6.8 Electricity

6.8.1 Electricity Characteristics

This plant is planned a mini-mill steel plant using direct reduction, electric arc furnace, continuous casting and bar & rod mill. Accordingly, electricity characteristics differ from the case of conventional BOF steelmaking process in the following points:

- ° Power consumption per ton of product is extremely large figure.
- ° For the large-capacity electric furnace operation, technical investigation on the flicker compensation is of great importance.

Apart from the above, following items require same study as in the case of general steelmaking plant:

- ° Large load fluctuation, particularly in the rolling shop.
- ° Sudden power supply stop affect security in each shop.

Table 6.8-1 below shows the electricity balance for Stage I of this plant. Unit power consumption, which was the basic data to obtain this table, was

calculated from example of electric arc furnace operation (reduced pellet used) and those of other similar plants.

Production capacity:	800,000 t/y
Power consumption of the plant as a whole:	870,000 MWH/y
Maximum power:	150,000 kW
Maximum capacity:	180,000 kVA

Above data clearly indicates that the planned plant has a large power consumption. Namely, approximately 700 kWH per ton of product is required for the operation of electric arc furnace proper, and this figure runs up to approximately 1,000 kWH or more for the plant as a whole. Because power consumption per ton of crude steel in general integrated BOF steel plant is approximated at 500 - 600 kWH, the level of power consumption of this plant becomes further conspicuous.

Besides, four electric arc furnaces are planned, each having the capacity of 70t, which far exceeds the existing largest record of 25 tons in Egypt. Consequently, the measure to compensate flicker, having been treated as a minor problem conventionally, should be emphasized: by proceeding with the

flicker forecasting as well as technical study of compensating unit in accordance with the general standard, undesirable influence on general users connected to the same network must be improved. As regards other characteristics, study must be made by analyzing the power supply conditions for this plant. For example, it is necessary to pay due consideration to the installation of emergency generator, transformer with on load tap changer, as well as the determination of specification for electrical equipment and control system to ensure satisfactory production and quality.

Furthermore, electricity characteristics requiring another investigation is the problems of relation with the power supply source. Except for the emergency case, this plant always should receive power from E.E.A. (Egyptian Electricity Authority). As this plant is considered to demand the largest power supply among existing steel plants in Egypt, following problems should be solved relating to the power supply:

- If E.E.A. has the capacity to ensure the stable and priority supply of required power.

° If the flicker compensating measure closely related to the power supply capacity is possible within the economically feasible range.

Solution to these problems is the essential prerequisite in starting this plant project. However, these are important problems of infra-structure concerned with this project. Accordingly, forward proceeding to solve them should be pushed on the specific program to promote this project.

ELECTRICITY BALANCE

JOB No.

DATE

		Unit Power Consump.	Product	Power Consump.	Operating Time	Average Power	Load Factor	Max. Demand	REMARKS
		KWH/pro.T	T/Y	MWH	H/Y	MW	%	MW	
	Material handling								
	DR plant	136	703,000	95,608	7,500	12.8	0.9	14.2	
	Melt shop EF	700	818,100	572,670	7,200	79.6	0.77	103.7	
	Continuous caster	20	769,000	15,380	7,920	2.0	0.8	2.5	
	Melt shop Aux.	20	818,100	16,362	7,200	2.3	0.5	4.5	
	Bar & Rod mill	125	732,000	91,500	5,000	18.3	0.7	26.2	
	Water treatment					1.8	0.8	2.2	
	Compressed air					0.42	0.8	0.5	
	Oxygen plant					0.98	0.8	1.2	
	Maintenance shop					0.16	0.2	0.8	
	Air pollution					1.7	0.8	2.2	
	Calcining plant					0.8	0.9	0.9	
	Others					2.5	0.5	5	
	Subtotal			791,520				163.9	
	Div. factor							1.1	
	Loss			79,150					
	Total			870,670		123.36		149	

Table 6.8-1 Electricity balance for stage - 1

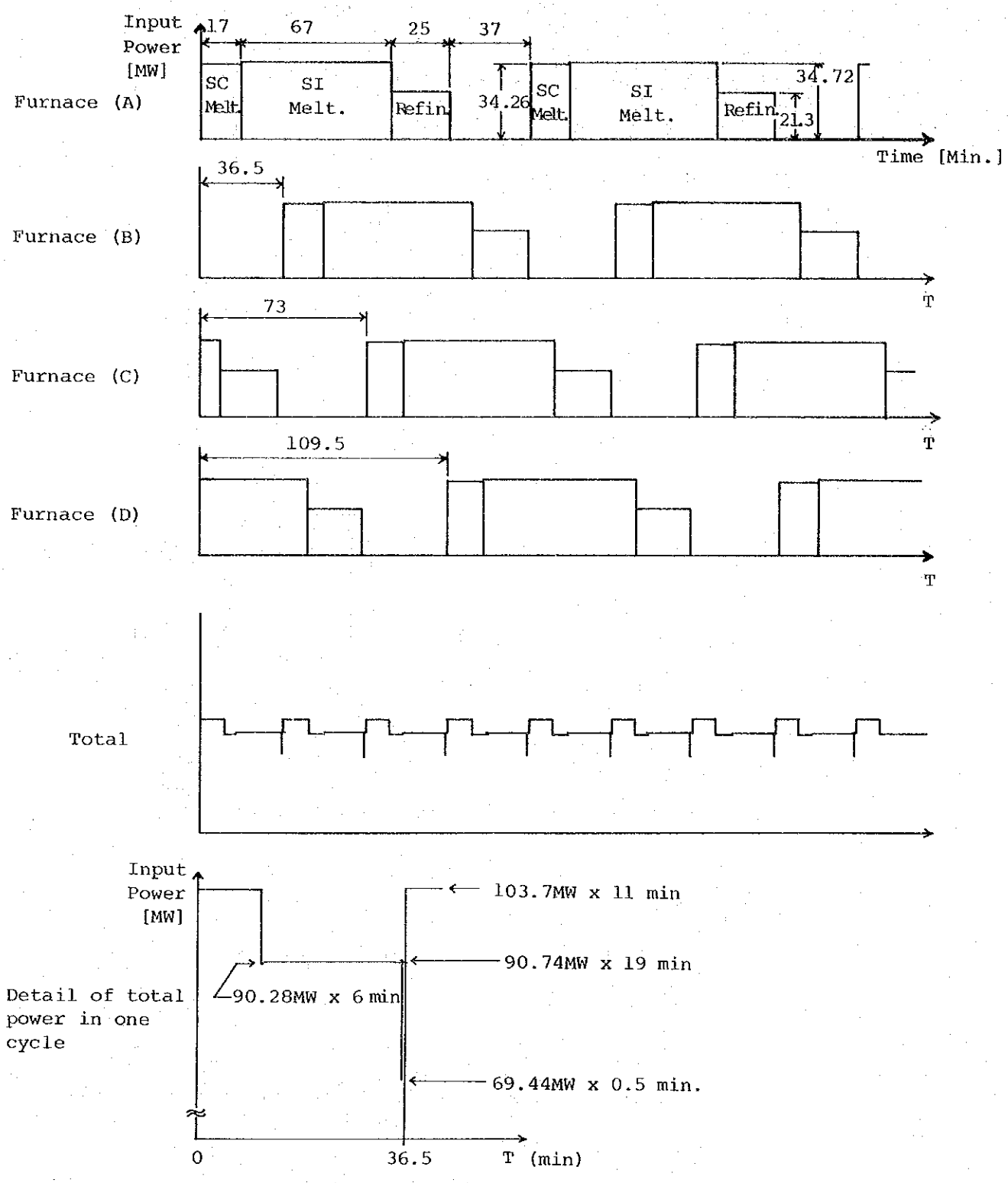

Fig. 6.8-1 Electric arc furnace power chart

6.8.2 Power Supply Condition

Power supply condition is described here using reference information made available to us and partial investigation in Egypt.

