As for the condenser vacuum, case study was conducted on 700 mmHg and 710 mmHg, and the condenser vacuum is decided to be 710 mmHg which is more economical in case that the utilization factor exceeds 46%.

Comparison of both the condenser vacuum of 700 mmHg and 710 mmHg are described as follows.

Table 5-6 Cost comparison of 700mmHg and 710mm condenser vacuum

1. Comparison of specifications

Torget value	unit	700mmHg	710mmHg	Remarks
Thermal efficiency	%	Base	Higher by 0.5%	100% Load
Cooling area	m^2	10510	15200	
CWP Spec.	m^3/H	25,000 x 12.0m	25,000 x 12.8m	Estimate
Shaft power of CWP	KW	983 x 2	1049 x 2	Refer to Note-1

Note-1: Specifications for CWP is estimated as follows because of unknown factors

$$S = \frac{25{,}000\ m^3/H \times 12.0\ m \times 1.025}{60 \times 0.85} \times 0.163 = 983\ KW$$

2. Economic comparison

Torget value		unit	700mmHg	710mmHg	Remarks
Const. cost equivalent to thermal eff. difference.	Thermal efficiency	M¥	Base	- 236.1	Refer to Note-2
	Power for pump	M¥	Base	+ 22.4	"
Cost difference of equipment		M¥	Base	+ 140.0	Refer to Note-3
Total		M¥	Base	- 73.7	

Note-2: Construction cost equivalent to thermal efficiency difference is calculated based on the following formula.

$$A = \frac{24 \times 365 \times L \times Lf \times Fc}{Ic \times \eta_B \times (1-L_0) \times 10^9}$$

$$B = \frac{HR(100) \times \Delta S \times A}{L}$$

where, A : Unit construction cost equivalent to thermal efficiency difference M¥/Kcal/KWH

L : Rated output of plant (300,000) KW

Lf: Utilization factor (0.70) %/100

Fc: Unit fuel price (1.93) $¥/10^3$ Kcal

Ic: Fixed cost rate (0.16) %/100

η_B: Boiler efficiency (≒0.90) %/100

Lo: Plant loss factor (0.01) %/100

B : Unit construction cost equivalent to station auxiliary power M¥/KW

HR: Thermal efficiency at rated output Kcal/KWH
(100)

ΔS: Motor input to CWP KW

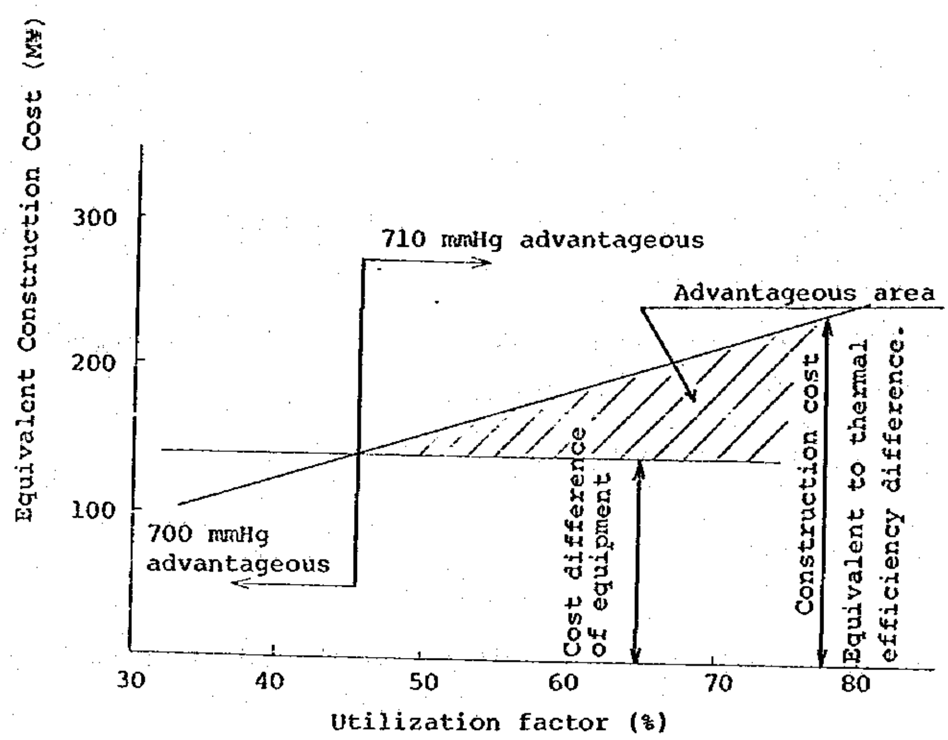
$$\Delta S = \frac{\text{Shaft power}}{\text{Motor efficiency}}$$ (Motor efficiency is assumed to be 92%)

Note-3 : All costs for condenser, CWP and motor as of 1983 are included, but costs for transportation and installation are not included.

3. Summary

As for the economical aspects, as described in item (2), since the reduction in operation cost is higher than increase of equipment cost at more than 46% of utilizetion factor, 710 mmHg vacuum is more economical.

Fig. 5-2 Economic Evaluation of Condenser Vacuum



d. Condenser Circulating Water Pump

There are volute pumps, axial flow pumps and mixed flow pumps for the condenser circulating pump. For this project, the mixed flow pump directly coupled with the electric motor will be adopted, for its relatively small size and higher head at no-discharge operation and practically no variation of the shaft horsepower.

e. Feedwater Heater

There are the horizontal type and the vertical type of feedwater heaters, and as there is not much difference in their merits and demerits.

However, since in case of the vertical type feedwater heater, water level control during unit start-up is more difficult than that of horizontal type one, in this project the horizontal type feedwater heaters will be adopted.

Horizontal type feed water heaters should have adequate drainage space in a way not to affect in anyway the heating surface and it should have an efficient venting system. Provision for atmospheric venting will be installed.

As for the number of stage of extraction steam, it is concluded that 8-stage extraction steam system is more economical than 7-stage extraction steam system in case that the utilization factor exceeds 52%. Therefore, 8-stage extraction steam system will be adopted.

Comparison of 8-stage extraction and 7-stage extraction steam systems, and horizontal and vertical type feedwater heaters are described as follows.

Reason of adoption of the four-stage LP and HP feedwater heaters and 8-extraction steam system

1. Comparison of specifications

Items		unit	8-extraction steam system	7-extraction steam system	Remarks
Thermal efficiency		%	Base	approx. 0.6% lower	
Evaporation at MCR		T/H	Base	- 50	Refer to Note-1
No. of Feed water heater	HP heater		3	2	
	Deaerator		1	1	
	LP heater		4	4	

Note-1 : When the CRH steam is extracted for heating of highest pressure feed water heater in case of 7-extraction steam system, approximately 50 tons of evaporation will be reduced.

2. Economic evaluation

Items	unit	8-extraction steam system	7-extraction steam system	Remarks
Construction cost equivalent to thermal efficiency difference	M¥	Base	+ 283.9	
Cost difference of equipment	M¥	Base	- 210.0	Refer to Note-2
Total	M¥	Base	+ 73.9	

Note-2 : Cost for one additional HP heater and capacity up of evaporation (as of 1983) are included in cost difference of equipment, but costs of transportation and installation are not included.

3. Results of economic evaluation in two cases, (1) CRH steam is extracted for highest HP heater and (2) HP turbine extraction steam is extracted for highest HP heater, are shown in the following figure.
4. Summary : As described the above, 8-extraction steam system is more economical than 7-extraction system at more than 52% of utilization factor. (Refer to the following figure.)

Economic evaluation of 8/7 extraction steam system

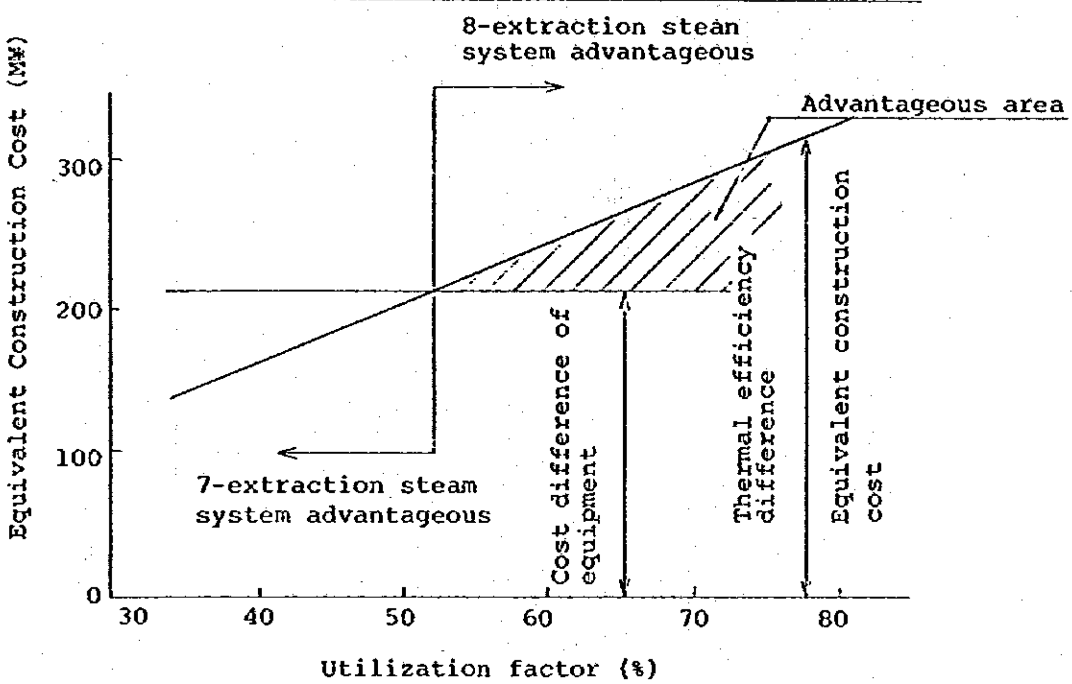


Table 5-7(1) Comparison of Vertical and Horizontal FW Heaters

	Design	Layout	Operation and Maintenance	Cost
Horizontal Type	1. As there is practically no part of heat exchanger section that does not work effectively, the heating surface is smaller. 2. As this type is not limited too much in length, the heating surface need not be too large.	1. Larger installation floor area is necessary. 2. As each leg of the FW heaters is fixed on the floor, the thermal expansion of FW piping must be absorbed by bends of the piping, and piping tends to be longer. However, since FW heaters can be located nearer to the boiler, this arrangement is more attractive in this point. There are not much differences with respect to extraction piping and drain piping. 3. This type of FW heaters is not affected by the span and height of the travelling crane.	Operation Water level control at start-up and low load is relatively easy. Maintenance 1. Winches and other tools are necessary for extracting the interior of heater. 2. Removal of water box cover is easy.	Overall cost of horizontal FW heaters is lower.

Table 5-7(2) <u>Comparison of Vertical and Horizontal FW Heater</u>

	Design	Layout	Operation and Maintenance	Cost
Vertical Type	1. As FW path opposite the drain cooling section is not effective for heat exchange, the overall heating surface becomes larger.	1. As the thermal expansion of FW piping can be absorbed by the sliding legs of FW heater, the FW piping can be shorter, but the return piping to the boiler becomes longer. 2. Layout is limited by the span and height of the travelling crane. In case vertical heaters are located by the turbine side, the crane span would be 24 - 25 m, with 350 MW class unit. In case turbine-driven FWP's are used, the arrangement is affected by the exhaust piping. 3. Generally, the floor area can be economized by adoption of vertical type heaters.	<u>Operation</u> Drain level control at start-up and low load time is sometimes difficult. <u>Maintenance</u> 1. Travelling crane can be used for extracting the heater interior. 2. Removal of the water box cover is somewhat difficult.	

f. Air Ejector

There are two kinds of air ejector; one is the steam air ejector, and the other vacuum pump.

Vacuum pump can be easily operated and is suitable for automation, however, since drum type boilers are adopted for this project, vacuum up of the condenser is not required at the same time of boiler start-up.

Therefore, steam air ejector with a merit of simple construction, low cost no moving parts, less trouble and low operating and maintenance cost will be adopted for this project.

g. Overhead Travelling Crane

The heaviest piece of equipment in the generator stator, but the erection of the stator will be made by the pole-up method, and therefore, the capacity of overhead travelling crane will be decided in consideration of the turbine and the generator rotor.

a) Main hoist

The main hoist will have the capacity enough to hoist the generator rotor, the heaviest piece to be lifted.

b) Auxiliary hoist

The capacity of the auxiliary hoist will be determined in consideration of the load when the upper cylinder of the HP and IP turbines is turned over.

* In the event that there occurs the necessity of fine vertical adjustment of the generator stator after the setting of the generator has been completed, the adjustment will be effected by the use of oil jacks, without using the overhead crane.

5) Electrical and Control Facilities

a. Electrical Facilities

a) Generators

i. Unit capacity will be decided to get 300 MW output at the HV terminal of the step-up transformer, with the station service power taken into consideration.

ii. Power factor of 0.8 lagging is selected for improvement of voltage in the power consuming areas, and leading phase operation within the system stability limit will be possible.

iii. Short circuit ratio will be 0.58 for improvement of system stability.

iv. Generator cooling will be hydrogen cooling which has been proven by long operating results.

b) Main transformers

i. Main transformers (Generator step-up transformers)
As the power plant is situated near the power consuming area, the main transformer with the off-load tap changer will be sufficient.

ii. Station service transformers
Since the operating range of the generator terminal voltage is the rated voltage ±5%, the station service transformer with the off-load tap changer will be adopted.

iii. Start-up transformer
The start-up transformer will be with the on-load tap changer, so that it may cope with the 220 kV system voltage variations.

c) Station service power facilities

i. 6.6 kV switchgears

6.6 kV busbars will be supplied from the start-up transformer and the station service transformers and will supply to larger auxiliary equipment. 201 kW and larger motors will be supplied at 6.6 kV.

ii. At the time of unit start-up, the power will be received from 220 kV line through the start-up transformer to the common busbar and the unit busbars which supply to the auxiliary equipment, and after the generator is synchronized, the unit busbars will receive power from the station service transformer and the common busbar will receive power from the start-up transformer, and will supply to the common auxiliary equipment.

iii. The coal handling system will be supplied from the common busbar at 6.6 kV and 1 back-up feeder will be provided from the unit busbar.

iv. 380 V switchgear

380 V busbars will receive power from the 6.6 kV busbars through power transformers and will supply to medium sized auxiliary equipment. Electric motors within the range of 200 kW to 76 kW will be supplied from these busbars.

v. 380 V motor control center

380 V motor control centers will receive power from the 380 V switchgears and will supply to smaller auxiliaries. Electric motors of 75 kW and less will be supplied from the motor control centers.

vi. 220 V distribution panel

220 V distribution panel will receive power from the 380 V switchgear and will supply the lighting, power, working power, air conditioning power, etc.

vii. Uninterruptible power supply

Uninterruptible power supply will be provided to supply the plant control and computer power through the inverter from the D.C. power supply, to protect them from power failure and/or power supply shocks.

viii. D.C. power supply

D.C. power supply is the most important equipment for the safety and operation of the power plant, and it must have 100% reliability.

The D.C. power source supplies not only the normal load of control power, indicating lamps, protective relays, uninterruptible power supply, etc., but the emergency power supply for the safety of the major equipment at the time of the power plant black-out.

In case of the 220 kV transmission line failure, the emergency gas turbine generator would be started up automatically and the station service power supply would be restored in 10 minutes or so, but in consideration of possible starting failure of the gas turbine generator, the D.C. power supply capacity from the batteries is set at 60 minutes, sufficient to bring the turbine generator to a stop safely.

i) The capacity of the battery charger will be the normal D.C. load plus the capacity needed for the equalizing charging.

ii) There are two types of storage batteries; the alkaline batteries advantageous for discharge of shorter duration and the lead batteries advantageous for long-lasting discharge.

Type of battery either lead acid or alkaline which ever suitable for safe operation of the power plant with necessary proper charging system for either type will be adopted for this Project.

Load for D.C. power source is as follows.

D.C. LOAD

ITEM	CONTENTS
Main turbine bearing oil pump	To secure bearing oil pressure for protection against buring of main turbine bearing.
BFPT bearing oil pump	To secure bearing oil pressure for protection against buring of BFPT bearing.
Emergency seal oil pump	To secure hydrogen seal oil pressure for generator.
Emergency television cooling fan	To secure cooling air for protection against buring of furnace monitoring television.
Solenoid valve for control	Power source for heavy oil emergency trip valve, light oil emergency trip valve, dampers for nills, etc. in emergency situation.
BTG control power source	Control power source for interlock, alarm, instrument etc.
Electric control power source	Control power source for 220 kV circuit breakers,metal-clad switchgears, power center, protection relay, etc.
Power source for gas turbine start-up	Power source for start up of gas turbine.
Emergency lighting	Lighting in emergency situation.

d) Emergency gas turbine generator

i. A gas turbine generator will be installed against possible failure of 220 kV transmission line and the start-up transformer trouble.

ii. The capacity of the emergency gas turbine generator will cover the station service power necessary for starting up of one 300 MW unit, and could not cover the power for the coal handling and ash disposal, because coal is not used at the start-up time.

iii. The gas turbine generator will not only be started automatically at the time of black-out, but will be started up remote-manually from the central control room for periodical check-up.

iv. For the purpose of prevention of over-loading of the gas turbine generator by the station auxiliary load, a start lock out system would be considered with the auxiliaries not needed for the unit start-up.

b. Plant Control System

a) Degree of automation

Since the power generating units of this Project will be operated as the base load supplying power plant with coal and the frequency of starts and stops is expected to be a matter of 3 - 5 times/year, the semi-automatic control system will be adopted, with a reduction of construction cost taken into consideration.

A full-automatic power plant is primarily meant for a peak-load power plant which has to be started up and shut down frequently by a limited number of operators. And if full automatic control is adopted for a base-load power plant with few starts and stops, the functioning of the automatic control devices has to be checked and confirmed as a routine maintenance, and there is even the risk of mistripping due to unnecessary operation. Thus it is not advisable to adopt the full-automatic control for such base-load power plants.

b) Central control system

The boilers, turbines and generators will be operated by the central control system and all the major equipment will be operated automatically and supervised at the central control room.

c) Auxiliary equipment of the turbines, boilers and generators will be individually controlled automatically at the local control panels. Important auxiliaries will be supervised both locally and in the central control room.

d) The other local equipment will be watched and controlled directly at the local control panels. The alarms will be collectively indicated in the central control room, so that any abnormal operating condition may be detected in the central control room.

e) Starting and stopping of units

When starting up and shutting down the unit, the accessories to the boiler and turbine and the common equipment are started or stopped at the local control panels. Major auxiliary equipment are started and stopped remotely from the central control room. When the preparation for unit start-up has been completed, the boiler is lit off from the central control board, and when the steam conditions are right, the turbine is started and then the generator is synchronized in the central control room.

f) Routine operation of units

i. Protective devices of the main turbine are tested periodically on the spot.

ii. Auxiliary equipment with spare units will be switched over periodically, on the spot, so that the operation of the units may be confirmed.

iii. Half-side operation of the condenser, heater bypass operation and other abnormal operation will be made locally on the spot.

g) Automatic start-up of stand-by units

Stand-by auxiliary units will be started up automatically when the units in normal operation should trip, and alarm is initiated to announce the start of the stand-by unit.

h) Supervision of unit by computer

Information on the operating conditions is inputted in the computer, and the data will be displayed on the CRT or the typewriter, as needed.

The inputted information will be memorized for alarming and performance calculations. The computer will be used for hourly logging and daily calculation for management of operation.

i) Design policy for protective devices

i. Consideration against disturbances in the unit

Consideration will be made so that the unit may not fall into unstable state at the sudden change of load or failure of main auxiliary equipment. Especially, the boiler, the turbine and the generator shall continue sufficiently coordinated operation even in the transient conditions.

ii. Consideration against loss of control power and control air and at the time of recovery

The control power will be supplied from the DC, AC and uninterruptible power sources according to the importance of the control equipment, and control air will be backed up from the station service air compressor, however in case of loss of power or air supply, abnormal operation will be prevented by continuation of the existing state, operation to the safer side or safety unit trip. And when the power and air supply is recovered, the operating conditions will be returned to normal without any shock.

i) Equipment to stay as they are

In case of electric power or control air failure, these equipment will continue the conditions as they are.

ii) Equipment to tend to safer side

Solenoid valves and air operated valves for local control which need not continue the existing conditions will be actuated towards the safer side.

iii) Equipment to lead to unit trip

In case of a total power and air failure where there is no prospect of an early recovery, the unit will be tripped.

c. Communication Facilities

a) For mutual communication among different places in the power plant, a telephone system with an automatic exchange will be installed.

b) For inter-communication among the Energy Center and power stations and substations, a microwave communication system will be installed.

c) In addition, a paging system will be installed to supplement for smooth communication within the power plant.

d. Lighting Facilities

a) Indoor lighting

Sufficient lighting facilities will be provided indoors the powerhouse, appurtenant building and workshops.

b) Outdoor lighting

Lighting facilities for night work and patrolling will be installed at the outdoor switchyard, outdoor facilities, coal yard, oil tank yard and roads.

6) Outdoor Switchyard Facilities

The output of this power plant is transmitted by 220 kV, 2-circuit transmission lines into the Suez System and then to the consuming areas of Egypt, and a part of the output is distributed through a 220 kV/22 kV distribution transformer directly to the Ayun Musa Area.

For development of the Sinai Area, 220 kV transmission lines are planned to the North and to the South of the power plant.

And for these purposes, the 220 kV outdoor switchyard will be installed within the power plant grounds, where ample space will be reserved for future addition of transmission lines.

a. The switchyard will be of outdoor type for economy of construction cost, and the insulator washing device will be provided for regular insulator washing under energized conditions.

b. The transmission voltage will be 220 kV for interconnection with the 220 kV system at New Suez Substation.

c. Double busbar arrangement will be adopted, and the busbars may be divided into 4 sections by line switches.
The circuit breakers will be arranged by 1½ C.B. system.

d. Communication Facilities

a) For smooth operation and supervision of the switchyard equipment, the data transmission system will be installed.

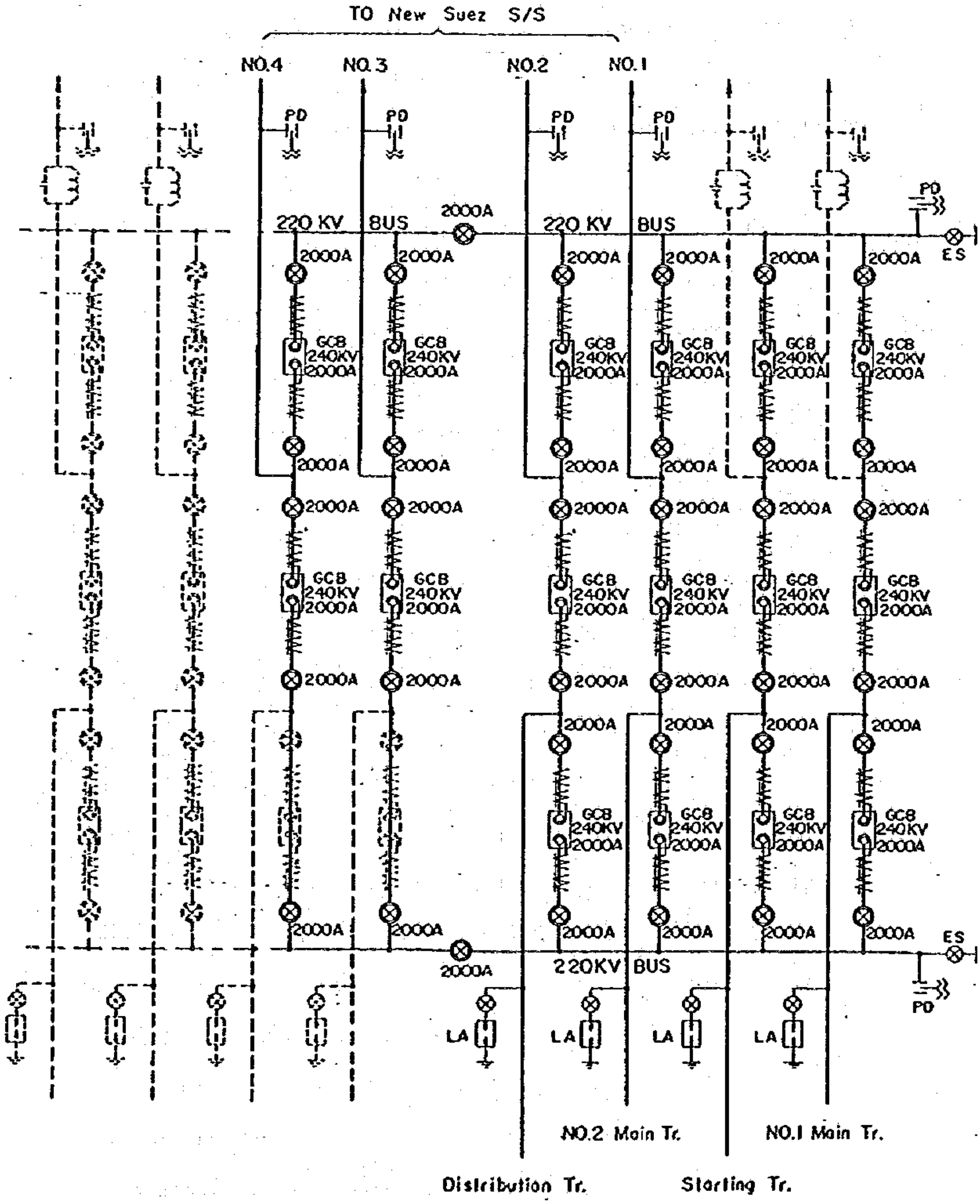
b) The transmission line fault locator will be installed

c) Coupling and terminal equipment of the power line carrier will be installed.

d) Towers and terminal equipment for the micro-wave circuit will be installed.

e. The switchyard control room will be built to house the relay boards for protection of the transmission lines, busbars and transformers, the communication equipment boards, the air compressor board, the power sources board, and other control boards.

Fig. 5-3 Ayun Muso P/S Outdoor Switchyard Single line Diagram



7) Fuel Receiving and Storage Facilities

Fuel receiving facilities including unloaders and conveyer system to coal storage yard will be installed for 1,200 MW generating units in the first stage. And coal storage yard will be installed for 1st stage 600 MW, and extension of coal storage yard for 2nd stage 600 MW will be able to installed without interruption in operation of existing 300 MW x 2 units.

a. Coal

a) Design conditions

i. Basic conditions of power plant

Type: Coal-fired/heavy oil-fired

Rated output: 1,200 MW at high tension of step-up transformer (Ultimate output)

Plant Efficiency : 39%

Utilization Factor : 80%

Design calorific value: 6,500 kcal/kg (Mean)

Surface moisture : 7%

Kind of coal: Domestic (Maghara) coal will be blended with imported coal to supplement the shortage in quantity.

