rank among the product of the cement manufacturers in the Philippines.

Therefore it is recommended that the same quality control method as present one is continued.
The items that require special care are described below.

(1) Homogeneity of raw meal

Since the process is converted from wet process to dry process, the care must be taken in keeping the homogeneity of raw meal.

Although after conversion to dry process a blending equipment will be constructed and raw material feeders will be improved, the correction of chemical composition of raw meal can't be made as in wet process and there is no such equipment as a slurry basin that store a large amount of homogeneous raw meal.
Therefore the control of homogeneity in early stage after conversion should be done carefully.

(2) Raw material mixing proportion

Through the conversion to dry process, the heat consumption of kiln will be decreased from 1,450 kcal/kg-cl to 800 kcal/kg-cl, mixing ratio of ash to raw meal will be decreased.

Since SM and IM of coal ash is 1.3 and 7.1 respectively generally speaking the proportion of limestone, high silica clay and pyrite cinder will be decreased and that of low silica clay will be increased.

The dust which is thrown away at present will be used by recirculation, raw material consumption will be decreased.

In this report the raw material consumption is assumed to decrease from present 1,800 kg/t-cl to 1,610 kg/t-cl.

One example of raw material preparation after the renovation is shown as follows.

Example of preparation

(i) Premises

Heat consumption : 800 x $10^3$ kcal/t-cl

Coal to be used : Refer to Table 9-2-1.

Moduli of clinker : LSF 0.92

SM 2.2

IM 1.6

Chemical composition of raw materials:

Refer to Table 6-1-2.

Table 9-2-1 Test Data of Coal (by ICC)

| No. | Delivered time of sample | Ash (%) | Calorific value | | Chemical Analysis of Ash (wt%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gross kcal/kg | Net kcal/kg | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_3$ |
| C-1 | 1985,Feb.,Mar. | 16.4 | 6,471 | 6,188 | 46.3 | 36.5 | 4.9 | 7.2 | 0.5 | 0.5 |
| C-2 | 1985,Jun.,Aug. | 21.0 | 6,040 | 5,767 | 48.8 | 35.6 | 5.0 | 6.6 | 0.6 | 0.5 |
| C-3 | 1985,Jan.,Dec. | 21.8 | 5,622 | 5,360 | 59.4 | 28.7 | 4.3 | 4.2 | 0.9 | 0.6 |

(ii) Results of calculation

The results are shown in Table 9-2-2.
This results is one example and so further study will be necessary after the renovation.

Table 9-2-2 Raw Meal Preparation and Moduli after Renovation

| Coal | C-1 | C-2 | C-3 |
|---|---|---|---|
| Limestone | 81.4% | 81.9 | 82.1 |
| High silica clay | 7.5 | 8.6 | 6.3 |
| Low silica clay | 9.8 | 8.1 | 10.3 |
| Pyrite cinder | 1.3 | 1.4 | 1.3 |
| Total | 100.0 | 100.0 | 100.0 |
| Raw meal | | | |
| LSF | 0.97 | 0.99 | 1.01 |
| HM | 2.17 | 2.23 | 2.26 |
| SM | 2.30 | 2.34 | 2.25 |
| IM | 1.44 | 1.38 | 1.40 |
| Clinker | | | |
| LSF | 0.92 | 0.92 | 0.92 |
| HM | 2.05 | 2.05 | 2.05 |
| SM | 2.20 | 2.20 | 2.20 |
| IM | 1.60 | 1.60 | 1.60 |

(3) Control of kiln system

Through the renovation, the wet long kiln is converted to dry NSP kiln and the stability of kiln operation is rather improved. However, the care must be taken in operating the kiln until the operators are versed in it.

## IX-3 Improvement of Environmental Protection

As stated in V-3-3, the environmental control of whole plant should be promoted daily regardless weather the renovation is implemented or not.

Especially as to the dust pollution, the establishing a measuring method of dust concentration at the outlet of dust collectors and observance of the regulation are important.

In accordance with the regulation of National Pollution Control Commission (NPCC), the control figure for dust concentration is 500 $mg/Nm^3$ for existing facilities and 300 $mg/Nm^3$ for new facilities respectively.

According to the renovation plan recommended in this report, an electrostatic precipitator for kiln and a bag filter for cement mill and bag filters in packhouse will be used as they are, and so these equipment should be maintained well by measuring the dust concentration in exhaust gas as mentioned above.

Also according to the renovation plan, dust collectors for raw mill, clinker cooler and coal mill will be installed newly and the dust concentration in exhaust gas will be 100 $mg/Nm^3$.

These new equipment should be well maintained together with the existing equipment.