a. Generator output and available power in Egypt

According to the actual record in 1975, power output and available power in Egypt are as follows:

Actual generated output (1975)

Item / Type	Max. Output (MW)	Energy Generated (MWH)
Thermal power	1,560.8	3,006.9
Hydro power	2,445	6,790.3
Total	4,005.8	9,797.2

To estimate available power to this plant, above figures must be referred to the following conditions:

- ° Generating output fluctuation of Aswan High dam in summer and winter.
- ° Restriction due to capacity of main transmission line
- ° Output reduction due to periodic maintenance of generator
- ° Others (consumption by station, etc.)

Overall analysis of above conditions leads to the available power with a certain fluctuation range for this plant operation. At minimum condition, this should be considered approximately 50% of maximum generated output.

Consequently, power priority supply to this plant in dependence of existing generated output seems to be difficult. Rather, it should be recommended to depend on a newly planned power plant because the power requirement of this plant is extremely large and, under the current power consumption of Egypt, there seems to be little allowance to cover this large requirement.

b. Relationship with the power plant construction plan

Fortunately to say, Egyptian Ministry of Electricity is planning the new power plants in Alexandria area as follows:

Kafr el Dawar:	110 MW x 3 (1979-80)
Abu Kir:	150 MW x 4 (1981-83)

If these power plants are put into operation prior to the completion of this project, available power of 600 - 800 MW must be expectedly

assigned to this plant. This will enable the stabilized power supply and ensure successful countermeasure for the flicker problem occurring during the electric arc furnace operation. As a prerequisite for this project, it is desirable to bring the above described power plant project into operation previously.

As regards these new power plant, Abu Kir power plant is planned to utilize natural gas as well as in the case of this project, enabling an ideal combination of power supply source and steel plant. Namely, overlapped utilization of natural gas energy for the production of direct reduced pellet for the electricity power generation for this steel plant will prove highly efficient for this energy. Besides, it will enhance the meaning of steel plant project.

It appears that existing Egyptian steel plants have little problem with power supply because of their low power requirement. Actually, however, there seems to be several cases of some plants waiting for power. Also the actual operation of power plant and substation appears to have full load with little allowance, and

expansion program is reported to be gradually under way. From the aspect of overall relationship between the power output and the demand load, therefore, the power output growth will have to be accelerated more than the increase in demand load by newly installing the power plant, substation, and increasing the transmission line capacity.

Based on these viewpoints, promotion of the power generation project in Alexandria area is of critical importance for the stabilized power supply to this project.

c. Electric power system

According to the program of Egyptian Ministry of Electricity, El-Dikhila substation is under construction in the southwest side of this plant site on the basis of other reduced-iron plant project. This substation will receive 220 KV power via each two transmission lines from Ameria substation and Abu-Kir power plant.

This electric system forms a loop with 220 kV system of Delta district, and further is connected to Aswan High dam hydraulic power plant,

the largest in Egypt, by 500 kV transmission line via Cairo.

Accordingly, the electric system from El-Dikhila substation is to receive power from the most reliable system in Egypt, which is most favorable in achieving the priority power supply for this project.

In addition to aforementioned power plant construction, the transmission line construction work to El-Dikhila substation should also be completed prior to the start-up of this plant. For the internal arrangement plan of El-Dikhila substation, it is necessary from the viewpoint related to the power receiving method, to modify some of the plan promoted according to other reduced iron plant plan.

Refer to attached drawing.

DWG. No. JICA-6-8-03
220/66 kV Switchgear single line diagram for El-Dikhila substation

DWG. No. JICA-6-8-04
Location of El-Dikhila substation and transmission line

6.8.3 Power Receiving Method

It is optimum to receive power from E.E.A. via the above described El-Dikhila substation. For specific plan, Egyptian Ministry of Electricity will study and make final decision. Here the description below is based on JICA proposal.

Following three methods may be considered to receive power from El-Dikhila substation:

a. Feeding from 220 kV double bus

b. Feeding from 66 kV double bus

c. Feeding while changing voltage level for each shop

Ex. 220 kV feeding for electric arc furnace
66 kV feeding for others

On determining which to select, following factors require consideration:

° For the compensation of flicker, it is preferable to set the critical bus at higher voltage level to increase three-phase short-circuit capacity. Experimental result shows that flicker figure is in reverse proportion to the short-circuit capacity of power supply system. Accordingly, incoming voltage of 220 kV is most advantageous.

° Considering the maximum power required for this plant the future expansion program, 220 kV is better suited than 60 kV for the voltage level. If 66 kV level is selected, current capacity becomes too large and uneconomical.

° It is advisable to concentrate the dividing

point of power control responsibility between E.E.A. and this plant to one point. Namely, power receiving at two or more points will exert negative effect on the mutual power control.

Of the above three proposals, we would recommend a Proposal, which proposes power receiving at 220 kV. As an alternative to this, power transmission, not via El-Dikhila substation, but direct from 220 kV system of Ameria and Abu Kir to the receiving substation of this plant may be considered. However, this 220 kV system has extreme importance for the Egyptian power control, and thus, direct connection of the plant to E.E.A. power system is not recommendable.

As a conclusion, it is recommended to transmit power from El-Dikhila substation to this plant via 220 kV double line at Stage 1. Cable capacity must be more than max. 180 MVA for each cable.

Finally, concerning the utilization of 66 kV and 11 kV sides of El-Dikhila substation, Egyptian Ministry of Electricity will perform study. We would like to add here that these will prove useful for the peripheral equipment of this project, and in particular, as a power supply for the temporary construction work.

6.8.4 Flicker Compensating Measure

General description of flicker compensating measure and its relationship with the power supply condition will be given below. For the detail specification of flicker compensating unit, refer to Item, "Steelmaking Shop Equipment."

a. General description of flicker compensating unit

° Flicker caused by electric arc furnace

Flicker means the flickering of luminescent light accompanying the fluctuation of voltage. This is attributable to irregular change or fluctuation of current charged into the electric arc furnace, which is caused by the fluctuation of arc length during scrap melting, repeated shortcircuiting due to collapse of scrap around arc, etc.