Apparent specific gravity: 0.8

ii. Coal consumption (Wet base)

At 1,200 MW: $3,255 \times 10^3$ tons/year

iii. Volume

i) To support the power plant, 300,000 tons/year (dry) of the domestic Maghara coal will be materialized and 2,742,000 tons/year (dry) will be made up with imported coal. These two kinds of coal will be blended before firing.

ii) Maghara coal will be received by 25-ton trucks.

iii) Imported coal of 2,934,000 tons/year (wet) will be received at the berth of power station by 60,000 DWT coalers.

iv. Working hours

Two-shift operation, 14 hours

(7:00 - 15:00, 14:00 - 22:00)

One hour overlapping for shift change

v. Storage capacity

60 days consumption (669,000 tons) will be stored.

vi. Coal storage system

A coal stockpile method and a large scale silo method are considered for a coal storage system. The former is a well proven and conventional method for coal storage widely used at steel industries, cement factories and power stations, and the latter is a new method recently developed and employed where the environmental regulation is strict. Though the silo method requires less area for construction and is superior in enviornmental preservation, it still has some technical difficulties to be solved, such as preventive measures for explosion, mixing technology, etc. Considering the first coal-fired power plant in Egypt, the open stockpile method, being suprrior in operationability, safety, and construction cost, will be adopted.

In addition, owing to the mechanization and automation of the equipment, the operation cost of the stockpile method is remarkably reduced.

vii. Layout and facilities

i) Coal unloading and handling facilities

In consideration of receiving of the domestic coal and the imported coal and delivery of the coal to the power plant, the facilities will be laid out as shown in the following system diagram.

ii) Coal storage yard

In consideration of the receiving and consumption rates of the domestic and the imported coal, the yard will be laid out as shown in the following sketch.

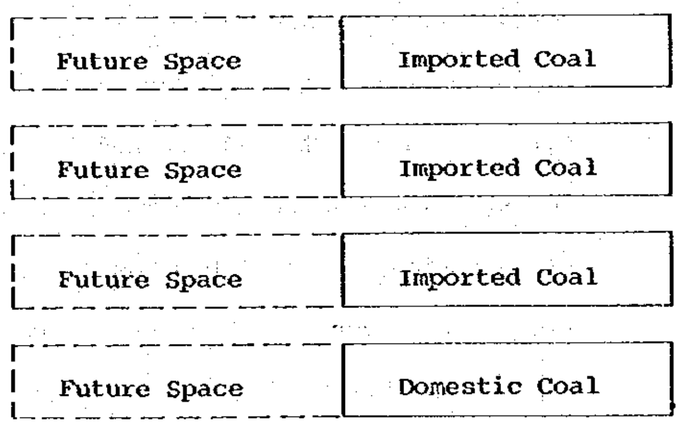
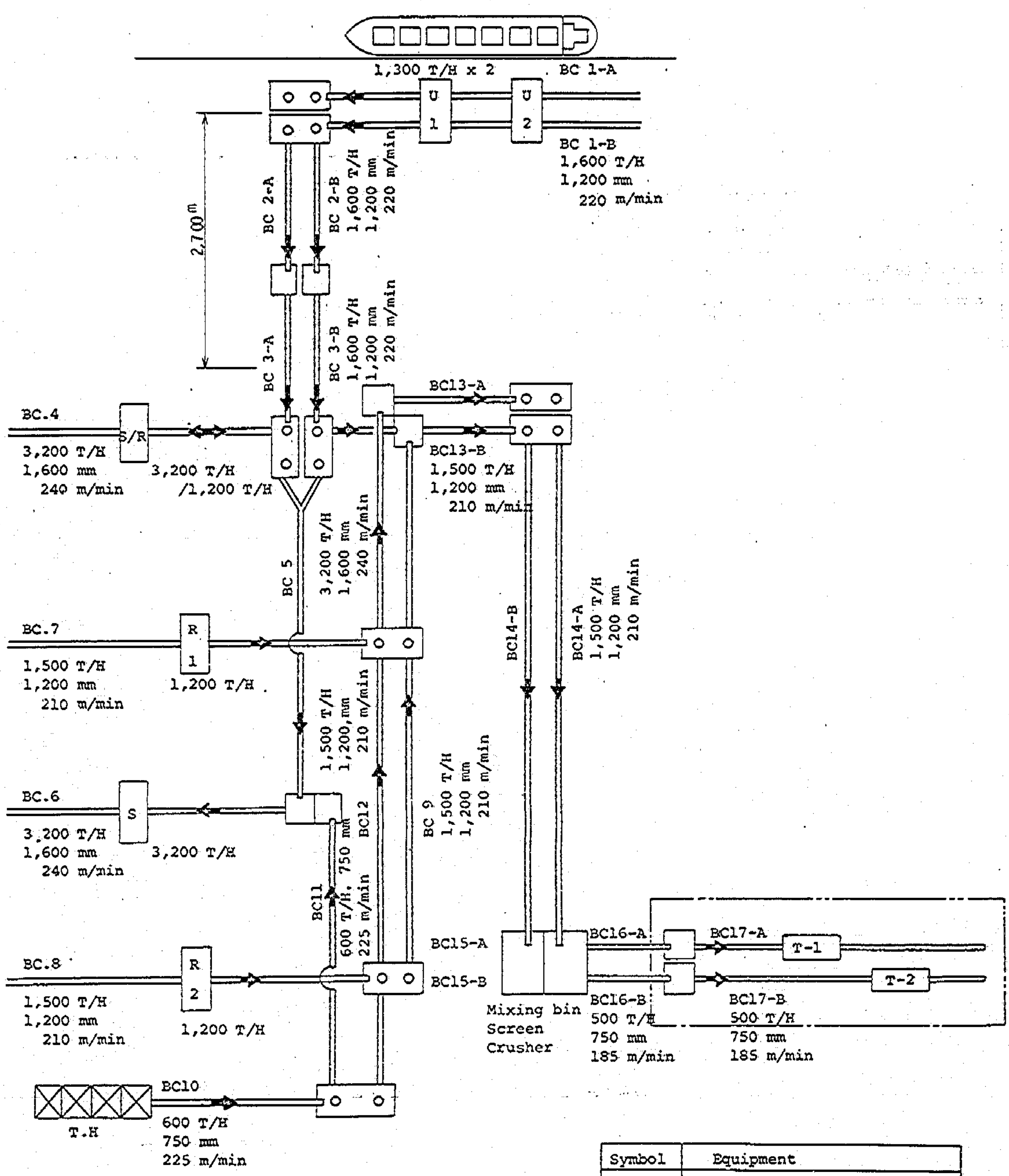


Fig. 5-4 Diagram of Coal handling system



Symbol	Equipment
U	unloader
S/R	Stacker/Reclaimer
S	Stacker
R	Reclaimer
T	Tripper
B.C	Belt Conveyor
T.H	Truck Hopper

b) Preliminary design

i. Unloader

i) Design conditions

A. Annual handling volume of the imported coal : 2,934 x 10^3 tons (wet)

B. Coaler type : 60,000 DWT

C. Unloading time : Two-shift operation (7:00 - 22:00) 14 hours actual working time

D. Working efficiency : 64%

E. Days required for coal unloading from one coaler

A) Annual available days are assumed to be 310 days. (15% of a year will be loss due to national holidays and bad weather.)

B) Berth occupancy ratio: 40 - 60%
The above figures are based on the fact that voyage to Australia (round) required about 60 days and to East America about 50 days, and that the voyage will be affected by the meteorological and oceanological conditions.

C) Number of berth: 1 (one)

Unloading days

= (Annual available days) x (Berth occupancy ratio) x (Ship Capacity) x (Number of berth)/ Annual coal handling volume

$$= \frac{310 \times (0.4 \text{ to } 0.6) \times 60{,}000 \times 1}{2{,}934 \times 10^3} - 0.25$$

= 2.3 to 3.5 (Ave. 3.0 days)

Note: 0.25 is based on the assumption:

3 hours for port entry to landing

3 hours for leaving to embarkation.

Thus, 6/24 hours = 0.25

F. Unloading days

$$\frac{2{,}934 \times 10^3}{60{,}000} \times 3 \text{ days} = 147 \text{ days}$$

ii) Capacity of unloader

$$\frac{2{,}934 \times 10^3}{147 \text{ days} \times 14 \text{ hours} \times 0.64} = 2{,}228 \text{ tons/hour}$$

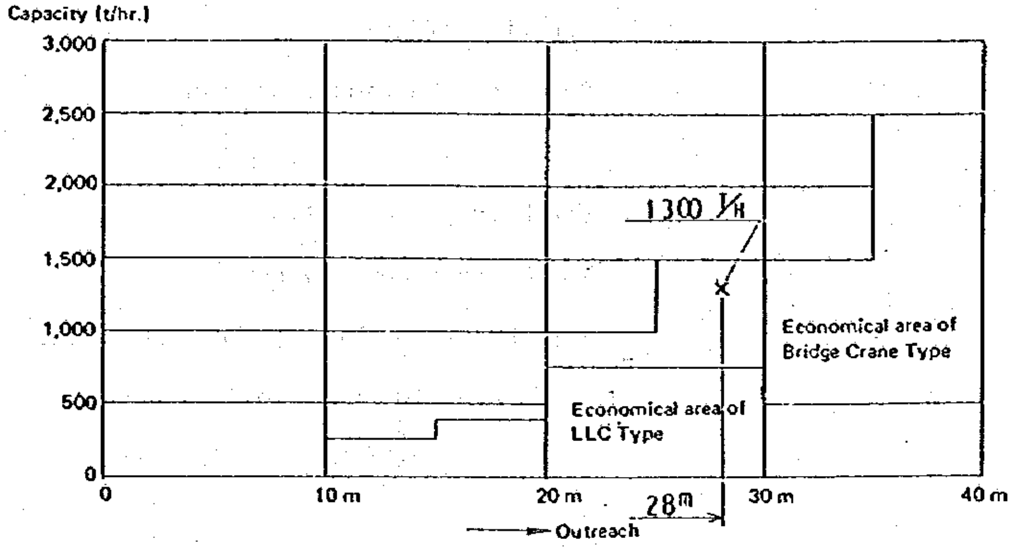
Adding a 10% margin, the capacity will be 2,450 tons/hour.

iii) Number of unloader: 2 units

1,300 tons/h x 2 units (17% margin)

iv) Type of unloader

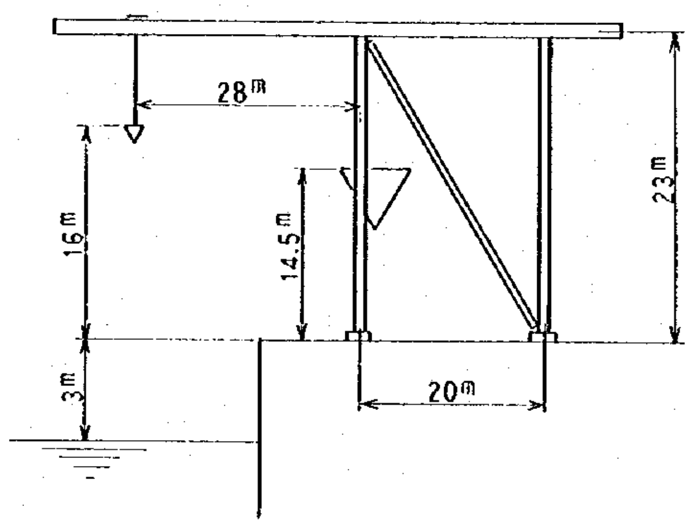
There are two types of unloader; one is of crab-bucket type for intermittent unloading operation and the other is of bucket elevator and vertical screw type for continuous unloading operations. The crab bucket type, which is expected more stable unloading operation, will be adopted.



* Outreach means the maximum distance of the grab bucket from the quay face to the sea side.

Note: LLC Type: Level Luffing Crane Type

v) Dimensions of unloader



vi) Capacity of unloader

Refer to the figure on page 5-69.

vii) Berth occupancy ratio

A. Berth occupancy hours

The unloading operation is scheduled as shown in the following chart and the coaler will be at anchor for 3.25 days.

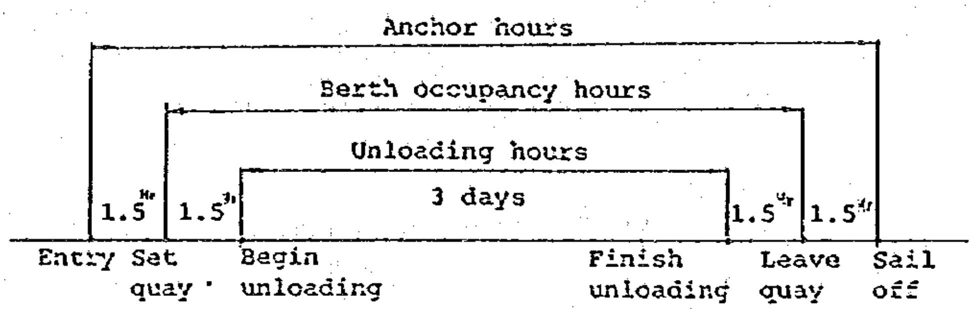
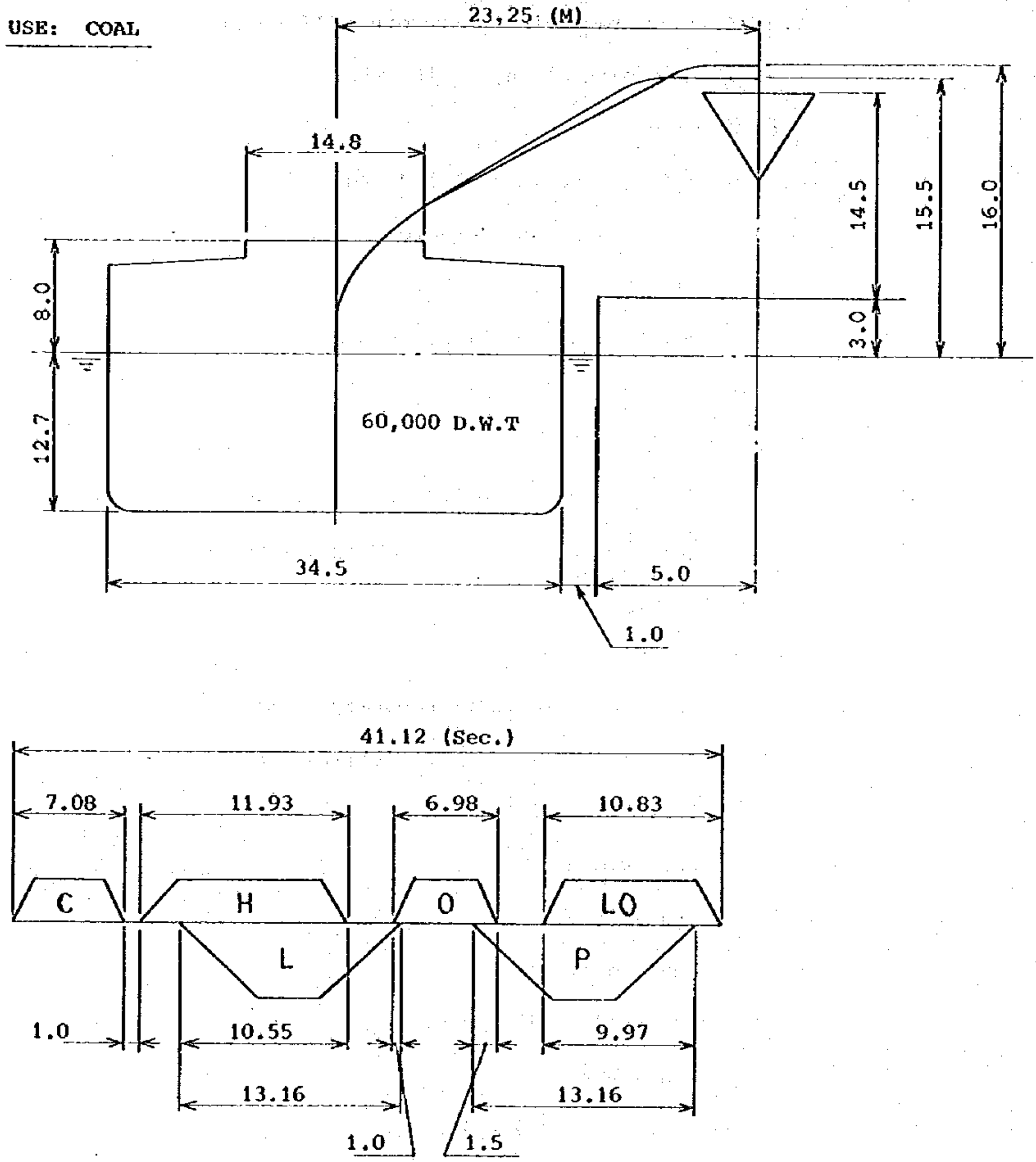


Fig. 5-5 Duty Diagram of 1,300 T/H Unloader



UNLOADING CAPACITY

$$Q = \frac{15\ t \times 3,600}{41.12} = 1,313\ \text{Ton/Hour}$$

C :	Closing	120 m/min
H :	Hoisting	120 m/min
L :	Luffing	160 m/min
O :	Opening	120 m/min
P :	Pushing	160 m/min
LO:	Lowering	120 m/min

ii. Receiving conveyors

i) Capacity, Qr

Two lines of receiving conveyors will be installed, and each conveyor line will be fed by each unloader.

Cu = Unloading capacity - 1,300 t/h

N = Unloading unit per conveyor - 1 unit

= Unloading capacity peak ratio - 1.2

Qr = Conveyor capacity - 1,300 t/h x 1 x 1.2

= 1,560 t/h ≒ 1,600 t/h

ii) Number of lines

In consideration of the unloader peak ratio of 20%, 2 lines of 1,600 t/h conveyors will be installed.

iii) Receiving conveyor data

Qm : Theoretical transport capacity (t/h)

A : Cross-sectional area of materials on belt (m^2)= 0.1676

Belt Width	:	1,200 mm
Trough angle	:	35°
Angle of repose	:	20°

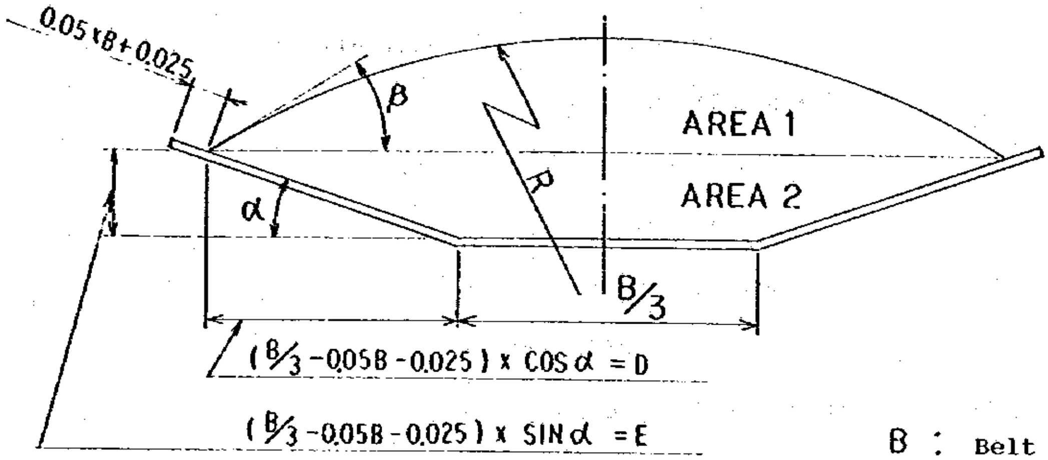
V : Belt speed = 220 m/min.

Qm = 60 x A x V x 0.8

= 60 x 0.1676 x 220 x 0.8

≒ 1,770 > 1,600 t/h (11% margin)

Fig. 5-6 Cross-Sectional area on Belt (m^2)



B : Belt width
α : Trough angle
β : Angle of repose

$$R = \frac{(B/3 + 20)}{2 \times \sin\beta}$$

$$AREA\ 1 = \pi R^2 \times \frac{\beta}{180} - R^2 \sin\beta \cos\beta$$

$$AREA\ 2 = (B/3 + D) \times E$$

$$AREA = AREA\ 1 + AREA\ 2$$

iii. Stacker (including stacker/reclaimer)

i) Capacity Qs

Stacker is directly linked to receiving conveyors, and the capacity must be equal to 2 lines of conveyors.

1,600 t/h x 2 = 3,200 t/h

ii) Number of stackers

Number of stackers including stacker and reclaimer will be 2, in consideration of coal receiving lines.

iii) Stacker conveyor data

Qm : Theoretical transport capacity (t/h)

A : Cross-sectional area of materials on belt (m^2)= 0.3053

Belt Width	:	1,600 mm
Trough angle	:	35°
Angle of repose	:	20°

V : Belt speed = 240 m/min.

$$Qm = 60 \times A \times V \times 0.8$$

$$= 60 \times 0.3053 \times 240 \times 0.8$$

$$\fallingdotseq 3,517 > 3,200 \text{ t/h (10\% margin)}$$

iv. Truck unloading facilities

i) Number of trucks

Annual receiving quantity of Maghara coal is 300,000 tons (321,000 wet tons). On the basis of 25-ton trucks and 310 working days per year, the number of trucks to be handled per day will be,

$$\frac{300,000 \times 1.07}{310 \times 25} = 42 \text{ trucks}$$

ii) Allowable unloading time

$$\frac{8 \text{ H.} \times 60}{42} = 11.4 = 12 \text{ min/truck}$$

Actually when the conditions of trips of the trucks starting from Maghara coal mine early in the morning, making return trips of 225 km one way, and returning to the mine in the evening, are considered, it would be appropriate to adopt an unloading time of about 1/2 of the allowable unloading time. Therefore, the facility is planned for simulataneous 2-trucks unloading in 5 minutes.

iii) Equipment

2 trucks x 25 tons x 60/5 = 600 t/h

iv) Number of conveyor

1 line : 600 t/h x 1 line

v) Truck receiving conveyor data

Qm : Theoretical transport capacity (t/h)

A : Cross-sectional area of materials on belt (m^2)= 0.0617

Belt Width	:	750 mm
Trough angle	:	35°
Angle of repose	:	20°

V : Belt speed = 225 m/min.

Qm = 60 x A x V x 0.8

= 60 x 0.0617 x 225 x 0.8

≑ 666 > 600 t/h (11% margin)

v. Reclaimer

i) Capacity

A day consumption of coal at 1,200 MW (11,145 tons) will be reclaimed and delivered to the coal bunker in 14 hours. Where a reclaimer efficiency is 0.75,

$$\frac{11,145 \text{ tons}}{14 \text{ H} \times 0.75} = 1,061 \fallingdotseq 1,200 \text{ t/h}$$

Taking a larger margin of 13 % (only a 4 % margin for 1,100 t/h), the capacity will be 1,200 t/h. Though it may be possible to make 90% capacity of the above considering the coal mixing rate of 90 : 10 for the operation of 1,200 MW, the 1,200 t/h capacity is much more advantageous with a large margin.

ii) Number

Allowing for the mixing operation of the 2 different brands of coal during unloading of the imported coal, 2 units will be installed.

1,200 t/h x 2 units

And a reclaiming capacity of the stacker/ reclaimer is also 1,200 t/h.

vi. Dispensing conveyor

i) The belt conveyor up to the coal mixing bin will have a 20% extra capacity in consideration of peak capacity of the reclaimer, namely,

1,200 t/h x 1.2 = 1,440 ÷ 1,500 t/h

ii) Belt conveyor after coal mixing bin

$$\frac{2{,}800 \text{ t/day} \times 4 \text{ U}}{14} = 800 \text{ t/h}$$

With a 10% allowance, 800 t/h x 1.1 = 880 t/h, 500 t/h x 2 lines will be adopted.

iii) Dispensing conveyor data

Conveyor To Coal Mixing Bin:

Qm : Theoretical transport capacity (t/h)

A : Cross-sectional area of materials on belt (m^2)= 0.1676

Belt Width	:	1,200 mm
Trough angle	:	35°
Angle of repose	:	20°

V : Belt speed = 210 m/min.

Qm = 60 x A x V x 0.8

= 60 x 0.1676 x 210 x 0.8

≑ 1,689 > 1,500 t/h (13% margin)

Thus, the conveyor of 1,200 mm belt width and 210 m/min. belt speed will be adopted.

Conveyor After Coal Mixing Bin:

Qm : Theoretical transport capacity (t/h)

A : Cross-sectional area of materials on belt (m^2)= 0.0617

Belt Width	:	750 mm
Trough angle	:	35°
Angle of repose	:	20°

V : Belt speed = 185 m/min.

Qm = 60 x A x V x 0.8

= 60 x 0.0617 x 185 x 0.8

≑ 548 > 500 t/h (10% margin)

Thus, the conveyor of 750 mm belt width and 185 m/min. belt speed will be adopted.

vii. Coal mixing bins

i) Capacity

On the assumption that the reclaimer starts to run after the bin has been filled, the bin capacity, with which the bin should not be in empty while the reclaimer runs the whole length of its traveling range, is calculated.

Maximum traveling range	:	510 m
Running speed	:	30 m/min.

$$V = \frac{510 \text{ m}}{30 \text{ m/min}} = 720 \text{ t/h} \times 1/60 \text{ min/h} = 204 \text{ t}$$

Note: The maximum dispensing capacity is 720 t/h calculated with the coal mixing ratio of 0.9:

800 t/h x 0.9 = 720 t/h

ii) Time required in transporting coal from the reclaimer to the mixing bin, and quantity of coal necessary for preventing the bin from emptying

Conveyor length from reclaimer to coal mixing bin:

Maximum : 510 + 210 + 30 + 130 + 75 = 955 m

Minimum : 30 + 130 + 75 = 235 m

Where the length is increased by 10% for slope, hopper and chute,

Maximum : 1,051 m

Minimum : 259 m

Where the belt speed is 210 m/min.,

$$\text{Max.} = \frac{1{,}051 \text{ m}}{210 \text{ m/min}} \times 800 \text{ t/h} \times 1/60 = 67 \text{ t}$$

$$\text{Min.} = \frac{259 \text{ m}}{210 \text{ m/min}} \times 800 \text{ t/h} \times 1/60 = 17 \text{ t}$$

The times required are,

$$\text{Max.} = \frac{1{,}051 \text{ m}}{210 \text{ m/min}} = 5 \text{ min.}$$

$$\text{Min.} = \frac{259 \text{ m}}{210 \text{ m/min}} = 1.2 \text{ min.}$$

iii) Coal mixing bin capacity

204 + 67+ + 27 = 298 ≑ 300 tons

A margin of 2 minutes is considered (800 t/h x 1/60 min. x 2 min. = 27 tons)

iv) Coal mixing bin lowest capacity

70 tons

v) Coal mixing bin highest capacity

204 + 67 = 271 ≑ 270 tons

viii. Screens and crushers

i) Screen

Screens will have the same capacity as the belt conveyor after the coal mixing bins, namely,

500 t/h x 2 units.

The screen mesh size will be 50 mm.

ii) Crushers

Crushers will have 15% of the capacity of the conveyor after the mixing bins.

