4) Capacity of Each Modules

(1) Quarries

(a) Limestone Quarry

Required quantity:

1700x2x1.572x0.8966x7 = 33,545 T/W (dry base)

1700x2 T/D: Clinker production of existing and expansion project

Required capacity of limestone mining:

33,545/33 x 1.1 = 1118 T/H > 600 T/H

1.1: Allowance of mining

600 T/H: Existing mining capacity

Therefore additional equipment (1118-699=518 -> 600 T/H) for expansion project shall be required.

(b) Volcanic Rock Quarry

Required quantity:

1700x2x1.572x0.1034x7 = 3,869 T/W (dry base)

Required capacity of volcanic rock mining:

3,869/33 x 1.1 = 129 T/H > 75 T/H

75 T/H: Existing mining capacity

Therefore additional equipment (129-75=54 -> 75 T/H) for expansion project shall be required.

(2) Raw Material Crushing

(a) Limestone Crushing

Required quantity:

1700x2x1.572x0.8966x7 = 33,545 T/W (dry base)

Required capacity of limestone crushing:

33,545/42 x 1.2 = 958 T/H > 500 T/H

1.2: Allowance of crusher

500 T/H: Capacity of existing crusher

Therefore additional crusher (958-500=458 -> 500 T/H) for expansion project shall be required.

(b) Volcanic Rock Crushing

Required quantity:

1700x2x1.572x0.1034x7 = 3,869 T/W (dry base)

Required capacity of volcanic rock crushing:

3,869/48 x 1.2 = 97 T/H < 100 T/H

100 T/H: Capacity of existing crusher

Therefore extending of operating hours of existing crusher from 7 hours/day to 8 hours/day, it shall be sufficient for both of existing and expansion project.

(3) Raw Material Storage

(a) Limestone Stacking

Required stacking capacity:

500 T/H x 1.2 = 600 T/H

1.2 : Allowance of stacker

500 T/H : Capacity of new crusher

(b) Limestone Storages

Required storage capacity

1700x2x1.572x0.8966x14 = 67,090 tons

> 20,000 x 2 = 40,000 tons

40,000 tons : Existing limestone storage

14 : Required storage days

Therefore new storage of limestone (67,090 - 40,000 = 27,090 -> 20,000 x 2 tons) shall be required for expansion project.

(c) Limestone Reclaiming

Required capacity:

1700x1.572x0.8966x7/144x1.3x1.3 = 197 T/H

1.3 : Allowance of reclaimer

1.3 : Allowance of conveyor

Therefore new reclaimer (197-> 300 T/H) shall be required for expansion project.

(4) Raw Material Grinding

Following new raw material grinding shall be required for expansion project.

(a) Feeding

Required feeding of raw materials:

- Limestone: 1700x1.572x0.8966x7/144x1.1 = 128-> 150 T/H
- Volcanic Rock: 1700x1.572x0.1034x7/144x1.1 = 15-> 30 T/H

(b) Raw Grinding Mill

Required Grinding Capacity:

1700x2x1.572x7/144 = 260 T/H > 135 T/H

135 T/H: Existing Grinding Mill

Therefore new grinding mill (260-135=125-> 135 T/H) shall be required for expansion project.

(5) Raw Meal Storage and Homogenizing

(a) Raw Meal Storage

Required storage capacity:

1700x2x1.572x2=10,690 tons>3800x2=7,600 tons

7600 tons: Existing storage

2: Required storage days

Therefore additional storage (10,690 - 7600 = 3,090-> 3,600 tons) shall be required for expansion project.

(b) Raw Meal Homogenizing

Required capacity:

1700x2x1.572x8/24=1782 tons > 1200 tons

1200 tons: Existing homogenizing

Therefore new homogenizing (1782 - 1200 = 582-> 1200 tons) shall be required for expansion project.

(c) Discharge

Required capacity:

1700x1.572/24x1.3 = 145 T/H-> 150 T/H

1.3: Allowance of discharge

(6) Raw Meal Feeding

Required capacity for expansion project:

1700x1.572/24x1.3 = 145 T/H-> 150 T/H

1.3: Allowance of the equipment

(7) Clinker Burning

(a) Preheater/Kiln/Cooler

Required capacity of preheater/kiln/cooler:

1700/24 = 70.83 T/H

(b) Fuel Oil Firing

Required capacity of fuel oil firing:

1700/24x830/9800x1.2 = 7.2-> 7.5 T/H

1.2: Allowance of the equipment

(c) Clinker Transportation

Required capacity:

1700/24x1.7 = 120 T/H-> 150 T/H

(8) Clinker Storage

(a) Clinker Storage

Required storage capacity:

1700x2x7.5=25,500 tons > 8,500x2 = 17,000 tons

17,000 tons: Existing storage

7.5: Required storage days

Therefore new storage of clinker (25,500-17,000= 8,500 tons) shall be required for expansion project.

(b) Clinker Extracting

Required capacity;

1700x7/144x1.2x1.1 = 109 T/H-> 125 T/H

(c) Gypsum/Additive Crushing

Required capacity:

- Gypsum : 1700x2x0.03x7/144x1.2x1.1= 7 T/H
- Additive: 1700x2x0.05x7/144x1.2x1.1=11 T/H

Total =18 T/H

<20 T/H

20 T/H: Capacity of existing crusher

Therefore existing crushing shall be sufficient for both of existing and expansion project.

1.2: Allowance of the equipment

1.1: Allowance of the equipment

(9) Cement Grinding

(a) Feeding

Required capacity of feed weighers:

- Clinker : 1700x1.1x1.0 x7/144x1.1
  = 100 T/H
- Gypsum : 1700x1.1x0.03x7/144x1.1
  = 3 T/H-> 10 T/H
- Additive: 1700x1.1x0.05x7/144x1.1
  = 5 T/H-> 20 T/H

1.1: Allowance of Mill

1.1: Allowance of Weigher

(b) Cement Grinding

Required capacity of new grinding mill:

1700x2x(1+0.03+0.05)x7/144=179 T/H > 90 T/H

90: Existing mill capacity

Therefore new grinding mill (179-90=89-> 90 T/H) shall be newly required for expansion project.

(c) Cement Transportation

Required capacity:

90x1.1x1.2 = 119 T/H-> 130 T/H

1.1: Allowance of mill

1.2: Allowance of conveyor

(10)Cement Storage

(a) Cement Storage

Required capacity of storage:

1700x2x1.08x7=25,704 tons < 7,000x4
= 28,000 tons

28,000 tons: Existing storage

7: Required storage days

Therefore existing storage shall be sufficient for both of existing and expansion project.

(b) Discharge

Cement Dispatch Ratio: Bulk Cement 30%
Bagged Cement 100%

- Packing : 1700x2x1.08x7/96 = 268 T/H
  < 120 T/H x 3
  = 360 T/H

  360 T/H: Existing discharge

- Bulk : 1700x2x1.08x0.3x7/48 = 161 T/H
  Loading > 100 T/H

  100 T/H: Existing discharge

(11)Cement Packing

Required capacity:

1700x2x1.08x7/96x1.5= 402 T/H > 100 T/Hx3 = 300 T/H

1.5 : Allowance of packer

300 T/H : Existing packer

Therefore additional packing (402-300 = 102 T/H-> 100 T/H) shall be required for expansion project.

(12)Cement Dispatch

(a) Bag Loading

Required capacity:

4-packing line (existing 3-line plus 1-line for expansion) shall be installed so that total 6 line of bag loading shall be required (existing 5-line plus 1-line for expansion).

(b) Bulk Loading

Required Capacity:

1700x2x1.08x0.3x7/48 = 161 T/H > 100 T/H

100 T/H: Existing loading

Therefore additional loading equipment (161-100=61-> 100 T/H) shall be required for expansion project.

(13)Utilities

(a) Water Supply

Required quantity for existing plant:

Total cooling water (circulation)	: 200 T/H
Make up water	: 23 T/H
Drinking water	: 8 T/H

Required quantity for expansion project:

Total cooling water (circulation)	: 200 T/H
Make up water	: 23 T/H

New cooling water supply system from desalination plant shall be required except 2000 m^3 water pond.

(b) Compressed Air Supply

Required quantity for existing plant

Raw grinding mill and Clinker burning	: 16.5 Nm^3/min
Cement grinding and Packing	: 17 Nm^3/min

Required quantity for expansion project:

Raw grinding mill and Clinker burning	: 16.5 Nm^3/min
Cement grinding and Packing	: 2.5 Nm^3/min

New compressed air supply system for raw mill and clinker burning (19.6 m^3/min x 8 kg/cm^2) shall be required for expansion project.

(c) Fuel Supply

- Heavy oil

Required quantity for existing plant

Clinker burning	: 6.2 T/H
Hot gas furnace	: 1.24 T/H
Total	7.44 T/H

Required quantity for expansion project

Clinker burning	: 6.2 T/H
Hot gas furnace	: 1.24 T/H
Total	7.44 T/H

Required storage capacity

7.44x2x24x21=7500 tons > 5000 tons

5000 tons: Existing storage

21: Required storage days

Therefore additional storage (7500-5000)= 2500 tons) shall be required for expansion project.

- Diesel Oil

Required quantity for existing plant

Boiler and D/G Plant	: 0.4 T/H

Required quantity for expansion project

Boiler and D/G Plant	: 0.4 T/H
Diesel Power Plant	: 3.32 T/H

Required storage capacity

0.4x2+3.32x24x30=2966 tons > 500 tons

500 tons: Existing storage

30: Required storage days

Therefore new diesel oil storage (2966-500=2466 -> 2500 tons) shall be required for the expansion project.

(d) Steam Supply

Required quantity for existing plant

Heavy oil heating : 1.9 T/H

Required quantity for expansion project

Heavy oil heating : 1.9 T/H

Therefore new steam supply (1.9-> 2 T/H) shall be required for expansion project.

7.1.5 Feed Back from Existing Plant

Expansion project shall be planned based on the above mentioned concept. However it shall be investigated at the concrete stage of the project to feed back the condition of the existing plant operation and to study the necessity of increasing plant storgae capacities considering raw material, fuel and cement supply in Yemen, and finally construction of most suitable plant should be materialized.

1) Feed back of the existing plant

- Study of optimization of the process

- Improvement of the plant equipment

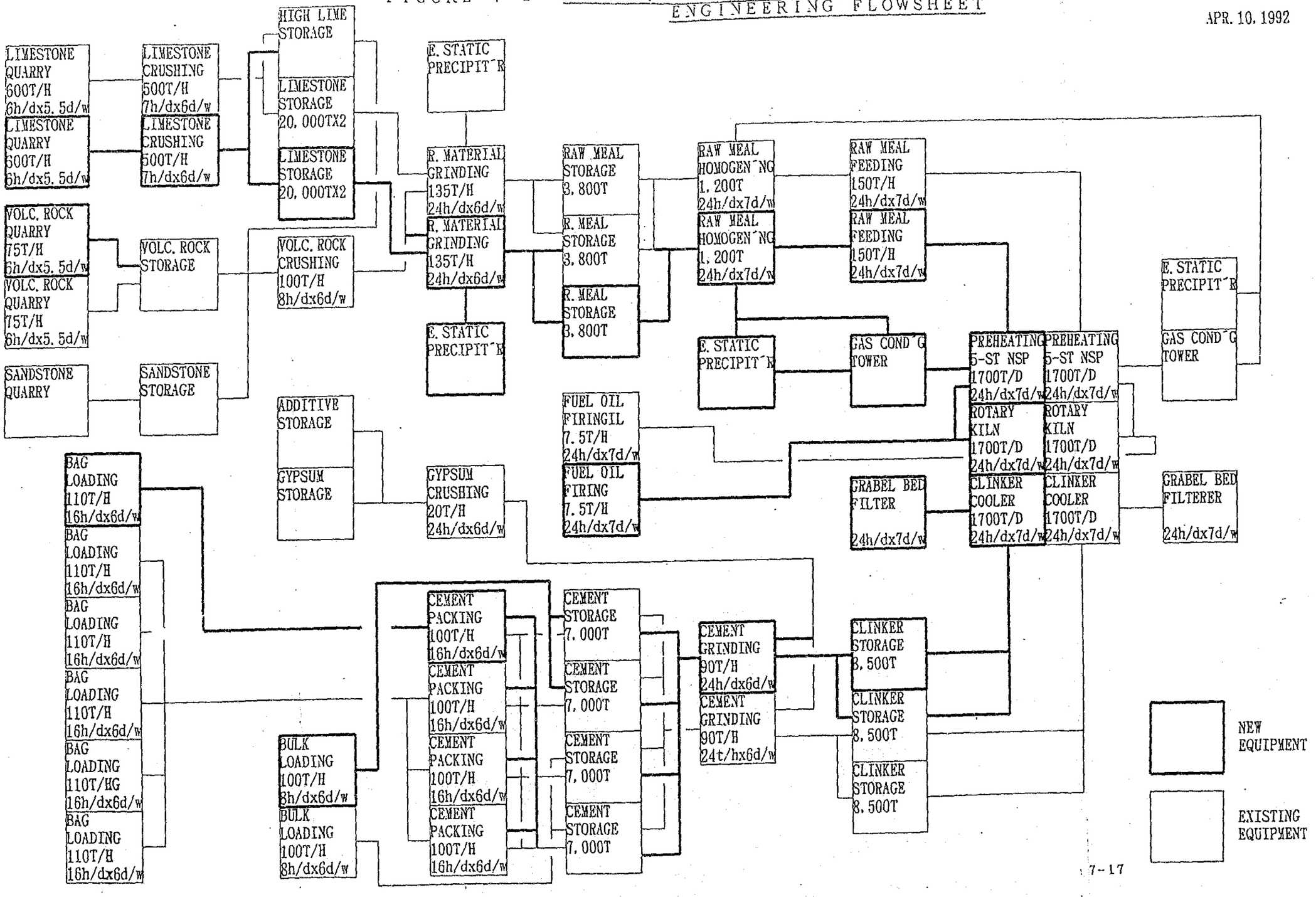
2) Increase of the storage capacities

Study of the following storage capacities

- 1 set of 8,000 t clinker silo
- 1 set of 3,80 t raw meal silo
- 1 set of 7,000 t cement silo
- increase of diesel oil storage tank from 2,500 m^3 to 4,000 m^3

FIGURE 7-1 MAFRAQ CEMENT PLANT EXPANSION PROJECT
ENGINEERING FLOWSHEET

APR. 10. 1992



7.2 Plant Site and Layout

7.2.1 Plant Site

Main equipment of the expansion plant shall be constructed adjacent to the existing equipment in the Mafraq Plant site. Details are shown in Figure 7-2 "Expansion Plant Plot Plan". Expansion plant site shall be consisted of the following five sites.

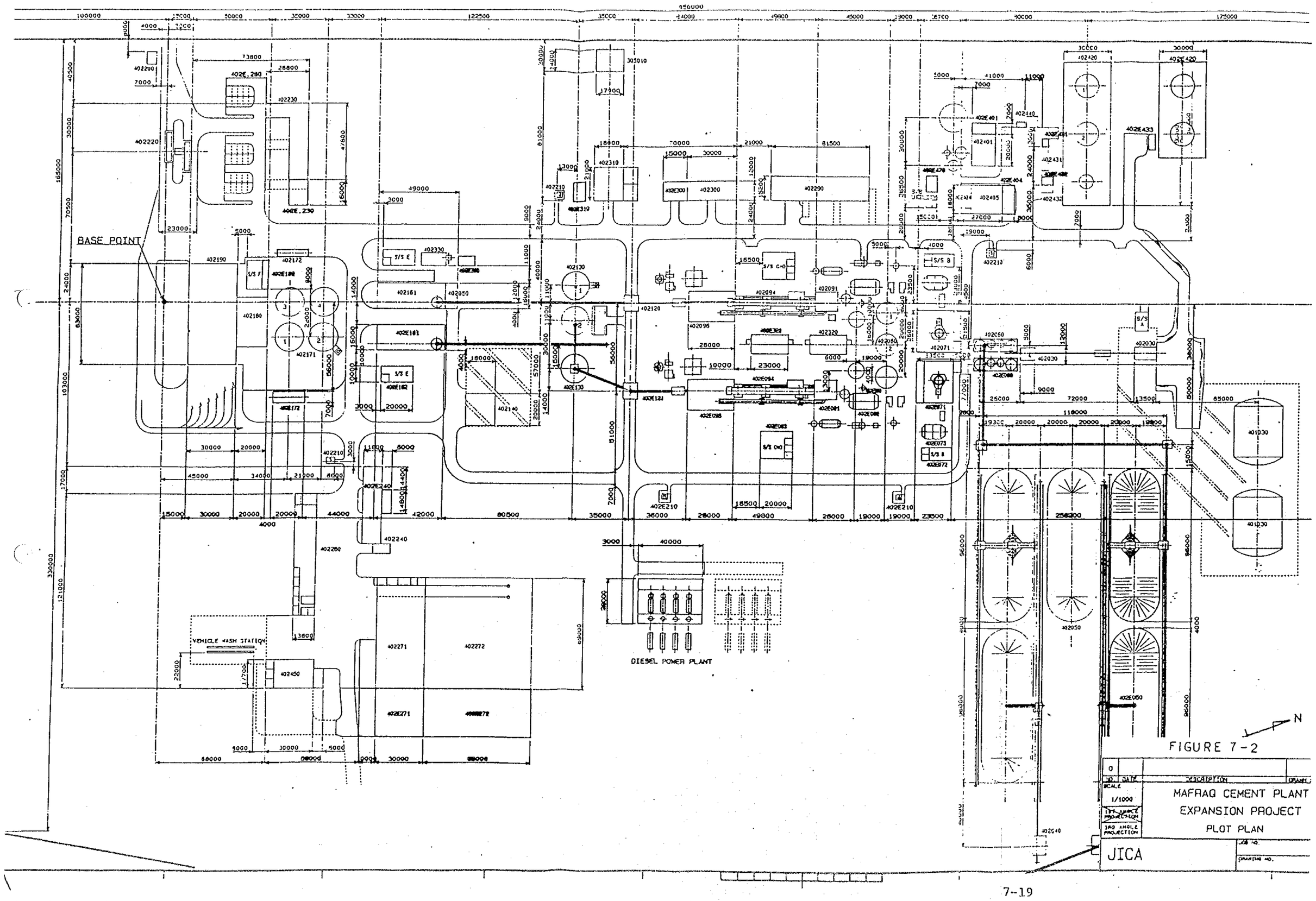
1. Plant Site : Production line from raw grinding mill to cement delivery and supporting facilities are installed.