## IX-4 Improvement of Energy Efficiency and Plant Running Efficiency

The heat efficiency of a plant is determined from the total heat consumption of the entire facility. Therefore, unless the capacity of individual facility is balanced, the plant heat efficiency will decrease even though individual equipment may have high heat efficiency. In order to improve plant heat efficiency, the heat consumption of all facilities must be controlled systematically and totally.

In this renovation, the heat efficiency will improve greatly compared to the present wet system, because specific heat radiation loss from kiln shell will decrease owing to higher production, also because of heat exchange of raw meal and kiln exhaust gas together with precalcining. Furthermore, heat consumption can be decreased by 60 - 70 kcal/kg-cl by minimizing primary air down to about 12% of the necessary air and keeping the secondary air temperature to more than 1,000°C.

It should be possible to lower heat consumption to under 800 kcal/kg-cl under stable operation after this innovation. For such a system, a continuous operation of 6 - 9 months is normal in Japan and it is necessary for ICC to maintain a good control to achieve similar long continuous operation.

## IX-5 Improvement of Maintenance Practice

The purpose of maintenance management is to improve operation efficiency as well as reduce maintenance and repair cost. The maintenance management should be conducted by fully considering both long term and short term economy.
The basic approach to maintenance management will not change whether renovation is executed or not, but it will be necessary to provide training for operators, and to prepare maintenance standards and maintenance system incorporating the following points.

1. Operation and maintenance personnels must be fully familiar with the construction, characteristics and capacity of all pieces of equipment.

2. Understand the life cycle of the spare parts of all machinery and equipment, also prepare an inspection standard (inspection point, period, method, qualified inspector and necessary action) classified into daily inspection and periodical inspection.

3. Prepare a lubrication standard (lubrication point, period, amount & type).

4. Prepare an inventory standard for spare parts.

5. Since coordination and cooperation between operation department and maintenance department is an important point for upgrading operation efficiency, maintenance efficiency and safe operation, operation standards and maintenance standards must be prepared by fully considering this point.

6. Some maintenance and repair should be conducted under the supervision of the manufacturer's supervisor should be conducted by the manufacturer, since it would be more expensive to repair by yourself.
   For raw material receiving and cement grinding departments, which will not be renovated, maintenance management must be strengthened and necessary repair must be performed to permit realization of their potential capacities.

## IX-6 Improvement of Education and Training

In accordance with this renovation plan, after the conversion of process from wet long kiln to dry NSP system, the most modern operation technology is necessary for raw mill, kiln, and NSP equipment.

For this purpose the preparation of proper operation manual and technical training of operating staff are necessary and it is recommended to conduct the above two items during the conversion works (before the operation of the converted plant).

Since many technical staffs of this plant have attended the training courses of cement technology, the mastering of new technology, preparation of manuals, training of operators, and on the job training will be conducted with these staffs as leaders.

As stated in V-3-1, the process control of existing facilities to be used after the renovation is important and in order to cope with the clinker production of 2,600 ton/day the finish mill group is required to operate two mills and the packhouse is required to conduct two shifts operation.

For this the training for improvement of operation efficiency of the existing equipment is necessary too.

## IX-7 Improvement of Safety Control

It goes without saying that like other various kinds of controls the safety control should be carried out regardless whether the renovation is implemented or not.

It is natural that the aim of safety control is:

to be away with all the disasters i.e. not only big disasters but very minute ones, and to keep the health of employees.

For example, in order to conduct the above-mentioned control, many plants in Japan have established the organization for the safety control and actively conduct the daily safety control.

It is, therefore, recommended that the following activities should be promoted.

- To organize a Safety and health committee for managing all the matters on safety and health.
  The general manager of the plant should be the chief.

- To establish a regulation for safety and health as a basic policy of safety control.
  In this regulation the laws and regulations of the Philippines on safety are should be incorporated.

- To establish a standard for safety works by reviewing the operation and maintenance works in the plant from a safety point of view.

- To recheck and improve all the operational and maintenance facilities attached to the plant equipment such as stairs, working trap etc. for preventing danger.

At the same time to completely provide the workers with protecting tools through the similar method mentioned above.

- To conduct the safety inspection and to hold safety conference periodically for observation of safety and health regulation and enhancement of safety senses.

## IX-8 Improvement of Organization and Manning Plan

### IX-8-1 Organization After the Renovation

The essential point of process control after the renovation.

The process after the renovation is described in VII-2.
That is: the equipment connecting to raw mill, raw meal silos, kiln, and coal mill are operated together, and so the control in a body is necessary.

Considering this matter, the following amendments are required in the organization.

(1) Raw mill group and silo group

The raw mill group and silo group of the Mill department are to be transferred to the Kiln department.

(2) Indirect organization

Indirect organization including the Assistant vice president, Secretariat, Technical Staff and Administration division are not to be changed with the same number of employee as it is.