75 t/h x 2 units

ix. Sampler, coal scalers and separator

In the receiving and dispensing systems of the imported and domestic coal,

i) sampler and coal scalers for quality and quantity control will be installed; and

ii) magnet separator for removing iron pieces contained in the coal.

x. Coal sample reduction instrument

The instrument is used for analysis of imported, domestic and consumed coal.

xi. Bulldozer

2 units for clearing of the remaining coal in coal piles; and

2 units for accumulating the coal in the coalers.

xii. Others

i) Piping and pump system with hose outlets mounted in a constant interval

ii) Ventilation facilities

The ventilation equipments with dust collector will be installed in the conveyor transfer building and screen/crusher room and at the lower part of coal mixing bin.

iii) Fire extinguisher facilities

The water spraying system is also used as fire extinguishing.

b) Coal storage capacity

The coal storage capacity at the power stations varies on the acquired area, location of and distance from the coal mines and coal reserve center, as well as capacity and operating conditions of the power plant. In a case of Japanese utility companies, the storage capacity is generally designed to have a volume of coal with which the power plant could operate continuously at the rated capacity for a period from one to 1.5 months. For the Project will depends its fuel supply mainly on import from overseas, 60 days reserve is considered with the following reasons.

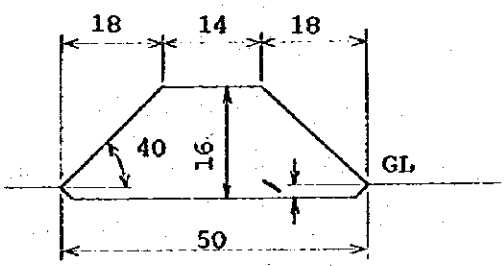
i. Regarding the period of a general strik, several studies on the matter are projected for 60 days at maximum.

ii. Similary, a large scale coal reserve center in Japan is designed to have 60 days reserve. The project has no such a reserve center, the same concept will be applicable.

iii. According to the past records, spontaneous combustion of coal only occur after 60 days storage.

c) Shape of stockpile

i. The width of stockpile will be 50 meters in consideration of the boom length of stocker/reclaimer. And the height will be 16 meters with which the past records proves that spontaneous combustion of coal will not occur if the stockpile is removed with a rotation rate of every two months. The coal storage volume is computed on the basis of the following cross-section of stockpile.



The bottom of the stockpile is lowered from the ground level by 1 m for prevention of mixing of soil of the ground surface when reclaiming.

$$\text{Cross section} = \frac{50 + 14}{2} \times 15 + (50 - 1) \times 1$$

$$= 529 \text{ m}^2$$

Actual weight of stockpile per meter long

$$Q = 529 \times 0.8 \times 0.7 = 300 \text{ t/m}$$

where, coal storage efficiency: 0.7

specific gravity of coal: 0.8

ii. Length of stockpile

$$\frac{335 \times 10^3}{300 \times 4} = 280 \text{ m/pile}$$

Future at 1,200 MW; 560 m

b. Heavy Oil

a) Design conditions

Rated output and efficiency: same as those with coal

Kind of heavy oil: Mazaut oil from Egypt

Calorific value: 10,500 kcal/kg

Specific gravity: 0.94

b) Heavy oil consumption: 3,432 kℓ/day

c) Oil storage: 10,000 kℓ

d) Storage tanks: 36,000 kℓ x 3

e) Receiving: 1,000 kℓ/h, by 5,000 kℓ tanker or barge

f) Facilities and operating conditions

i. For 5,000 kℓ tankers with unloading pumps of 8.5 kg/cm^2 or larger head, loading arms and receiving equipment (air separator, strainer and flow meter) will be installed on the berth.

ii. For 5,000 kℓ tankers with unloading pumps of lower head of 4 - 5 kg/cm^2, the booster pump to be installed at the entrance to the power plant grounds will be used.

iii. For barges without unloading pumps, an oil unloading pump will be installed on the berth.

iv. Heavy oil storage tanks will be heated with the auxiliary steam from the boiler.

v. Heavy oil storage tanks will be equipped with the automatic foam fire extinguishing facility.

c. Light Oil

a) Light oil consumption

i. For 10 cold starts and stops per year: 700 kℓ

For 7 days operation of emergency gas turbine generator per year : 1,100 kℓ

Total 1,800 kℓ

ii. For bulldozers : approx. 50 kℓ

b) Storage capacity

For power plant	:	2,000 kℓ x 1
For bulldozers	:	50 kℓ x 1
For coaler bulldozers:		5 kℓ x 1

c) Facilities and operating conditions

i. Light oil will be received by tank lorries.

ii. Receiving facilities will be installed for each tank.

8) Water Supply

a. As there is neither rivers nor lakes near the power plant site and no fresh water is available, necessary fresh water for the power plant will be produced by the seawater desalination plant.

b. Fresh water requirement comprising the boiler make-up water, the drinking water, the miscellaneous station service water and water for the housing, is estimated at 2,000 t/day.

c. For desalination of sea water, there are two processes, the reverse osmosis process (RO) and the evaporation process [multi effect system (MES) and multi-stage flash system (MSF)].

a) These processes are compared in Table 5-8.

b) The reverse osmosis process involves less troubles such as scaling and is advantageous in simpler operation and maintenance and in case of rising of fuel cost, and further technical improvement is expected. However, the membrane must be imported continuously for maintenance and there are not many examples of large capacity installation.

c) The multi-stage flash system has many records of practice and high reliability, but the multi effect process is more advantageous in that it required less power, less installation space, resulting in lower construction cost and lower cost of water produced, and the automation of the process is easier.

d) Therefore, a 2,000 t/d desalination plant by MES process will be installed.

d. Boiler Make-up Water

a) The fresh water produced by the seawater desalination plant will be stored in the raw water tank.

b) The water from the raw water tank will be treated in the demineralizing plant and the demineralized water suitable for the boiler make-up water will be stored in the demineralized water tank.

The boiler make-up water will be fed into the condenser hotwell automatically by the condenser hotwell level.

e. Drinking Water

The water from the raw water tank will be added with salt, sodium bicarbonate, etc. to suit to drinking and will be chlorinated and then supplied to the power plant and resident quarters for drinking water.

f. Miscellaneous Station Service Water

Water from the raw water tank will be sent to the station service water tank, and will be used for miscellaneous station service water.

Table 5-8 Comparison of Desalination Processes

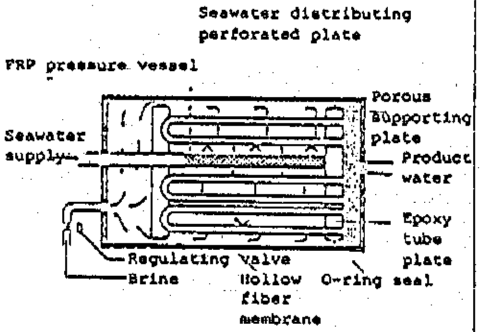
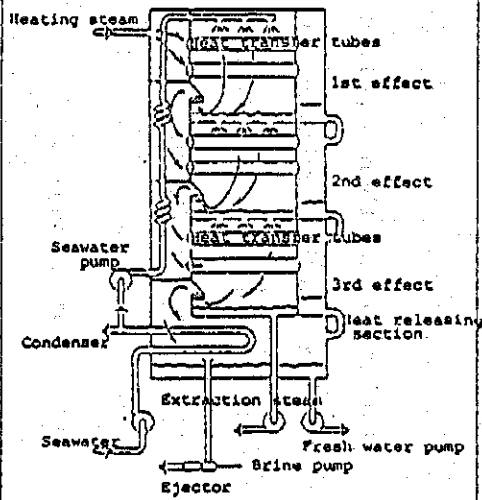
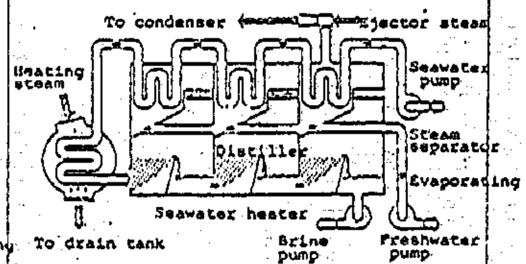
ITEMS	Reverse osmosis process (RO)	Distillation process: Multi effect (MES)	Distillation process: Multi-stage flash (MSF)
1. Principle	Seawater pressurized at a higher pressure than the osmotic pressure of seawater (about 25 kg/cm²) is forced along the semi-permeable membrane, through which the fresh water is separated.	Several evaporating sections are cascaded and the evaporated steam generated in the, 1st effect section is used the consecutively to produce fresh water.	Heated seawater is flashed at consecutively lower pressures and the flashed steam is condensed into fresh water.
2. Schemctic Diagram			
3. Speafications			
Seawater intake flow	145 T/H	565 T/H	565 T/H
elect. power consumption	333 KWH	113 KWH	185 KWH
Installation area	1,220 m²	130 m²	240 m²
Installation height	4.5 m	12.5 m	5.5 m
Water quality (TDS)	Less than 200	Less than 10 ppm	Less than 10 ppm
4. Economics			
Constrnction cost	(2.7 Million US$)	(2.6 Million US$)	(3.4 Million US$)
Production cost	(3.0 US$ /T)	(2.9 US$/T)	(3.4 US$/T)

Table 5-9 Comparison of Desalination Processes

Item			Reverse osmosis process (RO)	Distillation process	
				Multi effect (MES)	Multi-stage flash (MSF)
Automation	Control range		0 - 100%	30 - 100%	50 - 100%
Comparison of Performances	Corrosion		No problem	Countermeasure necessary	Countermeasure necessary
	Scaling		None	Practically none	Susceptible to scale
	Demineralizer		3B3T + MBP required	MBP sufficient	MBP sufficient
	Operation (Minutes)		Starting incl. pre-treatment 90 Stopping 10	Starting 60 Stopping 15	Starting 90 Stopping 30
	Maintemance	Maintenance	Membrance Washing: 2-3 times/yr.	Practically no maintenance	Chemical cleaning: once/year
		Maintenance cost	¥71,000,000/year	¥30,000,000/year	¥45,000,000/year
		Decline of performance	20%/3 years	20%/5 years	
		Preservation when not in use	Sealed with formalin	Dried and sealed with N_2	Dried and sealed with N_2
	Recovery rate (Fresh water / Seawater)		Approx. 30%	Approx. 10%	Approx. 10%
	For potable water Station service water		O.K	Pure	Pure

9) Utilization of Ash

a. Production and Characteristics of Coal Ash

Fuel coal used in coal-fired thermal power plants, generally, is pulverized into fine particles with a size of less than about 0.1 mm, sent to burners with hot air, fired at a high temperature (approximately 1,600 C°) in the furnace, and finally become ash after melting and solidification. At the above process, a part of ash falls into furnace bottom hopper. When the high temperature combustions gas passes through superheaters, reheaters and economizers, the gas temperature decreases by the heat exchange with the heating surface. In this process, a part of ash contained in the combustion gas drops into the economizer hopper. On the other hand, a plenty of fine particles are contained in the combustion gas exhausted from the boiler outlet gas duct, and the dusts are collected by electrostatic precipitator.

Ash dropped into the furnace bottom hopper is called clinker ash, ash collected from economizer hopper is called cinder ash, the remaining ash collected in the down stream gas duct is called fly ash.

Furthermore, fly ash is classified into coarse ash and fine ash; the fine ash is called fly ash generally. Recent dust collectors have been formed by electrostatic precipitators. Ash collected by electrostatic precipitators is called fly ash or EP ash.

Names of the ash stipulated in JIS are listed in the table below.

Names of Coal Ash (JIS B0126-1974)

No.	Name	Meaning
4401	Cinder	Coarse ash produced by combustion
4402	Fly ash	Fine ash produced by combustion
4403	Pyrite	Foreign matters not pulverized in the process of pulverizing
4404	Clinker	Massive ash produced by combustion

Coarse ash is composed by more than 80% of SiO_3 and Al_2O_3, and is identified as fly ash. The appearance of the coarse ash is gray-white in color, and spherical particle like glass.

The fineness and characteristics depend slightly upon pulverized coal used, combustion conditions and collecting method.

b) Components of Ash

Table 5-10 Example of Test results of fly ash in various countries

Countries	Number of samples		Chemical contents (%) Ignition loss	SiO2	Al2O3	Fe2O3	CaO	MgO	SO3	Na2O	K2O	Total	$\frac{SiO_2}{Al_2O_3}$	Specific gravity	Specific surface (cm^2/g)
Japan	12	Average	0.73	57.96	25.86	4.31	3.98	1.58	0.34	1.49	2.15	98.40	3.83	2.14	3.090
		Maximum	1.23	63.27	28.35	5.90	6.74	2.09	0.81	2.36	3.15	99.27	4.31	2.23	4.150
		Minimum	0.06	53.41	22.88	2.82	1.04	1.00	0.02	0.88	1.73	97.48	3.47	1.96	1.220
USA	34	Average	7.83	44.11	20.81	17.49	4.75	1.12	1.19	0.73	1.97	99.73	3.71	2.40	3.673
		Maximum	18.0	51.9	28.3	31.3	12.0	1.4	2.8	2.10	2.98	100.55	5.76	2.69	4.795
		Minimum	1.0	32.7	14.6	8.5	11.1	0.7	0.3	0.22	1.28	97.94	2.93	2.14	2.430
England	14	Average	3.86	46.16	26.99	10.44	3.06	1.96	1.59	0.90	3.26	98.22	2.92	2.10	5.180
		Maximum	11.70	50.70	34.10	13.50	7.70	2.90	6.80	1.90	4.20	102.90	3.19	2.33	8.100
		Minimum	0.60	41.40	23.90	6.40	1.70	1.40	0.60	0.20	1.80	96.10	2.52	1.90	2.500
France	17	Average	3.72	48.45	25.89	8.07	5.95	2.36	1.01	0.64	3.94	100.3	3.38	-	-
		Maximum	15.15	54.05	33.40	15.30	38.75	4.45	7.00	0.85	6.00	-	7.38	-	-
		Minimum	0.30	29.90	10.80	5.80	1.48	1.10	0.10	0.15	0.70	-	2.58	-	-
West Germany	9	Average	9.65	41.13	24.39	13.93	5.06	1.85	0.77	-	-	96.78	2.88	-	-
		Maximum	20.10	49.54	29.35	20.88	11.81	4.26	2.10	-	-	98.35	3.57	-	-
		Minimum	1.48	34.10	21.06	8.37	2.18	0.75	0.12	-	-	94.33	2.59	-	-
USSR	15	Average	-	55.08	25.97	7.83	5.08	1.81	1.63	-	-	97.40	3.70	-	-
		Maximum	-	62.08	37.15	12.01	10.62	2.90	3.78	-	-	-	5.09	-	-
		Minimum	-	47.90	20.71	3.08	1.10	0.28	0.20	-	-	-	2.20	-	-

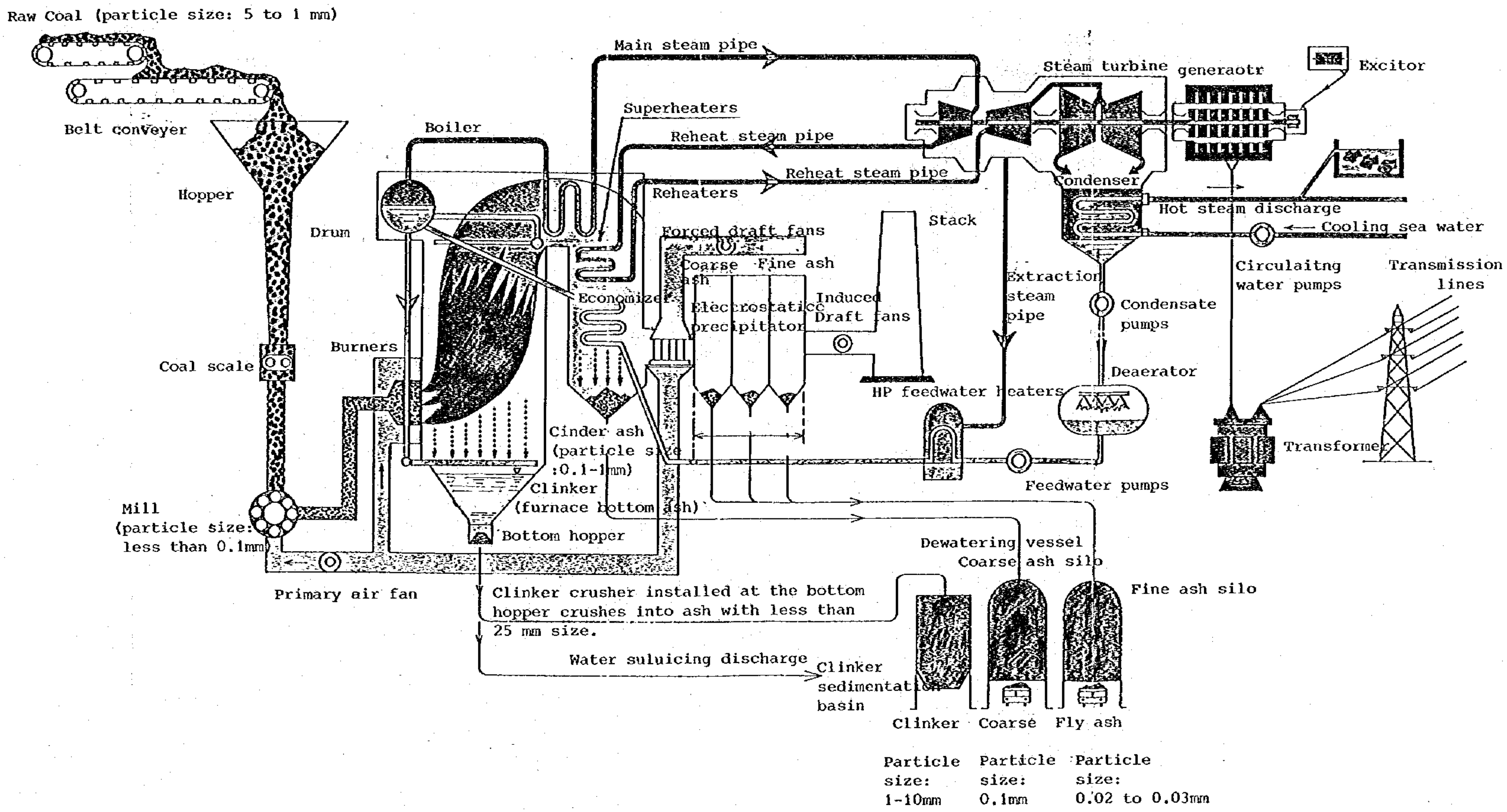
Data source: Cement, Concrete, No.267, issued by Cement Association

Example of components of coarse ash

Ignition loss (%)	SiO_3	Al_3O_3	Fe_2O_3	CaO	MgO	SO_3	TiO_3	Specific surface (cm^2/g)
0.50	59.9	23.8	4.7	3.8	1.4	0.1	1.34	1.200-1.500

Data source: HOKUDEN SAND (Name of product), issued by Hokuden Kogyo K.K.

Fig. 5-7 Production Process of Coal Ashes



b. Possibility of Coal Ash Utilization

Fig. 5-8 Coal Ash Utilization

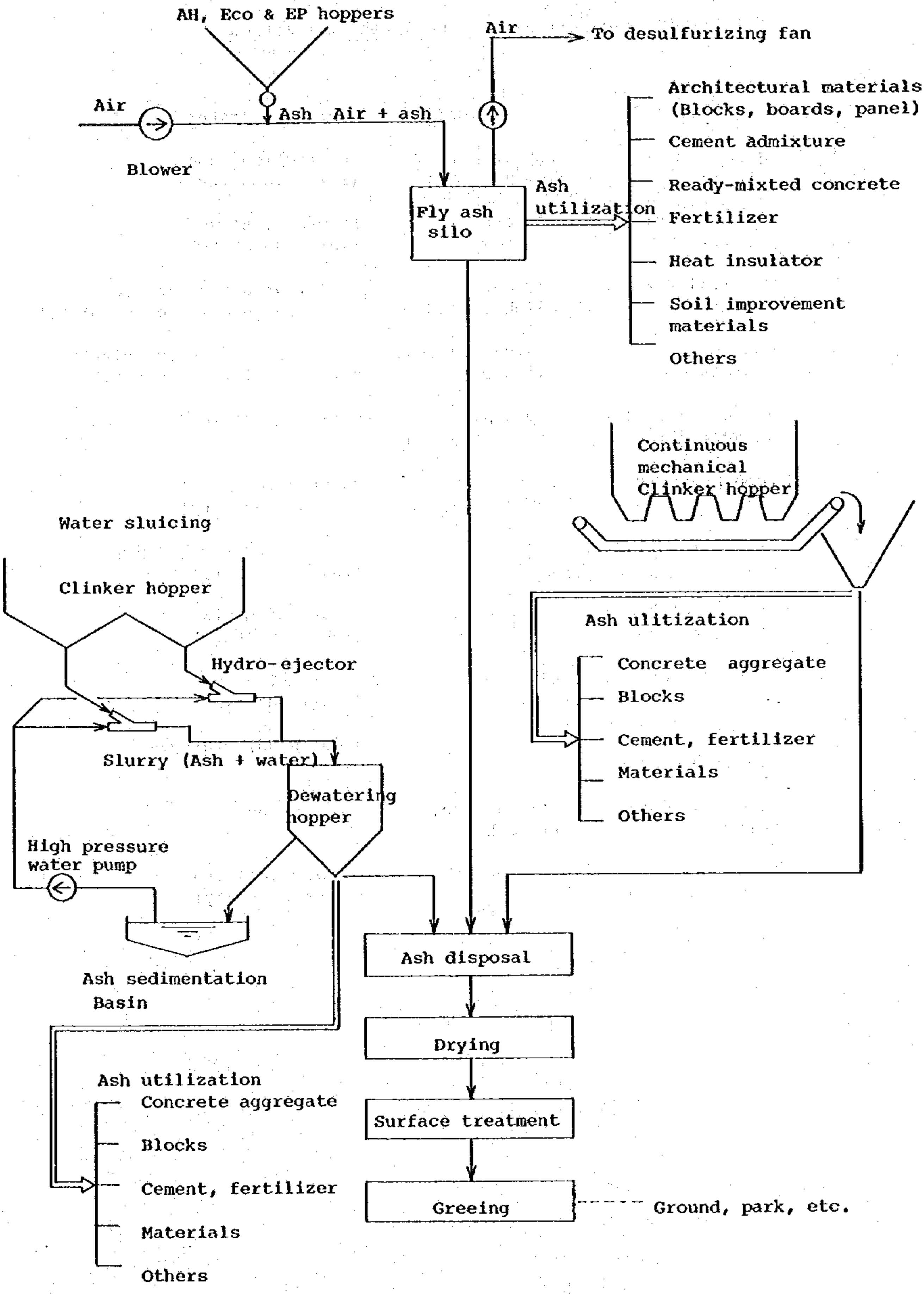


Table 5-11 Summary of Coal Ash Utilization

No.	Use	Ash Used	Present Status and Q'ty
1.	Cement admixture	Fly ash	In practical use (large quantity)
	For ready mixed concrete	Fly ash	In practical use (large quantity)
2.	Material for cement	Fly ash, clinker ash	Substituted for clay in practical use (large quantity)
3.	Concrete aggregate	Coarse fly ash, clinker ash	Practical use as substituted for sand (large quantity)
	Secondary cement product	Fly ash, coarse fly ash	Board, panel (medium quantity)
	Road pavement	Clinker ash, coarse fly ash	Under development (medium quantity)
4.	Artificial light aggregate	Fly ash	Technically succeeded (large quantity)
	Artificial heavy aggregate	Fly ash	To be industrialized (large quantity)
5.	Refractories	Fly ash	In practical use (small quantity)
6.	Material for aluminum		Under study overseas
7.	Cement hardening agent	Clinker ash, fly ash	Under study
8.	Land filling, land formation	Clinker ash	In practical use (large quantity)

c. Outline of Ash Utilization for the Project

a) Ash production and utilization

Coal consumption is estimated approximately 1,521,000 tons per year, and ash production will be approximately 300,000 tons per year assuming that ash content is 20% of the consumption.

i) Ash distribution and utilization can be classified by the particle size of ash as follows;

Item	Ash distribution and Utilization*			Remarks
Coal consumption (10^3 ton/year)	1,521			300MW x 2 unit
Ash production (10^3 ton/year)	300			1,521 x 0.2
Ash distribution particle Size (mm)	1 - 10	0.1 - 1.0	less than 0.1	
Ratio (%)	20	5	75	
Volume (10^3 ton/year)	60 Bottom ash (clinker ash)	15 Cinder ash from eco- nomizer, air preheater	225 (180)* Fly ash from EP	* Assumed that 80% of ash production will be reused as fly ash.
Utilization	Land fill, Roadbed materials	Tiles, Blocks Grout materials	Fly ash cement Mixture with ready-mixed concrete	

ii. Outline of Ash Utilization

i) Bottom ash and Cinder ash

The bottom ash and cinder ash can be used for land restorage for excavated land, abandoned coal mine, etc. without special processing.

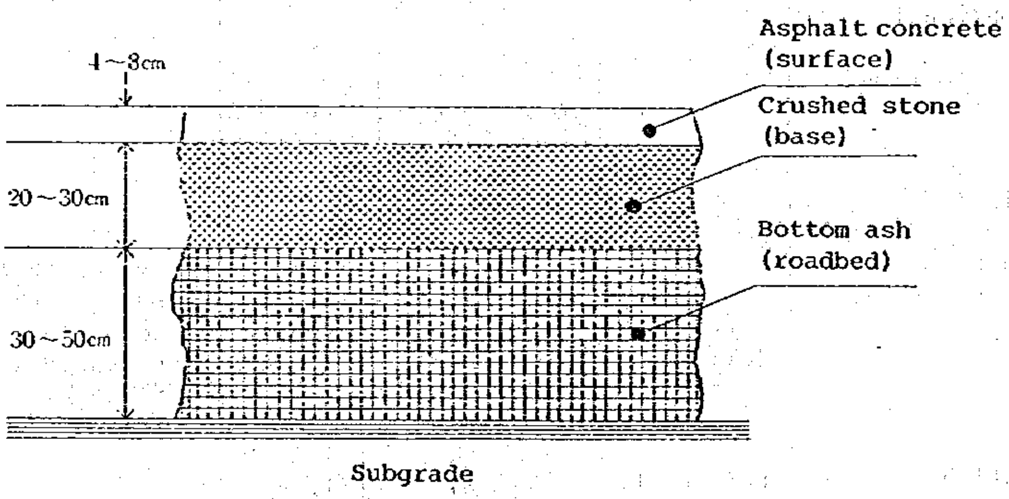
In case of utilization for roadbed, the ashes have superior characteristics in compression and durability by consolidation, and can be utilized for land fill of loose land as land stabilizer.

In Europe and America, and other countries, the ashes have been utilized for roadbed.

<u>Major utilization</u>

Road pavement, ground reclamation, land fill after piping works, etc.