2. Limestone Quarry Site : Limestone crushing and garage are installed.

3. Diesel Power Plant Site : Diesel power plant are installed for electric power supply

4. Water Source Site : Wells and water pumps are installed for water supply

5. Housing Area Site : Housing for plant employee are installed.


BASE POINT
VEHICLE WASH STATION
DIESEL POWER PLANT
N
FIGURE 7-2
MAFRAQ CEMENT PLANT
EXPANSION PROJECT
PLOT PLAN
JICA

7.2.2 Section of the Expansion Plant

All the equipment for the expansion project shall be belonged to the following sections:

Section		Name
10. Raw Material Quarrying	101	Limestone Quarry
	102	Volcanic Rock and Sandstone Quarry
11. Raw Material Crushing, Storage and Handling	111	Limestone Crushing
	112	Additive Crushing
	113	Limestone Mix Bed
	114	Additive Handling
	115	Gypsum Crushing
12. Raw Meal Preparation	121	Raw Meal Grinding and Drying
	122	Raw Meal Homogenizing and Storage
20. Clinker Burning and Handling	201	Clinker Burning
	202	Clinker Handling and Storage
21. Cement Grinding	211	Cement Grinding
	212	cement Handling and Storage
22. Cement Delivery	222	Cement Packing
	223	Cement Delivery in Bags
	224	Bulk Cement Loading
30. Utilities Supply	301	Water Storage, Treatment and Distribution
	302	Compressed Air Production and Distribution
	303	Heavy Fuel Oil Storage and Distribution
	304	Diesel Oil Storage and Distribution

		305 - 312	Electrical Equipment and Instrumentation
		314	Fire Fighting Equipment
40.	Civil Engineering and Work :	402	Productions Buildings and Supports
		406	Supporting Facilities
		407	Utilities Supply
		408	Housings
50.	Garage :	506	Vehicles Maintenance Garage
60.	Quality Control :	602	Laboratory Automation
70.	Diesel Power Plant :	701	Power Plant
80.	Water Supply :	801	Pump System

7.3 Description of Production Equipment

7.3.1 Production Equipment

Production equipment for the expansion plant shall be explained hereunder.

Flow sheet of production equipment is shown in Figure 7-3 Flow Sheet.

101 Limestone quarry

Type : Blast mining
Capacity: 600 T/H

Basically same quarry and mining bench shall be used for both existing and expansion plant.
Therefore, the additional mining equipment for increasing mining capacity shall be newly purchased.

102 Volcanic Rock and Sandstone Quarry

Type : Rip mining
Capacity: 75 T/H

Mining for the expansion plant also shall be done in the same quarries.
As the existing mining facilities have the enough capacity, it is not required additional equipment for the expansion plant.
However, three dump trucks shall be required for transporting mined products to the plant site.

111 Limestone Crushing

Type : Hammer crusher mounted mobile bed
Capacity: 500 T/H

Limestone mined from the various limestone mining faces are transported to the electric operated mobile crushing plant by means of portable belt conveyors.
The crushed limestone are carried out by belt conveyors to the mixed bed for pre-homogenization through automatic sampling station.
New belt conveyors connecting between quarry and plant site are installed along with existing belt conveyors.

112 Additive Crushing

Type : Compound crushing (Existing)
(Impact and Cone Crusher)
Capacity: 100 T/H

Existing additive crushing have enough capacity for both of existing and expansion plant, so that it is not required additional new crushing equipment.
Transportation equipment connecting between existing additive crushing and new raw grinding mill hoppers are newly installed for the expansion plant.

113 Limestone Mix Bed

Stacking: Lateral type with slewing boom 500 T/H
Storage : Prebleinding Bed 20,000 tons x 2 piles
Reclaiming:Bridge mounted type 300 T/H

Same type of limestone mix bed is installed for the expansion plant.
Crushed limestone is stored to the mix bed by the stacker. This stacker is possible to store limestone both sides of mix bed by slewing stacking boom to the opposite side.
Mixed limestone is transported to the raw grinding mill hoppers by means of belt conveyors.
The limestone is also transported to the existing grinding mill hoppers by changing the change over damper installed on the belt conveyor.

114 Additive Handling

Type : Front end loader
Capacity: 5.4 m^3

A new equipped front end loader is used for transporting additives from existing additive storage to additive crusher.

115 Gypsum Handling

Type : Jaw crusher (Existing)
Capacity: 20 T/H

As the existing gypsum crusher has the enough capacity for both existing and expansion plant operation, it is not required additional gypsum crusher.
The installation are executed only gypsum transportation equipment from existing to the expansion plant.

121 Raw Meal Grinding and Drying

Type : Vertical Roller Mill
Capacity: 135 T/H

Same grinding and drying process equipment as existing plant is installed.
Difference is only the new connecting duct between preheater exhaust duct and raw mill inlet hot gas duct so that a part of hot exhaust gas from preheater is used for drying gas for raw meal and will be reduced to the fuel oil consumption of hot gas furnace.
Maximum four kinds of raw materials including limestone and volcanic rock are fed to the raw grinding vertical roller mill from the feed hoppers through weigh feeders, belt conveyors and bucket elevators.
Raw materials dried and ground in the roller mill are drawn out from the mill by mill exhaust fan and collected by cyclone and electrostatic precipitator. Then ground raw meal in transported to the storage silos by means of air slides and

bucket elevator.

122 Raw Meal Homogenizing and Storage

Type	:	Storage silo and continuous homogenizing silo	
Capacity:	Storage silo	3,800 tons	(New)
		3,800 tons	(Existing)
	Homogenizing silo	1,200 tons	(New)

Ground raw meal from the grinding mill is transported to storage silos by means of air slides and bucket elevators. One storage silo is newly installed and one of existing two silos is used commonly for existing and expansion plant.

Raw meal storaged in above two silos is withdrawn by air extraction from the lower part of the silos and sent to the continuous homogenizing silo. The homogenized raw meal is led either to the raw meal feed bin or raw meal storage silos.

Dust collected from the preheater exhaust gas electrostatic precipitator is also returned into the homogenizing silo.

201 Clinker Burning

Clinker Burning
- Type : Dry short kiln with preheater and precalciner
- Capacity: 1,700 T/D

Fuel Firing
- Type : Heavy oil firing
- Capacity: 7.5 T/H

Clinker Cooling
- Type : Horizontal grate cooler
- Capacity: 1,700 T/D

Same clinker burning process as existing plant is applied for the expansion plant.
The raw meal is fed to the five stage preheater and precalciner where more than half of the heat input is taken to calcine the raw meal to approximately 85%. Exhaust gas from preheater are led to an electrostatic precipitator (EP) through a gas conditioning tower and a part of exhaust gas is led to a raw grinding mill for drying of raw material. The collected dust from EP is transported either to by-pass dust bin or homogenizing silo.
Calcined raw meal from the preheater enters into the rotary kiln where clinkering is completed by the heat of kiln burner and it is discharged into clinker cooler where producted clinker is cooled down.
Heavy fuel oil is used for the kiln and precalciner firing.
To prevent the coating trouble in the preheater, kiln exhaust gas by-pass system is installed.
Induced gas from the kiln outlet is led to an electrostatic precipitator through a gas conditioning tower and the collected dust from the

EP is discarded to a by-pass dust bin where the dust is led either to dust disposal truck or additive hopper of the cement grinding mill system by means of pneumatic conveyor.

202 Clinker Handling and Storage

Type : Reinforced concrete silo
Capacity: 8,500 tons (New)
8,500 tons (Existing)

Clinker cooled down and crushed in the clinker cooler is conveyed by means of deep bucket conveyors to the clinker silos.
One clinker silo is newly installed and one of existing two clinker silos is used commonly for existing and expansion plant.
A clinker bin is installed in the transfer point of the clinker conveyor for receiving unburnt clinker.
From the two clinker storage silos, the clinker is extracted and fed to clinker hopper of the cement grinding mill through belt conveyors.

211 Cement Grinding

Type : Two compartment compound mill
Capacity: 90 T/H

Same cement grinding process as existing plant is applied for the expansion plant.
Clinker, gypsum and additive from the each hopper are discharged and proportioned by weigh feeders, then fed into cement mill.
Ground product in the cement mill is conveyed to air separator where the coarse material is returned to the mill while the fine product is collected by cyclones and bag filter and led to cement silos by means of pneumatic conveyor.

212 Cement Handling and Storage

Type : Reinforced concrete silo
Capacity: 7,000 tons x 4 (Existing)

Cement ground by cement mill is conveyed to the existing four cement silos by means of pneumatic conveyors.
Storage capacity of existing cement silos are enough for both of existing and expansion plant operation so that installation of new silo is not required.

222 Cement Packing

Type : Rotary packer
Capacity: 100 T/H x 3 (Existing)
100 T/H x 1 (New)

Cement is extracted from four cement silos and conveyed to cement packers by means of air slides and bucket elevators.
Then cement is packed in 50 kg bags and fed to truck loading.
One new cement packer is installed in the existing packer building along with existing three packers.
The cement packing and delivery system are operated as one system which is combined existing and expansion plant.

223 Cement Delivery in Bags

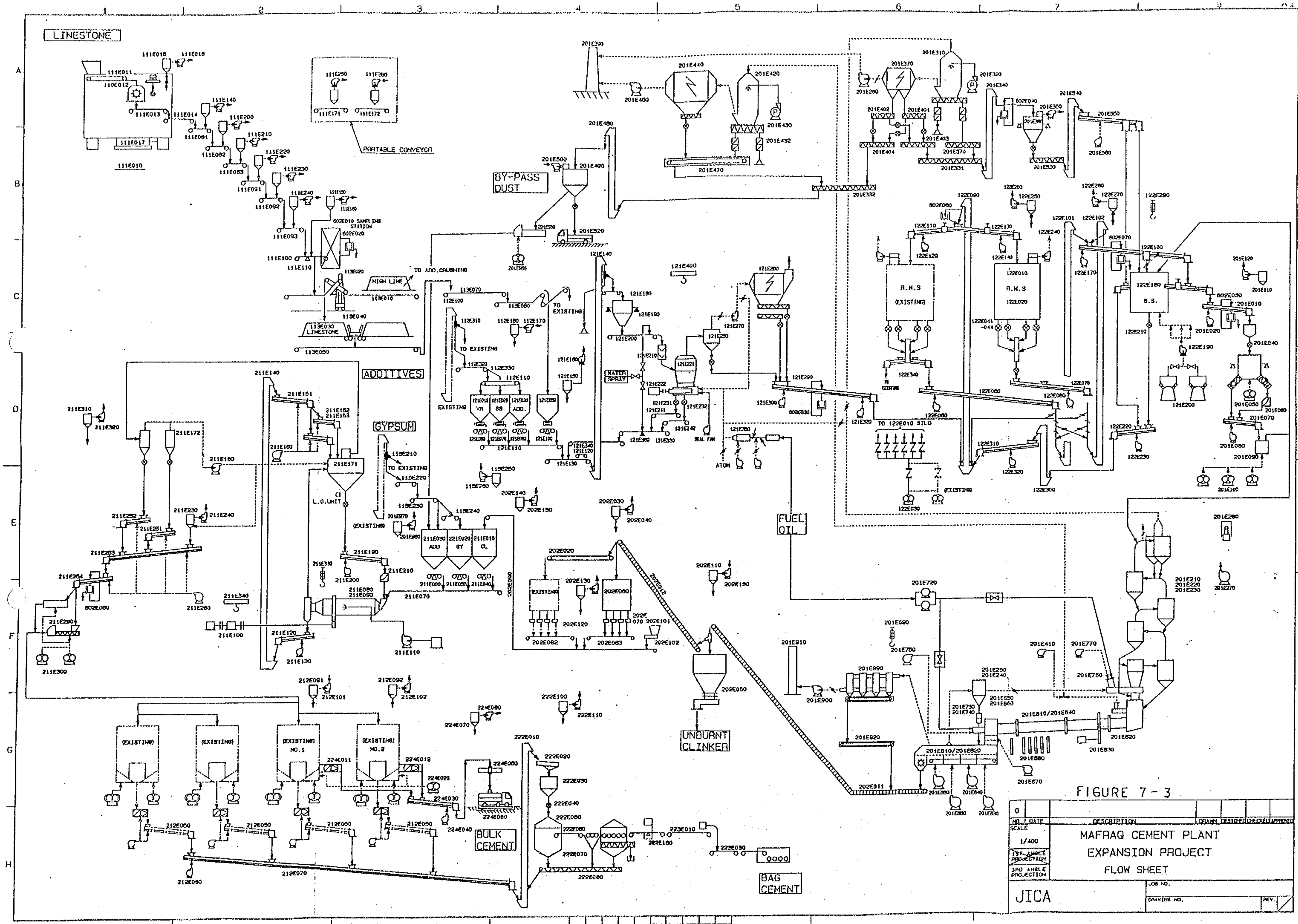
Type : Automatic truck loading and manual truck loading
Capacity: Automatic truck loading
2,200 bag/H x 3 (Existing)
2,200 bag/H x 1 (New)
Manual truck loading
2,200 bag/H x 2 (Existing)

One automatic truck loading is newly installed for expansion plant.
Total six sets of truck loading including five existing loading are operated both of existing and expansion plant.

224 Bulk Cement Loading

Type : Loading spout
Capacity: 100 T/H

New bulk cement loading is installed opposite side of existing bulk loading.
Bulk cement is loaded directly to the truck from existing two cement storage silos.
Weigh bridge is provided to control the feeding to truck.


LINESTONE
PORTABLE CONVEYOR
BY-PASS DUST
TO ADD.CRUSHING
HIGH LINE
113E030 LINESTONE
TO EXISTING
ADDITIVES
GYPSUM
L.O.UNIT
WATER SPRAY
SEAL FAN
ATOM
FUEL OIL
TO 122E010 SILO
A.H.S (EXISTING)
A.H.S 122E020
122E180 B.S.
UNBURNT CLINKER
BULK CEMENT
BAG CEMENT
(EXISTING)
(EXISTING) NO.1
(EXISTING) NO.2
111E010
111E011
110E012
111E013
111E014
111E015
111E016
111E017
602E010 SAMPLING STATION
201E300
201E440
201E420
201E430
201E432
201E450
201E470
201E480
201E490
201E500
201E510
201E520
201E332
201E310
201E370
201E320
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122E130
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122E340
122E060
122E070
122E080
122E300
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212E080
222E010
222E020
222E030
222E040
222E050
222E060
222E070
222E080
223E010
223E030
224E060
0
NO.
DATE
DESCRIPTION
DRAWN
DESIGNED
CHECKED
APPROVED
SCALE
1/400
1ST ANGLE PROJECTION
3RD ANGLE PROJECTION
MAFRAQ CEMENT PLANT
EXPANSION PROJECT
FLOW SHEET
JICA
JOB NO.
DRAWING NO.
REV.

FIGURE 7 - 3

7.3.2 Utilities Supply

301 Water Storage, Treatment and Distribution

Process Water System:

- Raw Water Storage: 5,000 m^3 (Existing)
- Water Treatment : 40 m^3/H (Existing)
  15 m^3/H (Expansion)
- Water Storage : 500 m^3 x 1 (Existing)
- Recycled Cooling Water System : 200 m^3/H (New)

Drinking Water System:

- Raw Water Storage: 50 m^3 (Existing)
- Water Treatment : 8.5 m^3/H (Existing)
- Water Storage : 100 m^3/H (Existing)

Water supply system in the Mafraq cement plant is operated as one system combined with existing plant and expansion plant.

Raw water transported from deep wells is led either to process water system or drinking water system.

Process water system is consist of recycled cooling water system, boiler water supply and fire fighting water.

New installation additionally required for the expansion plant are as follows:

- Expansion of existing water treatment (15 m^3/H)
- Recycled cooling water system including cooling tower and warm water basin for expansion plant equipment (200 m^3/H)

Existing drinking water system is used and pipe-

line is expanded to expansion plant. However, drinking water to expanded housing area is supplied separately from new water treatment installed in housing area.