When the flicker exceeds a given allowable limit, various troubles (interference to TV picture, flickering of luminescent light, etc.) are caused in the general users receiving power from the same electric power system. Therefore, technical study must be made to

decide if the flicker compensating unit is necessary or to determine its specification.

° Flicker compensating principle

Generally, with large electric arc furnace capacity and relatively low line capacity, large voltage fluctuation is caused, and the allowable flicker limit according to general standard is exceeded. Thus the flicker compensating unit becomes necessary.

As a general flicker compensating unit, the reactor control system using thyristor is recommended.

This system consists of compensating the voltage fluctuation caused by reactive power during electric arc furnace operation by means of capacitor parallel to reactor. This system also contributes to improve power factor. In addition, capacitor is incorporated parallelly to the reactor as a harmonic filter for harmonic current from the thyristor in this flicker compensating unit and electric arc furnace.

b. Relationship with the power receiving method

As is described in above 6.8.3, "Power Receiving Method," capacity of flicker compensating unit varies depending upon the power receiving method.

Economically, 220 kV power receiving method is advantageous. If the 66 kV receiving method is adopted and the critical bus is set at 220 kV and 66 kV voltage levels, capacity of the flicker compensating unit becomes increased and not desirable. In particular, for the power receiving at 66 kV and critical bus at 66 kV level, the capacity may be more than doubled compared with 220 kV receiving.

c. Flicker compensating unit

Flicker compensating unit configuration becomes as shown in Fig.6.8-2 on the basis of following presuppositions:

Presupposition

Short-circuit capacity - 2,500 MVA at 220 kV

Critical bus - 220 kV (Flicker control point)

Flicker figure to control - Voltage fluctuation during short-circuit in furnace to be 2%

Improved power factor - 0.9

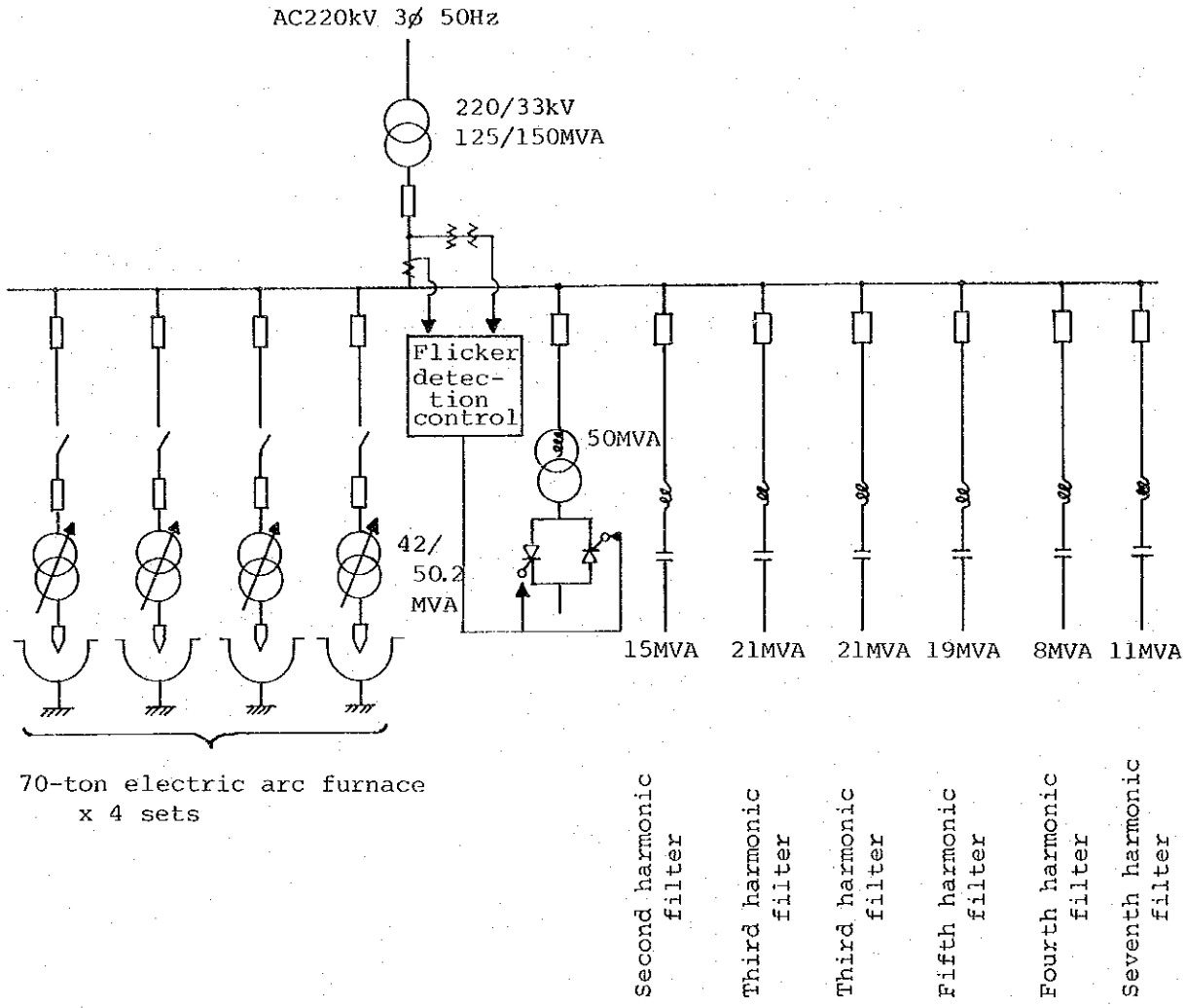

Fig.6.8-2 Configuration of flicker compensating unit

6.8.5 Power Receiving and Distribution Facilities

a. General

Power receiving and distribution facilities include the system to transform 220 kV incoming voltage into 33 kV, 11 kV, and 3.3 kV distribution voltages, telephone system, road illumination system, and temporary power supply system for construction work.

b. Basic plan

1. Power receiving system

(1) Type

Following three types may be considered as a power receiving system for this steel plant:

(1) Gas-insulation closed type (GI type)

(2) Indoor type (Cubicle type)

(3) Outdoor structure type

Judging from the site condition, Proposal (1) is recommended since the total construction cost is economical, installation work is easy, and small space is enough.

(2) Current capacity of receiving circuit breaker and bus bar

By assuming that the load in Stage 2 is 360 MVA, the above said capacity is set at 2000 A.

(3) Receiving transformer

On load tap changer is to be provided to cover large fluctuation of line voltage (±5% for normal, ±10% for emergency).

During normal operation, the transformer for general load and that for electric arc furnace load are operated separately. The former is to be provided enough capacity so that it can act as back-up during the down time of the latter transformer.

(4) Bus

For 220 kV bus, double bus is adopted to make the maintenance and inspection easy. For the 33 kV circuit, single bus is adopted, which is specially designed to ensure back-up for each transformer. Indoor type closed panel

is used for 33 kV or below.

(5) 33 kV grounding system

To avoid abnormal voltage and inductive interference during ground, fault resistance grounded neutral system of 100 A is used.