<u>Sample of usage</u>



ii) Fly ash

Fly ash utilized for admixture of cement can be roughly classified into two kinds:

- Admixture in cement factory
- Mixture with ready-mixed concrete

<u>Fly ash cement</u>

Cement mixed with fly ash has characteristics of less water consumption and better fluidity, and it has been widely utilized for architectural and dam construction materials. According to JIS R.5213-1979, 3 kinds of fly ash cement is stipulated in accordance with mixing rate of fly ash in the cement as follows:

Item	Kind (Mixing rate of fly ash)		
	A-class (less than 10%)	B-class (10 to 20%)	C-class (20 to 30%)
Specific sheet (cm^2/g)	More than 2,500	More than 2,500	More than 2,500
Setting time starting (min) Finish (hour)	 More than 60 Within 10	 More than 60 Within 10	 More than 60 Within 10
Stability	Good	Good	Good
Compressive Strength (kg/cm^2) 3 days 7 days 28 days	 More than 70 More than 150 More than 300	 More than 60 More than 120 More than 260	 More than 50 More than 100 More than 210
Contents Magnesium oxide Sulfuric trioxide Ignition loss	 Less than 5.0% Less than 3.0% less than 3.0%	 Less than 5.0% Less than 3.0% -	 Less than 5.0% Less than 3.0% -
Major use	General materials for architectural works	Materials for building construction	Materials for dam construction

In addition to the above stipulation, fly ash proper to be mixed with cement is additionally stipulated by JIS A.6201-1977 as follows;

Silicon dioxide	More than 45%
Moisture content	Less than 1%
Ignition loss	Less than 5%
Specific gravity	More than 1.95 g/cm³
Unit water volume ratio	More than 102%
Compressive strength ratio 28 days More than 60% 91 days More than 70%	

Additive to ordinary portland cement

After the amendment of JIS R 5210 "Portland Cement", fine particles of fly ash, blast-furnace slag, etc. could have been mixed with portland cement with a mixing rate of 5% at the maximum, and in recent the portland cement mixed with such fine particles has been utilized for civil and architectural construction materials as universal cement.

iii. Scale of coal ash utilization under the project

i) Cinder ash and EP ash unusable for fly ash can be mixed in cement with a mixing rate of approximate 10% for tiles, blocks and grout materials. Basing on the above utilization, fly ash mixing factory with a treating capacity of 60,000 tons/year will be possible.

ii) Based on the stipulation of fly ash quality, 10 to 30% of fly ash collected can be mixed with cement. Cement mixing factory with a capacity of 180,000 tons/year will be possible.

d. Example of Artificial Light Weight Aggregate Manufacturing Manufacturing and quality of concrete:

a) Outline of process

Artificial light weight aggregate manufacturing plant installed near coal-fired thermal power plant site is characterized as follows:

i) Fly ash produced in the power plant, water and small quantity of pulverized coal for additives will be required as raw materials for manufacturing the products.

ii) Sintering and solidification will be performed by burners in heating furnace.

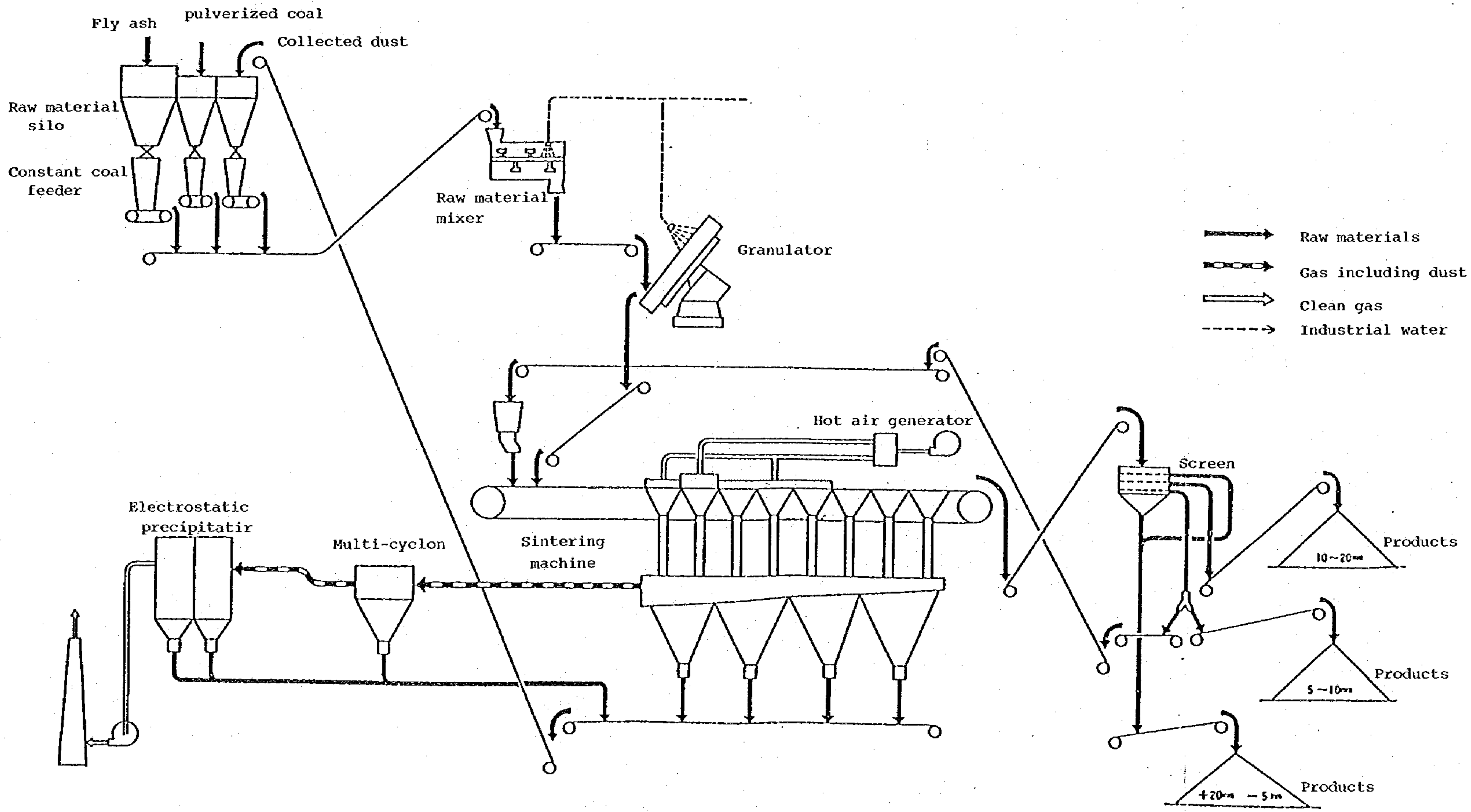
iii) Whole facilities are compact because of no installation of big rotary kiln.

Manufacturing process is shown in the following flow chart. After fly ash is mixed with small quantity of pulverized coal, raw pellet with arbitary size can be produced by granulator with mixing about 15% water.

Raw pellet is sintered and solidified into aggregate by Dwight-Lloyd type sintering machine after heating and drying. Since there is no fusion between the respective pellets at sintering, there are many advantages such as lower pressure loss of combustion and cooling air, low auxiliary power consumption, short processing time for sintering and cooling down and no need of crushing process.

The facilities are composed of raw materials mixer, granulator, sintering machine, dust collector, etc. It does not need a product cooling process. Therefore, as the system is relatively simple, the equipment cost will be lower than that of external heating method by conventional rotary kiln.

Fig. 5-9 Example of granulating and sintering equipment of fly ash



b) Example of Characteristics of Light Weight Aggregate

Items	Measured Value Coarse Aggregate	Standard Value Coarse Aggregate	Method of Measurement
Bone dry specific gravity	1.30	$1.0 \leqq M < 1.5$	JIS A1110 JIS A1135
Surface-dried specific gravity	1.64		JIS A1110 JIS A1135
Water absorption ratio (%)	26.4		JIS A1110 JIS A1135
Weight of unit volume (Kg/m^3)	0.86		JIS A1104
Ratio of absolute volume (%)	60.0	$\geqq 60$	JIS A1104
Massive clay (%)	0.3	$\leqq 1$	JIS A5002
Ignition loss (%)	1.4	Art. agg. $\leqq 1.0$ Nat. agg. $\leqq 5.0$ By-pro. agg. $\leqq 5.0$	JIS R5202
Stability (%)	6.2	$\leqq 12$	JIS A1122
Chloride (%)	0	$\leqq 0.01$	JIS A5002
Organic impurity	Less than Standard color	Less than standard color	JIS A1105
Sulfuric anhydride (%)	0	$\leqq 0.05$	JIS R5202

Table 5-12 Charactoristics of Artifical lightweight concrete aggregate made from fly ash

Kind of coarse aggregate	Mixing No.	Maximum size (mm)	Range of slump (cm)	Range of air Content (%)	Water Content (%)	Rate of fine aggregate (s/a) (%)	Unit Weight: Water W (kg)	Unit Weight: Cement C (kg)	Unit Weight: Absolute volume of coarse aggregate: Artificial Aggregate (l)	Unit Weight: Absolute volume of coarse aggregate: Natural (l)	Unit Weight: Absolute volume of fine aggregate (l)	Unit Weight: AE Agent (g)	Mixing Rate of lightweight aggregate in coarse aggregate (%)	Weight of unit volume (kg/l)	Compressive strength (kgf/cm²): 7 days	Compressive strength (kgf/cm²): 28 days
Mixture of Natural and artificial lightweight aggregate	1	20	18 ± 1	4 ± 1	60.0	50.0	204	340	0	324	324	85	0	2.24	233	302
	2	20	18 ± 1	4 ± 1	60.0	50.0	198	330	109	220	329	66	33	2.14	223	304
	3	20	18 ± 1	4 ± 1	60.0	50.0	196	327	220	110	330	49	67	2.07	231	310
	4	20	18 + 1	4 ± 1	60.0	50.0	196	327	330	0	330	49	100	1.95	237	326

Data Source: Laboratory of Osaka Cement Co. and OC Engineering Co.

c) Manufacturing Cost for Artifical Lightweight Aggregate

Construction of aggregate manufacturing plant with manufacturing capacity of 200 tons/day:

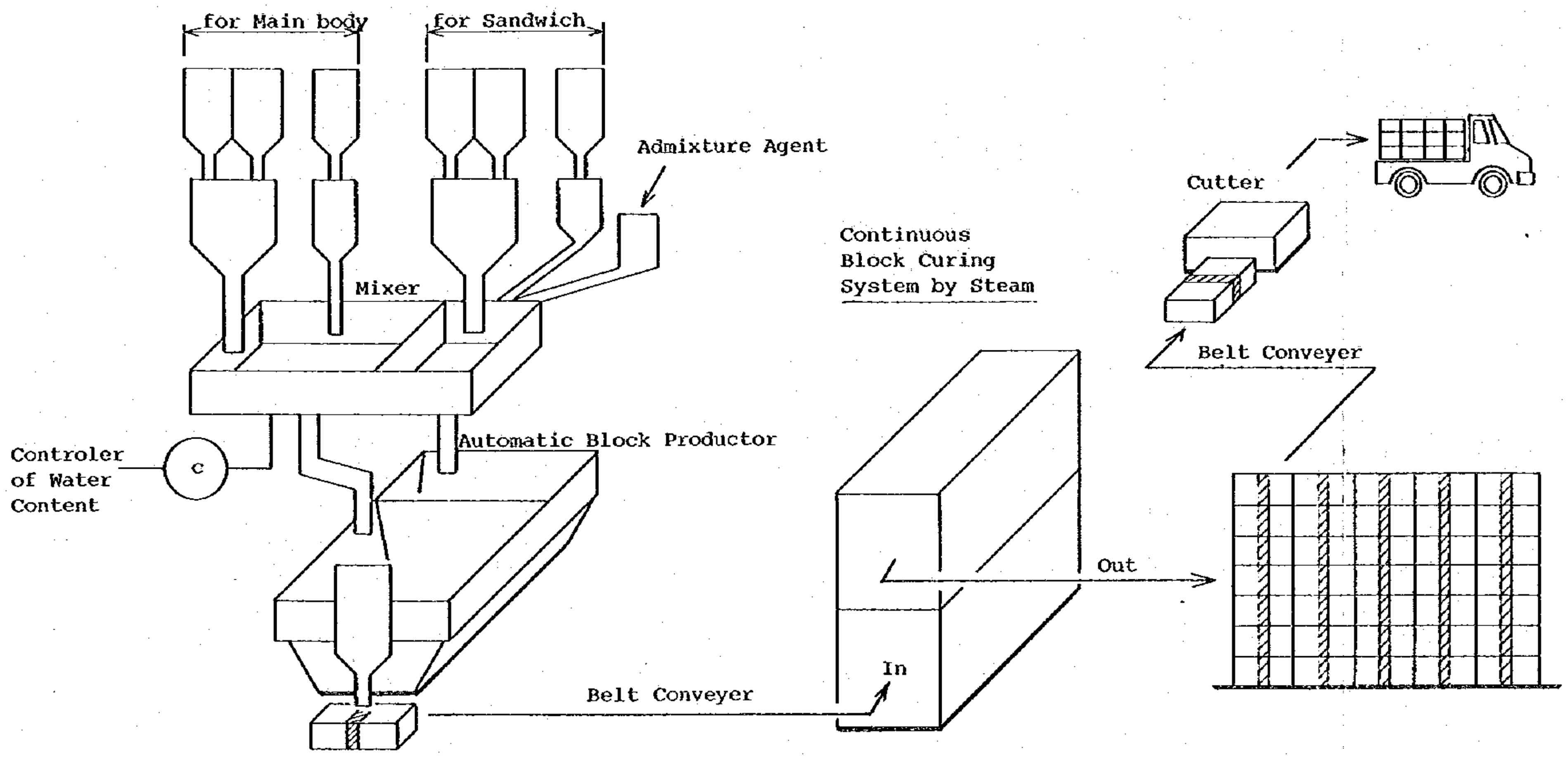
Approximately 10,000 x 10^3 US$ (including Equipment, Civil works and installation works)

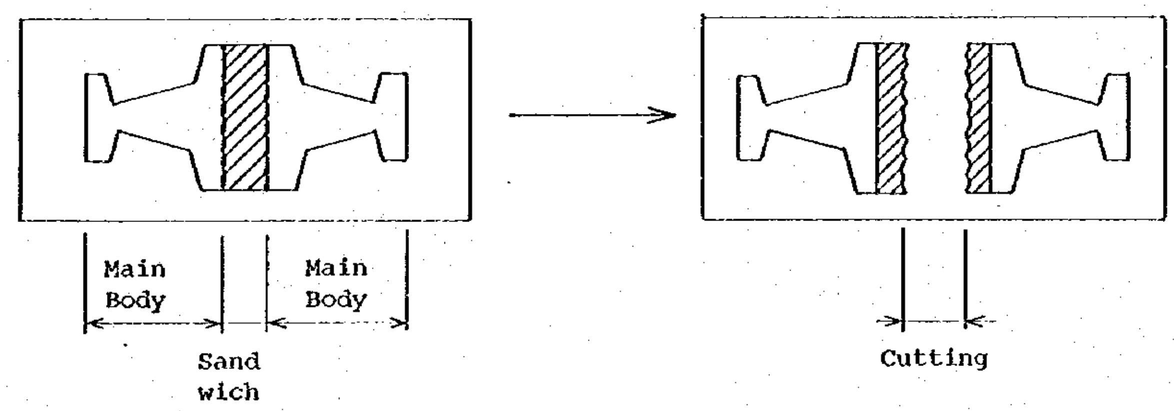
Standard price of product: 37 to 52 US$/$m^3$

c. Example of Concrete Block Manufacturing

a) Plant System

Fig. 5-10 Concrete Block Manufacturing





b) Manufacturing Conditions

Proportion

Unit water content	:	120 Kg/m^3
Cement (C+F)	:	280 - 300 Kg/m^3 (F/C+F=20%)
Sand (S)	:	1,048 Kg/m^3
Gravel (G)	:	901 Kg/m^3
S content ratio	:	54%
Air content ratio	:	5%

Curing of Green Block by Steam

Steam temperature	:	40 - 60 °C
Curing time	:	4 - 6 hours

Number of Daily Production

Working hours	:	8 hours
Daily production	:	1,800 - 2,000 pcs/unit

Plant and Production Cost

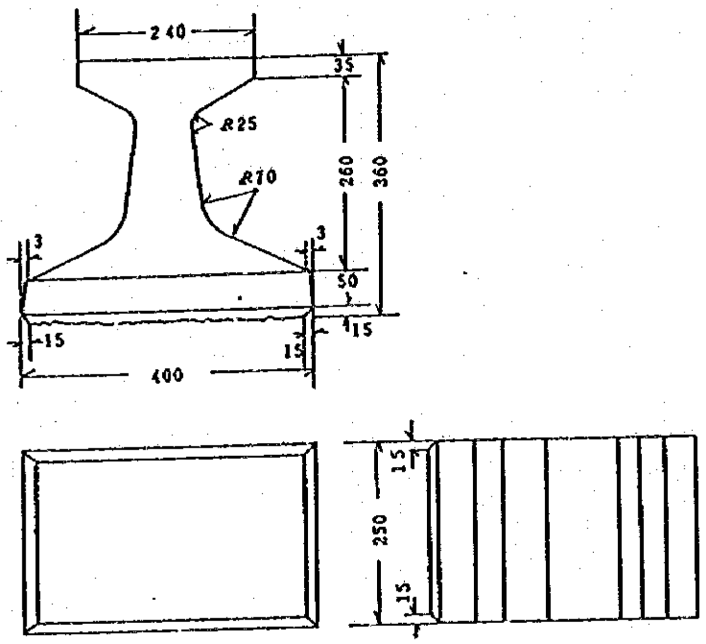
Plant cost including equipment, materials and installation cost:

Equipment & Materials	:	About 780,000 US$/unit
Installation	:	About 200,000 US$/unit
Total		About 980,000 US$/unit

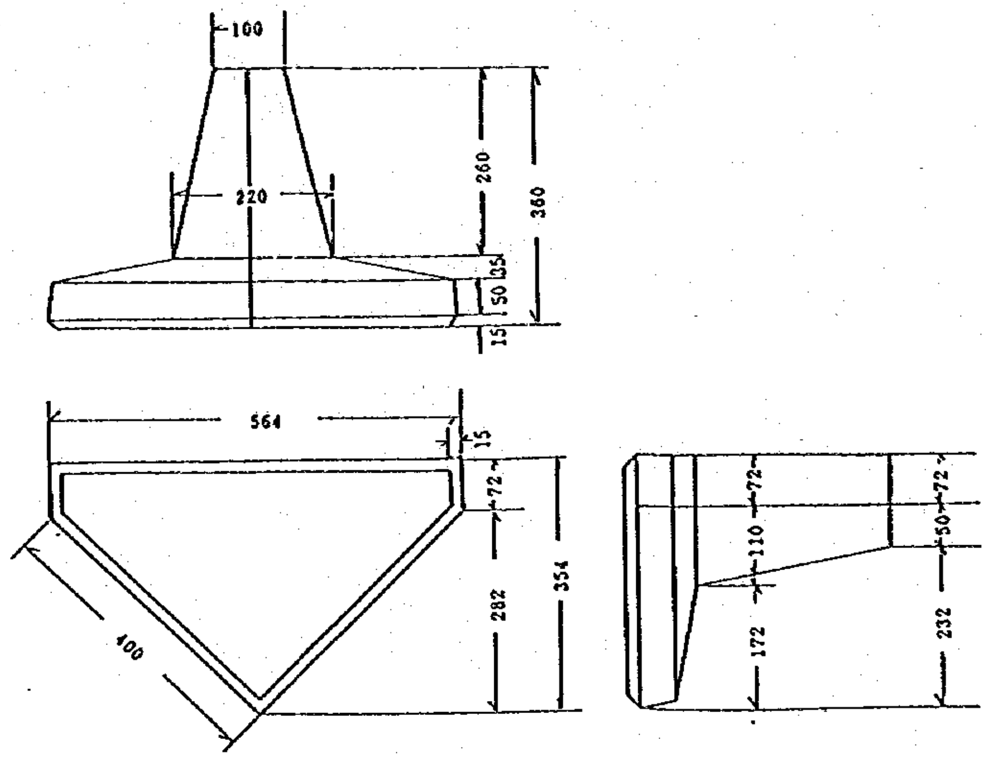
Production cost: 2 to 3 US$/piece at factory c). Kinds of Concrete Block (Example)

Fig. 5-11 Kinds of Concrete Block

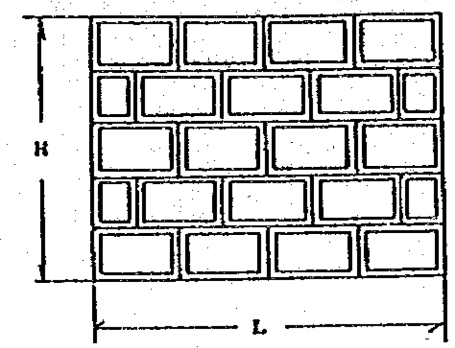
TYPE - A

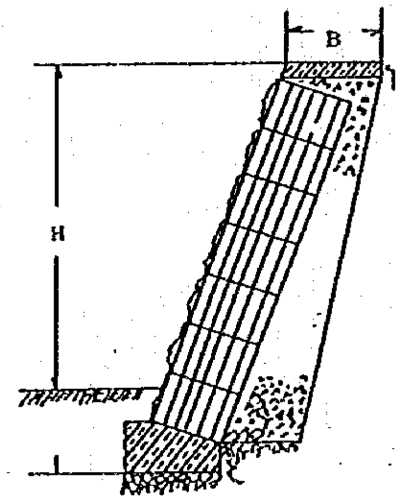


TYPE - C

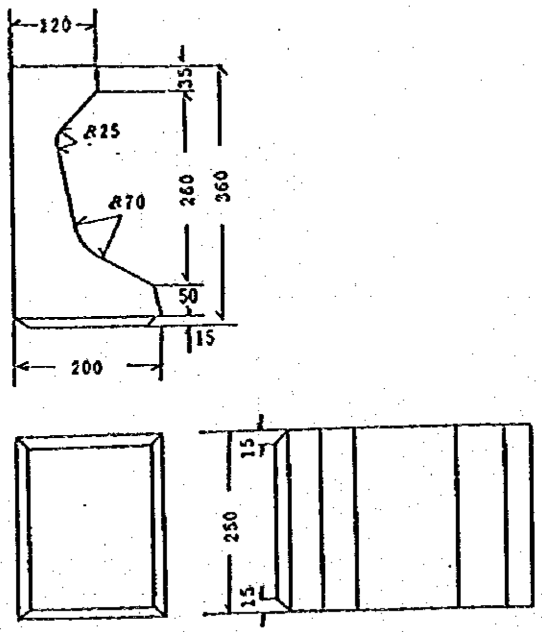


Coursed Masonvy

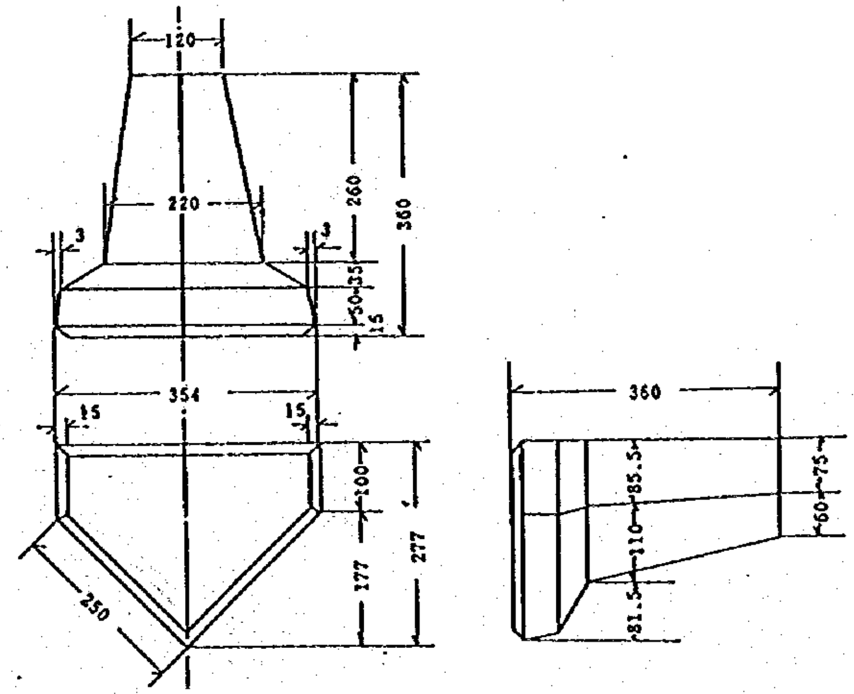




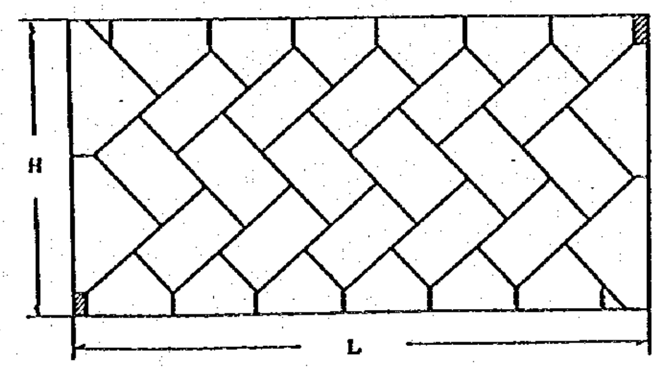
TYPE - B



TYPE - D



Uncoursed Masonry



Facilities for Effective Utilization of Coal Ash and Ash Transportation Facilities

As for the facilities for effective utilization of coal ash and the coal ash transportation system, the system and their specifications should be determined in consideration of distance and route from the power plant. On the other hand, as for the power plant side, the ash handling system within the power plant compound as well as transportation to other should also be taken into account. And in case that the facilities for the effective utilization of coal ash is located in the vicinity of the power plant, transportation by trucks is generally adopted for the clinker transportation method, however in case that total management of the facilities is made in the power plant, water sluicing transportation system is the most suitable method from the view point of economical aspects. However, comparison of both the transportation by trucks and conveyors shows no difference in costs. But in case of fly ash transportation, on the contrary, transportation by trucks is generally adopted and more economical than the transportation by conveyors.

As a result of review of determining the final discharge of coal ash exclusively, both the transportation systems should be taken into account in consideration of easiness of the transportation of the coal ash. Comparison of the both systems is described in the following tables. In addition, the facility costs are estimated on the assumption that the all the coal ash produced from the power plant are transported to the coal ash collecting facilities in the case that the facilities is located in the vicinity of the power plant. Furthermore, the estimate is based on the conditions that the service life of the tank-lorry is four years and the others sixteen years and the Tank-lorry will be replaced every four years.