302 Compressed Air Production and Distribution

Type : Semi central compressed air supply

Capacity:

For raw grinding and clinker burning

19.6 m^3/min x 8 kg/cm^2 (New)

For cement grinding and packing

19.6 m^3/min x 8 kg/cm^2 (Existing)

Supply of compressed air is divided to raw grinding and clinker burning section, and cement grinding and packing section.

This compressed air supply system is also combined of existing plant and expansion plant.
For raw grinding and clinker burning section, new compressed air supply is required and for cement grinding and packing, existing compressed air supply is used.

303 Heavy Fuel Oil Storage and Distribution

Fuel Oil Storage: 2,500 m^3 x 2 (Existing)
2,500 m^3 x 1 (New)
Steam Boiler : 2 T/H (New)

New heavy oil storage tank in addition to existing two storage tank is installed.

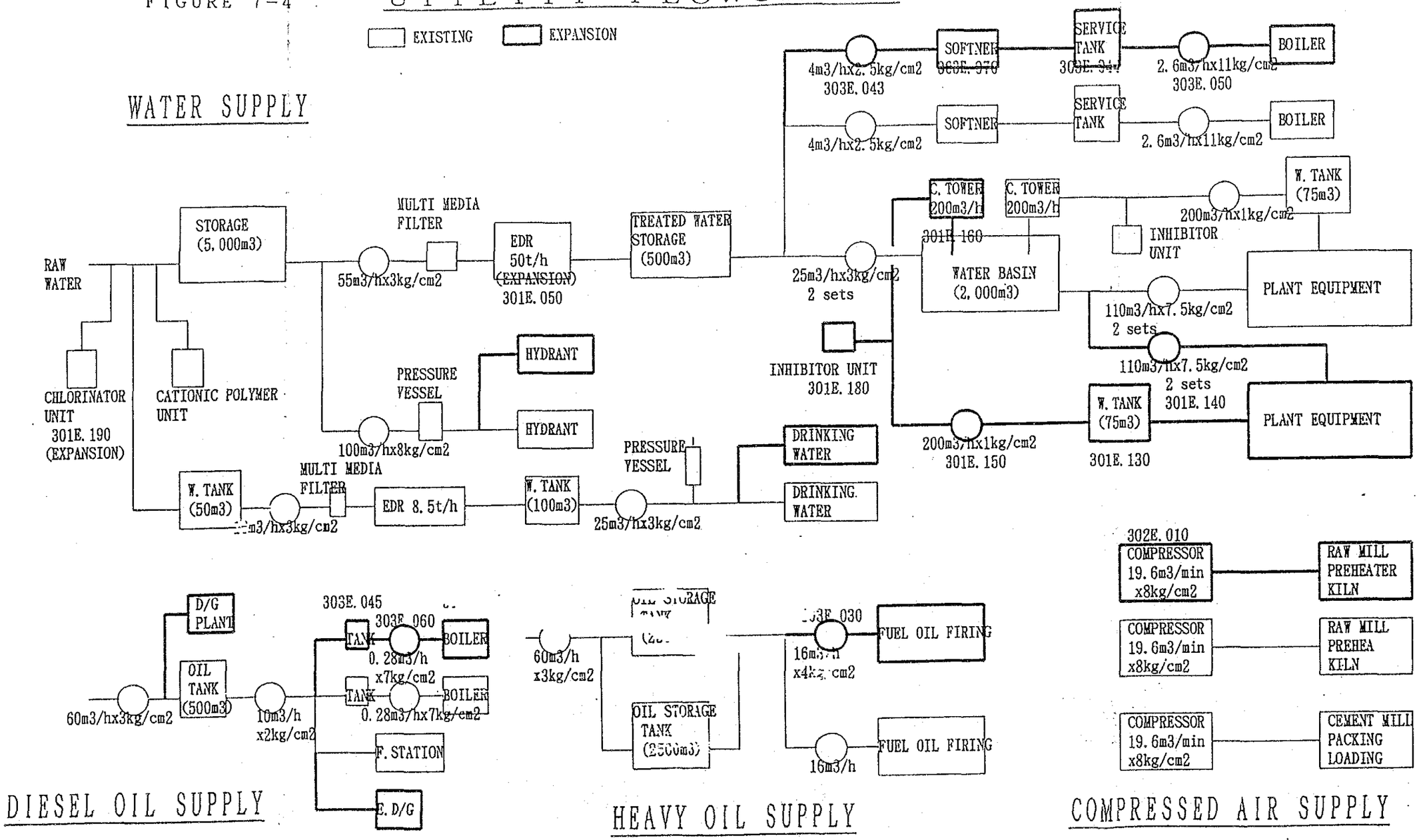
Fuel oil supply system to expansion plant including steam boiler for oil heating up is installed.

304 Diesel Oil Storage and Distribution

Diesel Oil Storage: 500 m^3 (Existing)

Existing diesel oil storage is used for the expansion plant.
New diesel oil transfer pump is installed for supplying diesel oil to steam boiler and emergency diesel generator.
Diesel oil supply for diesel power plant is independently installed.

FIGURE 7-4 UTILITY FLOWSHEET



7.3.3 Electrical Equipment and Instrumentation

1) Electrical

(1) Electric Power Distribution System

Electric power for expansion plant shall be supplied by diesel Generators. According to the parallel running of 4 - Diesel Generator sets (including the stand-by, 1 set), required power capacity shall be produced. This produced power shall be supplied to each substation located in plant area through the main 6.6 kV switchgear installed in one room of Diesel Generator housing.

Each substation is located as listed below:

- Raw Material Preparation
- Raw Material Grinding
- Clinker Burning
- Cement Grinding
- Cement Dispatch
- Utility
- Housing
- Well

Besides, for convenient operation, existing main 6.6 kV switchgear and its system shall be considered to connect together for electric power supplying/receiving. But, parallel operation between purchased electric power for existing and produced electric power shall not be done.

For reference, refer to Figure 7-5 "Single Line Diagram" attached herewith.

(2) High Voltage Distribution

6.6 kV voltage produced by Diesel Generator shall be distributed to each substation through main 6.6

kV Switchgear installed in the one room of Diesel Generator house. Received 6.6 kV electric power in each substation located in plant area shall be supplied for high voltage motors and L.V. Transformers/Load center.

6.6 kV Switchgear shall be of the indoor, metal-clad type with draw-out interrupting devices.

(3) Low Voltage Distribution

Each substation shall be equipped with the L.V. Transformer having the suitable capacity. In principle, outdoor, oil immersed type power transformer is preferred. But, it may be considered the dry type for small capacity. Load center (L/C) and Motor Control Center (MCC) receive the low voltage through the transformer and low voltage power shall be distributed to each load for plant operation. L/C and MCC are indoor, metal-enclosed type with drawout interrupting devices/units.

(4) Compensation Equipment

For power factor improvement, suitable rated power factor compensation equipment shall be provided in each substation or independent load. Improved power factor is aimed to about 90%.

(5) Earthing System

The earthing system shall be done by interconnected ring laid round the various sections with multiple earth rods. And it shall be considered that laid earth wire is connected to existing earthing system at several points.

Independent earthing system shall be provided for following system:

- Lightning arrester
- Transformer neutral
- Instrument
- CPU

(6) Lighting System

For lighting system, suitable lighting fixtures such as fluorescent type, mercury type shall be provided. Quantity of fixtures shall be calculated and provided in accordance with approved standard's illumination level. Emergency lighting fixture shall be located for operator and maintenance person who are led to safety place at night. An automatic switching system, photoelectric switch shall be applied for the exterior illumination.

(7) Telephone, Paging and Clock System

For telephone system, existing automatic exchanger shall be considered to use. Then, suitable number of telephone shall be provided. But, capacity of exchanger shall be checked and confirmed.

For paging system, existing amplifier shall be considered to use as same as telephone system. Handsets and speakers shall be provided in suitable location at plant.

For clock system, existing master clock shall be considered to use. Several slave clocks shall be provided.

(8) Air Conditioning and Air Filtration

Air conditioning equipment shall be provided for office, canteen, etc. Suitable type of air conditioner shall be selected for each room or building.

Ventilation equipment shall be provided for electric room, substation, diesel generator room and compressor room. And proper filtration system shall be considered for minimizing the ingress of dust.

(9) D.C. System

For D.C. system, rectifier and nickel-cadmium type batteries shall be provided. And D.C. power shall be received from them. Batteries are installed in the room with ventilation equipment.

2) Instrument

(1) Instrument System

Generally, all plant system shall be controlled from Central Control Room except following sections.

- Mobil Crusher
- Raw Material Stacking
- Packing Plant & Cement Delivery

For the above plants, control panels shall be installed in the each existing control room.

According to the P&I Diagram, suitable instrument equipment shall be provided.

Each part of the plant shall be designed to equip the Auto/Manual operation with suitable interlock and sequence due to the operation philosophy.

On the main control desk, it is designed to watch the plant operating condition by CRT and start/stop control by push button station. Generally, following parts are controlled on the control desk in main control room;

- Reclaiming of the Mix Bed
- Raw Material Service Hopper
- Raw Mill Grinding
- Storage of Raw Meal
- Homogenizing of the Raw Meal & Kiln Dust
- Recycling & Kiln Feed System
- Clinker Burning & Cooling
- Handling & Storage of Clinker
- Cement Grinding

Control panel is equipped the required instrument such as indicator, recorder, converter, ITV monitor, etc.

(2) System Structure

The system structure which permits the operation and control of the plant consist of the following:

- Process control and measuring system
- Motor control system
- Process computer system

a. Process control and measuring system

According to the P & I Diagram, each type of instrument, such as pressure, temperature, flow, level, weight, etc. is provided. Signal shall be standardized to 4 - 20 mA DC except special instrument. Type of actuator for damper and control valve is electro-hydraulic or motor or air with 4 - 20 mA DC operation signal.

Measured process data are shown on the each

receiver instrument equipped on the control panel or desk. And important data is designed to input to CPU and suitable treatment shall be done.

b. Motor control system

According to the operation philosophy, operation logic such as motor start/stop, damper open/close, etc. shall be constructed in programmable Logic Controller (PLC). By the PLC, motors shall be operated sequentially.
Generally, local push button stations shall be installed near the operated machine for trial operation or emergency stop or safety interlock at maintenance. In this case, the motors shall be operated individually irrespective of PLC.
For safety, interlock system shall be considered.

c. Process computer system

Process computer shall be used for collecting the process data, watching the plant condition, check the performance and alarm. Capacity of the computer shall be decided by operation and process requirement.
Color CRT and printer for data logging is used for the watching and operation of plant and record. The process computer will keep the process data 72-hour periods for selective call back at any time. Called back data will be either printed out or displayed on CRT by operator. Alarm shall be printed out and displayed on the CRT.

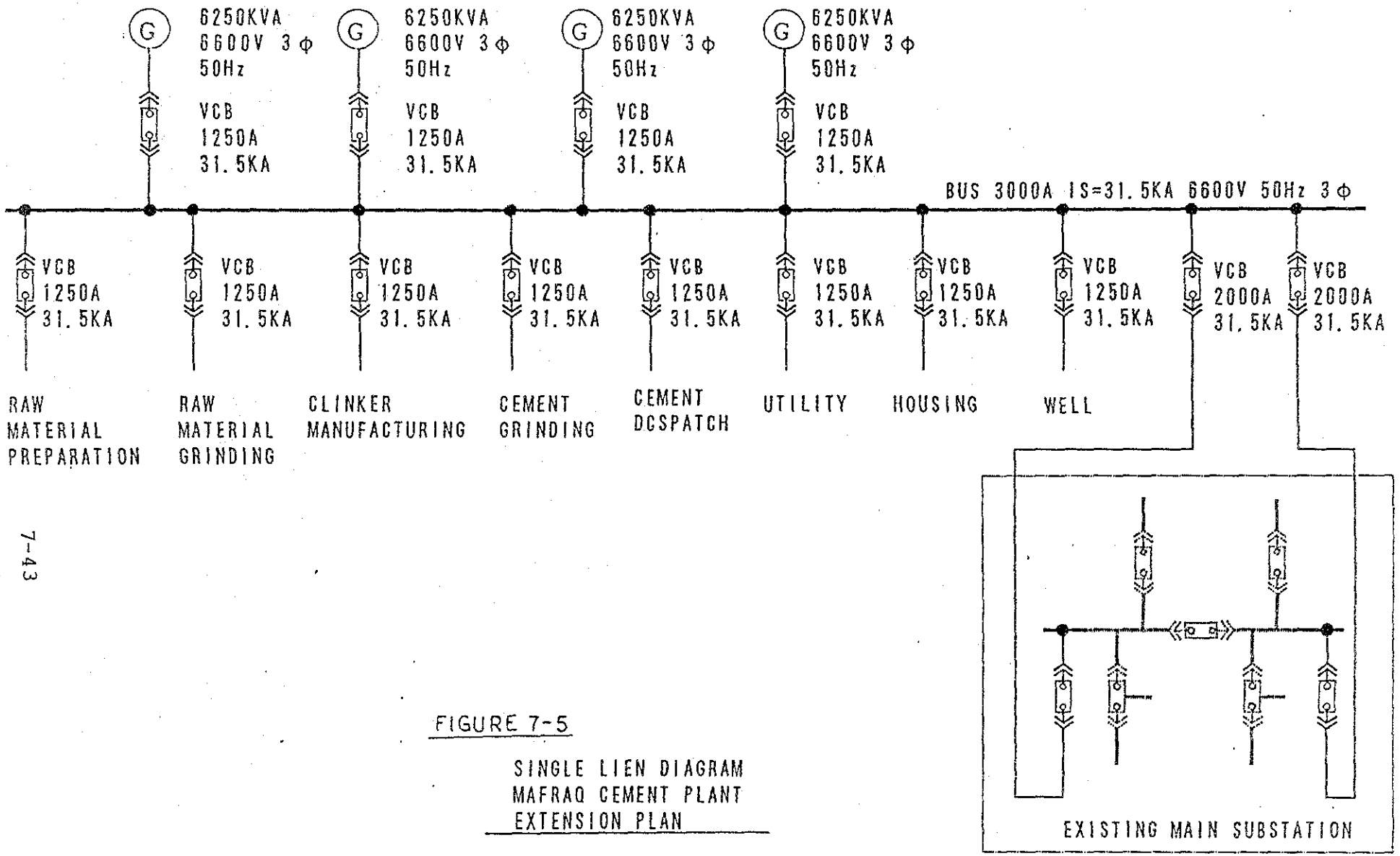


FIGURE 7-5

SINGLE LIEN DIAGRAM
MAFRAQ CEMENT PLANT
EXTENSION PLAN

7.3.4 Auxiliaries

314 Fire Fighting Equipment

Type : Water hydrant, portable fire extinguisher and fixed carbon dioxide

Capacity: Fire fighting pump
100 m^3/h x 8 kg/cm^2 (Existing)

Existing fire fighting system is expanded to expansion plant.

New installations are outdoor type hydrant, portable extinguisher and fixed carbon dioxide for new electric room.

506 Garage

Type : Maintenance for heavy vehicles

This garage is installed near quarry substation in the limestone quarry.

The equipment is the same as existing garage.

602 Laboratory Automation

Type : Automatic sampling, sending and analyzing

This system consist of the following machineries.

- Sampling station
  Crushing, drying and grinding
- Auto Sampler
  Seven samplers including slot and screw sampler
- Automatic sample preparation
  Ground and pressed to briquettes
- X-Ray analyzer
  Online type twelve analyse components

Automatic sample preparation and X-Ray analyzer are installed in existing laboratory.

7.3.5 Civil Engineering and Work

402 Production Buildings and Supports

Expansion plant shall be installed along with the existing plant in the Mafraq plant site.

Following civil engineering and work shall be executed for the production equipment.