(3) Maintenance division

Since after the renovation sufficient maintenance works are necessary and at the same time considerable portion of existing equipment are to be used, the Maintenance division are not to be changed with the same number of employee as it is.

(4) Packhouse

As stated in V-1-4 this plant has 6 units of packing machine and their capacities are at most 40 t/h/unit even in case good maintenance is made. After the renovation cement corresponding to 2,600 ton of clinker is to be shipped and further the proportion of pozzolan cement to ordinary portland cement is apt to increase in the future.

Due to the reason mentioned above the two shift operation is required for the Packhouse and so 20 workers are to be added to the present staffs making the total 40.

(5) Raw mill and kiln department

After the renovation, all the equipment of this department are controlled by centralized control system equipped with sufficient instruments in a central control room.

Therefore the present Kiln department employee can be reduced to a certain extent even after the raw mill group and silo group join to it.

This department is to be called the Raw mill and kiln department.

(6) Raw crusher and finish mill department

After the renovation two finish mills are required to be operated. As stated in (1), the raw mill group and silo groups are tranferred and the works of raw slurry are suspended.

Due to the reasons mentioned above the present Mill department employees can be reduced to a certain extent.

This department is to be called the Raw crusher and finish mill department.

Based on the above consideration, the manning plan after renovation was prepared.
According to this plan the number of employee of the Production division is increased by 12 from present 117 to 129. Therefore total employee of the plant changes from present 348 to 360.

The manning plan of the plant, the manning plan of the Production division, and the manning organization chart are shown in Table 9-8-1, Table 9-8-2 and Fig. 9-8-1 respectively.

Table 9-8-1 Manning Plan of Antipolo Plant after Renovation

| | No. of Personnel |
|---|---|
| Assistant Vice President, Secratariat and Tachnical Staff | 38 |
| Administration Division | 83 |
| Production Division | |
| Office | 2 |
| Packhouse | 40 |
| Raw Mill and Kiln Department | 43 |
| Raw Crusher and Finish Mill Department | 44 |
| Sub-total | 129 |
| Maintenance Department | 100 |
| Grand Total | 360 |

The above personnel can be classified by rank as follows:

| | |
|---|---|
| Senior | 13 |
| Junior | 14 |
| Keyman | 28 |
| Rank and File | 305 |
| Total | 360 |