Table 5-13 Clinker Ash Collecting Plant and Transportation Facilities

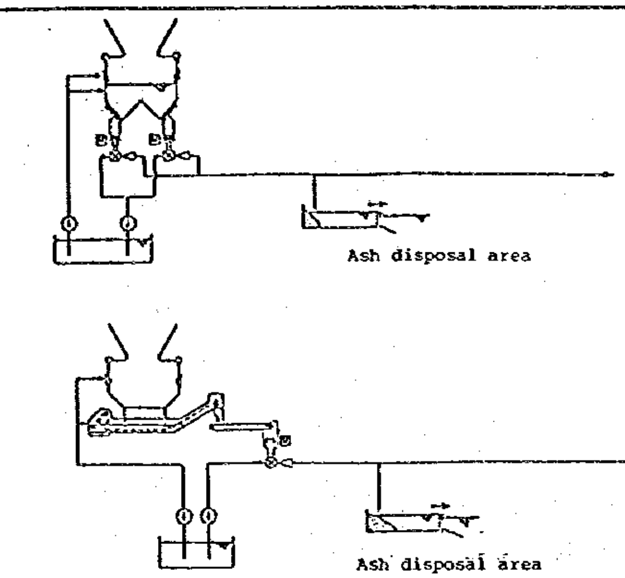
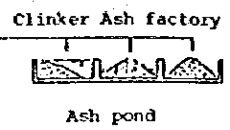
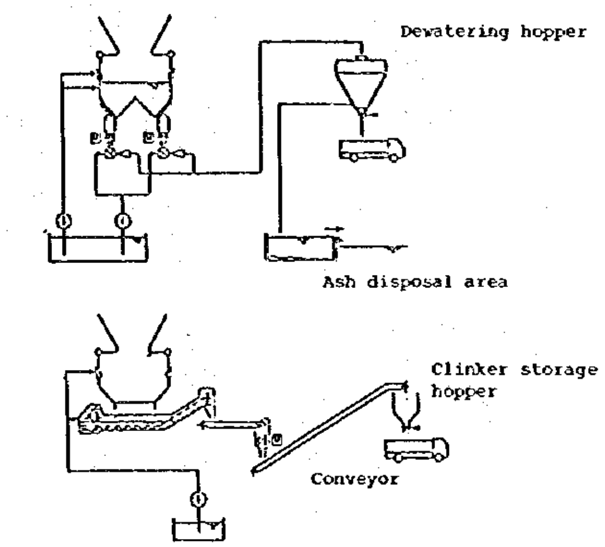
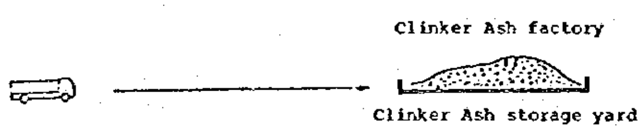
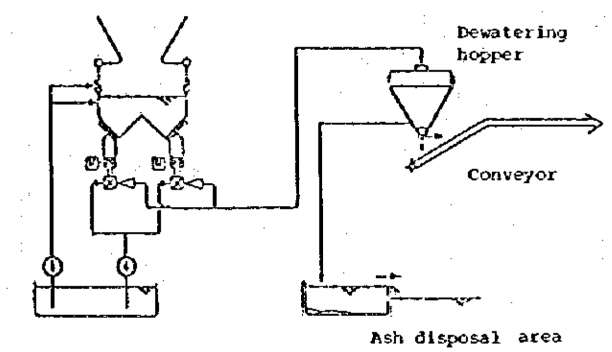
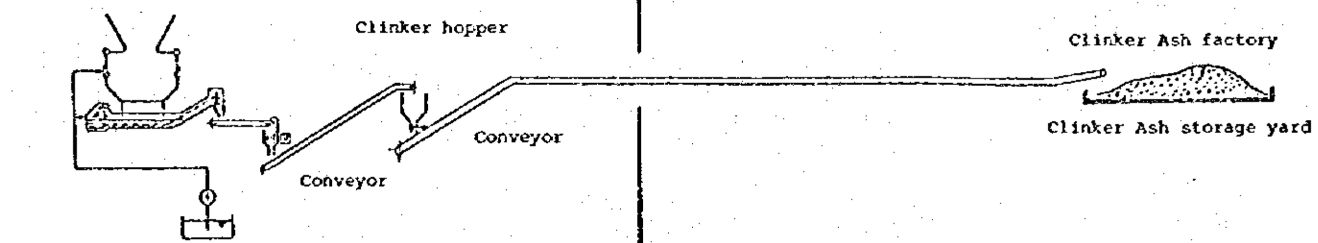
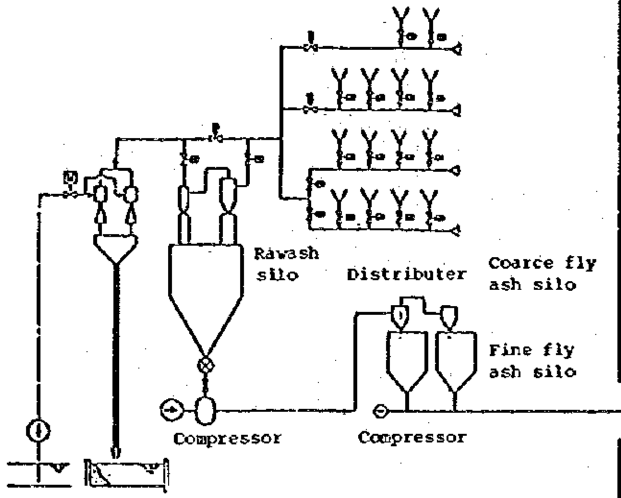
	Clinker Ash Collecting Plant and Transportation Facilities			
Water Sluicing Transportation	 	In this system, clinker ash produced from the power plant is conveyed to ash pond in the ash factory through water sluicing piping system.	**Water Sluicing Transportation** The water sluicing transportation system is suitable in the case that the clinker ash factory is located in teh vicinity of the power plant. For clinker ash collecting facilities, several ash ponds and transportation pipings will be needed.	**Facility Cost as of 1983 in Japan** Ash collecting facilities for 600 MW 1.0×10^6 US$ (Ash pond in the ash factory) Transportation facilities 0.5×10^6 US$ (One line each for No. 1 and No. 2 unit)
Truck Transportation	 	In this system, clinker ash produced from the power plant is dewatered by the dewatered hopper (water sluicing type), or stored once in the clinker ash storage hopper (mechanical type), and then the dewatered clinker as is transported to the ash factoyr by trucks.	**Truck Transportation** Truck transportation is suitable in the case that the clinker ash factory is located far from the power plant, or that the clinker ash can be transported directly to road construction site since the ash can be utilized for subbase coursematerials. For clinker ash collecting facilities, dewatering hoppers, on clinker ash storage hoppers, and ash disposal area (used for the power plant), clinker ash storage yard and trucks will be needed.	**Facility Cost as of 1983 in Japan** Ash collecting facilities for 600 MW Water sluicing type: 1.0×10^6 US$ Mechanical type: 1.0×10^6 US$ (In both the cases, cost for storage yard is excluded) Transportation facilities for 600 MW 1.0×1.0^6 US$ Total number of trucks: 16 The trucks will be replaced with new one every four years.
Conveyor Transportation	 	In this system, clinker ash produced from the power plant is dewatered by the dewatering hopper (water sluicing type), or stored once in teh clinker ash storage hopper, and then the dewatered clinker ash is transported to the ash factory by conveyors.	**Conveyor Transportation** Conveyor transportation is suitable in the case that the clinker ash factory is located in the vicinity of the power plant, or in relatively near place. For clinker ash collecting facilities, dewatering hoppers, or clinker ash storage hoppers, and ash disposal area (used for the power plant), clinker ash storage yard and conveyors will be needed.	**Facility Cost as of 1983 in Japan** Ash collecting facilities for 600 MW Water sluicing type: 1.0×10^6 US$ Mechanical type: 1.0×10^6 US$ (In both the cases, cost for storage yard is excluded) Transportation Facilities 0.95×10^6 US$ (Common facilities for No. 1 and No. 2 unit)

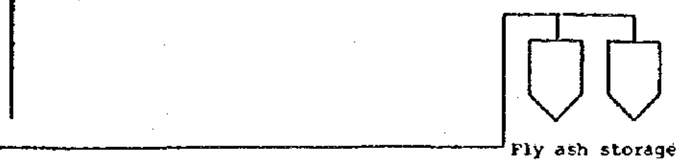
Table 5-14 Fly Ash Collecting Plant and Transportation Facilities

Fly Ash Collecting Plant and Transportation Facilities

Pneumatic Transportation

In this system, the coarse fly ash and fine fly ash are collected separately in the respective fly ash silos at the power plant, and they are transported by pnuematic transportation to cement factory through compressed air madia.





Pneumatic Transportation

The pneumatic transportation system is suitable in case that the fly ash collecting plants like cement factory are loacted in the vicinity of the power plant. For the fly ash collecting facilities, raw fly ash silos, storage silos, compressors, distributors, transportation piping, etc. will be needed.

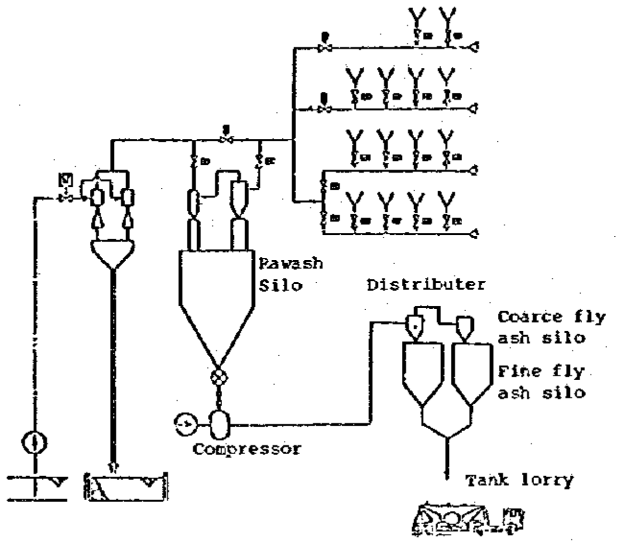
Facility Cost as of 1983 in Japan

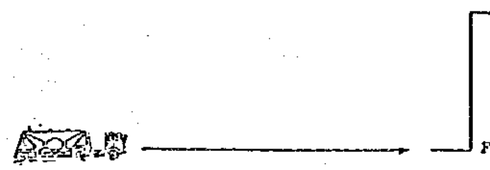
Ash collecting facilities for 600 MW
5.0×10^6 US$ (excluding stock silos)

Transportation facilities
1.5×10^6 US$

Truck Transportation

In this system, the coarse fly ash and fine fly ash are collected separately in the respective fly ash silos at the power plant, and they are transported by trucks, or tank-lorry mounted with air compressor to cement factory.





Truck Transportation

Truck transportation system is spplied in the case that the fly ash collecting plants like cement factory are located on the inland and the transportation by seas is not needed. For the fly ash collecting facilities, raw fly ash silos, sotrage silos, compressors, distributors, trucks, tank-lorry mounted with compressor, etc. will be needed

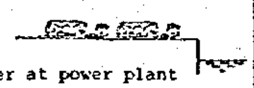
Facility Cost as of 1983 in Japan

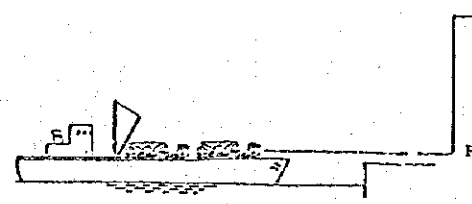
Ash collecting facilities for 600 MW
5.0×10^6 US$ (excluding stock silos)

Transportation facilities
Total number of tank-lorry mounted with compressor: 28
The tank-lorry will be replaced with new one every four years.

Sea Transportation

In this system, the collected fly ashes in the respective fly ash silos are conveyed to the pier of the power plant, then transported by seas to cement factory.



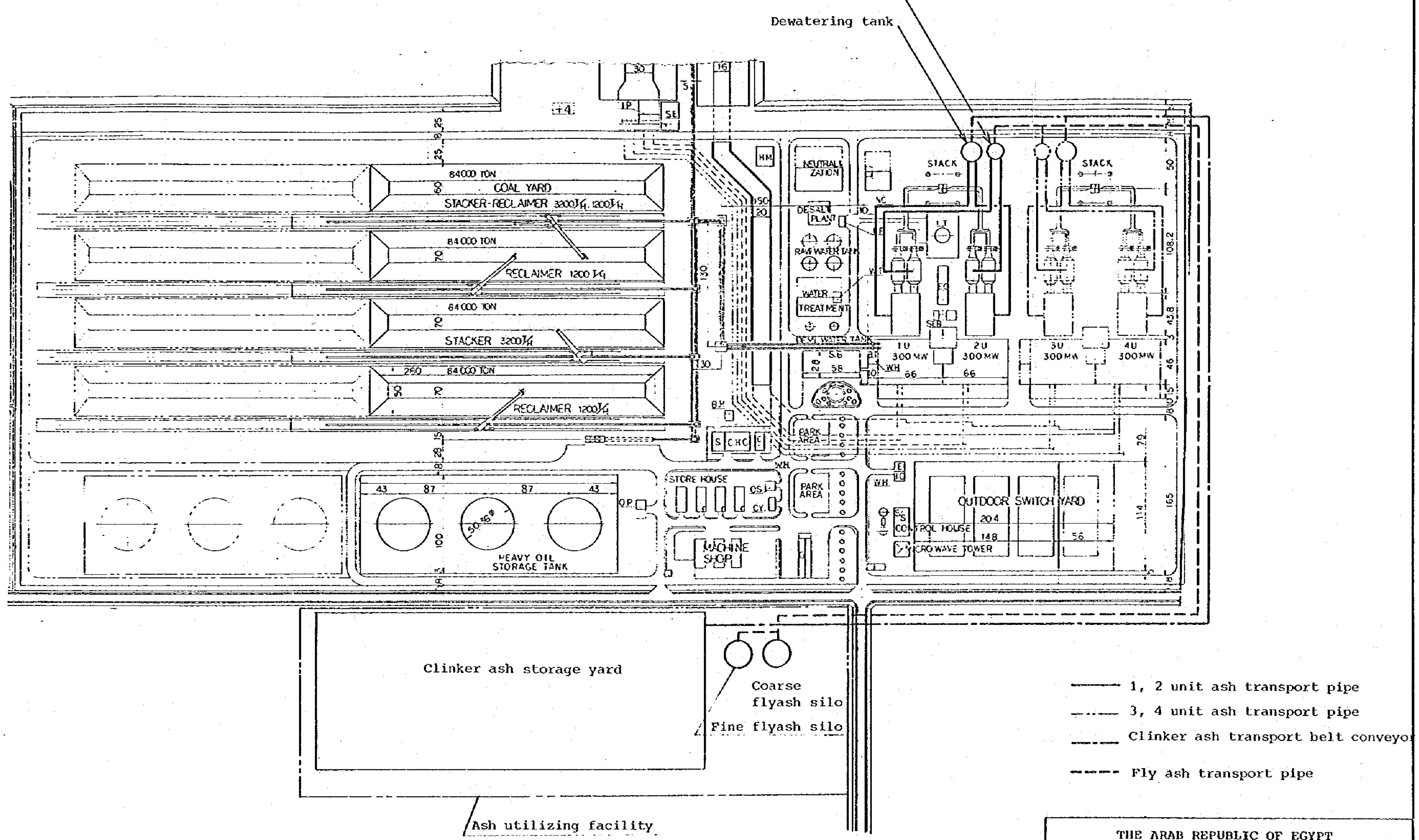


Sea Transportation

Sea transportation system is applied in the case that the fly ash collecting plants like cement factory are located for from the power plant with unloading pier, or unloading part facilities are available near the collecting plants. For the fly ash collecting facilities, raw fly ash silos, storage silos, compressors, distributors, traucks, tank-lorry mounted with compressor, etc. will be needed. As for sea transportations, special-purpose ships, or chartered ships will be needed.

———

Fig. 5-12 Transport Route to Ash Utilizing Facility



THE ARAB REPUBLIC OF EGYPT

SINAI COAL-FIRED THERMAL POWER PROJECT

TITLE
Ash Transport Route to Ash Utilizing Facility

SCALE | DRAWING NO.

10) Operation Program of Power Plant

a. Manning Program

a) Job description for Sinai Coal-fired Thermal Power Plant Personnel

i. Superintendent (Category - 2)

Plant Superintendent will be totally responsible for all matters related to the power plant; operations, maintenance and administration of the plant, and he is representative of the power plant.

ii. Maintenance Section

i) General Manager of Maintenance (Category - 3)

General Manager of Maintenance will be responsible for maintaining the complete power plant facilities including all the generating and auxiliary equipment, desalination plants, coal and oil unloading/handling equipment, buildings such as powerhouse and appurtenant buildings, and adjacent area. He is directly responsible to the office of the Plant Superintendent, and he will establish schedules and controls for the performance of all maintenance works. A complete set of files giving the maintenance history of all equipment will be maintained under his direction. His staff will be divided into six (6) subsections; Coal Handling Maintenance, Turbine Maintenance, Boiler Maintenance, Electrical Maintenance, Instrument & Control Maintenance and Central Shop.

Work orders, work completion reports, requisitions for tools, materials, spare parts, etc., will all be subject to his approval. He will be in close communication with the General Manager of Operations and the office of the Superintendent to establish mutually satisfactory schedules, priorities, budget requirements, etc.

ii) Coal Handling Maintenance Engineer (Category - 4)

Coal Handling Maintenance Engineer will be responsible for performing overhauls on coal/oil handling and unloading facilities including harbor facilities, coal storage facilities and oil storage tanks, and carrying out preventive maintenance routines on all items related to coal and oil handling and unloading facilities.

Defective items will be removed to the Central Shop under the same section for repair, whenever possible. In addition to all the planned overhauls, he is responsible for performing necessary maintenance and emergency repairs in accordance with work orders and priorities established by the General Manager of Maintenance.

iii) Turbine Maintenance Engineer (Category - 4)

Turbine Maintenance Engineer will be responsible for performing overhauls on turbine and its auxiliary equipment, and carrying out preventive maintenance routines on all items related to turbine system. Defective items will be removed to the Central Shop under the same section for repair, whenever possible. In addition to all the planned overhauls, he is responsible for performing necessary maintenance and emergency repairs in accordance with work orders and priorities established by the General manager of Maintenance.

iv) Boiler Maintenance Engineer (Category - 4)

Boiler Maintenance Engineer will be responsible for performing overhauls on boiler and its auxiliary equipment including coal supply conveyor and desalination plant, and carrying out preventive maintenance routines on all items related to boiler system. Defective items will be removed to the Central Shop under the same section for repair, whenever possible. In addition to all the planned overhauls, he is responsible for performing necessary maintenance and emergency repairs in accordance with work orders and priorities established by the General manager of Maintenance.

v) Electrical Maintenance Engineer (Category - 4)

Electrical Maintenance Engineer will be responsible for performing and carrying out preventive maintenance routines on all electrical equipment in the plant, including electrical equipment of desalination plant, and also he is responsible for repair and maintenance of high and low voltage switchgear, protective devices and instrumentation associated with generator, exciter, transformers and switchgears.

vi) Instrument & Control Maintenance Engineer (Category - 4)

Instrument & Control Maintenance Engineer will be responsible for maintenance, calibration and repair of all instruments and automatic control devices associated with turbine, boiler and desalination plant. His responsibility will include maintenance and repair of data logging computer system and power plant simulator system for personnel training.

vii) Central Shop Engineer (Category - 4)

Central Shop Engineer will be responsible for disassembly and overhaul of equipment brought into the Shop by Turbine, Boiler, Coal Handling Maintenance Subsections, and will be responsible for such works as machining, fabricating, welding, plate work, etc, and also responsible for covering emergency repairs.

iii. Operation Section

i) General Manager of Operations

General Manager of Maintenance will be responsible for efficient and safe operation of the power plant including desalination plant. He is directly responsible to the office of the Plant Superintendent for reporting daily operation result. He is also responsible for close communication with the Load Dispatching Center.

His responsibilities are summarized as follows;

- Leadership for maintaining of each equipment performance
- Close communication with related sections
- Leadership for keeping operating charts and records
- Establishment of temporary organization and communication when disaster occurred
- Acknowledgement of defeated equipment and establishment of measures to be taken.
- Leadership for appropriate operating procedures.

ii) Shift Engineer (Category - 4)

Shift Engineer will be responsible for efficient and safe operation of the power plant, and he is responsible for the operation of units on an hour by hour basis, and also responsible for keeping a log of all important events which occur during his working time so that the record of these may be passed on to the following shift. When an equipment is defeated or damaged, he is responsible for requesting Turbine, Boiler, Electrical, Coal Handling or Instrument & Control Engineers to repair the defeated or damaged equipment.

iv. Technical Affairs Section

i) General Manager of Technical Affairs (Category - 3)

General Manager of Technical Affairs will be responsible for assisting the Plant Superintendent in technical affairs in the plant, including plant efficiency control, measures against environmental pollution, study and research on new technology for thermal power sector, development of new computer program. He is directly responsible to the office of the Plant Superintendent for reporting the items related to technical affairs.

His responsibility are summarized as follows;

. Planning and execution of performance test, and judgement of the test results

- Judgement of operating results and statistical data on the plant
- Acknowledgement of conditions of operation and maintenance
- Decision making of organization for emergency situation when disaster occurred
- Study on regulations applied to power generation and close communication with related agencies.

ii) Manager of Follow-up and Planning (Category - 4)

Manager of Follow-up and Planning will be responsible for improvement planning of plant efficiency, scheduling of unit shutdown needed for periodic overhaul, emergency repairs and unit start-up after the overhaul and repairs. He is directly responsible to the Manager of Technical Affairs.

iii) Manager of Plant Performance (Category - 4)

Manager of Plant Performance will be responsible for thermal efficiency control, environmental affairs, planning of periodical performance tests for each equipment in the plant, pursuit of cause of the accident. He is also directly responsible to the General Manager of Technical Affairs.

iv) Manager of Instruments & Control (Category - 4)

Manager of Instruments & Control will be responsible for studying development of new programs related to power plant management, and pursuit of cause of computer trouble. He is also directly responsible to the General Manager of Technical Affairs.

v. General Manager of Plant Chemistry (Category - 3)

Manager of plant chemistry will be responsible for leadership for procurement schedule of chemicals, determination of water and steam quality limits, analysis of fuel (coal and oil), review of the test results on turbine oil, lubricating oil and insulation oil, control of environmental pollution based on test results, budgetary planning for chemicals and measuring instruments and leadership for judgement of water and steam quality during unit start-up. He is directly responsible to the plant Superintendent for reporting his duties.

vi. Warehouse Engineer (Category - 4)

Warehouse Engineer will be responsible for administration and management of all the spare parts stored in the Warehouse, and long-term fuel receiving program, arrangement of tag-boats needed for leading the coaler and oil tanker to pier and verifying volume of coal and oil received.

vii. Training Coordinator (Category - 4)

Training Coordinator will be responsible for all items related to education and training of all the power plant personnel, and operation of power plant simulator for personnel training. His responsibilities are summarized as follows;

i) Planning and execution of training schedule

ii) Arrangement and preparation of training materials and trainers

iii) Evaluation of effect of training

iv) Orientation for newcomers to the plant

He is directly responsible to the office of the Plant Superintendent.

viii. Administration and Finance Section

i) Manager of Administration and Finance (Category - 4)

Manager of Administration and Finance will be responsible for all general office work which is not directly related to operation, maintenance or technical affairs of the plant.

His responsibilities are summarized as follows;

- All bookkeeping activities, payrolls, receipts and disbursement of funds
- Financial statements and reports
- Requisitions for funds
- All purchasing and procurement activities
- Preparation of purchase orders and inquiries

- Obtaining and verifying requisitions for materials, parts and services from the Maintenance Section, Operation Section, Technical Affairs Section, Plant Chemistry Section and Warehouse Engineer and Training Coordinator.
- Planing purchase orders and expediting deliveries
- Procurement of staff, personnel files and records
- Enforcement of EEA's personnel policies
- Supervision of secretaries, typists and clerks
- Public relations
- Implementation of promotions and terminations
- Allocation, procurement and/or repair of office equipment and furniture, telephones, stationery
- Supplies and supervise mailroom, transportation, messenger and guard services and vehicles as well as first aid, safety and health services.

b) Organization

Manning program for administration, technical, maintenance, operation and chemical of the power plant is as shown on the Organization chart. Total number of personnel will be 709 (ultimately 854 for 1,200 MW). Personnel by section will be as follows.

Manning by each category

Category	At 600 MW	At 1,200 MW
1	0	0
2	1	1
3	4	4
4	38 (E-11, T-16)	50 (E-11, T-33)
5	121 (E-12, T-44)	145 (E-14, T-55)
6	152	192
7	202	246
8	51	76
Others	140	140
Total	709	854

Note: E and T in the brackets mean Engineer and Technician.