1. General
   - Levelling of ground
   - Roads and paved platform
   - Drainage and sewer

2. Building, support and foundation for process line
   - Limestone crushing
   - Belt conveyor supports
   - Sampling station
   - Limestone mix bed
   - Raw mill hoppers
   - Raw mill building
   - Homogenizing and storage silos
   - Preheater, EP and chimney
   - Kiln support
   - Cooler room
   - Clinker bin
   - Clinker silo
   - Cement mill building
   - Bulk loading
   - Garage

3. Building, support and foundation for utilities
   - Raw mill compressor room
   - Cement mill compressor room
   - Emergency D/G room
   - Water treatment
   - Water pump house
   - Fuel oil tank
   - Fuel oil pump house
   - Boiler room

4. Electric room and cable tunnel
   - Substation B
   - Substation C + D
   - Substation E
   - Substation F
   - Utility substation
   - Quarry substation
   - EP electric room
   - Cable tunnel

7.3.6 Equipment List

101 Limestone Quarry
102 Volcanic Rock and Sandstone Quarry
111 Limestone Crushing
112 Additives Crushing
113 Limestone Mix Bed
114 Additive Handling
115 Gypsum Crushing
121 Raw Meal Grinding and Drying
122 Raw Meal Homogenizing and Storage
210 Clinker Burning
202 Clinker Handling and Storage
211 Cement Grinding
212 Cement Handling and Storage
222 Cement Packing
223 Cement Delivery in Bag
224 Bulk Cement Loading
301 Water Storage, Treatment and Distribution
302 Compressed Air Production and Distribution
303 Heavy Fuel Oil Storage and Distribution
314 Fire Fighting Equipment
506 Vehicle Maintenance Garage
602 Laboratory Automation