(6) Protection system

(a) Incoming line

Because of small distance to the power source, cable is used as an incoming line, and highly reliable pilot wire relay method is recommended (however without wire).

(b) 220 kV bus

With bus protection

(c) Transformer

Protection to be provided against internal fault, overload, etc.

(d) 33 kV line

Protection to be provided against overload, ground fault.

2. Distribution facility

Cable is used entirely, which is installed in pits or directly embedded.

3. Communication system

(1) Private branch-exchange ٢- Cross-bar system including 500 circuits

(2) Internal Announcing system - One set

(3) Fire alarm system - One set

(4) Wired paging - One set

(5) Wireless paging - One set

(6) Wireless communication system - One set

4. Road illumination system

Target intensity: 7 lux

5. Temporary power supply system

Receiving 11 kV power from El-Dikhila S/S and distributing 3 kV

c. Specification

1. Power receiving facility One set

220 kV switchgear x 5

Transformer 125/150MVA, 220/33KV x 2

33 kV switchgear x 19

Transformer 12.5/15MVA 33/3KV x 2

3 kV switchgear x 19

2. Power distributing facility One set

33 KV CV 3C 200 325 mm^2 x 3,700 m

" " " 1C 500 mm^2 x 900 m

3 KV CV 3C 100 ∿ 325 mm^2 x 12,700 m

3. Communication system One set

Switchboard - 500 circuits, 360 telephone sets

Underground communication duct - 7200 m

Announcing - 84 speakers

Fire alarm system - 360 detectors

Fire fighting system - one set

Wired paging - 4 main units

Wireless paging - 7 main units

Wireless - 3 main units

4. Road illumination system One set

Road length - 11,500 m

5. Temporary power supply facility One set

11 kV power receiving facility x 1

Transformer 5MVA 11/3 KV x 1

3 kV switchgear x 5

Refer to attached drawing.

DWG. No. JICA-6-8-01
Single line diagram of plant main power distribution system

DWG. No. JICA-6-8-02
Layout of 220 kV substation (Gas insulation type)

6.8.6 Emergency Power Supply System

a. General

Emergency power supply system for Direct Reduction plant is installed within the plant. Emergency system for later process is provided in the substation for common use. Here the common emergency system is described.

b. Generator set

Diesel engine generator 3 kV 2000 kVA 1 unit

c. Objects of emergency power supply

Electric arc furnace	
Ladle crane hoisting (travelling)	200 kW x 1
Continuous casting	
Drawing and straightening roll	7.5 kW x 12 = 90 kW
Electric arc furnace and continuous casting	
Illumination	100 kW
Water treatment	
Hydrant	160 kW x 1
Emergency	260 kW x 1
Illumination	40 kW

Waste water treatment	21 kW
Bar and Rod	
Instrument	15 kW
Illumination	100 kW
Others	100 kW
TOTAL	1,086 kW

PROJECT

BIBLIOGRAPHY

MARK	DESCRIPTION	DATE	SIGN

Main receiving substation

AC 220 KV 3φ 50 Hz

2000A 40KA

125/150 MVA 220/33 KV

1200A 40KA

3000A 25KA

33 KV

N.O

600A 25KA

12.5/15 MVA 33/3.3 KV

3000A 40KA

3.3KV

50 MVA

2nd 15MVA, 3rd 21MVA, 3rd 21MVA, 5th 19MVA, 4th 8MVA, 7th 11MVA

Flicker and power factor compensation system

DE G 2000 KVA 1500KVA

1500KVA

2000 KVA

33KV

30MVA 33/11KV

42/50.2 MVA 33/0.395 KV

70-Ton Arc furnace + 4sets steelmelt shop

103,7MW

DR plant (emergency)

Bar & Rod mill (emergency)

0.9MW 6.7MW 2.5MW 1.7MW (stage1) 3.4MW (stage2) 2.2MW (stage1) 4.4MW (stage2) 2.5MW 6.7MW 0.9MW 0.8MW 1MW

Calcining plant, Steelmelt shop, Continuous caster, Services & Utilities (Air compressor i.e Oxygen plant), Services & Utilities (Water treatment), Continuous caster, Steelmelt shop, Calcining plant, Maintenance shop, Office

14,2MW 14,2MW 26,2MW 26,2MW

DR plant, Bar & Rod mill

LEGEND: SYMBOL

- Transformer
- Circuit Breker
- Line Switch
- Disconnecting Switch
- Static Capacitor
- G Emergency Generator
- DE Diesel Engine
- Reactor
- Thyristor

EL DIKHEILA PROJECT

DWG. NO.	JICA-6-8-01
TITLE	SINGLE LINE DIAGRAM OF PLANT MAIN POWER DISTRIBUTION SYSTEM
SCALE	NON
DATE	APRIL. 1979

DATE OF ISSUE

PROJEC

BIBLIOGRAPHY

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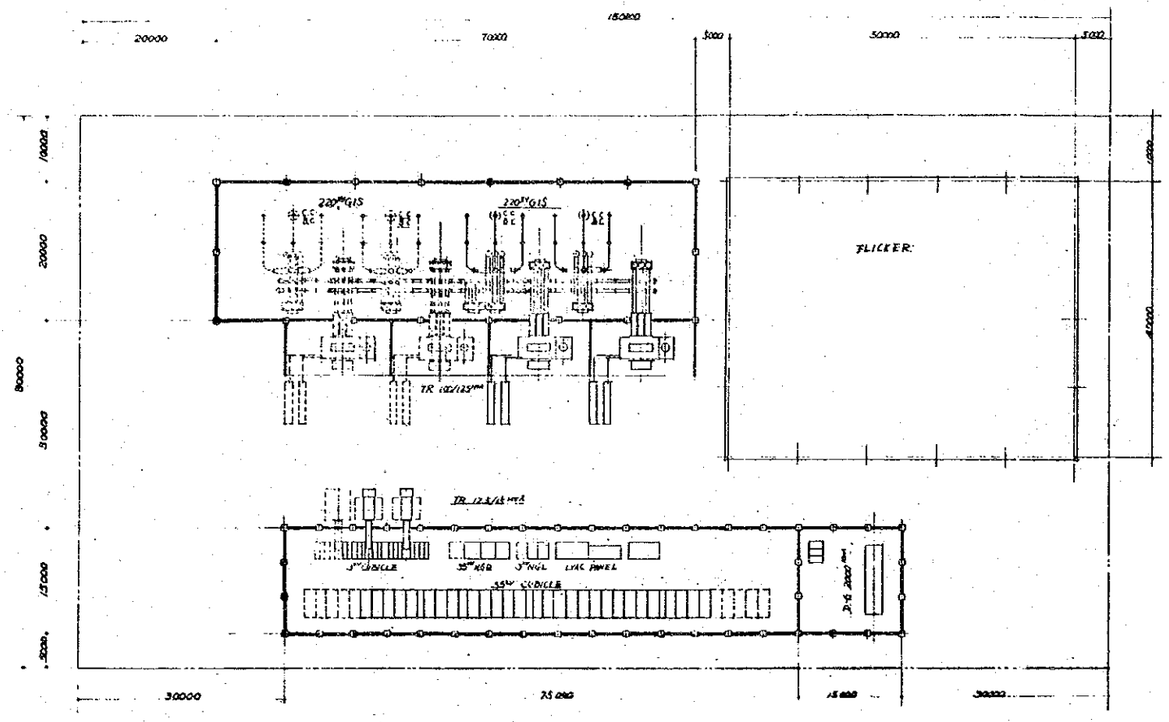
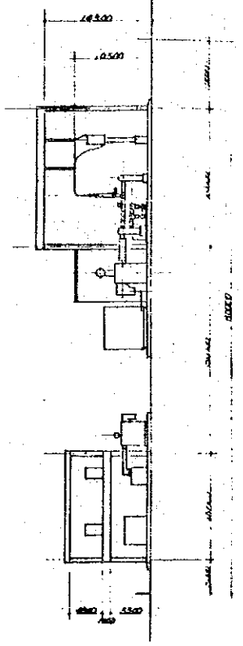
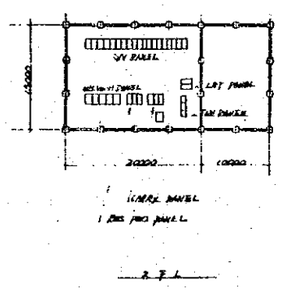