Manning by each section

i. Administration section

Category	At 600 MW	At 1,200 MW
2	1	1
3	0	0
4	3 (E-1)	3 (E-1)
5	8	8
6	37	42
7	88	90
8	0	0
Others	140	140
Subtotal	139	146

ii. Technical affairs section

Category	At 600 MW	At 1,200 MW
3	1	1
4	12 (E-6, T-6)	12 (E-6, T-6)
5	35 (E-5, T-4)	35 (E-5, T-30)
6	40	48
7	55	63
8	49	73
Others	60	60
Subtotal	252	292

iii. Maintenance section

Category	At 600 MW	At 1,200 MW
3	1	1
4	12 (E-6, T-6)	12 (E-6, T-6)
5	35 (E-5, T-30)	35 (E-5, T-30)
6	40	48
7	55	63
8	49	73
Others	60	60
Subtotal	252	292

iv. Operation section

Category	At 600 MW	At 1,200 MW
3	1	1
4	18 (E-4, T-10)	30 (E-4, T-26)
5	64 (E-4, T-10)	80 (E-4, T-18)
6	68 (T-2)	92
7	56	88
8	0	0
Others	63	63
Subtotal	270	354

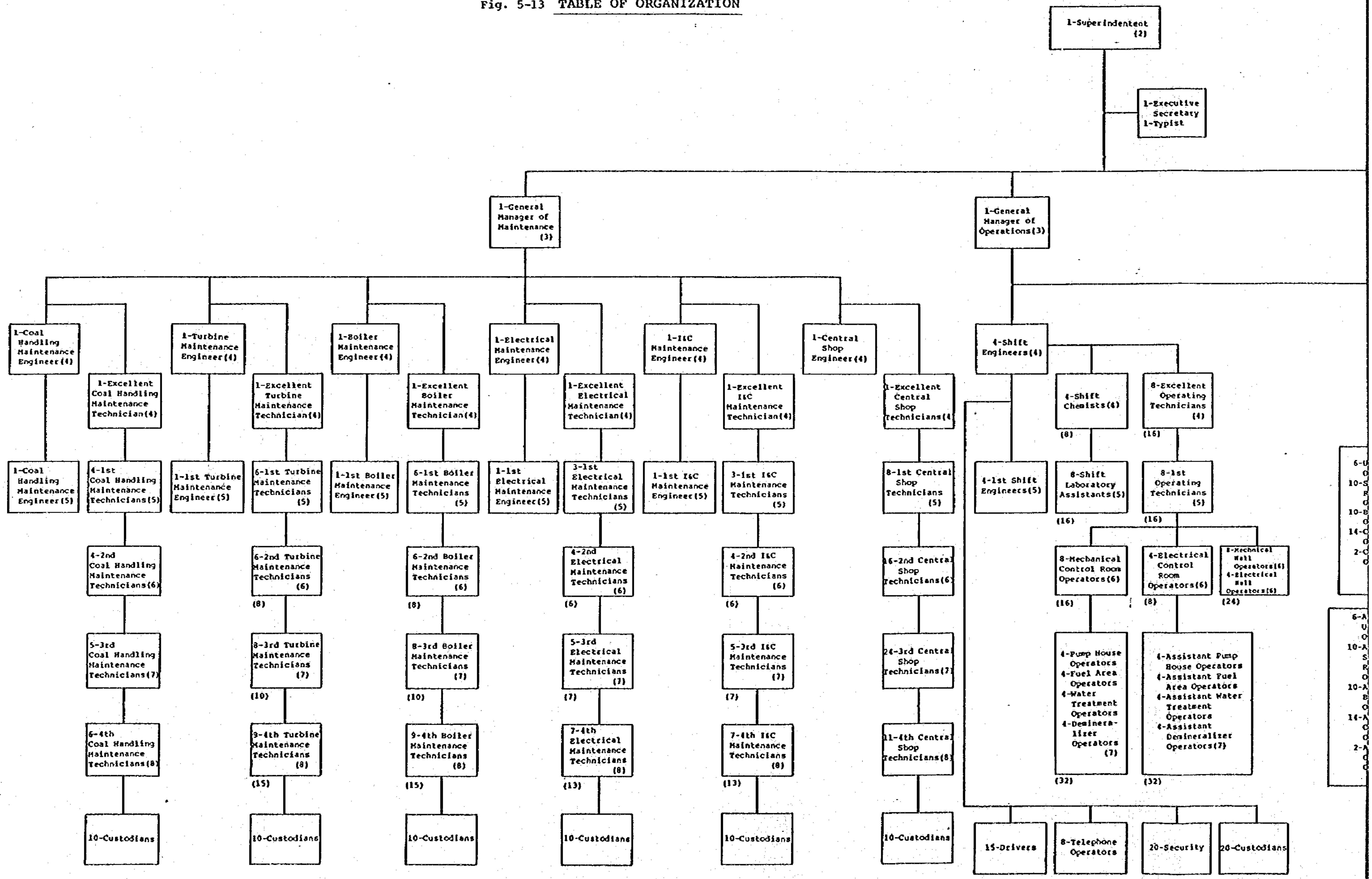
v. Plant chemistry section

Category	At 600 MW	At 1,200 MW
3	1	1
4	1	1
5	4	5
6	4	5
Subtotal	10	12

Grand Total	709	854

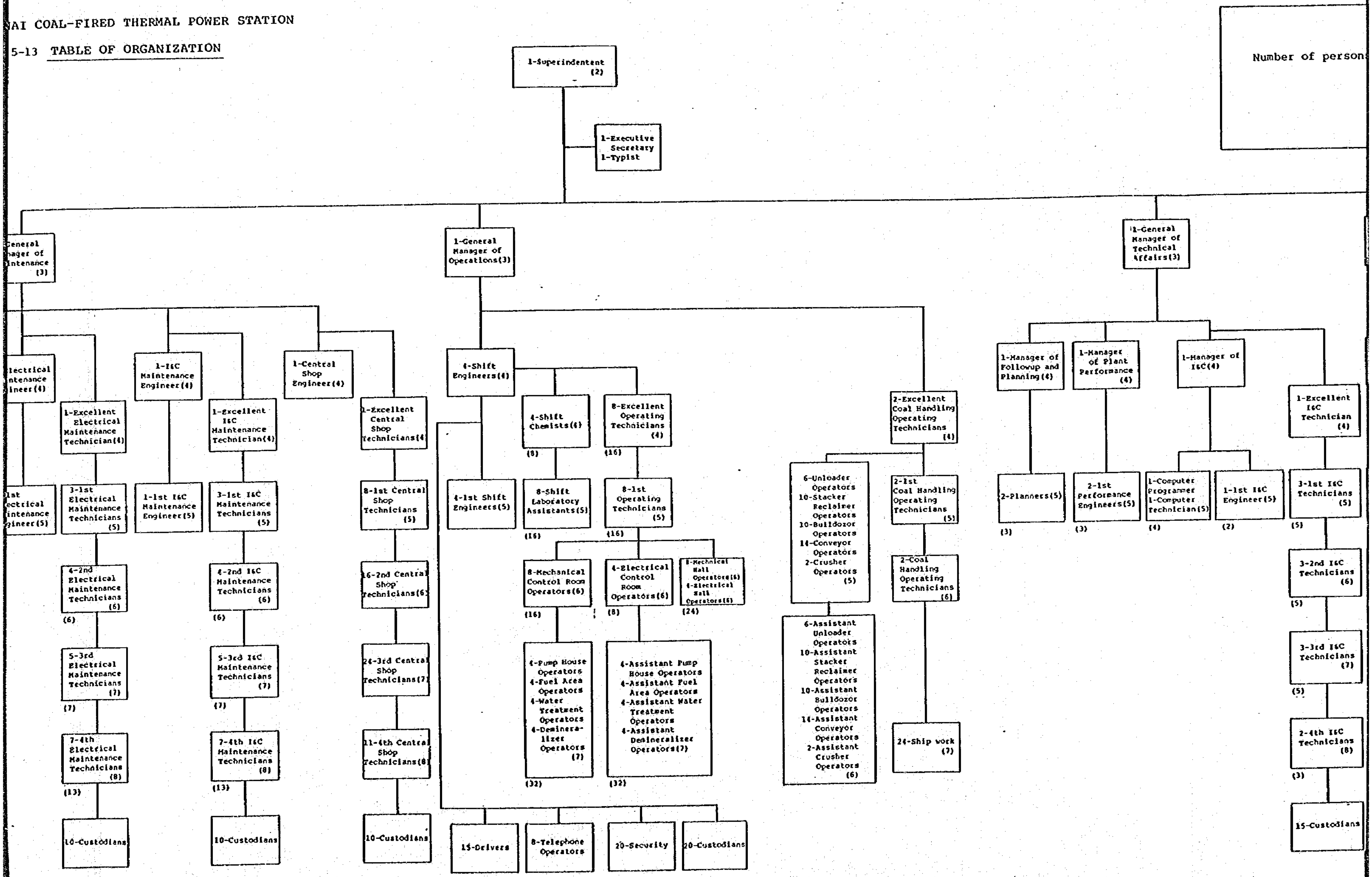
SINAI COAL-FIRED THERMAL POWER STATION

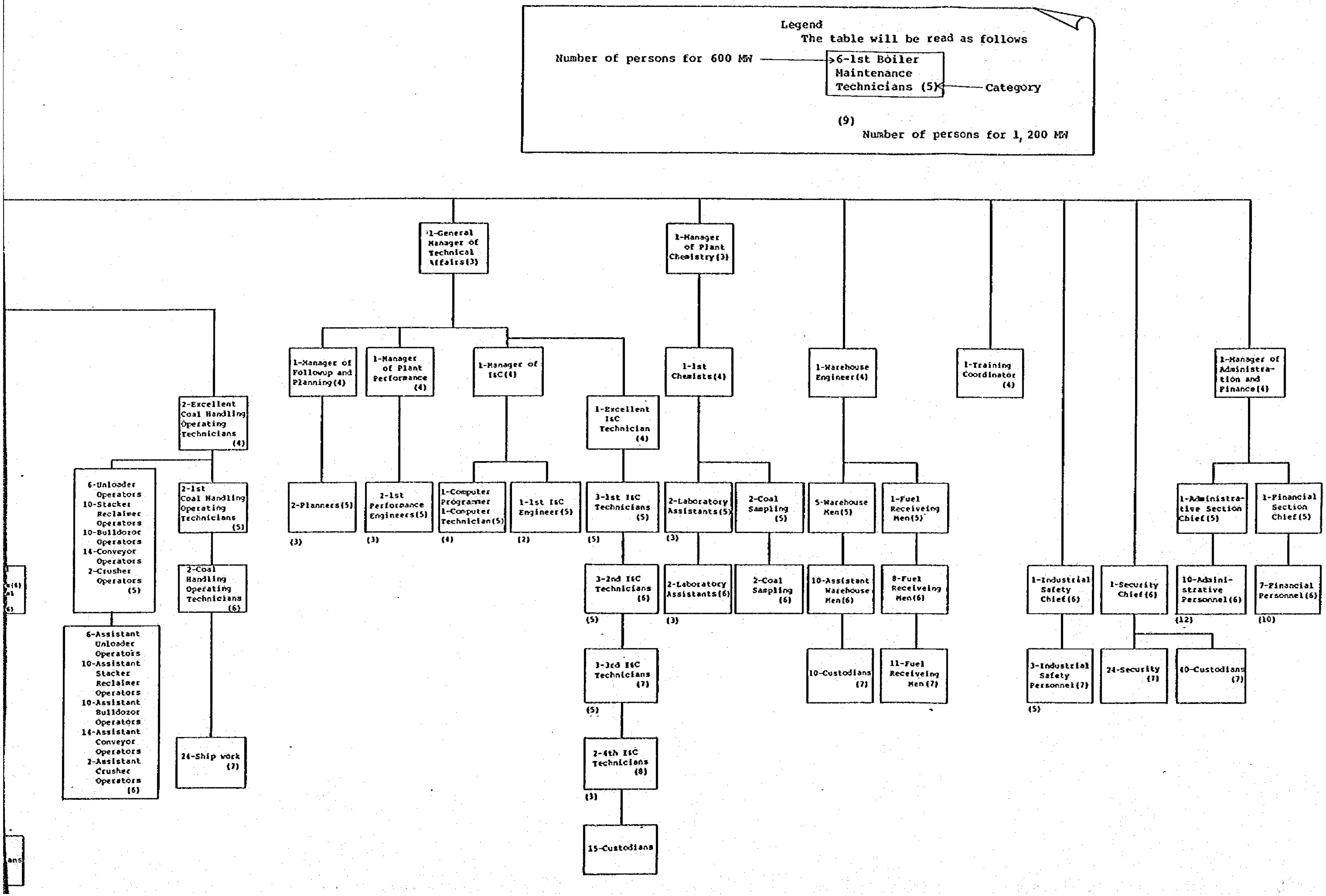
Fig. 5-13 TABLE OF ORGANIZATION



AI COAL-FIRED THERMAL POWER STATION

5-13 TABLE OF ORGANIZATION




Legend
The table will be read as follows
Number of persons for 600 MW
6-1st Boiler Maintenance Technicians (5)
Category
(9)
Number of persons for 1,200 MW
1-General Manager of Technical Affairs(3)
1-Manager of Plant Chemistry(3)
1-Manager of Followup and Planning(4)
1-Manager of Plant Performance (4)
1-Manager of I&C(4)
1-Excellent I&C Technician (4)
1-1st Chemists(4)
1-Warehouse Engineer(4)
1-Training Coordinator (4)
1-Manager of Administration and Finance(4)
2-Excellent Coal Handling Operating Technicians (4)
6-Unloader Operators 10-Stacker Reclaimer Operators 10-Bulldozer Operators 14-Conveyor Operators 2-Crusher Operators (5)
2-1st Coal Handling Operating Technicians (5)
2-Planners(5)
(3)
2-1st Performance Engineers(5)
(3)
1-Computer Programmer 1-Computer Technician(5)
(4)
1-1st I&C Engineer(5)
(2)
3-1st I&C Technicians (5)
(5)
2-Laboratory Assistants(5)
(3)
2-Coal Sampling (5)
5-Warehouse Men(5)
1-Fuel Receiving Men(5)
1-Administrative Section Chief(5)
1-Financial Section Chief(5)
2-Coal Handling Operating Technicians (6)
3-2nd I&C Technicians (6)
(5)
2-Laboratory Assistants(6)
(3)
2-Coal Sampling (6)
10-Assistant Warehouse Men(6)
8-Fuel Receiving Men(6)
1-Industrial Safety Chief(6)
1-Security Chief(6)
10-Administrative Personnel(6)
(12)
7-Financial Personnel(6)
(10)
6-Assistant Unloader Operators 10-Assistant Stacker Reclaimer Operators 10-Assistant Bulldozer Operators 14-Assistant Conveyor Operators 2-Assistant Crusher Operators (6)
3-3rd I&C Technicians (7)
(5)
10-Custodians (7)
11-Fuel Receiving Men (7)
3-Industrial Safety Personnel(7)
(5)
24-Security (7)
40-Custodians (7)
24-Ship work (7)
2-4th I&C Technicians (8)
(3)
15-Custodians

b. Training System and Program

In thermal power plants, the latest industrial technology in electrical, electronic, mechanical, chemical, control sectors has been applied. Furthermore, the technology innovation in these fields has been increasingly remarkable and progressive.

Engineers and technicians engaged in public utility company whose important purpose is stable supply of electricity are required to have extensive knowledge and excellent technics. Therefore, for achievement of the above purposes, not only the short-term training program like training operation and maintenance, but also the long-term training program in planning, design and engineering should be included in the program. In addition, training materials and facilities, and textbooks for the said purposes should be prepared before hand.

a) Training system

Training system will be classified into the following three sub-systems;

i. Training of newcomers

ii. Training in fundamentals, and

iii. Training in speciality.

In the training of newcomers, knowledge about the outline of thermal power plant and orientation will be given to the trainees, and in addition, training in power plant operation will be conducted on OJT (On the Job Training) base existing thermal power plants.
In the training in fundamentals after the training of newcomers, the trainees will be assigned to respective sections such as maintenance section (electrical, instrument & control and mechanical subsections), operation section and technical affairs section and chemical section in thermal power plants, and study the fundamentals on thermal power plant engineering. Especially in chemical section, training will be conducted on OJT base in the Research Laboratory.
As described above, training in speciality for each sector will be conducted to the trainees with knowledge of maintenance and operation of thermal power plant. In this training, the latest technology on design and maintenance will be studied at the existing thermal power plants and manufacturers' works.
As one of training items in this training, operation technicals and operational remedies against critical power plant accident will be studied with the aid of the plant simulator. Training items with the aid of plant simulator will be roughly described as follows;

Training items by plant simulator

A. Unit start-up

(1) Cold start-up

(2) Warm start-up

(3) Hot start-up (very hot start-up)

B. Unit shutdown

(1) Shut-down for boiler banking

(2) Shut-down for forced cooling down

C. Normal operation

(1) Load up/down

(2) Operation at maximum/minimum load

D. Particular operation

(1) Half-side operation of condenser, draft system (forced draft fan and reduced draft fan)

(2) By-pass operation of feedwater heaters

E. Routine operation

(1) Switchgear of auxiliaries (Boiler feedwater pumps, mills, fuel oil pumps, fuel oil heaters, cooling water pumps, etc.)

(2) Steam-free test (Turbine main stop valves, reheat stop valve and intercept valves)

(3) Sootblower operation

F. Corrective measures against faults

(1) Boiler trip

(2) Burner light off

(3) One IDF trip

(4) One FDF trip

(5) Feedwater flow low

(6) Unstable combustion

(7) Boiler tube failure

(8) Turbine trip

(9) Fluctuation of feedwater heater drain level

(10) One condensate pump trip

(11) One cooling water pump trip

(12) Turbine bearing oil pressure drop

(13) Loss of auxiliary power supply

G. Operational methods of automatic controllers

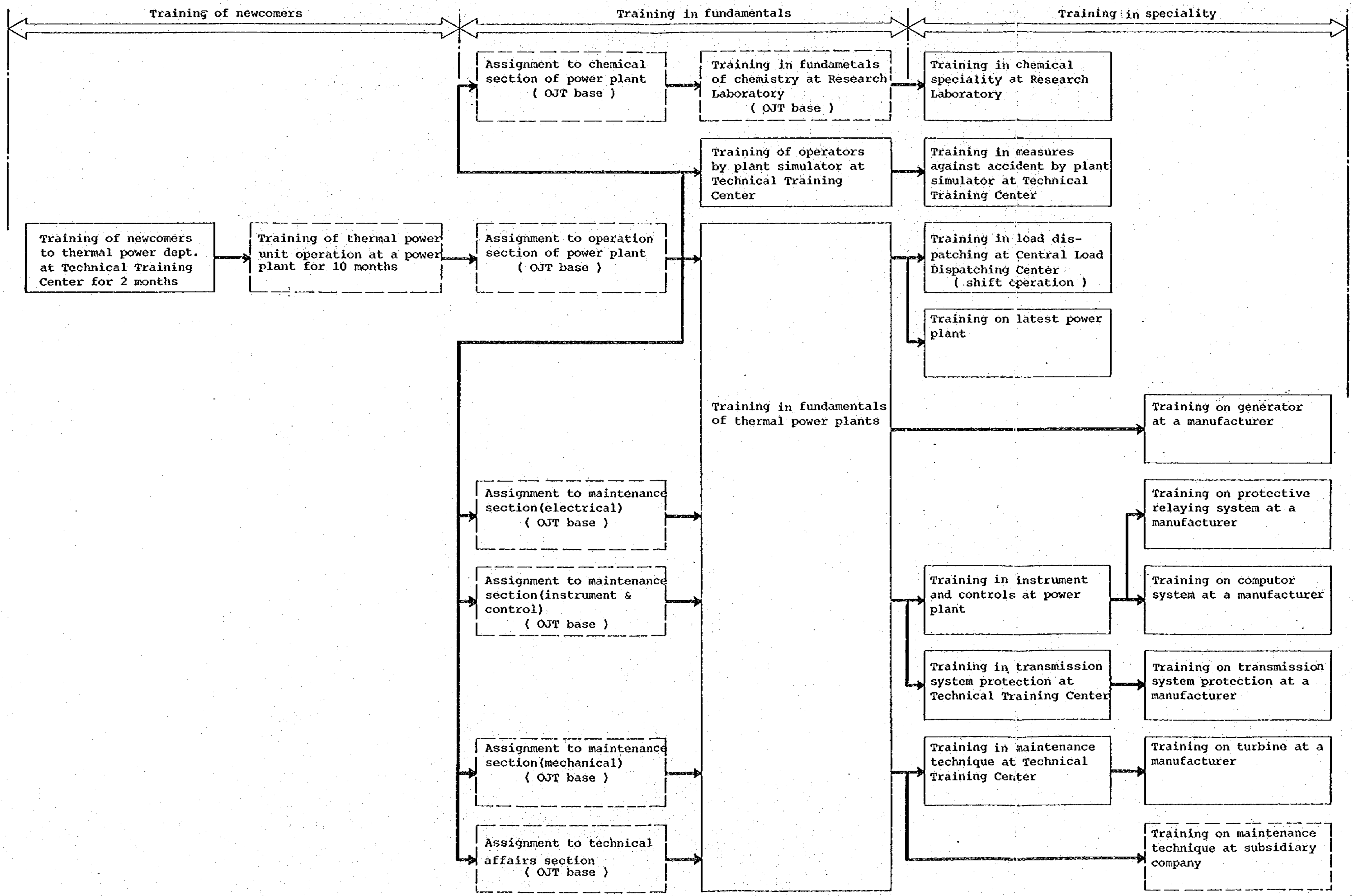
(1) Automatic boiler control
(Automatic plant control)

(2) Sequence controller

(3) Local controller

The system continuing from the training of newcomers to the training in speciality aforementioned is shown in Fig. 5-3.

Fig. 5-14 TRAINING SYSTEM OF THERMAL POWER PLANT PERSONNEL



b) Training Program of Thermal Power Plant Personnel

Based on the aforementioned training system, training coordinator will have full responsibility and leadership regarding the training program.

In the training conducted in the thermal power plants, the training of newcomers, the training in fundamentals and a part of the training on speciality will be included.

The participant trainees and training contents are described below. In general, the training program should be divided into two phases; one for newcomers, and the other for personnel with experience of more than 2 to 3 years for more satisfactory results of training.

1. Plant Operation Course

i) Participants

<u>Power Plant</u>

1st shift engineers

Shift chemists

Excellent operating technicians

1st operating technicians

Mechanical control room operators

Electrical control room operators

Mechanical hall operators

Electrical hall operators

Pump house operators

Fuel area operators

Assistant pump house operators

Assistant fuel area operators

Coal handling equipment

Excellent coal handling operaing technicians

1st coal handling operating technicians

Coal handling operaing technicians

Unloader operators

Stacker reclaimer operators

Buldozor operators

Conveyor operators

Crusher operators

Assistant unloader operators

Assistant stacker reclaimer operators

Assistant buldozor operators

Assistant conveyor operators

Assistant crusher operators

ii) Contents

Hot and cold unit start-up and shut down procedures, normal and abnormal operation, safe and unsafe conditions, alarms, troubles and remedies. Measures against serious troubles. Synchronization and generator, and transformer protective circuits, station service circuits. operation procedures for desalination plant. Operation procedures for desalination plant. Operation procedures for coal handling and unloading facilities.

ii. Water and Waste Water Treatment Course

i) Participants

Shift chemists

Shift laboratory assistants

Water treatment operators

Demineralizer operators

Assistant water treatment operators

Assistant demineralizer operators

ii) Contents

Plant water balance, flows and quality at different load. Coagulation and filteration equipment operation, chlorination equipment operation, waste water sources, treatment and disposal. Boiler feedwater internal treatment, steam and water analysis including water produced by desalination plant. Operation and trouble shooting. Water, steam and drain sampling. Operation of chemical injection system including bearing cooling water system and desalination plant.

iii. Mechanical Equipment Course

i) Participants

Excellent coal handling maintenance technicians

Excellent turbine maintenance technicians

Excellent boiler maintenance technicians

Excellent central shop technicians

Coal handling maintenance engineers

1st coal handling maintenance technicians

1st turbine maintenance engineers

1st turbine maintenance technicians

1st boiler maintenance engineers

1st boiler maintenance technicians

1st central shop technicians

2nd coal handling maintenance technicians

2nd turbine maintenance technicians

2nd boiler maintenance technicians

2nd central shop technicians

3rd coal handling maintenance technicians

3rd turbine maintenance technicians

3rd boiler maintenance technicians

3rd Central shop technicians

4th Coal handling maintenance technicians

4th turbine maintenance technicians

4th boiler maintenance technicians

4th Central shop technicians

ii) Contents

Construction of equipment and components, materials, method of assembling, parts list and details covering turbine and auxiliaries, boiler and auxiliaries, desalination plant, pumps, fans, compressors, piping and valves.

Normal maintenance requirements, general repairs, unusual repairs and need for outside repairs and transportation

iv. Electrical Equipment Course

i) Participants

Excellent electrical maintenance technicians

1st electrical maintenance engineers

1st electrical maintenance technicians

2nd electrical maintenance technicians

3rd electrical maintenance technicians

4th electrical maintenance technicians

ii) Contents

Construction of equipment and components, main and auxiliary systems, metering and protective equipment covering generator, exciter and auxiliaries including electrostatic precipitator, high and low voltage transformers and switchgears, and emergency power supply system (gas turbine generator), motor control centers, power centers and metal-clad switchgears. Lighting and communication system, control circuits and interlocks.

All equipment installed in the switching station within the power plant compounds.

v. Instrument & Control Course

i) Participants

Excellent instrument & control maintenance technicians

1st instrument & control maintenance engineers

1st instrument & control maintenance technicians

2nd instrument & control maintenance technicians

3rd instrument & control maintenance technicians

4th instrument & control maintenance technicians

ii) Contents

Major and minor control loops and components.

Primary measuring elements, transmitters, transducers, controllers, amplifiers, function generators, etc.

Design, construction, adjustment, calibration, sensitivity maintenance and trouble shooting.

Design, system construction, maintenance, trouble shooting and components of data logging computer including output-input typewriter, cathode ray tube (CRT) display, trend recorder, computer auxiliary panel and computer alarm system.

vi. Technical Affairs Course

i) Participants

1st excellent instrument & control technicians

Planners

Performance engineers

Computer programmers

Computer technicians

1st instrument & control technicians

2nd instrument & control technicians

3rd instrument & control technicians

4th instrument & control technicians

ii) Contents

Planning and methods of performance tests and judgement of the test results, judgement of operating results, statistical data on the power plant, confirmation of conditions of operation and maintenance. Regulations applied to power generation sector. Improvement planning of power plant efficiency, scheduling of unit shutdown and unit start-up for periodic overhaul and repair.

Environmental countermeasures (noise, air pollution, vibration, hot water discharge, etc.)

c. Maintenance

a) Overhaul

i. Necessity of overhaul

Equipment of high reliability and performance must be selected and installed for the thermal power plant equipment of which the continuous operation under severe conditions of high temperature and high pressure is required.

And yet the equipment cannot be free from deterioration of capability and performance under the severe conditions.

Overhauls of equipment for recovery of performance and preventive inspection and maintenance are the prerequisite for the stable supply of electric power.

ii. Classification of overhauls

Overhauls of power plant equipment are classified as follows.

i) Periodical inspection and maintenance

Inspection and maintenance made periodically based on recommendations by equipment manufacturers and requirements of the national laws.

ii) Routine inspection and maintenance

Inspection and small repairs carried out daily or weekly according to the rules within the electric power company.

iii) Scheduled inspection and maintenance

Inspection and maintenance made periodically according to the operating hours and operating conditions, based on the rules within the electric power company.

iv) Inspection and repair at the time of failure

Inspection and repair works for recovery of foundation and performance of the equipment, in case of failure or sudden decline in the performance.

iii. Timing of periodical inspection and maintenance

The periodical inspection and maintenance is divided into

Regular inspection

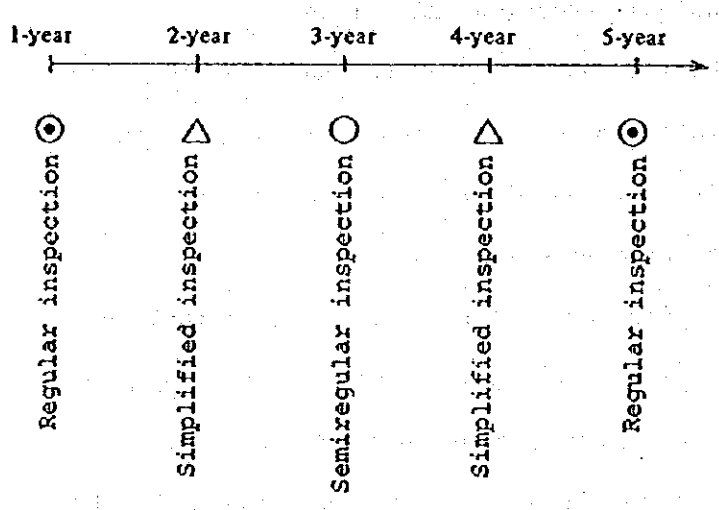
Semi-regular inspection

and Simplified inspection

And are carried out on the following schedule.

<u>OUTLINE OF INSPECTION CLASSIFICATION</u>

Inspection Classification	Inspection Frequency	Major Different Points
Regular inspection	Once every four years	1. For turbine, open the upper casing and remove rotor to inspect. 2. For boiler, remove drum internals and totally disassemble and inspect all safety valves.
Semiregular inspection	Once every four years	1. For turbine, open the upper casing and inspect rotor on the turbine base. 2. For boiler, remove drum internals and totally disassemble and inspect all safety valves.
Simplified inspection	Once every two years	1. Not open turbine. 2. For boiler, remove some of drum internals for inspection. Not disassemble safety valve.



INSPECTION CLASSIFICATION AND CYCLES

b) Central

i. Policy of use of maintenance machines and tools

Various maintenance machines and tools are needed for the overhaul works described in a). These maintenance tools are prepared as the standard accessories to the equipment, but machine tools and related facilities are necessary for working of metallic materials.

The fabrication works needing machine tools and related facilities can be done by either of the following alternatives.

- At the existing machine shop in the vicinity
- At own machine shop in the power plant
- Combination of above

In this Project, in view of the fact that the power plant site is for away form cities (approx. 25km from Suez City), the machine shop capable of working the bowls and rollers of the coal pulverizer, smaller pumps and smaller valves, will be installed in the power plant.