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
101.	LIMESTONE QUARRY			
101E.010	WAGGON DRILL	1	PERCUSSIVE ROTARY CRAWLER TYPE 20m/h(Drilling) of 89mmD	Same as existing
101E.020	MOBILE COMPRESSOR	1	ROTARY SCREW TYPE 21m3/min x 7kg/cm2	Same as existing
101E.030	PORTABLE HAMMER DRILL	4	PORTABLE ROCK DRILL AND BREAKER up to 50cm/min(Drilling)	Same as existing
101E.040	FRONT-END LOADER	4	WHEEL LOADER 5.4m3(BUCKET)	Same as existing
101E.050	BULLDOZER	1	HYDRAULIC CONTROLLED TILTDOZER 525 HP	Same as existing
101E.070	ELECTRIC BLASTING MACHINE	1	CONDENSER DISCHARGE TYPE 50 shots	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
102.	VOLCANIC ROCK AND SANDSTONE QUARRY			
102E.050	DUMP TRUCK	3	REAR DUMP TRUCK 20tons	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
111.	LIMESTONE CRUSHING			
111E.011	APRON FEEDER	1	HEAVY DUTY TYPE 500t/h 1800mmW x 14.4mL	Same as existing
111E.012	LIMESTONE CRUSHER	1	DOUBLE SHAFT HAMMER CRUSHER 500t/h, 1200mm--70mm R10%	Same as existing
111E.013	DISCHARGE CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 500t/h, 1600mmW x 11mL	Same as existing
111E.014	BOOM CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 500t/h, 1200mmW x 14mL	Same as existing
111E.015	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 500m3/min, 260.2m2	Same as existing
111E.016	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 500m3/min x 250mmAq	Same as existing
111E.017	WALKING MECHANISM	1	HYDLAULIC WALKING MECHANISM 0.7m/min	Same as existing
111E.020	DUCT, CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing
111E.081	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 700t/h, 800mmW x 250mL x 2.8mH	Same as existing
111E.082	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 700t/h, 800mmW x 30mL x 4.3mH	Same as existing
111E.083	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 550t/h, 750mmW x 94mL x -14.3mH	Same as existing
111E.091	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 550t/h, 750mmW x 147.44mL x 8.2mH	Same as existing
111E.092	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 550t/h, 750mmW x 484.9mL x -68.9mH	Same as existing
111E.093	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 550t/h, 750mmW x 547.26mL x 2.6mH	Same as existing
111E.100	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 500t/h, 750mmW x 45mL x 5mH	
111E.110	BELT WEIGHER	1	LOAD CELL TYPE 50-1000t/h,	Same as existing
111E.120	DUCT, CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
111E.140	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3, 20m2	Same as existing
111E.150	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 260m3, 124.4m2	Same as existing
111E.160	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 260m3/min x 250mmAq	Same as existing
111E.171	PORTABLE BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 700t/h, 800mmW x 25mL x 2.7mH	Same as existing
111E.172	PORTABLE BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 700t/h, 800mmW x 25mL x 2.7mH	Same as existing
111E.200	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3/min, 20m2	Same as existing
111E.210	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3/min, 20m2	Same as existing
111E.220	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3/min, 20m2	Same as existing
111E.230	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3/min, 20m2	Same as existing
111E.240	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3/min, 20m2	
111E.250	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3/min, 20m2	Same as existing
111E.260	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 30m3/min, 20m2	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
112.	ADDITIVES CRUSHING			
112E.100	BUCKET ELEVATOR (MODIFY)	1	CONTINUOUS DISCHARGE TYPE 100t/h, 20m.86H to 24mH	
112E.110	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 100t/h, 650mmW x 12.3mL	Same as existing
112E.160	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 150m3/min, 86.4m2	Same as existing
112E.170	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 150m3/min x 250mmAq	Same as existing
112E.200	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	
112E.310	CHANGE OVER DAMPER	1	MOTER DRIVE TYPE	
112E.320	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 100t/h, 650mmW x 12mL	
112E.330	CHANGE OVER DAMPER	1	MOTER DRIVE TYPE	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
113.	LIMESTONE MIX BED			
113E.010	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 500t/h, 750mmW x 232.4 mL x 9.2 mH	Same as existing
113E.020	STACKER	1	LATERAL TYPE WITH SLEWING BOOM 500t/h, 750mmW x 20mL(boom)	Same as existing
113E.030	MIX BEDS	1	OPEN YARD TYPE 20,000tons x 2, 20,000tons x 1	Same as existing
113E.040	RECLAIMING SCRAPER	1	BRIDGE MOUNTED TYPE 300t/h,	Same as existing
113E.050	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 300t/h, 750mmW x 214mL x 3mH	
113E.060	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	
113E.070	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 300t/h, 750mmW x 118mL x 7mH	
113E.080	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 300t/h, 750mmW x 52mL X 12mH	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
114.	ADDITIVE HANDLING			
114E.030	FRONT-END LOADER	2	WHEEL LOADER 5.4m3	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
115.	GYPSUM CRUSHING			
115E.210	CHANGE OVER DAMPER	1	MOTOR OPERATED TYPE	
115E.220	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 20t/h, 650mmW x 9mL x 2mH	
115E.230	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 20t/h, 650mmW X 28mL x 4.5mH	
115E.240	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 20t/h, 650mmW x 7mL	
115E.250	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 150m3/min, 82.9m2	
115E.260	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 150m3/min x 250mmAq	
115E.270	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
121.	RAW MEAL GRINDING AND DRYING			
121E.010	VOLCANIC ROCK HOPPER	1	STEEL MADE TYPE 400m3, 7.2mD x 14.5mH	Same as existing
121E.020	SANDSTONE HOPPER	1	STEEL MADE TYPE 200m3, 5mD x 14.5mH	Same as existing
121E.030	ADDITIVE HOPPER	1	STEE MADE TYPE 200m3, 5mD x 14.5mH	Same as existing
121E.050	LIMESTONE HOPPER	1	STEEL MADE TYPE 220m3, 6.8mD x 10.9mH	Same as existing
121E.060	VOLCANIC ROCK WEIGHER	1	MOMENTARY SPEED CONTROL 5-40t/h, 1000mmW x 3mL	Same as existing
121E.070	SANDSTONE WEIGHER	1	MOMENTARY SPEED CONTROL 0.4-5t/h, 650mmW x 3mL	Same as existing
121E.080	ADDITIVE MATERIAL WEIGHER	1	MOMENTARY SPEED CONTROL 4-30t/h, 1000mmW x 3mL	Same as existing
121E.100	LIMESTONE WEIGHER	1	MOMENTARY SPEED CONTROL 20-150t/h, 1200mmL x 3mL	Same as existing
121E.110	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 170t/h, 650mmW x 19.5mL	Same as existing
121E.120	MAGNETIC SEPARATOR	1	SEPARATOR WITH ELECTRIC TROLLEY	Same as existing
121E.130	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 270t/h, 750mmW x 12.3mL x 1.9mH	Same as existing
121E.140	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 270t/h, 28mH	Same as existing
121E.150	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 360m3/min, 166m2	Same as existing
121E.160	EXHAUST FAN	1	SINGLE SUCTION TURBOTYPE 360m3/min x 250mmAq	Same as existing
121E.170	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing
121E.180	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 270t/h, 750mmW x 9mL	Same as existing
121E.190	SURGE BIN	1	STEEL MADE TYPE 11m3, 2.5mD x 4mH	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
121E.200	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 270t/h, 1000mmW x 7mL	Same as existing
121E.210	FLAP DAMPER	1	DOUBLE STAGE DOUBLE FLAP DAMPER 270t/h, 1100mm x 1100mm	Same as existing
121E.221	GRINDING MILL	1	VERTICAL ROLLER MILL 135t/h, 2.8mD-table	Same as existing
121E.222	DRIVE UNIT	1	TRIPPLE STAGE REDUCTION 1600KW, 980rpm--27.7rpm	Same as existing
121E.231	ROTARY VALVE	1	ROTARY WITH FLAP PLATE 80t/h, 450mmD x 550mmW	Same as existing
121E.232	ROTARY VALVE	1	ROTARY WITH FLAP PLATE 80t/h, 450mmD x 550mmW	Same as existing
121E.241	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 80 t/h, 650mmW x 10.6mL x 2.6mH	Same as existing
121E.242	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 80 t/h, 650mmW x 10.6mL x 2.6mH	Same as existing
121E.250	CYCLONE	1	DOUBLE CYCLONE 3676mmD x 10160mmH	Same as existing
121E.260	ELECTROSTATIC PRECIPITATOR	1	HORIZONTAL GAS FLOW 2000m3/min, 50g/m3--0.05g/m3	Same as existing
121E.270	EXHAUST FAN	1	DOUBLE SUCTION TURBO TYPE 5800m3/min x -970/50mmAq	Same as existing
121E.290	AIR SLIDE	1	CLOSED TROUGH TYPE 160t/h, 350mmw x 50.6mL	Same as existing
121E.300	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 22m3/min x 550mmAq	Same as existing
121E.320	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 22m3/min x 550mmAq	Same as existing
121E.330	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 140t/h, 650mmW x 23.6mL x 4.6mH	Same as existing
121E.340	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 140t/h, 650mmw x 3.1ml	Same as existing
121E.350	HOT GAS FURNACE	1	HORIZONTAL HEAVY OIL FURNACE 12 x 10^6 kcal/h(1280 kg-oil/h)	Same as existing
121E.360	BELT WEIGHER	1	LOAD CELL TYPE 10-200t/h	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
121E.400	CRANE	1	QVERHEAD TRAVELLING TYPE 20 tons, 16mSpan x 19mTravelling	Same as existing
121E.410	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
122.	RAW MEAL HOMOGENIZING AND STORAGE			
122E.010	RAW MEAL STORAGE SILO	1	REINFORCED CONCRETE MADE 3800 tons, 14mID x 28mH	Same as existing
122E.020	AERATION UNIT	1	OPEN AIR SLIDE TYPE 50m2	Same as existing
122E.030	ROOTS BLOWER	1	ROOTS TYPE 30m3/min x 4000mmAq	Same as existing
122E.040	RAW MEAL DISCHARGE UNIT	4	CUT-OFF AND FLOW CONTROL GATES 38t/h (per one unit)	Same as existing
122E.050	AIR SLIDE	1	CLOSED TROUGH TYPE 150t/h, 350mmW x 14.5mL	
122E.060	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 14m3/min x 630mmAq	Same as existing
122E.070	AIR SLIDE	1	CLOSED TROUGH TYPE 150t/h x 350mmW x 10.5mL	Same as existing
122E.080	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 14m3/min x 630mmAq	Same as existing
122E.090	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 300t/h x 32.5mH	
122E.101	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 150t/h x 30.4mH	Same as existing
122E.102	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 150t/h x 30.4mH	Same as existing
122E.110	AIR SLIDE	1	CLOSED TROUGH TYPE 300t/h x 500mmW x 15mL	
122E.120	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 18m3/min x 630mmAq	
122E.130	AIR SLIDE	1	CLOSED TROUGH TYPE 300t/h x 500mmW x 10.966mL	Same as existing
122E.140	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 14m3/min x 630mmAq	Same as existing
122E.160	AIR SLIDE	1	CLOSED TROUGH TYPE 150t/h, 350mmW x 28.452mL	Same as existing
122E.170	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 24m3/min x 560mmAq	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
122E.180	HOMOGENIZING SILO	1	CONTINUOUS DISCHARGE TYPE 1200 tons, 10mID x 24mH	Same as existing
122E.190	AERATION UNIT	1	OPEN AIR BOX AND DISTRIBUTION 240mm x 240mm, 29m2	Same as existing
122E.200	AIR COMPRESSOR	2	RECIPROCATING TYPE 31.5m3/min x 2.1kg/cm2	Same as existing
122E.210	ROTARY VALVE	1	ROTARY WITH SLIDE GATE 150t/h, 630mmD	Same as existing
122E.220	AIR SLIDE	1	CLOSED TROUGH TYPE 150t/h, 350mmW x 6.819mL	Same as existing
122E.230	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 6m3/min x 630mmAq	Same as existing
122E.240	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 60m3/min, 31.1m2	Same as existing
122E.250	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 90m3/min, 42.3m2	Same as existing
122E.260	EXHAUST FAN	1	SUCTION TURBO TYPE 90m3/min x 250mmAq	Same as existing
122E.270	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 200m3/min, 103.7m2	Same as existing
122E.280	EXHAUST FAN	1	SUCTION TURBO TYPE 200m3/min x 250mmAq	Same as existing
122E.290	HOIST	1	ELECTRIC HOIST 2 tons, 30mL	Same as existing
122E.300	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 150t/h, 4.8mH	Same as existing
122E.310	AIR SLIDE	1	CLOSED TROUGH TYPE 150t/h, 350mmW x 14.407mL	Same as existing
122E.320	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 14m3/min x 560mmAq	Same as existing
122E.330	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing
122E.340	AIR SLIDE GATES	2	MOTOR OPERATED TYPE (MODIFY of 122050 AIR SLIDE)	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201.	CLINKER BURNING (RAW MEAL FEEDING)			
201E.010	AIR SLIDE	1	CLOSED TROUGH TYPE 150t/h, 350mmW x 16mL	
201E.020	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 16m3/min x 560mmAq	
201E.040	FEED BIN	1	STEEL MADE ON LOAD CELL 38m3, 3.2mD x 5mH	Same as existing
201E.050	AERATION UNIT	1	OPEN AIR SLIDE	Same as existing
201E.060	WEIGHER	1	IMPACT FLOW METERTYPE 18-150t/h	Same as existing
201E.070	AIR SLIDE	1	CLOSED TROUGH TYPE 150t/h, 350mmW x 2.05mL	Same as existing
201E.080	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 4m3/min x 500mmAq	Same as existing
201E.090	AIR LIFT	1	AIR LIFT 150t/h, 63mH, 1.25mD x 6.6mH	Same as existing
201E.100	COMPRESSOR	3	ROOTS BLOWER 63m3/min x 0.6kg/cm2	Same as existing
201E.110	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 200m3/min, 103m2	Same as existing
201E.120	EXHAUST FAN	1	SUCTION TURBO TYPE 200m3/min x 350mmAq	Same as existing
201E.130	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201.	(PREHEATING)			
201E.210	PREHEATER	1	PREHEATER WITH PRECALCINER 1700T/D, 5-STAGE	Same as existing
201E.220	PREHEATER REFRACTORY	1	HEAT RESISTANT BRICKS,CASTABLES AND INSULATION BOARD	Same as existing
201E.230	PREHEATER TOWER	1	STEEL STRUCTURAL MADE 11mW x 13.5mL x 53mH	Same as existing
201E.240	SECONDARY AIR DUCT	1	WELDED ROUND DUCT	Same as existing
201E.250	SECONDARY AIR DUCT (REFRACTORY)	1	HEAT RESISTANT BRICKS,CASTABLES	Same as existing
201E.260	MAIN DRAFT FAN	1	DOUBLE SUCTION TURBO,BACKWARD 4300m3/min x 840mmAq	Same as existing
201E.270	WATER PUMP	1	MULTI STAGE TYPE 7m3/h x 0.5/7.0kg/cm2	Same as existing
201E.280	SERVICE ELEVATOR	1	MAN AND LOAD ELEVATING TYPE 1.5 tons, 60.8mH	Same as existing
201E.300	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 50m3/min, 31.1m2	Same as existing
201E.310	STABILIZER	1	VERTICAL PARALLEL FLOW TYPE 2200Nm3/min, 6.5mD x 28.531mH	Same as existing
201E.320	WATER PUMP	2	TURBINE PUMP 24.1t/h x 38kg/cm2	Same as existing
201E.331	SCREW CONVEYOR	1	U-TROUGH TYPE 50t/h, 600mmD x 8.5mL	Same as existing
201E.332	SCREW CONVEYOR	1	U-TROUGH TYPE 60t/h, 600mmD x 12mL	Same as existing
201E.340	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 50t/h, 15.9mH	Same as existing
201E.350	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing
201E.360	DUST BIN	1	STEEL MADE TYPE 60m3, 4mD x 7.4mH	Same as existing
201E.370	ERECTROSTATIC PRECIPITATOR	1	HORIZONTAL GAS FLOW TYPE 3400m3/min, 80g/m3---0.05g/m3	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201E.390	STACK	1	STEEL MADE SELF STANDING 3820m3/min, 2.4/4.0mD x 70mH	Same as existing
201E.401	SCREW CONVEYOR	1	U-TROUGH REVERSIBLE TYPE 25t/h, 315mmD x 6.24mL	Same as existing
201E.402	SCREW CONVEYOR	1	U-TROUGH REVERSIBLE TYPE 25t/h, 315mmD x 6.24mL	Same as existing
201E.403	SCREW CONVEYOR	1	U-TROUGH REVERSIBLE TYPE 50t/h, 600mmD x 10.59mL	Same as existing
201E.404	SCREW CONVEYOR	1	U-TROUGH REVERSIBLE TYPE 50t/h, 600mmD x 10.59mL	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201.	(BY-PASS SYSTEM)			
201E.410	QUENCH FAN	1	SINGLE SUCTION TURBO TYPE 250m3/min x 150mmAq	Same as existing
201E.420	STABILIZER	1	VERTICAL PARALLEL FLOW TYPE 380Nm3/min, 4mD x 11.2mH	Same as existing
201E.430	WATER PUMP	1	TURBINE PUMP 12.1m3/h x 38kg/cm2	Same as existing
201E.440	ELECTROSTATIC PRECIPITATOR	1	HORIZONTAL GAS FLOW TYPE 780m3/min, 80g/m3---0.05g/m3	Same as existing
201E.450	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 800m3/min x -180/20mmAq	Same as existing
201E.470	CHAIN CONVEYOR	1	CLOSED TROUGH TYPE 10t/h, 200mmW x 19.5mL	Same as existing
201E.480	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 60t/h, 16.4mH	Same as existing
201E.490	DUST BIN	1	STEEL MADE TYPE 60m3, 4mD x 7.25mH	Same as existing
201E.500	DUST COLLECTOR with FAN	1	AUTOMATIC REVERSE PULSE AIR TYPE 50m3/min, 31.1m2	Same as existing
201E.510	DUCT, CHUTE & OTHERS	1	STEEL MADE TYPE PNUMATIC PIPE & SUPPORT	Same as existing
201E.520	BULK TRUCK	1	BULK CARRIER 25m3	Same as existing
201E.950	PNUMATIC CONVEYOR	2	25 t/h, 23 mV x 320mH	
201E.960	AIR COMPRESSOR	2	53.9 m3/min x 2.5 kg/cm2	
201E.970	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 60 m3/min,	
201E.980	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 60 M3/MIN x 350 MMaQ	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201.	(DUST RECOVERY)			
201E.530	SCREW CONVEYOR	1	U-TROUGH REVERSIBLE TYPE 25t/h, 600mmD x 2.1mL	Same as existing
201E.540	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 25t/h, 23.95mH	Same as existing
201E.550	AIR SLIDE	1	CLOSED TROUGH TYPE 25t/h, 250mmW x 7.4mL	Same as existing
201E.560	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 10m3/min x -10/500mmAq	Same as existing
201E.570	SCREW CONVEYOR	1	U-TROUGH TYPE 15t/h, 500mmD x 6mL	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201.	CLINKER BURNING			
201E.611	ROTARY KILN	1	DRY SHORT KILN 1700T/D, 3.8mD x 54mL	Same as existing
201E.620	SUPPORTING UNIT	1	3-SUPPORT	Same as existing
201E.630	DRIVE UNIT	1	SINGLE DRIVE 3-STAGE REDUCTION 3.0-0.6rpm, 200KW, 37kw(Aux.)	Same as existing
201E.640	KILN REFRACTORY	1		Same as existing
201E.650	KILN FIRING HOOD	1	STATIONARYTYPE	Same as existing
201E.660	HOOD REFRACTORY	1		Same as existing
201E.670	NOSE RING FAN	1	SINGLE SUCTION TURBO FAN 150m3/min x 250mmAq	Same as existing
201E.680	KILN SHELL COOLING FAN	12	AXIAL FAN 115m3/min x 20mmAq	Same as existing
201E.690	HOIST	1	ELECTRICAL HOISTING AND TRAVEL'G 5 tons, 16mH	Same as existing
201E.700	DUCT, CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201.	(FIRING)			
201E.720	OIL PUMP AND HEATER	1	SCREW PUMP AND HEATER UNIT 7.5t/h x 45kg/cm2	Same as existing
201E.730	KILN BURNER	1	PILLARD TYPE 3000kg/h	Same as existing
201E.740	KILN BURNER CARRIER	1	HANGING TYPE	Same as existing
201E.750	KILN PRIMARY AIR FAN	1	SINGLE SUCTION TURBO TYPE 100m3/min x 1500mmAq	Same as existing
201E.760	FF BURNER	1	OPD TYPE 1500kg/h x 3 sets	Same as existing
201E.770	FF PRIMARY AIR FAN	1	SINGLE SUCTION TURBO TYPE 100m3/min x 1500mmAq	Same as existing
201E.780	DUCT, CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
201.	(CLINKER COOLING)			
201E.810	CLINKER COOLER	1	HORIZONTAL GRATE COOLER 1700T/D, 52.3m2 (2-stage)	Same as existing
201E.820	COOLER REFRACTORY	1		Same as existing
201E.830	COOLER FAN(1ST FAN)	1	SINGLE SUCTION TURBO TYPE 500m3/min x 750mmAq	Same as existing
201E.840	COOLER FAN(2ND FAN)	1	SINGLE SUCTION TURBO TYPE 720m3/min x 700mmAq	Same as existing
201E.850	COOLER FAN(3RD FAN)	1	SINGLE SUCTUON TURBO TYPE 1100m3/min x 400mmAq	Same as existing
201E.860	COOLER FAN (4-5TH FAN)	1	SINGLE SUCTION TURBO TYPE 2200m3/min x 220mmAq	Same as existing
201E.890	GRAVEL BED FILTER	1	GRAVEL BED FILTER 5300m3/min, 50g/m3--0.05g/m3	Same as existing
201E.900	VENT FAN	1	DOUBLE SUCTION TURBO TYPE 5700m3/min x -280/10mmAq	Same as existing
201E.910	STACK	1	STEEL MADE TYPE 5700m3, 2.8mD x 25mH	Same as existing
201E.920	CHAIN CONVEYOR	1	CLOSED TROUGH TYPE 25t/h, 270mmW x 20mL	Same as existing
201E.940	DUCT, CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
202.	CLINKER HANDLING AND STORAGE			
202E.011	PAN CONVEYOR	1	DEEP DRAWN PAN WITH BAFFLES 150t/h, 700mmW x 45mL x 29.2mH	Same as existing
202E.012	PAN CONVEYOR	1	DEEP DRAWN PAN WITH BAFFLES 150t/h, 500mmW x 40mL x 24mH	
202E.020	STEEL TROUGH CONVEYOR	1	DEEP STEEL TROUGH TYPE 150t/h, 800mmW x 30mL	
202E.030	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 100m3/min, 42.3m2	Same as existing
202E.040	EXHAUST FAN	1	SUCTION TURBO TYPE 100m3/min x 350mmAq	Same as existing
202E.050	CLINKER BIN	1	CYLINDRICAL STEEL MADE TYPE 150m3, 5.5mD x 9.5mH	Same as existing
202E.060	CLINKER STORAGE SILO	1	REINFORCED CONCRETE MADE 8500tons, 18mD x 39mH	Same as existing
202E.070	VIBRATING FEEDER	4	CLOSED TYPE ELECTRO-MAGNETIC TYPE 125t/h, 700mmW x 1mL	Same as existing
202E.081	BELT CONVEYOR (MODIFY)	1	30 DEG.TROUGH, 3-CARRIER ROLLER 250t/h, 650mmW, 18.25mL to 22.5mL	
202E.083	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 250t/h, 650mmW x 22.5mL	Same as existing
202E.090	BELT CONVEYOR	1	30 DEG.TROUGH, 3-CARRIER ROLLER 250t/h, 650mmW x 101.7mL x 21.1mH	Same as existing
202E.101	CLINKER HOPPER	1	STEEL MADE TYPE 10m3	Same as existing
202E.102	VIBRATING FEEDER	1	CLOSED TYPE ELECTRO-MAGNETIC TYPE 60t/h, 500mmW x 1mL	Same as existing
202E.110	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 160m3/min, 86.4m2	Same as existing
202E.120	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 100m3/min, 42.3m2	Same as existing
202E.130	EXHAUST FAN	1	SUCTION TURBO TYPE 100m3/min x 250mmAq	Same as existing
202E.140	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 100m3/min, 42.3m2	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
202E.150	EXHAUST FAN	1	SUCTION TURBO TYPE 100m3/min x 250mmAq	Same as existing
202E.171	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE (UBE portion)	Same as existing
202E.180	EXHAUST FAN	1	SUCTION TURBO TYPE 160m3/min x 350mmAq	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
211.	CEMENT GRINDING			
211E.010	CLINKER HOPPER	1	STEEL MADE TYPE 200m3, 7mD x 10mH	Same as existing
211E.020	GYPSUM HOPPER	1	STEEL MADE TYPE 100m3, 7m x 4m x 10mH	Same as existing
211E.030	ADDITIVE HOPPER	1	STEEL MADE TYPE 100m3, 7m x 4m x 10mH	Same as existing
211E.040	CLINKER WEIGH FEEDER	1	MOMENTARY BELT SPEED CONTROL 13-100t/h, 1200mmW x 4.7mL	Same as existing
211E.050	GYPSUM WEIGH FEEDER	1	MOMENTARY BELT SPEED CONTROL 1.25-10t/h, 750mmW x 4.7mL	Same as existing
211E.060	ADD. WEIGH FEEDER	1	MOMENTARY BELT SPEED CONTROL 2.5-20t/h, 750mmW x 4.7mL	Same as existing
211E.070	BELT CONVEYOR	1	30 DEG. TROUGH 3-CARRIER ROLLER 120t/h, 650mmW x 9.325mH	Same as existing
211E.080	GRINDING MILL	1	CLOSED CIRCUIT COMPOUND MILL 90t/h(3200cm2/kg),4.2mD x 13.475mL	Same as existing
211E.090	GRINDING MEDIA	1	Cr-STEEL BALL 90-50-17mmD	Same as existing
211E.100	DRIVE UNIT	1	SIDE DRIVE 3200kw, 980/15.6rpm	Same as existing
211E.110	WATER SPRAY DEVICE	1	MILL INSIDE SPRAY 2.5t/h, (4t/h x 100mAq-Pump)	Same as existing
211E.120	AIR SLIDE	1	CLOSED TROUGH TYPE 270t/h,450mmW x 5mL	Same as existing
211E.130	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 15m3/min x -10/750mmAq	Same as existing
211E.140	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 270t/h, 19.85mH(F-F)	Same as existing
211E.150	AIR SLIDE	1	CLOSED TROUGH TYPE 270t/h, 450mmW x 6.1mL	Same as existing
211E.160	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 15m3/min x -10/750mmAq	Same as existing
211E.171	AIR SEPARATOR	1	O-Sepa N2000 90t/h(Product)	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
211E.172	CYCLONE	1	90t/h, 1.8mD x 4sets	Same as existing
211E.180	CIRCULATING FAN	1	DOUBLE SUCTION TURBO TYPE 2000m3/min x -650/-150mmAq	Same as existing
211E.190	AIR SLIDE	1	CLOSED TROUGH TYPE 180t/h, 400mmW x 12.3mL	Same as existing
211E.200	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 15m3/min x -10/750mmAq	Same as existing
211E.210	IMPACT FLOW METER	1	IMPACT LINE 0-300t/h	Same as existing
211E.230	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 1080m3/min, 676.4m2	Same as existing
211E.240	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 1200m3/min x -360mmAq	Same as existing
211E.251	AIR SLIDE	1	CLOSED TROUGH TYPE 70t/h, 250mmW x 4.6mL	Same as existing
211E.252	AIR SLIDE	1	CLOSED TROUGH TYPE 70t/h, 250mmW x 4.6mL	Same as existing
211E.253	AIR SLIDE	1	CLOSED TROUGH TYPE 140t/h, 300mmW x 10.7mL	Same as existing
211E.254	AIR SLIDE	1	CLOSED TROUGH TYPE 140t/h, 300mmW x 3.1mL	Same as existing
211E.260	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 20m3/min x -10/550mmAq	Same as existing
211E.290	PNEUMATIC CONVEYOR	2	KINYON PUMP 130t/h, 10inchD x 139mL x 33mH	Same as existing
211E.300	AIR COMPRESSOR	2	ROTARY COMPRESSOR 33.6m3/min x 1.75kg/cm2	Same as existing
211E.310	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 100m3/min, 42.3m2	Same as existing
211E.320	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 100m3/min x 250mmAq	Same as existing
211E.330	HOIST	1	ELECTRIC HOISTING AND TRAVELLING 2tons x 12mL	Same as existing
211E.340	CRANE	1	OVERHEAD TRAVELLING CRANE 15tons, 7.9mSpan x 9mL	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
211E.350	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
212.	CEMENT HANDLING AND STORAGE			
212 .050	AIR SLIDE	4	Modiffication of existing A/Slide 2-A/S 1 m extended, 2-A/S modified and 1-motor driven diverter added on each A/S(total 4)	
212E.073	AIR SLIDE	1	CLOSED TROUGH TYPE 120t/h, 300mmW x 41.9mL	Same as existing
212E.080	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 35m3/min x -10/550mmAq	Same as existing
212E.090.	DUST COLLECTOR	2	AUTOMATIC REVERSE PULSE AIR TYPE 150m3/min, 86.4m2	
212E.100	EXHAUST FAN	2	SINGLE SUCTION TURBO TYPE 150m3/min x 250mmAq	Same as existing
212E.120	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
222.	CEMENT PACKING			
222E.010	BUCKET ELEVATOR	1	CONTINUOUS DISCHARGE TYPE 120t/h, 18.5mH(F-F)	Same as existing
222E.020	VIBRATING SCREEN	1	CLOSED TROUGH TYPE 120t/h, 1200mmW x 2500mmL	Same as existing
222E.030	BIN	1	STEEL MADE TYPE 2.5m x 2.5m x 4mH	Same as existing
222E.040	BIN FEEDER	1	DOUBLE ROTARY FEEDER 140m3/h	Same as existing
222E.050	PACKING MACHINE	1	8-FILLING SPOUTS ROTARY PACKER 100t/h (2000bags/h)	Same as existing
222E.060	DISCHARGE CONVEYOR	1	FLAT BELT TYPE 100t/h, 800mmW X 1.3mL x 0.27mH	Same as existing
222E.070	BROKEN BAG TRAP	1	ALIGNING CONVEYOR 800mmW x 1.6mL	Same as existing
222E.080	SCREW CONVEYOR	1	U TROUGH TYPE 10t/h, 250mmD x 10.55mL	Same as existing
222E.100	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 340m3/min, 156.1m2	Same as existing
222E.110	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 340m3/min x 250mmAq	Same as existing
222E.130	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	Same as existing
222E.150	WEIGHT COMPENSATION WEIGHER	1	ELECTRONIC CHECK WEIGHER	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
223.	CEMENT DELIVERY IN BAGS			
223E.010	BELT CONVEYOR	1	FLAT BELT TYPE 100t/h, 650mmW x 33.6mL	
223E.030	AUT. TRUCK LOADER	1	AUTOMATIC BAG LOADING 2200bags/h	Same as existing
223E.060	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
224.	BULK CEMENT LOADING			
224E.010	DISCHARGE DEVICE	2	PNEUMATIC FEEDER 100t/h	Same as existing
224E.020	ROOTS BLOWER	1	ROOTS BLOWER 4.03m3/min x 6000mmAq	Same as existing
224E.030	AIR SLIDE	1	CLOSED TROUGH TYPE 100t/h, 300mmW x 26.4mL	Same as existing
224E.040	AIR SLIDE FAN	1	SINGLE SUCTION TURBO TYPE 35m3/min x -10/550mmAq	Same as existing
224E.050	TELESCOPIC CHUTE	1	MOVABLE TYPE 100t/h	Same as existing
224E.060	WEIGH BRIDGE	1	LOAD CELL TYPE 80 tons, 18m x 3.5m	Same as existing
224E.070	DUST COLLECTOR	1	AUTOMATIC REVERSE PULSE AIR TYPE 50m3/min, 21.5m2	Same as existing
224E.080	EXHAUST FAN	1	SINGLE SUCTION TURBO TYPE 50m3/min x 250mmAq	Same as existing
224E.090	DUCT,CHUTE & OTHERS	1	STEEL MADE TYPE	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
301.	WATER STORAGE TREATMENT AND DISTRIBUTION			
301E.020	RAW WATER PUMP	1	VOLUTE PUMP 40m3/h, x 30mH	
301E.030	MULTI-MEDIA FILTER	1	MULTI-MEDIA FILTER 40m3/h	
301E.050	E.D.R UNIT FOR PROCESS WATER (MODIFY)	1	Modificayion of existing to Capa. up. 40m3/h to 70m3/h(Product)	
301E.110	INDUSTRIAL WATER PUMP	1	VOLUTE PUMP 25m3/h x 30mH	Same as existing
301E.130	WARM WATER BASIN	1	REINFORCED CONCRETE MADE 75m3, 3.6mL x 4.2mW x 5.5mH	Same as existing
301E.140	COOLING WATER PUMP	3	VOLUTE PUMP 110m3/h x 7.5kg/cm2	Same as existing
301E.150	CIRCULATION WATER PUMP	2	VOLUTE PUMP 200m3/h x 1kg/cm2	Same as existing
301E.160	COOLING TOWER	1	COUNTER FLOW TYPE 200m3/h, 39deg.C--31deg.C	Same as existing
301E.170	DRAINAGE PUMP	5	PORTABLE SUBMERGED TYPE 15m3/h x 1.2kg/cm2	Same as existing
301E.180	INHIBITOR UNIT	1	CHEMICAL METERING PUMP 5-100l/day	Same as existing
301E.190	CHLORINATION UNIT	1	CHEMICAL METERING PUMP 5-100l/day	
301E.200	PIPING & OTHERS	1	PIPING,VALVE AND FITTING	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
302.	COMPRESSED AIR PRODUCTION			
302E.010	COMPRESSOR	1	RECIPROCATING TYPE 19.6m3/min x 8kg/cm2	Same as existing
302E.030	HOIST	1	TROLLEY HOIST 1.5tons, x 6mL	Same as existing
302E.040	PIPING & OTHERS	1	PIPING,VALVE AND FITTING	
302E.050	AIR DRYER	1		Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
303.	HEAVY FUEL OIL STORAGE			
303E.010	HEAVY OIL LOADING PUMP	2	60m3/h x 3kg/cm2	Same as existing
303E.020	OIL STORAGE TANK	1	2500kL, 14.63mD x 16.2mH	Same as existing
303E.030	TRANSFER PUMP	2	GEAR PUMP 16m3/h x 4kg/cm2	Same as existing
303E.040	STEAM BOILER	1	FIRE TUBE BOILER 2000kg/h, 6kg/h(Fuel firing)	Same as existing
303E.050	BOILER WATER PUMP	2	VOLUTE PUMP 4m3/h x 2.5kg/cm2	Same as existing
303E.060	FUEL OIL PUMP (BOILER)	2	SCREW TYPE 0.38m3/h x 10kg/cm2	Same as existing
303E.070	WATER SOFTENER (BOILER)	1	ION EXCHANGE RESIN TYPE 2-5m3/h	Same as existing
303E.080	PIPING & OTHERS	1	PIPING,VALVE AND FITTING	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
304.	DIESEL OIL STORAGE			
304E.030	TRANSFER PUMP	2	GEAR PUMP 10m3/h x 4kg/cm2	
304E.050	PIPING & OTHERS	1	PIPING,VALVE AND FITTING	