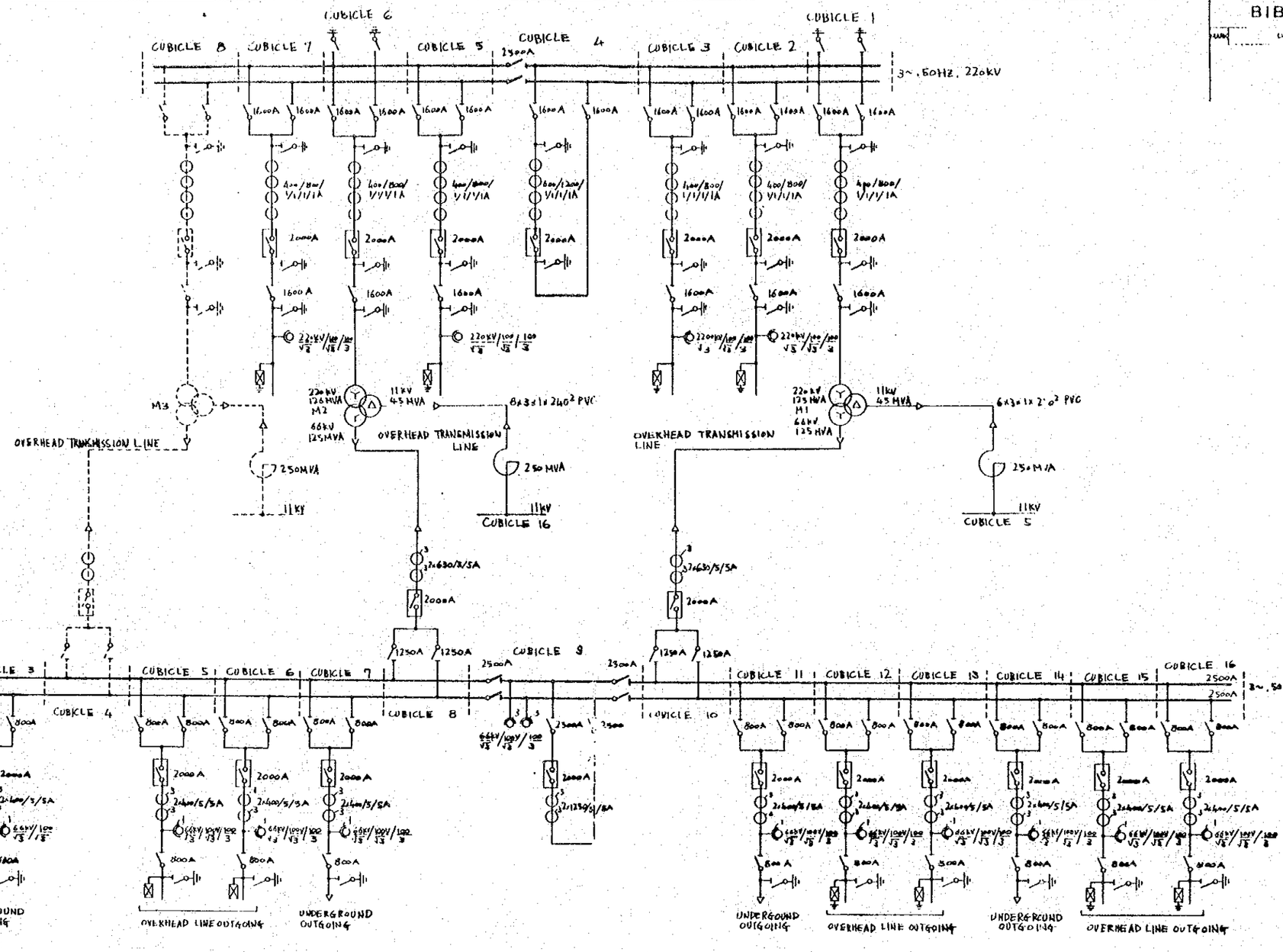
EL DIKHEILA PROJECT	
DWG.NO.	JICA-6-8-02
TITLE	LAYOUT OF 220KV SUB STATION (GAS INSULATION TYPE)
SCALE	1/400
DATE	APRIL. 1979