And larger fans and pump and larger valves will be worked in existing machine shops in Suez City.

The maintenance works will be carried out by the combined use of the above two methods.

ii. Machine shop in the power plant

The machine shop in the power plant will be equipped with the machine tools and related facilities (welding shop, carpentry shop, casting shop) that can handle an order of bowls and rollers of coal pulverizers and smaller valves.

The outline of the equipment and layout are shown on the following list and diagram.

i) Machine tools

	Item	Q'ty	Specification		
(1)	Heavy duty lathe	1	a.	Swing over bed	900mm
			b.	Height of center	455mm
			c.	Distance between center	2,000mm
			d.	Range of spindle speed	0-420mm
(2)	Medium duty lathe	1	a.	Swing over bed	650mm
			b.	Height of center	330mm
			c.	Distance between center	1,000mm
			d.	Range of spindle speed	24-1,070rpm

(3)	Light duty (usable as precision type)	1	a. Swing over bed 360mm b. Height of center 185mm c. Distance between center 550mm d. Range of spindle speed 83-1,800rpm
(4)	Shaping machine	1	a. Maximum stroke 550mm b. Number of stroke per minute (6 steps) 18-102 c. Maximum shaping width 600mm
(5)	Radial arm drilling machine	1	a. Distance from colum surface to spindle center 300-1,300mm b. Drilling and topping capacity 50mmø c. Distance from spindle nose to bed surface 380-1,290mm d. Spindle speed 12 steps (40-1,800rpm)
(6)	Pillar drill	1	a. Swing 650mm b. Drilling capacity 50mm c. Table diameter 510mmø d. Spindle speed 9 steps (75-1,525rpm)
(7)	Medium duty pedestal grinder	1	a. Wheel size 200mm(dia.) x25mm(thick) b. Full load speed 1,800rpm
(8)	Heavy duty pedestal grinder	1	a. Wheel size 300mm(dia) b. Full load speed 1,800rpm. c. Accessories 1 set
(9)	Drill grinder	1	a. Drill diameter 5-50 mmø b. Grinding Wheel Outside dimension 200mmøx40mm Inside dimension 110mmøx20mm c. Grinder inside diameter 40mmø
(10)	Universal tool and cutter grinder	1	a. Table size 740mm(L)x165mm(W) b. Table traveling length (longitudinal) 400mm c. Wheel traveling length (cross) 220mm d. Wheel elevating 240mm e. Horizontal swiveling angle of wheel head 360° f. Vertical swivling angle of wheel head 360° g. Table swiveling angle ±10° h. Center height 130mm

(11)	Power hacksaw	1	a.	Maximum cutting range Round 100mmø Square 150mm x 150mm
			b.	Angle of oblique cutting 45°, 100mm
(12)	Bandsawing machine	1	a.	Maximum cutting range Round 300mmø Square 300mm x 300mm
			b.	Blade dimension Length 3,700mm Width 25mm Thick 1mm
(13)	Universal milling machine	1	a.	Table max. stroke Longitudinal 900mm Cross 300mm Vertical 400mm
			b.	Table working surface 1,370mm x 310mm
			c.	Spindle range 40-1,750rpm
(14)	Lever-type shearing machine	1	a.	Cutting capacity Steel plate 4.0mm Round bar 12.0mmø Flat bar 8 x 70 mm b. Blade 250mm
(15)	Pipe bender	1	a.	Bending capacity Steel rod 65mmø Pipe 114.3mmø(4B)
			b.	Operation Hydro-electric
(16)	Thread cutting machine	1	a.	Type Portable, motor drive
		1	b.	Pipe threading and cutting capacity Pipe 12-100mmø Nipple 12-100mmø Bolt 6- 40mmø
(17)	Marking out table and benches	2	a.	Size Marking out table W 900 x L 1,200 x D 125 Benches W 750 x L 2,000

ii) Forging and Casting Equipment

(1)	Forge		A small workshop forge will be installed. The bed will be not less than 1.0 m x 1.5m and will be suitable for burning coke or charcol. The forge will be fired by bottled gas. A hood will be fixed over the forge and fumes will be expelled by ductwork through the workshop wall. A draught fan and motor will be provided and will be fully tropicalised. The forge table will be fitted with two 150 mm vices, one of which will be a "leg" vice.
(2)	Oven	1	An electric oven capable of being heated 300°C up to 1,000°C will be installed for the heat treatment of small components and drying of motor widings. Size W 1,200 x L 2,000 x H 1,200
(3)	Cupola Furnace with Blower	1	a. Capacity 100kg/hr
(4)	Hydraulic press	1	a. Capacity 30 ton b. Piston stroke 200mm

iii) Welding Equipment

(1)	Electric arc welding sets	10	a. Type AC 220 or AC 460 b. Welding cable 50m
(2)	Combined gas cutting and welding sets	10	a. Cutting capacity (mild steel) up to 10mm b. Welding Capacity (mild steel) up to 50mm

iv) Wood Working Machine

(1)	Lathe	1	a. Swing over bed 200mm b. Height of Center 150mm c. Distance between center 1,000mm d. Range of spindle speed 1,800-7,000rpm
(2)	Planing machine	1	a. Cutting size width 450mm thickness 250mm b. Feed Speed 8m/12m/min c. Speed of Cutter 5,000rpm

(3)	Circular Sawing Machine	1	a. Size of Circular saw:	405mm
			b. Speed of Circular Saw	3,700/2,300rpm
			c. Size of table	810 x 650mm
(4)	Bandsaw machine	1	a. Cutting size	
			Width	600mm
			Height	300mm
			b. Speed of wheel	700rpm
(5)	Hollow Chisel Mortiser	1	a. Size of chisel	4.7 - 25.4mm
			b. Size of Table	175 x 500mm
			c. Speed	3,380rpm
(6)	Fret sawing machine	1	a. Cutting size	
			Width	1,000mm
			Thickness	45mm
			b. Stroke	30mm
(7)	Universal sander	1	a. Size of sandpaper	180mm x 2,000mm
			b. Speed of sandpaper	1,100m/min

v) Machine Shop Equipment

(1)	Medium duty forklift	1	a. Max. lifting capacity	2,000kg
			b. Min. angle road width	1,920mm
			c. Size	
			Height	2,050mm
			Width	1,150mm
			d. Max. lifting height	4,050mm
(2)	Air Compressor	1	a. Pressure	7kg/cm²g
			b. Capacity	35m³/min
(3)	Machine shop overhead motor driven hoist pendant operated	1	Lifting capacity	5 ton
(4)	Tool rack	1	Made by wood and steel	
(5)	Carts	2	Transporting Capacity	2 ton
(6)	Oil separator pond	1	Made by Reinforced Concrete	

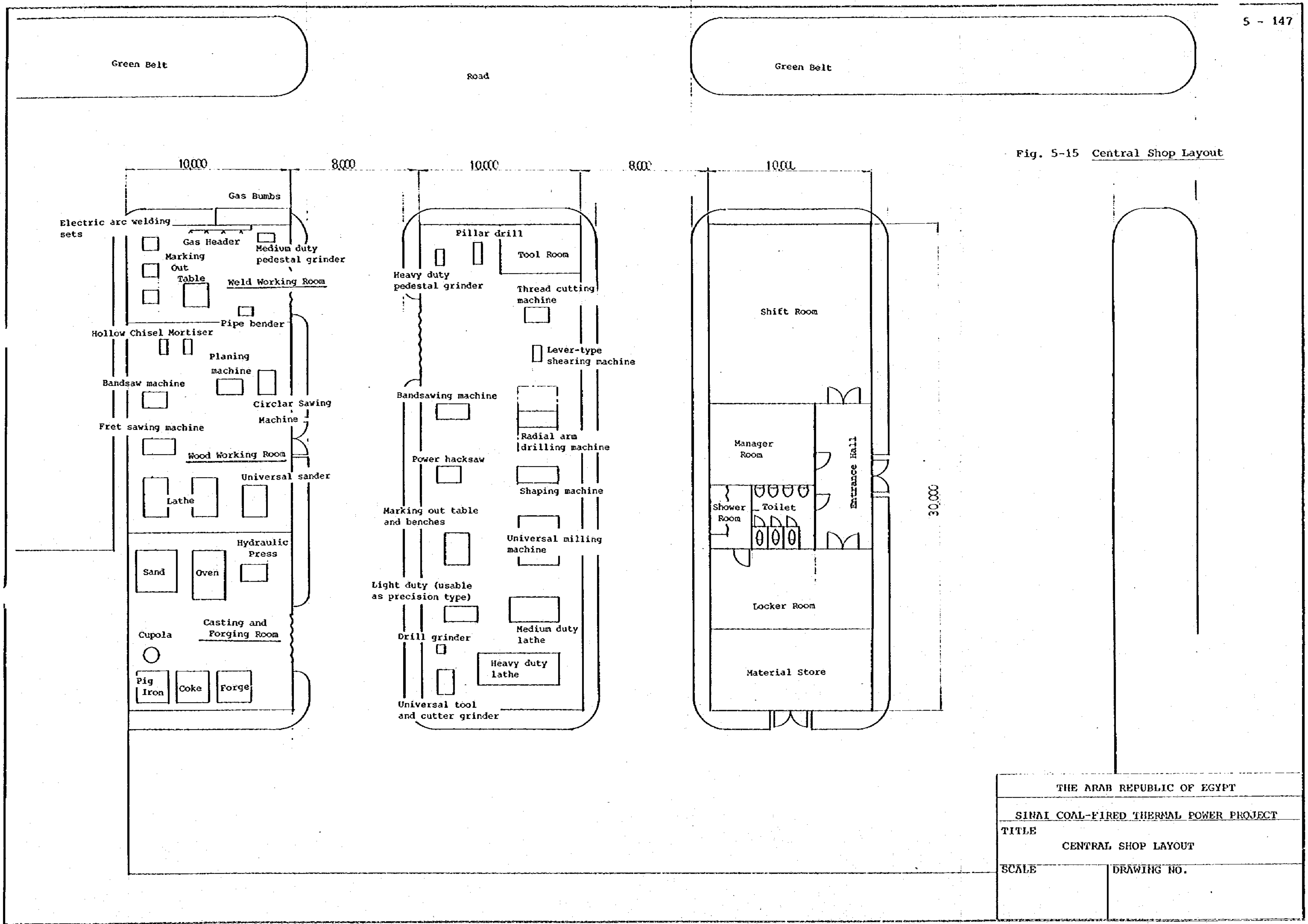


Fig. 5-15 Central Shop Layout

d. Chemical Administration

Chemical technology plays a very important role in the steam power plant for the maintenance of stable operation of the plant.

The chemical technology to handle the chemical troubles that occur in the water-steam system of the thermal power plant has been established, and it is of utmost importance that this established technique is followed strictly.

Water treatment is divided into the primary treatment or the treatment of the raw water to be fed for the boiler water and auxiliary equipment cooling water for removal of suspended matters and dissolved matters, the secondary treatment or the adjustment of quality of water in the water-steam circulating system through the boiler and turbine, the anti-corrosion treatment of the equipment during shut-down, and the chemical cleaning to remove harmful foreign matters in the equipment after construction or during operation.

For the primary and the secondary treatment, the water quality control standards appropriate for individual units are prepared, and the water quality is checked by the routine water analysis and chemical supervisory instruments, and the results of treatment is evaluated by the water quality records and operation records and inspection and analysis of samples at the time of overhaul.

For successful water treatment, the chemists at the power plant should see that the water treating plant and related equipment are operating properly, that the supervisory chemical instruments are working correctly and the water quality in each system is maintained within the standard values, by periodical sampling and tests.

In case of emergency or abnormal occasion, necessary actions should be taken promptly and precisely.

And for strict enforcement of the above procedures, a precise water treatment manual should be prepared, with which not only the chemical engineers but also the operators, maintenance and control and instrument engineers could be educated and enlightened and cooperate in the chemical attention for the power plant. If necessary, a joint meeting of engineers of the power plant will be held where the status of water treatment will be reported and pending problems and countermeasures will be discussed.

And a chemical center will be established mainly for the guidance of the power plant chemists and engineers, and for other surveys, researches and testing. This organization should have the authority to guide directly the power plant engineers in the chemical field.

If the chemical center becomes a mere research center or a third party-like technical laboratory, it would be a failure.

The main points of chemical administration are itemized in the following.

a) Water quality control

The damages done by poor chemical control at the thermal power plant is classified into the chronic deterioration of the boiler due to poor daily control of boiler feedwater and the acute deterioration of the boiler and turbine system due to improper chemical treatment at the abnormal time such as the unit start-up and shut-down or condenser tube leak.

Therefore, in the water quality control, the limit values for water quality, standard for unit start-up, equipment preservation standard and standard of treatments for abnormal situation, should be established and efforts should be made to maintain the water quality always within the limit values.

i. Water quality limit values

Limit values are established for pH, iron, silica, O_2, hydrazine and such important items.

ii. Water treatment standard at unit start-up

For unit start-up, the limit values should be established for each step and the normal water quality should be recovered quickly by observing the limit values.

iii. Standard for preservation for shut-down period

During the unit shut-down period, efforts should be made to prevent corrosion by such methods as sealing with steam or nitrogen, filling the boiler and feedwater heaters with water added with hydrazine, or dry preservation.

The preservative treatment may differ with the units, but in principle, the standard for preservation should be established for the unit for the periods of shut-down, and the standard should be followed.

iv. Water treatment at abnormal time

When any abnormal condition of water quality is detected as in the case of condenser tube leak or in case of unit start-up after chemical washing, suitable remedy should be taken promptly and efforts should be made to find the cause of the abnormality and recover the water quality in the normal operating conditions.

Especially in case of condenser tube leak, the salts leaking into the system, as well as dissolved oxygen make the cause of serious troubles, and early detection of leakage by supervisory chemical instruments and location of leaky tubes and repair are most essential.

b) Water quality test

The quality of the boiler make-up water, boiler feedwater and boiler water is tested for confirmation of whether the water quality is within the limit values or satisfy the target values.

In case any abnormality is detected in the water quality, the operating conditions, mode of chemical injection, water quality supervisory instruments, etc. should be checked for determination of the cause of abnormality, and prompt action will be taken with the cooperation of the related departments.

c) Check sheet

The operating conditions of the equipment related with the chemical treatment and functioning of the continuous water quality supervisory instruments will be checked on the check sheet, and if any abnormality is detected, prompt action will be taken for the remedy.

d) Continuous water quality supervisory instruments

It is essential that the water quality be supervised continuously, and pH, conductivity, dissolved oxygen, silica, turbidity meters are installed at strategic points in the system, and abnormal water quality is detected and taken care of quickly.

e) Chemical cleaning of boilers in operation

At the time of periodical overhauls, some boiler tubes in the high heat load zone are cut and the annual changes of the quality and thickness of deposits on the inside of the tubes are checked. And based on the predetermined standard of the quality and thickness for chemical cleaning, the time of chemical cleaning of that particular boiler is determined.

The time of chemical cleaning should be made based on the overall judgment of the nature and composition of the deposits and the results, metalic test of the tube material.

If any phenomena, such as increase of pressure differential through the boiler circulating pump, in case of forced circulation boilers, are noticed during operation to indicate deposit in the boiler tubes, it would make a ground for consideration of chemical cleaning.

f) Duties of chemical division

Duties of the chemical division of the thermal power plant comprise the water quality control, fuel control, etc. as described in the following. The manning of chemists differ by the number and size of units, but generally 6 to 9.

Even when the chemists' regular work hours are in the day time, they will in principle attend the unit start and stop and unit troubles and take appropriate actions.

The duties of chemists cover the following.

i. Water quality control

Quality control by the results of water analyses and continuous water quality supervisory instruments.

ii. Fuel analysis

Analyses of received fuel and consumed fuel, analysis of ash, flue gas measurements and tests

iii. Budget

Preparation of budget for chemical services and control of the budget

iv. Lubricating oil control

v. Custody and control of spare parts and materials

vi. Business related with other departments

i) Direction on the operation of the seawater chlorination equipment

ii) Direction on the operation of the water treating equipment

iii) Direction on the boiler water quality adjustment, such as boiler water blow down

vi) Request for repair of the continuous water quality supervisory instruments, control equipment, etc.

g) Chemical Laboratory

The chemical laboratory of 100 - 150 m^2 is usually prepared on the ground floor of the service building, and is equipped with the tables for chemical analyses and various analysis and measuring instruments.

e. Industrial Safety

Industrial safety is one of the most important items in the operation of thermal power plants. Preventive measures against fire, oil leakage, human casualties, etc. and quick countermeasure to be taken in case of troubles should be considered seriously.

When planning the safety measures, the planner should define clearly the objects for which protection should be considered, such as the items to be especially protected from fire, hazardous materials, high pressure gases, etc., and set up a safety enforcing organization headed by a safety enforcing officer and prepare sufficient facilities and materials for the effective enforcement of the safety measures.

a) Hazards and facilities to be protected

The hazards to be considered and facilities to be protected in the power plant are as listed in the following.

Hazard	Facilities to be protected
Fire	Buildings (Powerhouse , service building, appurtenant buildings); heavy oil and light oil tanks; oil pump yard; heavy oil receiving yard; coal storage yard; burner area; main turbine and BFPT oil reservoirs; lube oil storage; transformers; emergency generating set, station service boiler
Oil leakage	Heavy oil and light oil tanks; oil pump yard; main turbine and BFPT oil reservoirs
Gas explosion	Hydrogen generator; main generator area
Chemical leakage	HCl, NaOH, NH_3 storage areas

b) Hazard fighting equipment and facilities to be prepared

i. Fire fighting equipment and materials

Facilities for early detection and quick extinguishing and prevention of spreading of fire will be installed.

Against ordinary fires of buildings, fire engines and fire hydrants will be installed, and against oil fire at oil tanks and others, air foam hydrants will be provided. The fire hydrants, fire detectors and fire alarms will be provided on individual facilities according to the necessity. Fire extinguishers, fire fighting clothes, oxygen cylinders will be provided at strategic locations, for initial fire fighting.

ii. Oil leakage prevention

As heavy oil and other oil leakage has serious impacts on the environment, the oil tanks will be encircled with oil dikes to prevent leaking oil from damaging the vicinity, and the oil tanks will be provided with the level gauge and high and low level alarms.

And the waste water pits, where leaking oil might be collected, will be equipped with the oil detector and the waste water will be discharged after oil removal in the oil separating pond.

The heavy oil unloading pier will be provided with the oil fences, and oil-absorbing materials and neutralizing agent.

iii. Gas explosion prevention

The H_2 gas generator will be equipped with the H_2 gas detector, and it will be emergency shutdown in case any abnormality is detected. And electrical devices in the H_2 gas related areas will be of the explosion-proof type.

iv. Chemicals leakage prevention

HCl and NaOH tanks will be provided with the retaining dikes around them and the tanks will be provided with the liquid level gauges. Rubber gloves, rubber boots and such protective tools and water washing facilities will be provided for the protection of the operators.

As described in the foregoing, necessary facilities and tools will be provided properly in accordance with the national laws to match the local conditions.

c) Industrial safety enforcing organization and safety enforcing officer

The power plant should organize the industrial safety enforcing organization headed by the power plant superintendent as the safety enforcing officer.

This organization will, at normal times, be engaged in the preventive measures and checking of readiness of the hazard fighting equipment and tools and also in the safety education and training of the personnel. In case any hazard is threatening, the organization will be put on an alert, and if hazard should occur, the members will lead the evacuation and be engaged in the rescue operation, as needed.

The safety reinforcing officer will supervise the general safety reinforcement in the power plant.

The power plant safety activities may be divided into the following items which will be handled by divisions of the organization.

i) Formulation of the safety rules and standards

ii) Checking and keeping ready of the hazard fighting equipment, tools and materials

iii) Patrol and checking by check sheets of hazardous points over the power plant ground

iv) Education and training of personnel in the handling of hazardous chemicals

v) Planning and conducting of hazard fighting training

vi) Planning and conducting of safety education

vii) Preparation of safe working procedures

Fig. 5-16 Industrial Safety Enforcing Organization

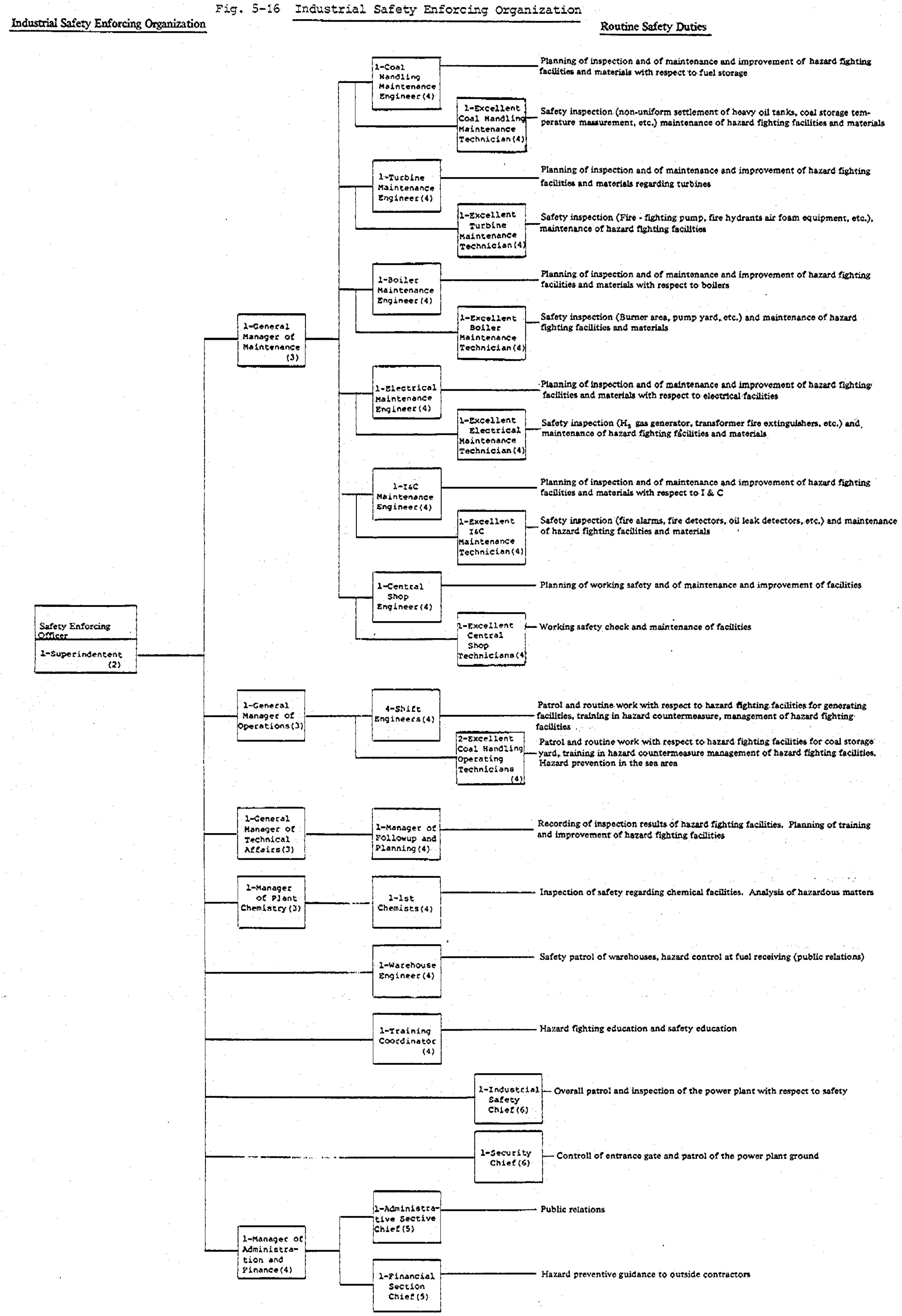
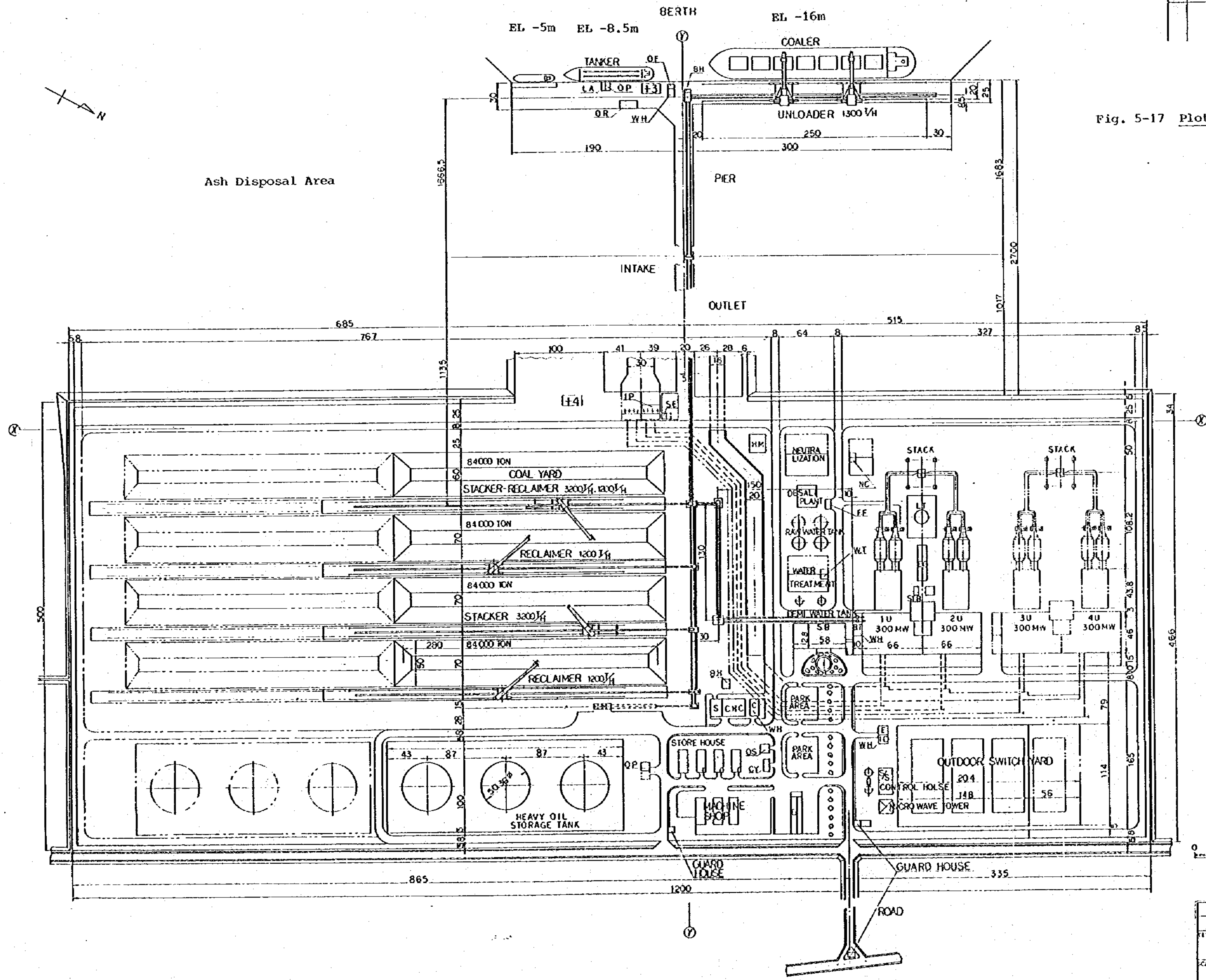