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
314.	FIRE FIGHTING SYSTEM			
314E.040	FIRE FIGHTING EQUIP.	1	OUTDOOR TYPE HYDRANT	Same as existing
314E.080	PORTABLE FIRE EXTINGSHER	30	DRY CHEMICALPORTABLE TYPE	Same as existing
314E.090	FIXED CARBON DIOXIDE	1 lot	CO2 EXTINGUISHER FOR ELECTRIC ROOM	Same as existing
314E.100	PIPING & OTHERS	1	PIPING,VALVE,AND FITTING	Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
506.	VEICLE MAINTENANCE GARAGE			
506E.010	CRANE	1		Same as existing
506E.020	MONORAIL HOIST	1		Same as existing
506E.040	AIR CONPRESSOR	1		Same as existing
506E.050	AIR CONPRESSOR	1		Same as existing
506E.060	DIAGNOSTIC & SERVICE TUNE UP CENTER	1		Same as existing
506E.070	ELECTRIC CHARGER	2		Same as existing
506E.080	MOBILE ELEC CHARGER	1		Same as existing
506E.090	WINDING DRUM FOR PORTABLE LIGHT	8		Same as existing
506E.100	MOBILE WELDING TRANS	1		Same as existing
506E.110	MOBILE WELDING TRANS	1		Same as existing
506E.120	GREASING & LUB. UNIT	1		Same as existing
506E.130	GREASING & LUB. UNIT	1		Same as existing
506E.140	MOBILE PAINT INSTALL	2		Same as existing
506E.150	VACUUM CLEANER	2		Same as existing
506E.160	GARAGE JACK	1		Same as existing
506E.170	GARAGE JACK	2		Same as existing
506E.180	PIT LIFT	2		Same as existing
506E.190	PIT LIFT	2		Same as existing
506E.210	WORK BENCH	10		Same as existing
506E.220	LIGHT BENCH	2		Same as existing
506E.230	PNEUMATIC DECANTER	5		Same as existing
506E.240	PNEUMATIC DECANTER	5		Same as existing
506E.250	SPECIAL DRUM	4		Same as existing
506E.260	WHEEL BALANCER	1		Same as existing
506E.270	AXLE FAN	2		Same as existing
506E.280	WHEEL BALANCER	1		Same as existing

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
506E.290	TIRE REMOVER	1		Same as existing
506E.300	TIRE REMOVER	1		Same as existing
506E.310	PORTABLE CAR WASHER	2		Same as existing
506E.320	RACK	12		Same as existing
506E.330	RACK	14		Same as existing
506E.340	INJECTION PUMP TEST BENCH	1		Same as existing
506E.350	DIESEL ENGINE INJECTION TESTER	1		Same as existing
506E.360	PNEUMATIC SCREWING MACHENE	3		Same as existing
506E.370	TOOL	1		Same as existing
506E.380	WATER TANK	1	10m3 x 10mH	
506E.390	PIPING & OTHERS	1		

ITEM NO	MACHINE NAME	Q'TY	SPECIFICATION	REMARKS
602.	LABORATORY AUTOMATION			
602E.010	SAMPLING STATION	1	THREE STAGE SAMPLING WITH CRUSHING,DRYING AND GRINDING	Same as existing
602E.020	AUTO SAMPLER (LIMESTONE)	1	MIXING,SAMPLING AND SENDING TYPE 200cc/sample	Same as existing
602E.030	AUTO SAMPLER (RAW MILL OUT)	1	SLOT SAMPLER 200cc/sample	Same as existing
602E.040	AUTO SAMPLER (KILN DUST)	1	SCREW SAMPLER 200cc/sample	Same as existing
602E.050	AUTO SAMPLER (KILN FEED)	1	SLOT SAMPLER 200cc/sample	Same as existing
602E.060	AUTO SAMPLER (REC.R.MEAL)	1	SCREW SAMPLER 200cc/sample	Same as existing
602E.070	AUTO SAMPLER (H.SILO IN)	1	SLOT SAMPLER 200cc/sample	Same as existing
602E.080	AUTO SAMPLER (C.MILL OUT)	1	SLOT SAMPLER 200CC/sample	Same as existing
602E.090	AUTOMATIC SAMPLE PREPARATION	1		Same as existing
602E.100	STATION LABORATORY	1		Same as existing
602E.120	X-RAY ANALYZER (ON-LINE ANALYSIS)	1	MULTI-CHANNEL TYPE X-RAY	Same as existing
602E.140	WATER CHILLER	1	WATER CHILLING UNITS FOR X-RAY ANALYZER	Same as existing

7.4 Supporting Facilities

This supporting facilities basically shall consist of the expansion of existing supporting buildings and stores.

Following facilities shall be installed.

- Administration building and parking canopy
  For the purpose of obtaining the office for administration & marketing and sales department, approximately half of existing building area shall be extended.

- Canteen
  Existing canteen which is capable of around 250 personnel at lunch time shall be extended its area approximately one third.

- Warehouse and refractory storage
  Existing warehouse for consumable spare parts and refractory storage shall be extended approximately one half of each storage area.

- Toilet blocks
  Two toilet blocks shall be installed for expansion plant area.

7.5 Diesel Power Plant

7.5.1 Power Supply Equipment

4 (four) - Diesel generator sets shall be provided for MAFRAQ EXTENSION CEMENT PLANT. 3 (three) sets are used for normal operation and 1 (one) set is stand-by. These generators shall be designed to run parallel.

7.5.2 Generator

Specification of Generator is as follow:

a) Type	: Open, Self ventilated, Rotating field type
b) Coupling	: Directly coupled to Diesel engine with common bed
c) Degree of protection	: IP 21
d) Rating	: Continuous
e) Voltage	: 6600V
f) Phase ' wire	: 3 Phase, 3 Wire
g) Frequency	: 50 Hz
h) Rated output	: 5000 kW
i) Number of pole	: Mfr's standard
j) Rotating speed	: Mfr's standard
k) Power factor	: 0.8 lagging
l) Insulation class	: F
m) Connection	: Star
n) Bearing	: Mfr's standard
o) Lubrication of bearing	: Mfr's standard
p) Excitation system	: Brush-less excitation system
q) Overload capacity	: 110%, 1 Hr
r) Painting color	: 7.5 BG 6/1.5

7.5.3 Diesel Engine

a) Revolution	: Mfr's standard
b) Fuel oil service tank	: Mfr's standard
c) Fuel oil	: Heavy oil
d) Starting system	: Air
e) Cooling	: Cooling tower type
f) Exhaust system	: Silencer

7.5.4 Generator Panel

Generator panel shall be a power distribution board with safety relays, circuit breakers and relays for thyristor type automatic voltage regulator assembled to operate and control diesel-engine driven generator safely.

Generally, starting and stopping shall be done by manual. But, parallel operation is required, automatic parallel operation shall be considered. Therefore, Governor, Automatic Voltage Regulator, Synchronizing Relay, Automatic Load Balancer shall be provided for automatic parallel operation.

7.5.5 Diesel Oil Storage

Diesel oil loading pump, oil storage tank (2,500 kl) and oil transfer pump shall be installed independently from the cement production line for supply of diesel oil to the power plant.

7.5.6 Spare Parts, Special Tool and Accessories

Manufacturer's recommended spare parts for 2-years, special tools for the disassembly of the engine and suitable accessories shall be supplied.

7.6 Water Supply

7.6.1 General Concept

1) Water source:

Water will be pumped up deep ground water through wells in the Twilah Sandstone formation that is widely distributed at Al Harfa village of Wadi Rahada.

2) Pumping Facilities:
Ground water will be pumped up with the use of submersible motor pump to a receiver tank installed on the ground. Electric power will be supplied by overhead line from the plant.

3) Water delivery facilities:
Water will be delivered about 10 km from the receiver tank through pipe-line to a water storage tank at the plant by a method of gravity flow utilizing 200m height difference.

7.6.2 Design Conditions

1) Water demand

Process water	: 500 m^3 per day
Drinking water	: 200 m^3 per day
Total	700 m^3 per day

2) Water supply quantity
Water supply quantity is calculated based on 8 hours operation time of submersible motor pump. In this case 1,458 l/min. of output shall be needed in order to supply 700 m^3/d in 8 hours.

3) Necessary number of water well

As estimated pumpage of the wells from the "Twilah" sandstone formation is seemed to be 400 - 700 l/min., 500 l/min. is adopted in this design. From this, 1,458 l/min. / 500 l/min. = 2.916 ≒ 3 about 3 wells shall be needed. In addition stand by well for emergency will be installed.

4) Well facilities

The location and depth of well in consideration of differences of horizontal distance and vertical depth will be determined in order not to affect the existing well.

Water source area is the plain of valley bottom, which is 200m higher than the plant site, thus, water can be delivered by means of gravity flow with adjustment after stocked in the receiver tank with use of submersible motor pump.

5) Water delivery facility

Route of water delivery will be established through the road along the "Wadi Rahaba" and marginal part of farm, and turn toward the west-north at the test boring (No. 1 well), further proceeds 300m in the "Wadi Habbaybah" and finally up to the reservoir tank at the plant site along the upstream of the "Wadi Ar Rub".

6) Automatic operation

Well operation will be made automatically through automatic water level measuring device to be installed in the reservoir tank. Opening and closing of the reservoir tank will be operated by electromagnetic gate valve which will be controlled by transmission of signal from the plant site in accordance with volume of water demand.

7.6.3 Main Specification

1) Deep well : Depth : 200m
Numbers : 4
Casing pipe: 200 mm dia x 150 ml

2) Water pump : Capacity: 500 l/min
Head : 150m
Numbers : 4

3) Receiver tank : Capacity: 100 m^3
Numbers : 1

7.7 Housing Facilities

7.7.1 Existing Housing Facilities

Housing area for the plant employees are located 3 km south west from the plant.

Already housing facilities for the existing plant employees were installed as a part of the existing plant construction work.

Numbers and the type of housings are as follows:

Numbers of housings	Type
1	A-Type Flat (149.5 m^2)
5	C-Type Flat (123.2 m^2)
10	C1-Type Flat (93.5 m^2)
42	B1-Type Flat (42 m^2)
80	D1-Type Flat (18 m^2)
132	E1-Type Flat (12 m^2)

Common Facilities

- Guest House
- Canteen
- Swimming Pool
- Tennis Courts
- Gate House
- Substation
- Drainage and Sewage
- Road and Lighting

7.7.2 New Housing Facilities

New 267 employees in addition to 488 employees for the existing plant shall be engaged for the expansion plant. (Details are mentioned in 8.3 Enhancement of Man-Power and Organization).

For these additional employees, following expansion of housing facilities shall be constructed.

Plot plan of the housing area is shown in Figure 7-6 and arrangement of each housing are shown in Figure 7-7, 7-8 and 7-9.

1) Housings

Number of housing	Type
8	C-Type Flat (123.2 m^2)
20	C1-Type Flat (93.5 m^2)
150	F-Type Flat (80.0 m^2)

2) Auxiliary Facilities

- Drinking water treatment
  Raw water storage tank, water pump, EDR unit and drinking water storage tank
- Substation and street lighting
- Drainage and sewage system

3) Civil Work

- Levelling of housing area
- New road

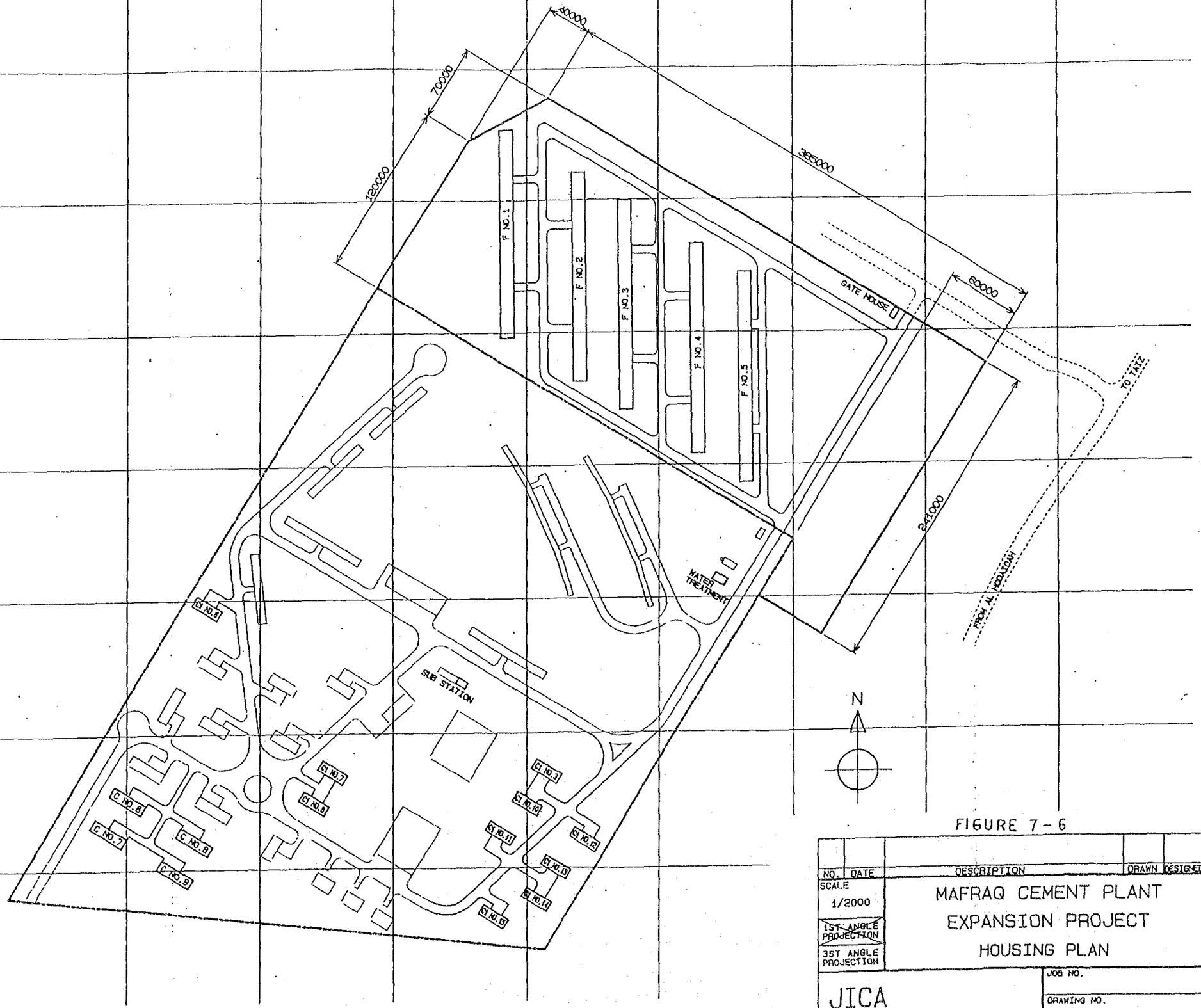


FIGURE 7-6

NO.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED

SCALE 1/2000

1ST ANGLE PROJECTION

3ST ANGLE PROJECTION

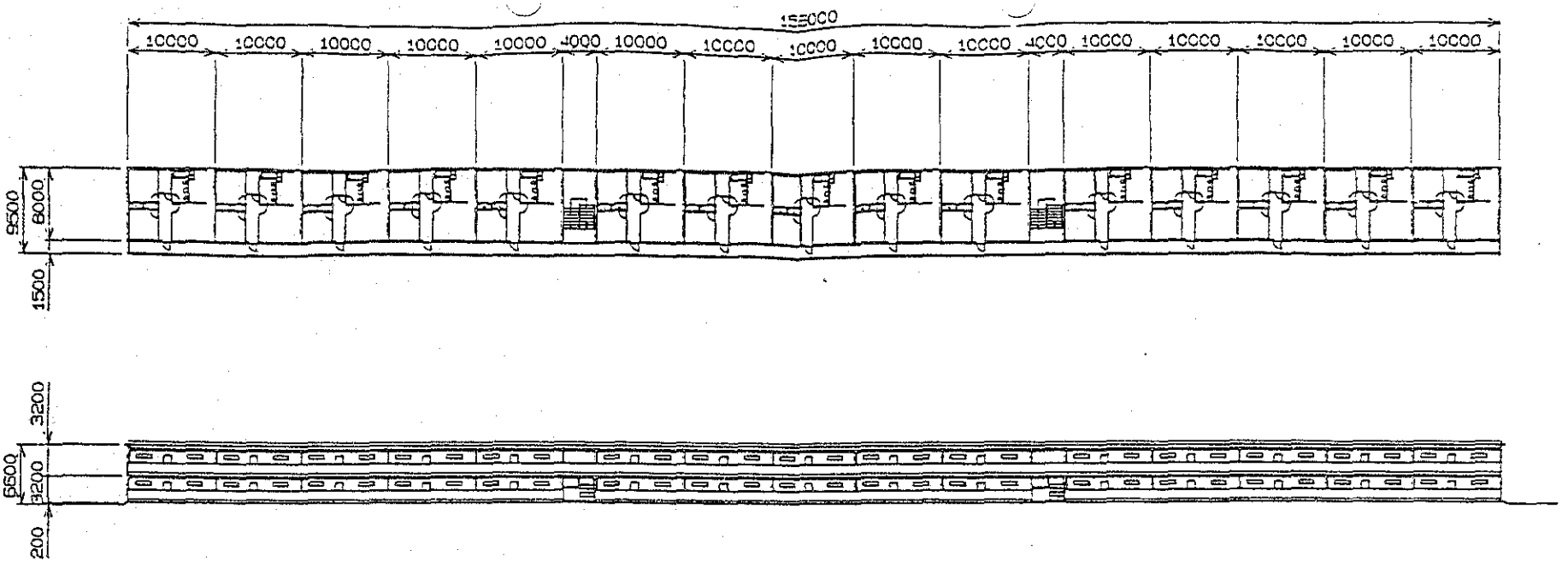
MAFRAQ CEMENT PLANT
EXPANSION PROJECT
HOUSING PLAN

JICA

JOB NO.