DATE OF ISSUE

PROJEC

BIBLIOGRAPHY

MARK	DESCRIPTION	DATE	SIGN



UNDER CONTRACT

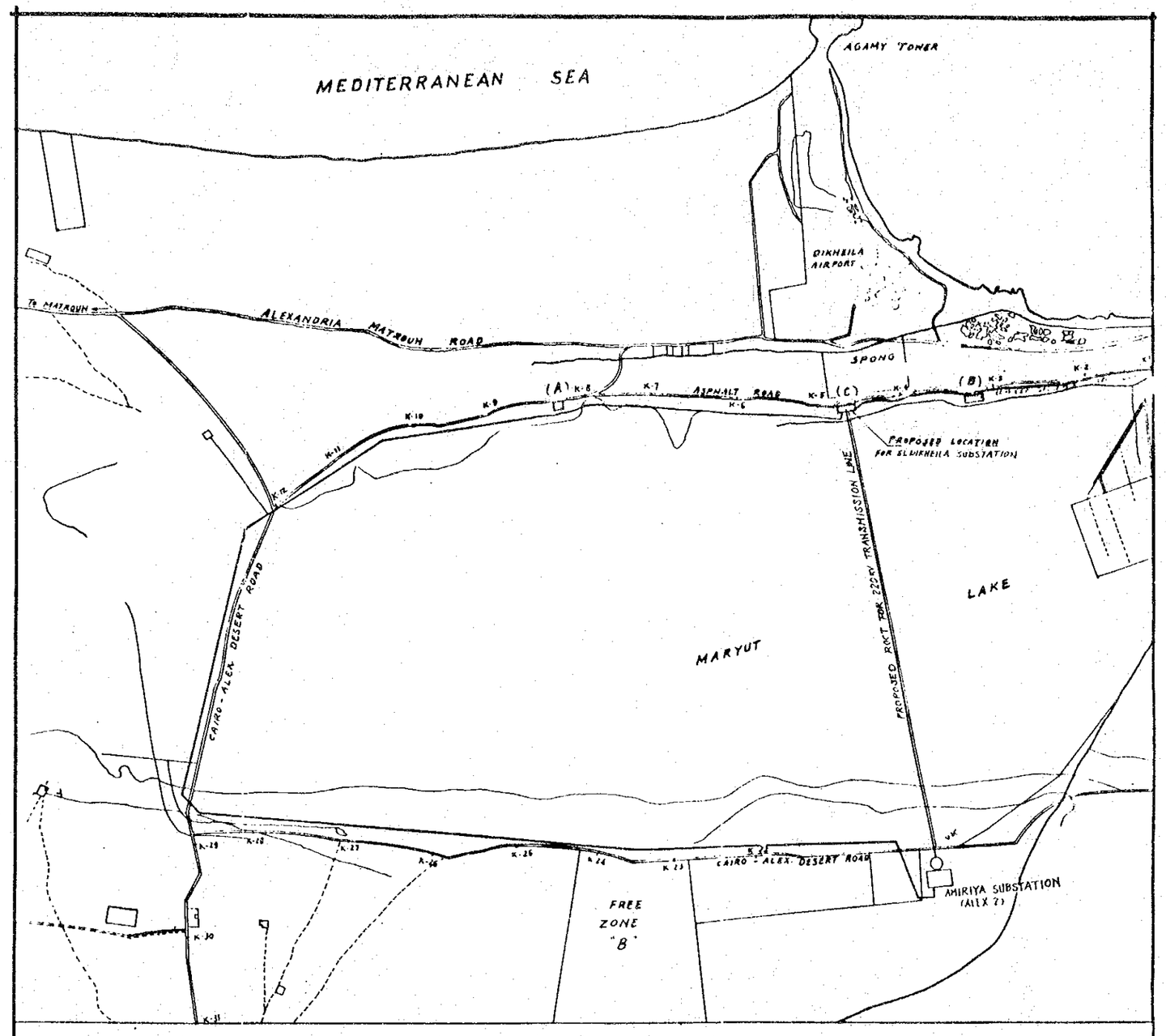
FUTURE EXTENSION

EL DIKHEILA PROJECT	
DWG NO	JICA-6-8-03
TITLE	220/66kV SWITCHGEAR SINGL LINE DIAGRAM FOR EL DIKHEILA SUBSTATION
SCALE	NON.
DATE	APRIL, 1979

DATE OF ISSUE

196

6 - 220


MEDITERRANEAN SEA
AGAMY TOWER
DIKHEILA AIRPORT
To MATROUH
ALEXANDRIA MATROUH ROAD
SPONG
ASPHALT ROAD
(A)
(B)
(C)
K-12
K-11
K-10
K-9
K-8
K-7
K-6
K-5
K-4
K-3
K-2
PROPOSED LOCATION FOR ELDIKHEILA SUBSTATION
PROPOSED R.K.T. FOR 220 KV TRANSMISSION LINE
CAIRO - ALEX. DESERT ROAD
LAKE MARYUT
K-29
K-28
K-27
K-26
K-25
K-24
K-23
K-22
K-30
K-31
FREE ZONE "B"
AMIRIYA SUBSTATION (ALEX 2)
H.T CABLES 220 K.V.
UNDER GROUND CABLES 66 K.V.
Roads
STATION FEEDING
PROPOSAL 1 - WITH H.T.C (ON TOWERS) 220 KV
PROPOSAL 2 - CONSTRUCTING ROAD THROUGH LAKE AND EXECUTE H.T (TOWER CABLE)
EL DIKHEILA PROJECT
DWG. NO. JICA-6-8-04
TITLE LOCATION OF EL-DIKHEILA SUBSTATION AND TRANSMISSION LINE
SCALE 1/20,000
DATE APRIL 1979