Fig. 5-17 Plot Plan (300 MW x 4U)



SYMBOL	EXPLANATION
HH	H_2 MANUFACTURE EQIPMENT
STB	STATION BOILER
SB	SERVICE BUILDING
OS	LUB.OIL STORAGE HOUSE
OR	OIL RECEIVING FACILITIES
LT	LIGHT OIL TANK
LA	LOADING ARM
IP	INTAKE PUMP HOUSE
G	GARAGE
EG	EMERGENCY GAS TARBINE
BH	BULLDOZER HOUSE
CHC	COAL HANDLING CONTROL HOUSE
CY.	CYLINDER HOUSE (N_2·CO_2·H_2)
F.F	FIRE FIGHTING PUMP HOUSE
OF	OIL FENCE HOUSE
OP	OIL PUMP HOUSE
NC	NEUTRALIZATATION CONTROL HOUSE
S	COAL DATA MAKING AND REDUCTION HOUSE
SE	SEA-WATER ELECTROLYSIS HOUSE
W.H	WOKERS HOUSE
W.T	WATER TREATMENT CONTROL HOUSE

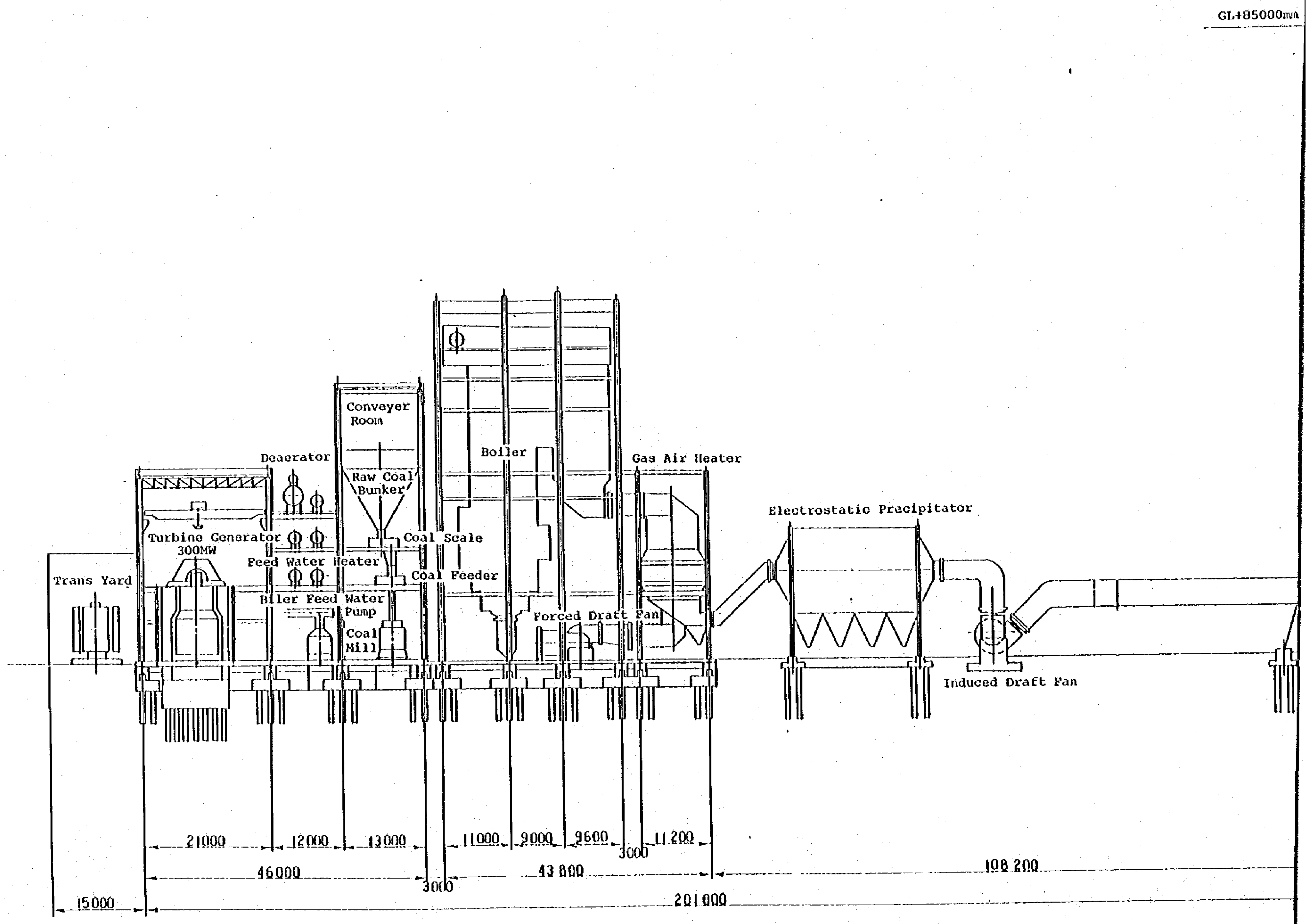
THE ARAB REPUBLIC OF EGYPT

SINAI COAL-FIRED THERMAL POWER PROJECT

TITLE: PLOT PLAN (300MW x 4U)

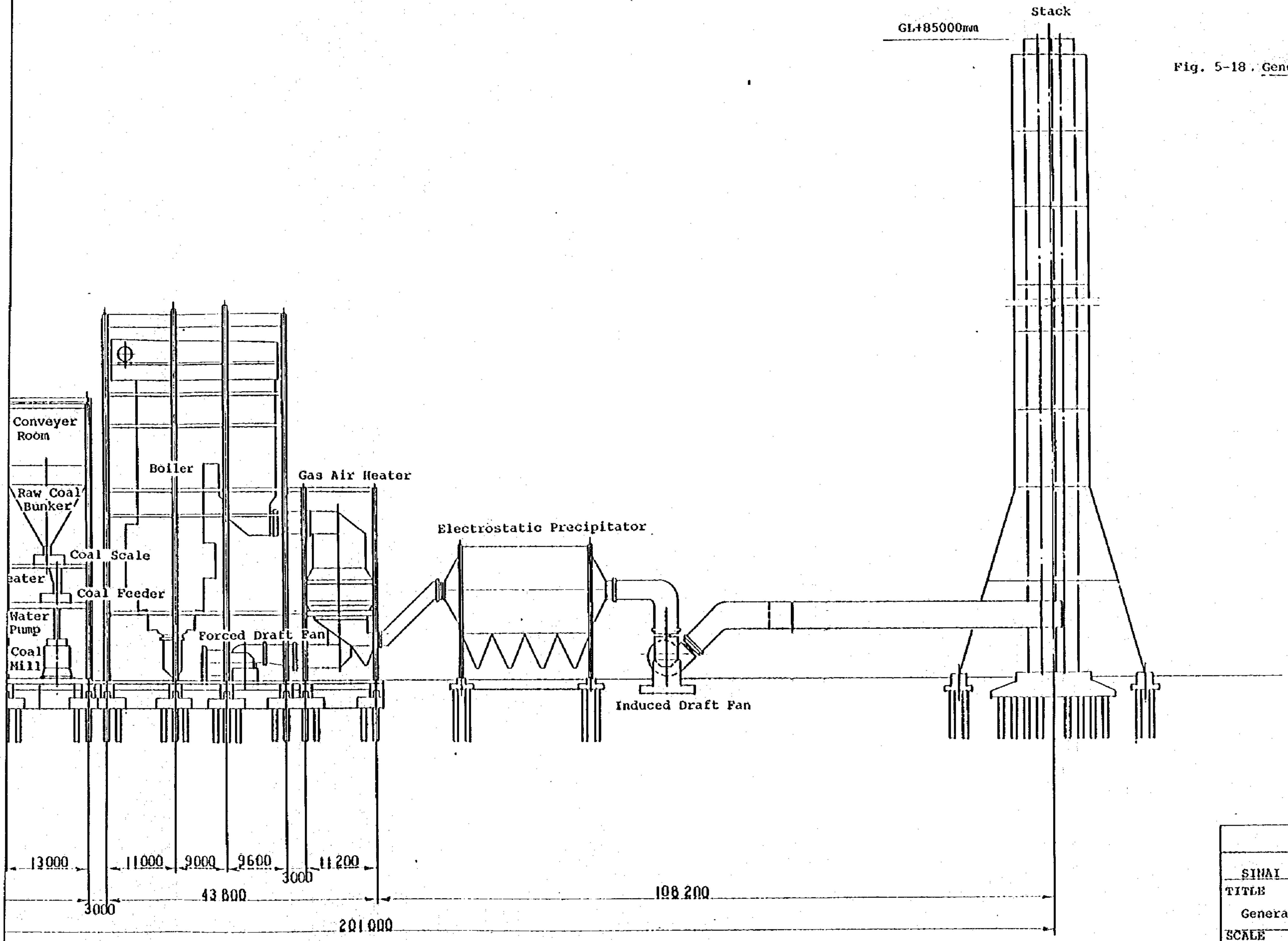
SCALE

DRAWING NO. P - 1

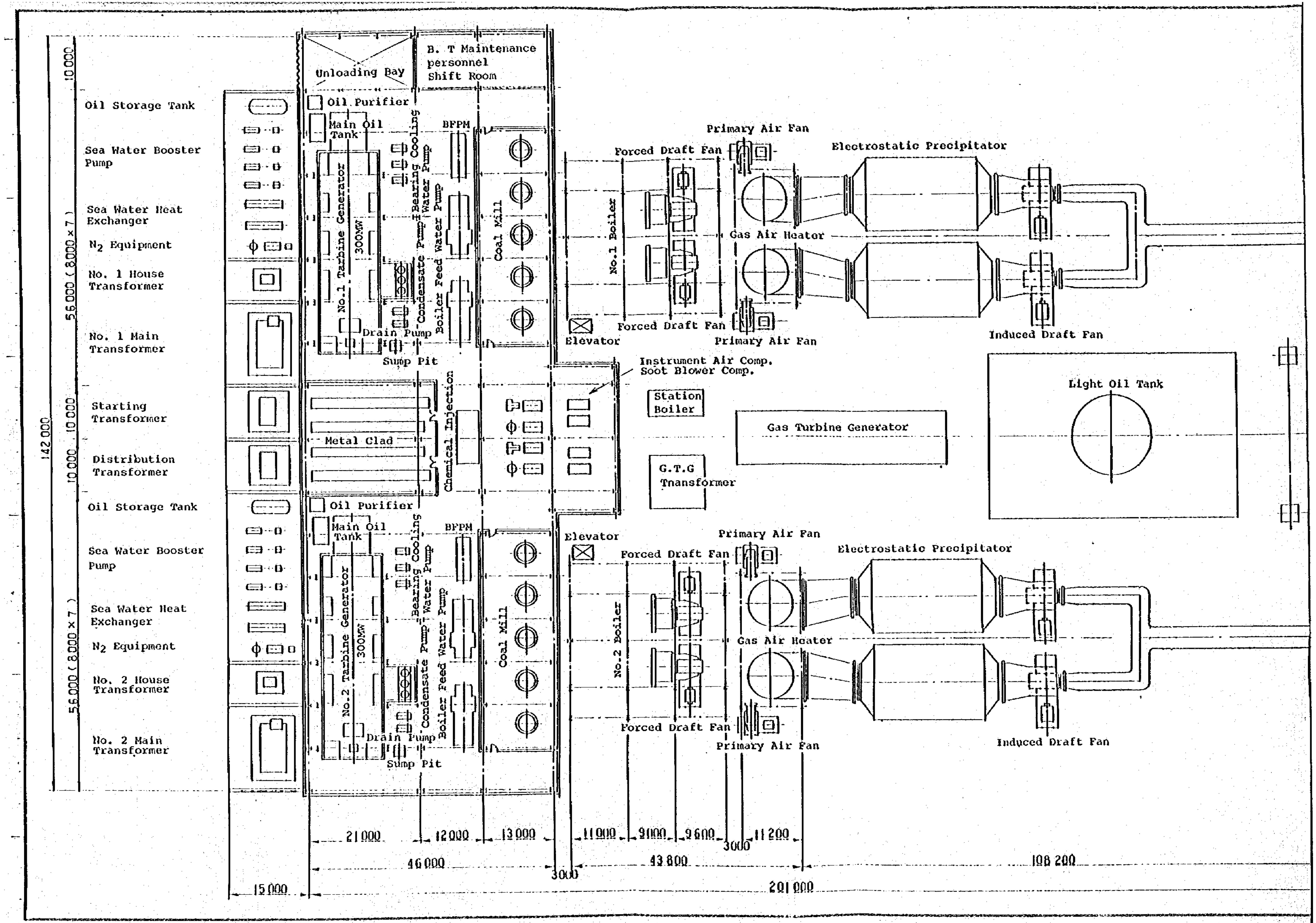


GL+85000mm
Conveyer Room
Boiler
Deaerator
Raw Coal Bunker
Gas Air Heater
Electrostatic Precipitator
Turbine Generator 300MW
Coal Scale
Feed Water Heater
Coal Feeder
Trans Yard
Biler Feed Water Pump
Forced Draft Fan
Coal Mill
Induced Draft Fan
21000
12000
13000
11000
9000
9600
11200
3000
46000
43800
108200
3000
15000
201000

Fig. 5-18 . General Arrangement Plant Side View

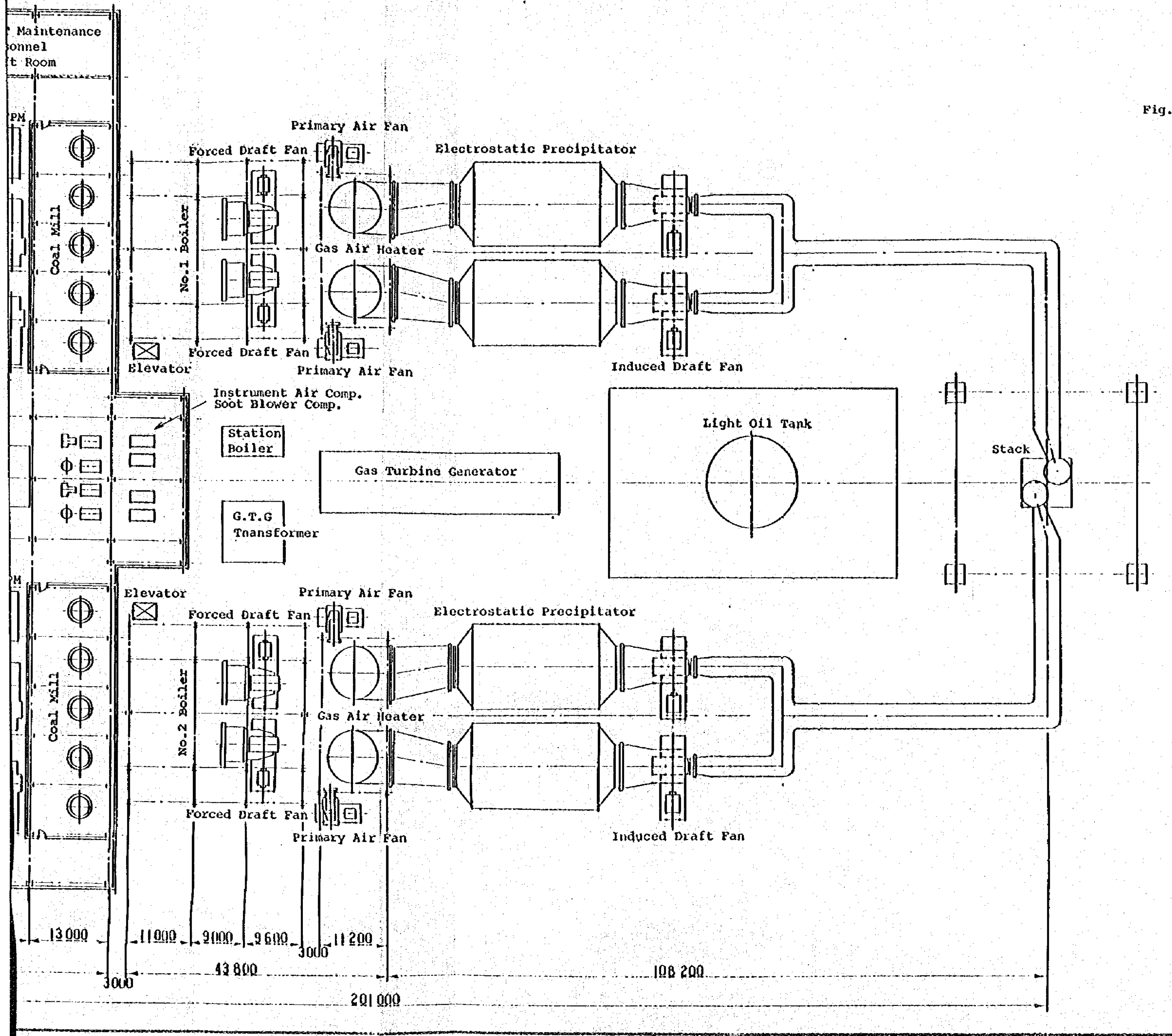


THE ARAB REPUBLIC OF EGYPT	
SINAI COAL-FIRED THERMAL POWER PROJECT	
TITLE General Arrangement Plant Side View	
SCALE 1/600	DRAWING NO. P - 2

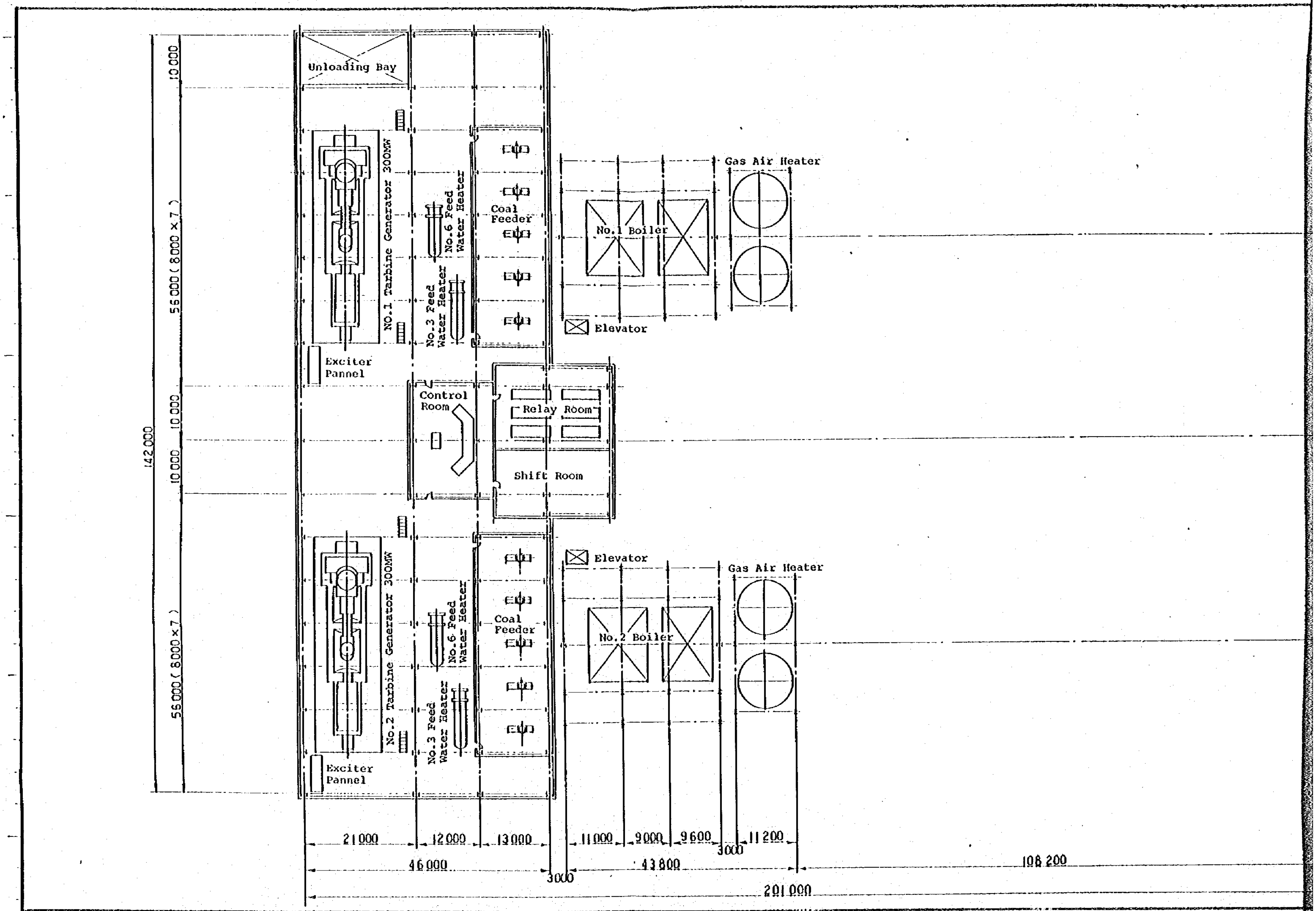


B. T Maintenance personnel Shift Room
Unloading Bay
Oil Storage Tank
Oil Purifier
Main Oil Tank
BFPM
Sea Water Booster Pump
No.1 Turbine Generator 300MW
Bearing Cooling Water Pump
Condensate Pump
Boiler Feed Water Pump
Coal Mill
Sea Water Heat Exchanger
N_2 Equipment
No. 1 House Transformer
No. 1 Main Transformer
Drain Pump
Sump Pit
Primary Air Fan
Forced Draft Fan
Electrostatic Precipitator
No.1 Boiler
Gas Air Heater
Elevator
Induced Draft Fan
Instrument Air Comp.
Soot Blower Comp.
Starting Transformer
Metal Clad
Chemical Injection
Station Boiler
Gas Turbine Generator
Light Oil Tank
Distribution Transformer
G.T.G Tnansformer
No.2 Turbine Generator 300MW
No.2 Boiler
No. 2 House Transformer
No. 2 Main Transformer
10 000
56 000 (8 000 × 7)
10 000
10 000
56 000 (8 000 × 7)
142 000
21 000
12 000
13 000
11 000
9 000
9 600
3000
11 200
46 000
3000
43 800
108 200
15 000
201 000

Fig. 5-19 General Arrangement Ground Floor

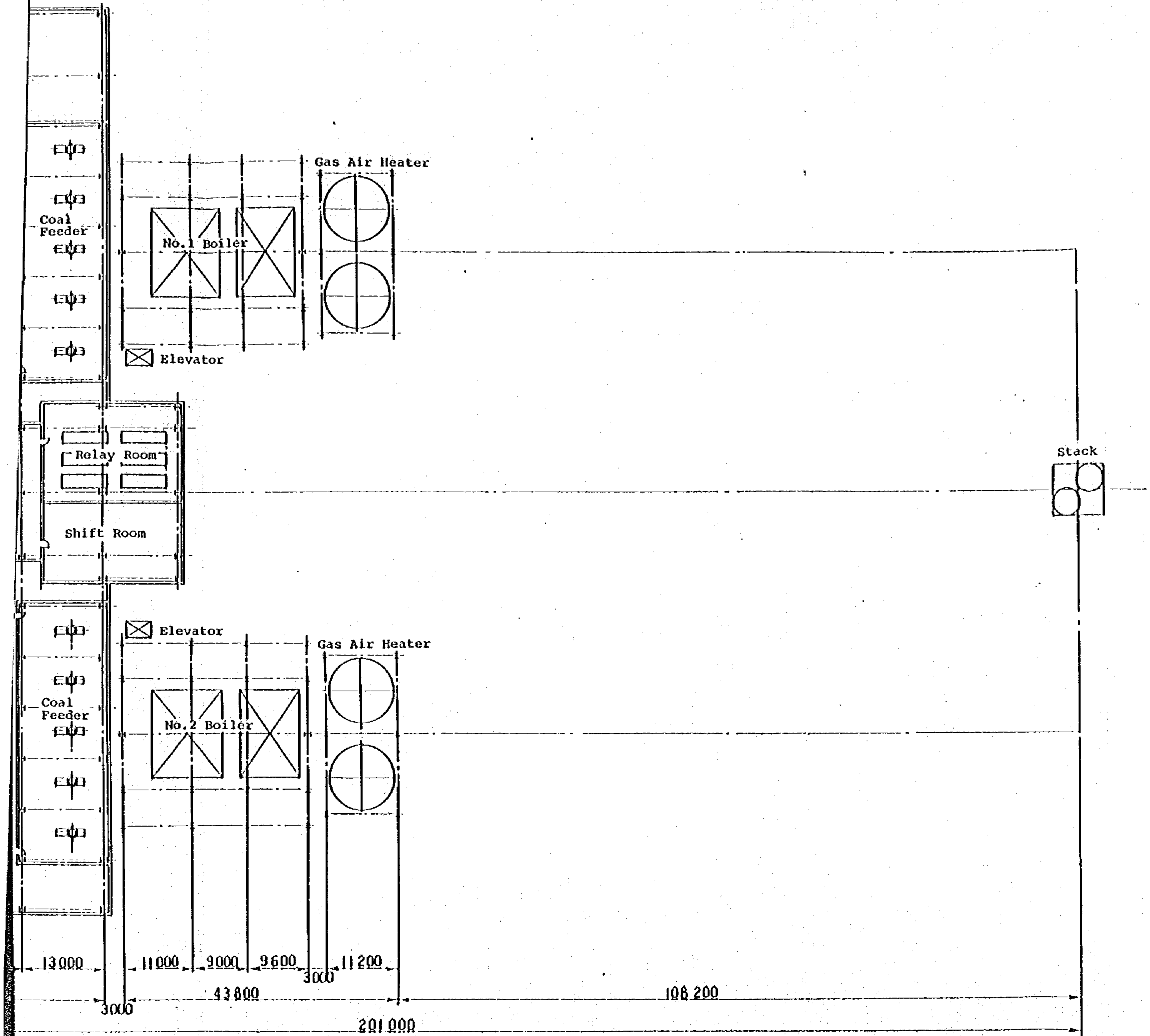


THE ARAB REPUBLIC OF EGYPT	
SINAI COAL-FIRED THERMAL POWER PROJECT	
TITLE General Arrangement Ground Floor	
SCALE 1/600	DRAWING NO. P - 3



Unloading Bay
No.1 Turbine Generator 300MW
No.6 Feed Water Heater
No.3 Feed Water Heater
Coal Feeder
No.1 Boiler
Gas Air Heater
Elevator
Exciter Pannel
Control Room
Relay Room
Shift Room
No.2 Turbine Generator 300MW
No.6 Feed Water Heater
No.3 Feed Water Heater
Coal Feeder
No.2 Boiler
Gas Air Heater
Elevator
Exciter Pannel
10 000
56 000 (8000 × 7)
10 000
10 000
56 000 (8000 × 7)
142 000
21 000
12 000
13 000
11 000
9000
9600
3000
11 200
46 000
3000
43 800
108 200
201 000

Fig. 5-20 General Arrangement Operating Floor



THE ARAB REPUBLIC OF EGYPT

SINAI COAL-FIRED THERMAL POWER PROJECT

TITLE

General Arrangement Operating Floor

SCALE 1/600

DRAWING NO. P - 4