DRAWING NO.

REV.



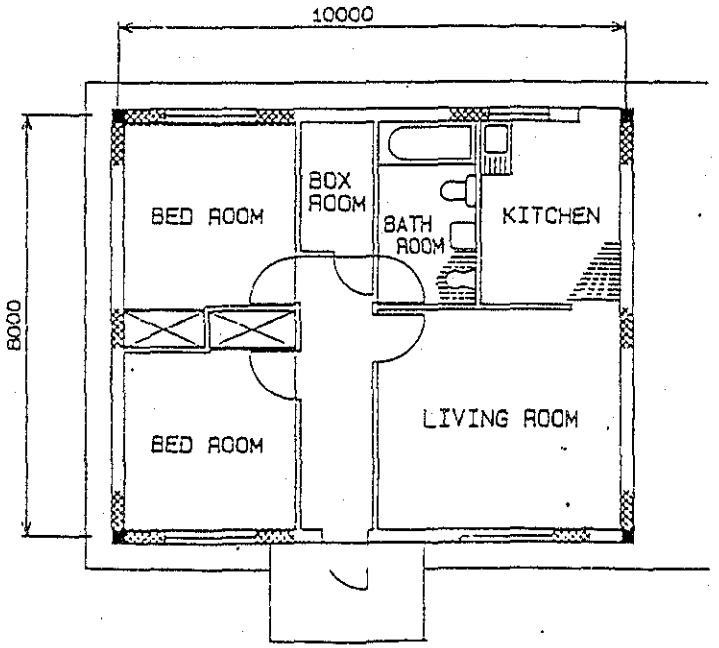


FIGURE 7 — 7

NO.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED

SCALE
1/500
1/100

1ST ANGLE PROJECTION

3ST ANGLE PROJECTION

MAFRAQ CEMENT PLANT
EXPANSION PROJECT
HOUSE TYPE "F"

JICA

JOB NO.

DRAWING NO.

REV.

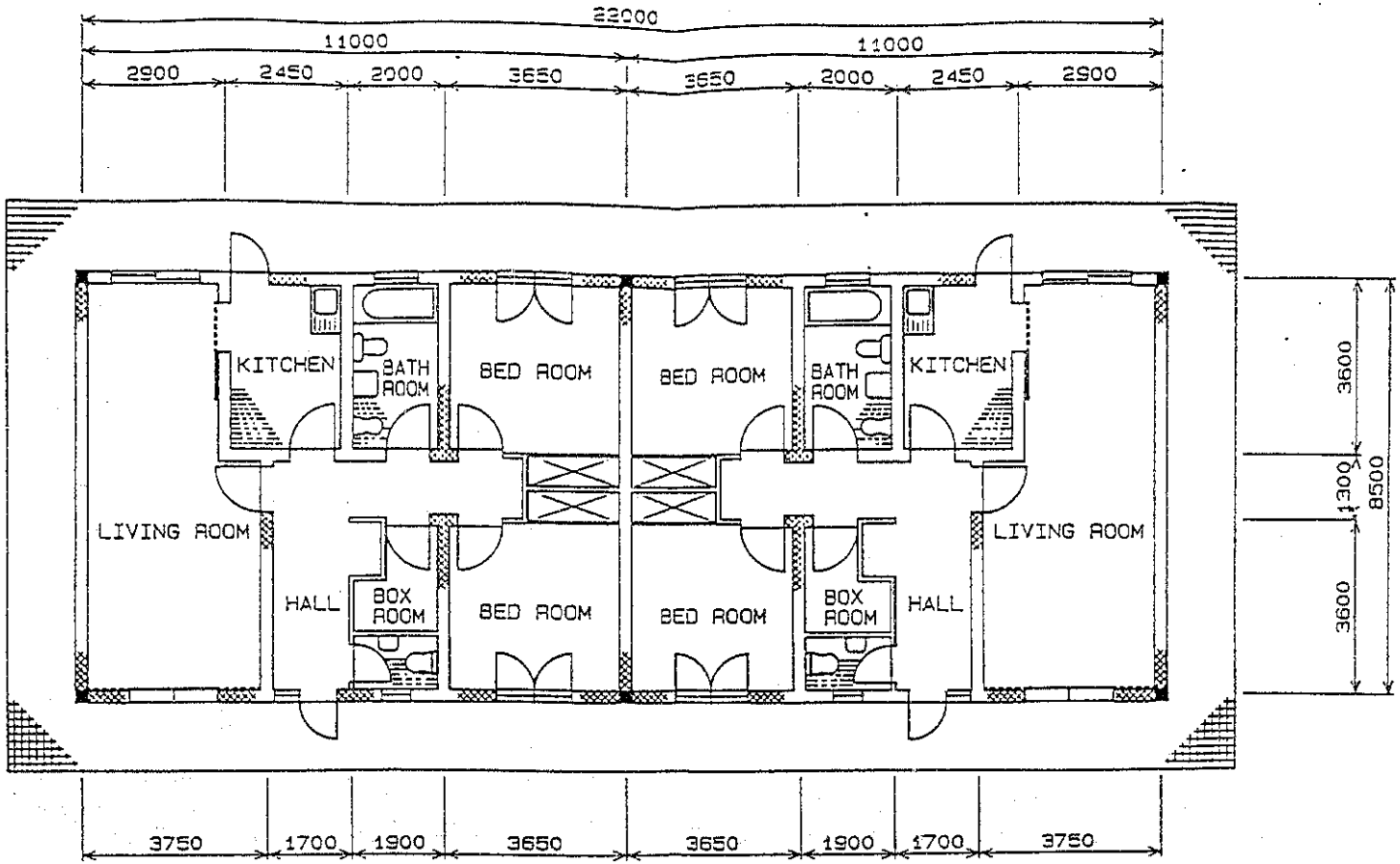


FIGURE 7 — 8

NO.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED

SCALE 1/100

1ST ANGLE PROJECTION

3ST ANGLE PROJECTION

MAFRAQ CEMENT PLANT
EXPANSION PROJECT
HOUSE TYPE "C1"

JICA

JOB NO.

DRAWING NO.

REV.

7-97

7-97

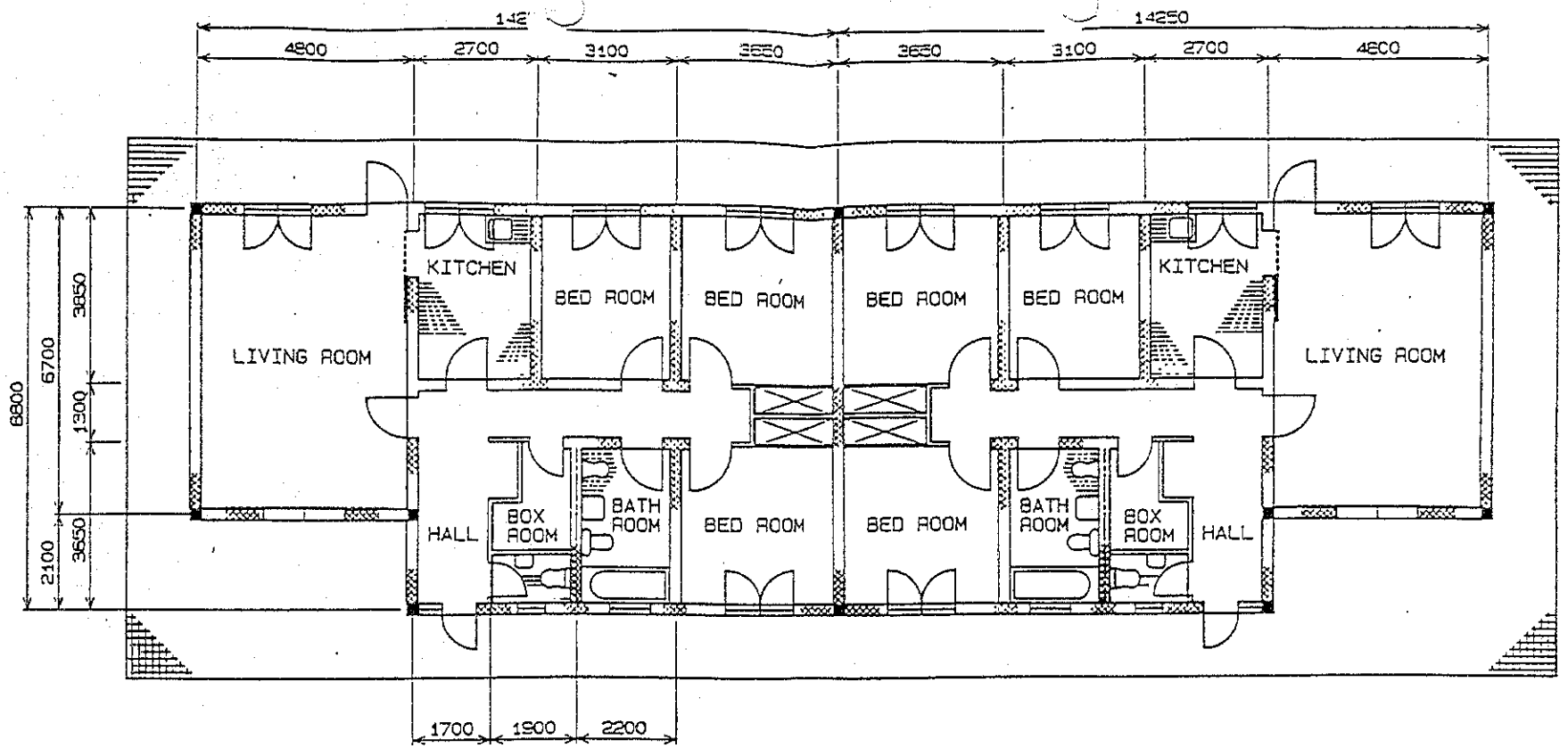


FIGURE 7 — 9

NO.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED

SCALE 1/100

1ST ANGLE PROJECTION

3ST ANGLE PROJECTION

MAFRAQ CEMENT PLANT EXPANSION PROJECT

HOUSE TYPE "C"

JICA

JOB NO.

DRAWING NO.

REV.

8

CONTENTS

8.1 Implementation Schedule

Followings are typical steps for the implementation of project. This implementation schedule is shown in Figure 8-1 Implementation Schedule.

8.1.1 Raising Funds Required

Funds required for the project are to be raised. If the government soft loan applies to the project, it is necessary to go through the proceedings, such as:

- Obtaining the approval of the Project from the Yemen Government,
- Requesting for the soft loan to the financing government by the Yemen Government,
- Investigating the Project by the financing government and
- Exchanging a loan agreement between Yemen government and financing government

To this end, almost a period of one year or more is required, though on a case basis, depending upon the financing government.

8.1.2 Consultation

After confirmed the First Step of raising the funds required, the project plan is to be studied in detail in the second step to determine the items to be implemented. Subsequently, a tender is to be held to select a construction contractor for the Project. To carry out these engineering works, experienced cement plant consultant is normally appointed to organize a joint task-force once the required funds have been raised.

The Project requires another one year to carry out the works.

- Selection of Consultant
- Detail study of the Plan
- Preparation of Tender Document
- Tender (from open to close)
- Evaluation of Tender
  (Selection of Contractor)

8.1.3 Construction

In this stage, the project construction is to be executed by the contractor awarded with the contract for the project in the second step. At the same time when this step has come to the end, the Plant is to be completely constructed and to start operation.

Most of the construction works shall be executed while operating the existing plant, however, it is required to be shut down several times of existing plant in order to complete the works related to the existing plant such as utilities supply.

A time schedule of the construction is given in Figure 8-1.

- A total period of 36 months is required to finish the Plant.
- 4 months are required for commissioning the Plant.
- Shipments are effected for a period of 10th thru 20th months.
- The civil engineering work is started in 5 months.
- 12th thru 32nd months are required for the erection.

8.2 Consulting Service

Once the funds settled to materialize the Project, it is necessary to appoint a consultant as a cement plant expert so as to concretize the plan.

The consultant is to basically play the following roles:

Phase-1: Preparation of tender documents
(1) Determination process and design for expansion plant
(2) preparation of tender document

Phase-2: Selection of Contractor
(1) Evaluation of Tenderer's proposal
(2) Assistance of contract negotiation

Phase-3: Supervision of Plant Construction Work
(1) Services in main office of the Consultant
(2) Services at plant site

These roles are enumerated below.

8.2.1 Preparation of Tender Documents

After signing a consultation service agreement, the consultant is to despatch an engineer to make arrangements concerning a detail study of the process and the basic design of the project. Then, he is to prepare a tender documents to appoint a contractor.

Survey of water source shall be also included the scope of work of the consultant.

The tender document is intended to:

a) Adjust all tenderers' proposals to the plan.

b) Make certain of the equipment performance as one of the technical aspects involved and clarify the dates of delivery.

c) Standardize or consolidate the contractual terms and conditions from a commercial point of view.

Contents of the tender document generally consist of the following:

- Introduction
- Instruction to tenderers
- Form of tender
- Form of agreement
- General condition (including scope of work)
- Special condition (including local condition)
- Raw materials (including chemical analysis)
- Specifications (Mechanical, Electrical, Civil, Erection and Commissioning)
- Training and technical assistance
- Drawings (layout, arrangement)

8.2.2 Selection of Contractor

After obtaining proposals from tenderers, the consultant is to evaluate them concerning their contents, i.e. tender price, terms and conditions of payment, equipment specifications, construction works and so on. Then he is to prepare an evaluation report.

Subsequently, the consultant is to have technical negotiations with one tender or two selected as a result of the evaluation concerning their proposal. In this stage, the consultant is to perform the following

functions:

- Prequality tenderers
- Invite tenderers
- Prepare an evaluation report
- Negotiate with tenderers
- Recommend a contractor

8.2.3 Supervision of Plant Construction Work

Once the contractor to carry out the plant construction has been selected, the Project at last enters into the construction phase.

Here, the consultant is to give technical services so that the construction can be easily followed up and the Plant will smoothly operate after completion of the construction.

In this stage, the consultant is to perform the following functions.