6.9 Oxygen Plant

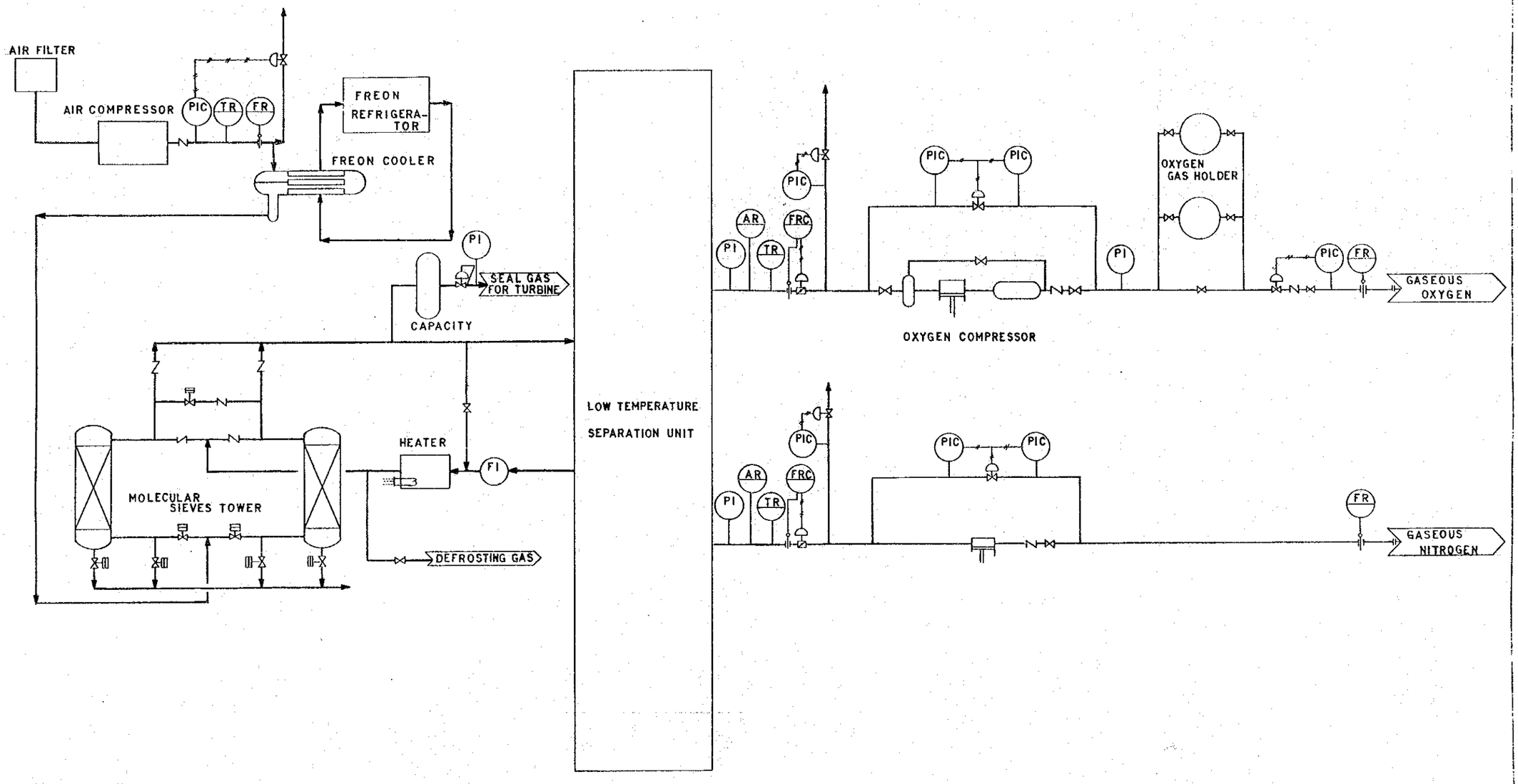
6.9.1 Concept

The oxygen quantity required for this project shall be 380 Nm^3/h on average, and it shall be consumed mainly by injection into the electric arc furnaces and repairing the tundishes after casting at the continuous casting plant. Meanwhile, the quantity of nitrogen required shall be 322 Nm^3/h on average, and this shall be distributed as inert gas to the sponge iron storage bins as well as to the ladle in the continuous casting plant for bubbling into molten steel so as to keep it at a uniform temperature prior to continuous casting.

The oxygen plant mainly comprises air compression unit, air cooling unit, decarbonation and desiccation unit, low temperature separation unit and compressors for compressing the oxygen and nitrogen up to the designated pressure. The general gas flow sheet is provided in Fig. 6.9-1.

Atmospheric air is induced through the air intake pipe, which shall be located in the area

Fig.6.9-1 GENERAL FLOWSHEET FOR OXYGEN/NITROGEN PLANT



with the least pollution, and through the air filter up to the air compressor. The compressed air shall be conveyed through the freon cooler, which removes moisture, to the molecular sieves tower, where the remained moisture and carbon dioxide are removed. And then, the air shall be conveyed to the low temperature separation unit, in which gaseous oxygen is generated with 0.2 Kgf/cm^2G pressure and 99.5% purity at a rate of 400 Nm^3/h and supplied to the oxygen compressor.

Gaseous oxygen shall be supplied to the oxygen gas holders and then stored in them, and from there it shall be distributed to the necessary points by the utility distribution system at a pressure of 18 Kgf/cm^2G. The gas holders are planned for the stable oxygen supplying. The gaseous nitrogen generated in the low temperature separation unit shall be delivered at a rate of 400 Nm^3/h and a pressure of 5 Kgf/cm^2G, with 99.9% purity.

6.9.2 Production Plan

6.9.2.1 Production Capacity and Products

Table 6.9-1 Capacity, Purity and Pressure

	Capacity	Purity	Pressure
Oxygen Gas	400 Nm^3/h	99.5% O_2	18 Kgf/cm^2G
Nitrogen Gas	400 Nm^3/h	99.9% N_2	5 Kgf/cm^2G

6.9.2.2 Plant Operation Time

This plant shall be operated for 340 days per year.

6.9.2.3 Unit Consumption

Table 6.9-2 Unit Consumption

Product	Unit Consumption	
Oxygen Gas	Electric Power Industrial Water	0.86 Kwh/Nm^3 9.0 ℓ $/Nm^3$
Nitrogen Gas	Electric Power Industrial Water	0.12 Kwh/Nm^3 0.7 ℓ $/Nm^3$

Note: 1. Industrial water means make-up water.

2. Nitrogen gas unit consumption includes electric power and industrial water, which are used only for compressing. Therefore, the common consumables for oxygen and

nitrogen shall be included in oxygen gas unit consumption.

3. Unit consumption for the compressed air is mentioned in Chapter 6.10.3.

6.9.2.4 Gas Balance

The oxygen and nitrogen gas balance is shown in Fig. 6.9-2.

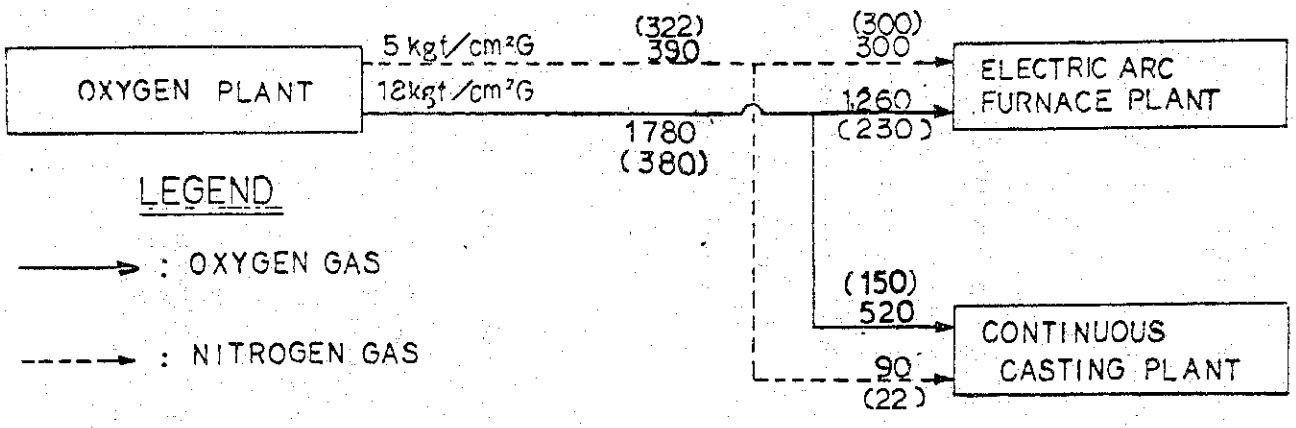
6.9.2.5 Manpower Requirements

The manpower requirements are shown in Table 6.9-3. The figures show the total number of people who will be working in the oxygen plant, the natural gas facilities and compressed air facilities. The oxygen plant shall be operated by 4 crews working 3 shifts.

Table 6.9-3 Manpower Requirements

Position		Day-Employee	Shift-Employee
Manager	1	1	
Engineer	3	3	
General Foreman	1	1	
Shift Foreman	4		4 (1/shift x 4 crews)
Operator	16		16 (4/shift x 4 crews)
Total	25	5	20

Fig.6.9-2 OXYGEN/NITROGEN GAS BALANCE



NOTE

1. UNIT OF THE ABOVE FIGURES IS Nm³/hr.
2. THE ABOVE FIGURES ARE MAX. VALUE.
3. FIGURES IN( ) ARE AVERAGE VALUE.

6.9.3 Equipment Specifications

Specifications of the main equipment are shown in Table 6.9-4. Water treatment facilities for the oxygen plant are planned in Chapter 6.10.1.