Fig. 9-8-1 Manning Organization Chart of Antipolo Plant after Renovation

Total Personnel: 360 persons

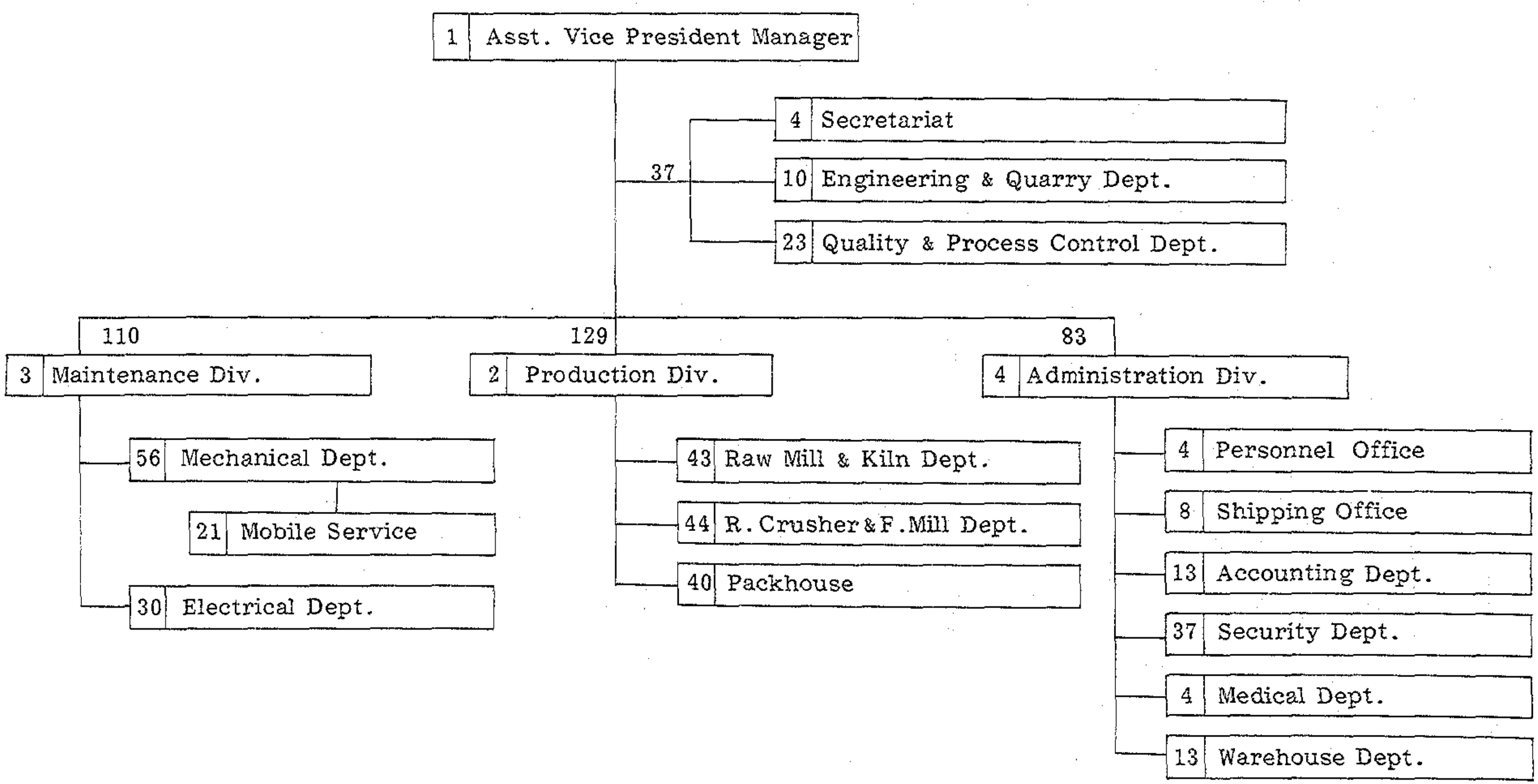


Table 9-8-1 Manning Plan of the Production Division after Renovation

Production Division

| | | |
|---|---|---|
| **- Office** | | |
| Division Manager | (S) | 1 |
| Secretary | (R) | 1 |
| Sub-total | | 2 |
| | | |
| **- Packhouse** | | |
| Foreman | (J) | 2 |
| Operator | (R) | 3 |
| Packer | (R) | 30 |
| Cement Silo Tender | (R) | 3 |
| Forklift Operator | (R) | 2 |
| Sub-total | | 40 |
| | | |
| **- Raw Mill and Kiln Dept.** | | |
| Superintendent | (S) | 1 |
| Foreman | (K) | 3 |
| O.H.C. Operator | (R) | 3 |
| Raw Mill Operator | (R) | 3 |
| Raw Mill Tender | (R) | 3 |
| Feeder and Silo Tender | (R) | 6 |
| S.P. Tender | (R) | 3 |
| Kiln Operator | (R) | 3 |
| Kiln Tender | (R) | 3 |
| Cooler Tender | (R) | 3 |
| Coal Mill Operator | (R) | 3 |
| Coal Mill Tender | (R) | 3 |
| Payloader Operator | (R) | 6 |
| Sub-total | | 43 |

- Crusher and Finish Mill Dept.

| | | |
|---|---|---|
| Superintendent | (S) | 1 |
| Foreman | (K) | 3 |
| Crusher Operator | (R) | 4 |
| Conveyor Tender | (R) | 7 |
| Bin Tender | (R) | 2 |
| O.H.C. Operator | (R) | 3 |
| Feeder Tender | (R) | 3 |
| Finish Mill Operator | (R) | 3 |
| Finish Mill Tender | (R) | 3 |
| Silo Tender | (R) | 3 |
| Dust Collector Tender | (R) | 3 |
| Compressor Tender | (R) | 3 |
| River Pump Tender | (R) | 3 |
| Dump Truck Operator | (R) | 3 |
| Sub-total | | 44 |
| TOTAL | | 129 |

# SECTION X FORMULATION OF REHABILITATION AND MODERNIZATION PROGRAM OF ICC

As mentioned in outline of the plant renovation, Chapter VII and IX, two kinds of high cost of electric power and fuel lie heavily in the production cost in this plant and enhance necessity of the plant renovation. So, the renovation should be performed to modify the wet type process to a dry type process of N.S.P, which is currently called the most technically advanced system, and consequently, to make cost-down of the production by decreasing electric power and fuel consumption and numbers of personnel required for the plant operation. The conversion for the electric power supply line should be also included in the renovation to reduce the electric charges as mentioned in Chapter VIII.
This chapter presents contents of the plant renovation which is basically framed;

1. to install a raw material grinding system of energy-saving type
2. to apply the most advanced N.S.P system
3. to centralize the control system which should be incorporated with the raw material grinding, burning and fuel (coal) supply system.

According to the above frame, specification of equipment is presented as follows, which have been studied taking into consideration of present condition of the plant,
Subsequently, the system itself has been found typical to be applied to N.S.P system. However, detail of the application should be studied further to get decision when the plant renovation would be carried out.