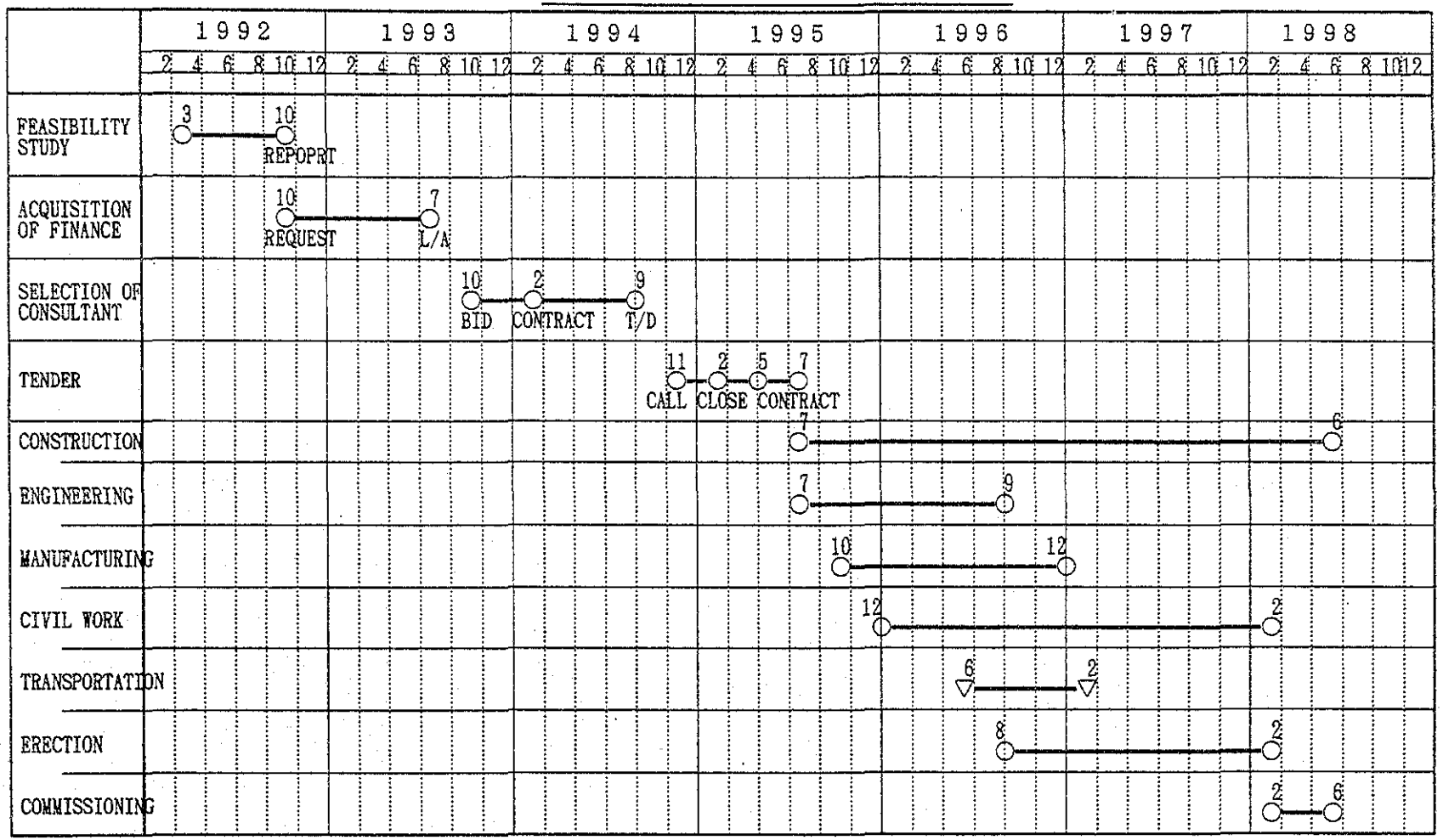
- Services in main office
  Examination of main drawings, checking of time schedules, inspection of main items and determination of training programme.

- Services at plant site
  Checking and supervision of civil works, mechanical equipment erection, electrical and control equipment erection, and other ancillary installation.
  Supervision of idle run test and load test.

FIGURE 8-1

MAFRAQ CEMENT PLANT EXPANSION PROJECT

IMPLEMENTATION SCHEDULE



8.3 Enhancement of Man-Power and Organization

For better understanding, the organization charts of Mafraq cement plant and its production department are shown in Figure 8-2 and Figure 8-3. Although basically any alteration is not considered after materializing at expansion project, the number of the workers for operation and maintenance shall be accordingly increased due to the expansion of the plant machinery.

1) Indirect Department

(Administration Dept., Sales Dept., Accounting Dept., Procurement Dept., Security office and Housing Estate Master)

Working volume may be increased more or less by the expansion but it is not necessary to prepare additional staffs because the existing plant is considered having enough in this department.

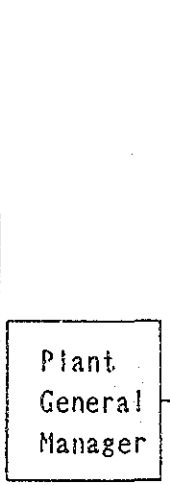
2) Production Department

Number of managers, engineers and supervisors at each dept. are not needed to be increased except the power station to be newly installed. It is philosophy that each senior employee either as engineer or supervisor will be responsible for both existing and expansion plant.

(1) Quarry

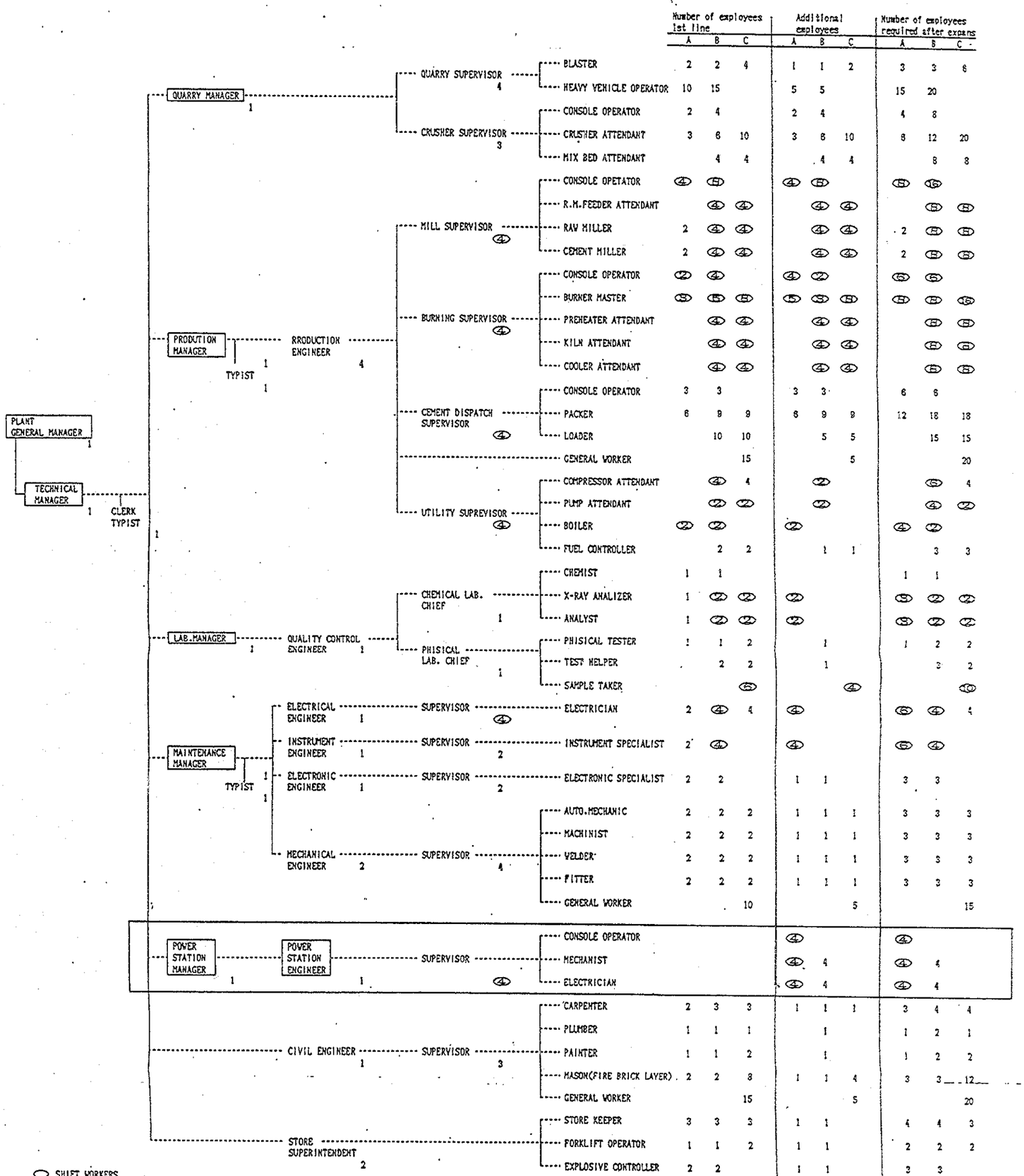
The number of workers for blasting and heavy vehicle operation will be increased by 50%. The same number of workers as existing for crushing will be added because similar equipment is additionally installed for expansion.

Figure 8-2
Organization Chart of Mafraq Cement Plant



	Number of employees for 1st line	Number of employees required after expansion	Number of additional employees
Administration Dept.	15	15	0
Sales Dept.		15	0
Accounting Dept.	15		
Production Dept.	438	705	267
Procurement Dept.	20	20	0
Security Office			
Housing Estate Maste			
Total	488	755	267

Figure 8-3 Organization of Production Department



Number of employees 1st line			Additional employees			Number of employees required after expans		
A	B	C	A	B	C	A	B	C
2	2	4	1	1	2	3	3	6
10	15		5	5		15	20	
2	4		2	4		4	8	
3	6	10	3	6	10	6	12	20
	4	4		4	4		8	8
(4)	(5)		(4)	(5)		(5)	(6)	
	(4)	(4)		(4)	(4)		(5)	(5)
2	(4)	(4)		(4)	(4)	2	(5)	(5)
2	(4)	(4)		(4)	(4)	2	(5)	(5)
(2)	(4)		(4)	(2)		(5)	(6)	
(3)	(5)	(5)	(5)	(3)	(5)	(5)	(5)	(6)
	(4)	(4)		(4)	(4)		(5)	(5)
	(4)	(4)		(4)	(4)		(5)	(5)
	(4)	(4)		(4)	(4)		(5)	(5)
3	3		3	3		6	6	
6	9	9	6	9	9	12	18	18
	10	10		5	5		15	15
		15			5			20
	(4)	4		(2)			(6)	4
(2)	(2)		(2)			(4)	(2)	
	2	2		1	1		3	3
1	1					1	1	
1	(2)	(2)	(2)			(3)	(2)	(2)
1	(2)	(2)	(2)			(3)	(2)	(2)
1	1	2		1		1	2	2
	2	2		1			3	2
		(5)			(4)			(9)
2	(4)	4	(4)			(6)	(4)	4
2	(4)		(4)			(6)	(4)	
2	2		1	1		3	3	
2	2	2	1	1	1	3	3	3
2	2	2	1	1	1	3	3	3
2	2	2	1	1	1	3	3	3
		10			5			15
			(4)			(4)		
			(4)	4		(4)	4	
			(4)	4		(4)	4	
2	3	3	1	1	1	3	4	4
1	1	1		1		1	2	1
1	1	2		1		1	2	2
2	2	8	1	1	4	3	3	12
		15			5			20
3	3	3	1	1		4	4	3
1	1	2	1	1		2	2	2
2	2		1	1		3	3	
71	143	152	69	101	91	140	244	253
1st line			2nd line			Total		

(4) SHIFT WORKERS

TYPIST					TOTAL
2	3	4	13	40	82
0	0	1	1	4	6
2	3	5	14	44	88

Grand Total
Existing : 438
Additional : 267
After Expansion: 705

(2) Production

As the similar or equivalent equipment relating to grinding, burning and cement dispatch will be constructed, the same number of operators and maintenance workers as existing in such department will be required additionally.

(3) Laboratory

For X-ray analyser to be newly installed, approximately 40% of the laboratory workers may be enough to be added mainly for sift works.

(4) Maintenance

The same number of sift workers for plant maintenance as existing will be required but additional 50% are enough only for day time maintenance.

(5) Power station

A new power station with diesel generators is planned to be installed for expansion plant. The operation and maintenance personnel including a manager and an engineer shall be newly prepared.

(6) Others

50% of employees for civil work and store keeping will be required additionally.

8.4 Training and Technical Assistance

8.4.1 Abroad Training

Table 8-1 shows the number of trainees and training duration. Basically all employees for expansion plant will be trained sufficiently at the existing plant.

The trainees who have much experience at the existing plant and so on should be dispatched to the abroad training. So that the number of trainees will be decreased except computer specialists who need special knowledge. As side effect training duration is also shortened to two months.

Table 8-1 Schedule for Abroad training

	Trainer	existing plant		expansion plant	
		No.of Trainees	Duration (month)	No.of Trainees	Duration (month)
Quality control	QC engineer Laboratory analyst	3	3	2	2
Computer	System engineer Specialist in computer supplier	3	3	3	2
Production operation	Production engineer	6	3	4	2
Total		12		9	

The following shows the example of training program

(1) General guidance

1) Orientation
2) Explanation of cement production process, material & gas flow and identification of equipment of Mafraq plant
3) Explanation of the process of cement plant
4) Explanation of process interlock of cement plant and Mafraq plant
5) Explanation of organization, work regulation, safety precaution
6) Visit to cement plant
7) Interview, test and evaluation

(2) Cement quality control training

1) General guidance
2) Quality control of cement
3) Raw mix proportioning calculation
4) Practical training of sampling
5) Observation and practical training of physical test, chemical and X-ray analysis
6) Explanation of laboratory automation

(3) Computer training

1) Maintenance for hardware
2) Software of computer
3) Language of computer
4) Application software
5) Trouble shooting
6) Graphic of computer

(4) Production operation training

1) General guidance
2) Concept of production process
3) Practical training of operation
4) Practical training of daily inspection

8.4.2 Site Training

Table 8-2 shows the number of trainees and duration for site training. The importance of the training is thought to be familiarization with new equipment for the expansion. The trainees after the training will play a great role to keep the plant condition good after the plant starts. Therefore, the number of site trainees is considered same number as existing plant. The quarry personnel for expansion is excluded because training by plant supplier is not necessary as each has finished experience at existing quarry. And the training duration will be reduced to max. three months applying OJT (On the Job Training).

Table 8-2 Schedule for Site training

	Trainer	existing plant		expansion plant	
		No.of Trainees	Duration (month)	No.of Trainees	Duration (month)
Quarry	Mining engineer Heavy vehicle service engineer	6	1	-	-
Mechanical maintenance	Mechanical engineer Equipment supplier`s specialist	8	5	8	3
Electrical maintenance	Electrical engineer Equipment supplier's specialist	8	5	8	3
Production & operation	Commissioning engineer	19	5	15	3
Cement quality control	QC engineer	3	3	3	1
Computer	Computer specialist	3	4	3	2
Power station		0	0	3	2
Total		47		40	

The example of training program is shown in below.

(1) General guidance

1) Orientation
2) Explanation of rules and regulation
3) Explanation of process, material & gas flow of Mafraq plant
4) Explanation of safety precaution

(2) Mechanical maintenance training

1) General guidance
2) Concept of production process
3) Study of main process line
4) Detail study and maintenance work of roller mill
5) Detail study and maintenance work of preheater, rotary kiln and clinker cooler
6) Detail study and maintenance work of tube mill
7) General maintenance work
8) Lubricants
9) Cooling water
10) Refractories
11) Spare parts stock
12) Preventive maintenance
13) Familiarization/training given by equipment supplier's specialists

(3) Electrical maintenance training

1) General guidance
2) Maintenance, trouble shooting and operation for
   - Power receiving
   - Instrument and one loop controller
   - Control system
   - Local control packages
   - Emergency power

(4) Production & operation training

1) General guidance
2) Concept of production process
3) Study of main process line
4) Operation of crushing
5) Operation of raw material grinding & homogenizing
6) Operation of clinker burning process
7) Operation of cement grinding process
8) General concept of quality control
9) Console operation in central control room
10) Interlocking diagram and alarm system
11) Operation of utility system
12) Familiarization/training given by equipment supplier's specialists

(5) Cement quality control training

1) General guidance
2) Quality control of cement
3) Raw mix proportioning calculation
4) Wet analysis of chemical laboratory
5) Physical test of cement and mortar
6) X-ray analyzing
7) Laboratory automation

(6) Computer training

1) Maintenance for hardware using actual supplied computer
2) How to operate computer

(7) Power station training

1) General guidance
2) Maintenance, trouble shooting and operation for power station
3) Familiarization/training given by specialists of power station

8.4.3 Technical Assistance

Key personnel for operation and maintenance of existing plant are needed according to the schedule shown in Table 8-3.
It is understood that the several workers with enough experience will be transferred from Amran cement plant but the greater part of employees are covered with unexperienced personnel. Therefore that is the reason why 27 foreign experts are dispatched as a technical assistance at the beginning of the existing plant operation.
As especially operation and maintenance for the expansion plant should be executed by the personnel with much experienced at existing plant, minimized number of experts will be dispatched from plant suppliers.
Table 8-4 shows the schedule of dispatched experts for expansion.

Table 8-3 Schedule of dispatched key personnel for existing

	Number	Duration (year)
Works manager	1	2
Production manager	1	2
Mechanical engineer	1	3
Electrical engineer	1	3
Production senior supervisor	1	2
Analyst	1	1
X-ray analyst	1	2
Ditto	1	1
Physical test foreman	1	1
Central control-room console operators	2	2
Ditto	2	1
Chief burner	1	1
Chief miller	1	1
Production supervisor	2	2
Ditto	2	1
Mining senior supervisor	1	2
Instrument engineer	1	3
Instrument attendant	1	1
Foreman mechanic	1	2
Foreman electric	1	2
Computer software specialist	1	2
System structure specialist	1	1
System structure attendant	1	2
Total	27	

(Source: Mafraq Cement Plant)

Table 8-4 Schedule of dispatched experts for expansion

	Number	Duration (year)
Mechanical engineer	1	1
Electrical engineer	1	1
Production engineer	1	1
Computer software specialist	1	1
Chief burner	1	1
Instrument attendant	1	1
Power station engineer	1	1
Total	7	