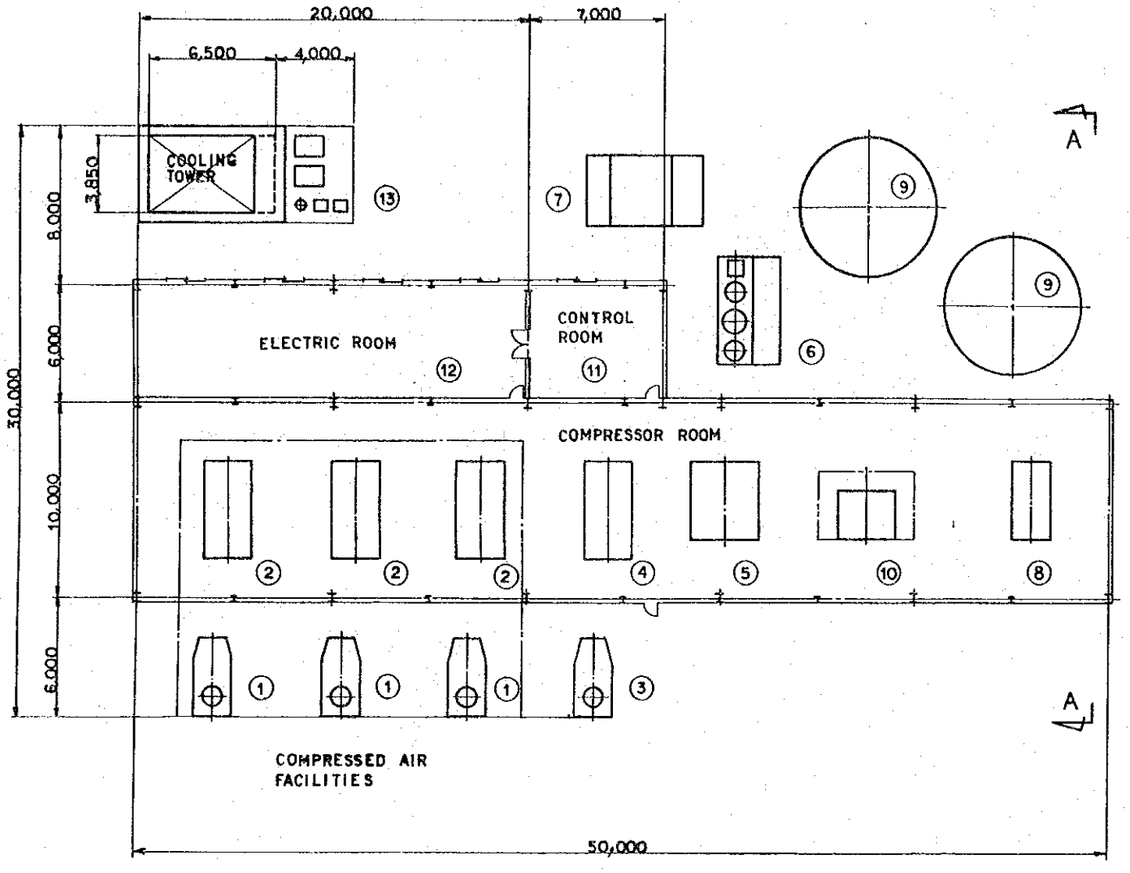
6.9.4 Plant Layout

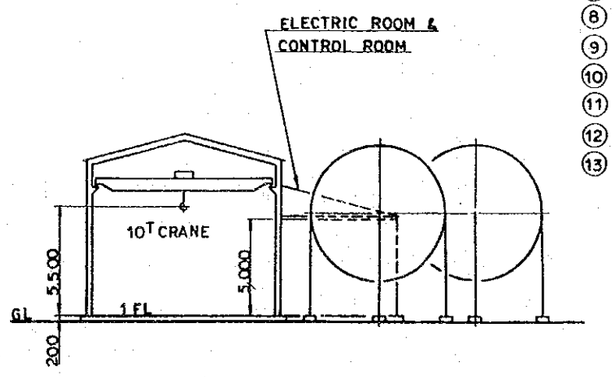
The layout of the oxygen and compressed air plant is shown in Dwg. No. JICA-6.9-01. The compressed air facilities shown in this drawing are mentioned in Chapter 6.10.3.

Table 6.9-4 Equipment List

Equipment	Q'ty	Description
1. Air Compression Unit	1 set	Air Filter Air Compressor Type : Centrifugal Cap. : 2900 Nm^3/h, $5Kg/cm^2G$
2. Air Cooling Unit	1 set	Precooler Freon Cooler with Drain Separator Freon Refrigerator
3. Decarbonation and Desiccation Unit	1 set	Two Molecular Sieves Towers Reactivation Motor Instrument Air Reservoir
4. Low Temperature Separation Unit	1 set	Warm and Cold Exchanger H.P. Column Main Vaporizer L.P. Column Two Liq. Oxygen Filters Oxygen Separator Rich Liquid Subcooler Nitrogen Subcooler Pure Nitrogen Subcooler Two Expansion Turbines Type : Vertical, single-stage radial with Blower Break Drain Pot

Equipment	Q'ty	Description
5. Oxygen Compression Unit	1 set	Oxygen Compressor Type : Reciprocating Cap. : 400 Nm^3/h, 30Kg/cm^2G
6. Oxygen Gas Holder	1 set	Two Oxygen Gas Holders Cap. : 200 m^3, 30Kg/cm^2G
7. Nitrogen Compression Unit	1 set	Nitrogen Compressor Type : Oil free reciprocating Cap. : 400 Nm^3/h, 5Kg/cm^2G
8. Piping and Valves	1 set	
9. Instrumentation	1 set	
10. Electrical Equipment	1 set	





VIEW A-A

NO.	NAME
1	AIR FILTER (FOR COMPRESSED AIR FACILITIES)
2	AIR COMPRESSOR (-DITTO-)
3	AIR FILTER
4	AIR COMPRESSOR
5	AIR PRECOOLING UNIT
6	MOLECULAR SIEVES TOWER
7	LOW TEMPERATURE SEPARATION UNIT
8	OXYGEN COMPRESSOR
9	OXYGEN GASHOLDER
10	NITROGEN COMPRESSOR
11	CONTROL ROOM
12	ELECTRIC ROOM
13	WATER TREATMENT FACILITIES

ELDIKHEILA PROJECT

DWG. NO. JICA-6.9-01

OXYGEN AND COMPRESSED AIR PLANT LAY OUT

SCALE 1/200 | DATE APR., 1979

6.10 Utilities

6.10.1 Water Treatment and Sewage Facilities

6.10.1.1 Concept

The water to be consumed for this project shall be supplied by the Alexandria Water Authority and the characteristics of this water are shown in Table 6.10-1. This water shall be supplied by one pipeline and separated into two lines for industrial usage and potable usage within the battery limits.

The industrial water shall be mainly required as make-up for the indirect and direct cooling water for the machines of the direct reduction plant, the electric arc furnace plant, the continuous casting plant, the bar and rod mill, the calcining plant and the oxygen plant and the air conditioning system of the building. To meet the above requirements, the capacity of the water treatment facilities is planned to be 1,060 m^3/h.

The potable water shall be used for drinking, toilets and so on. And the capacity of the water

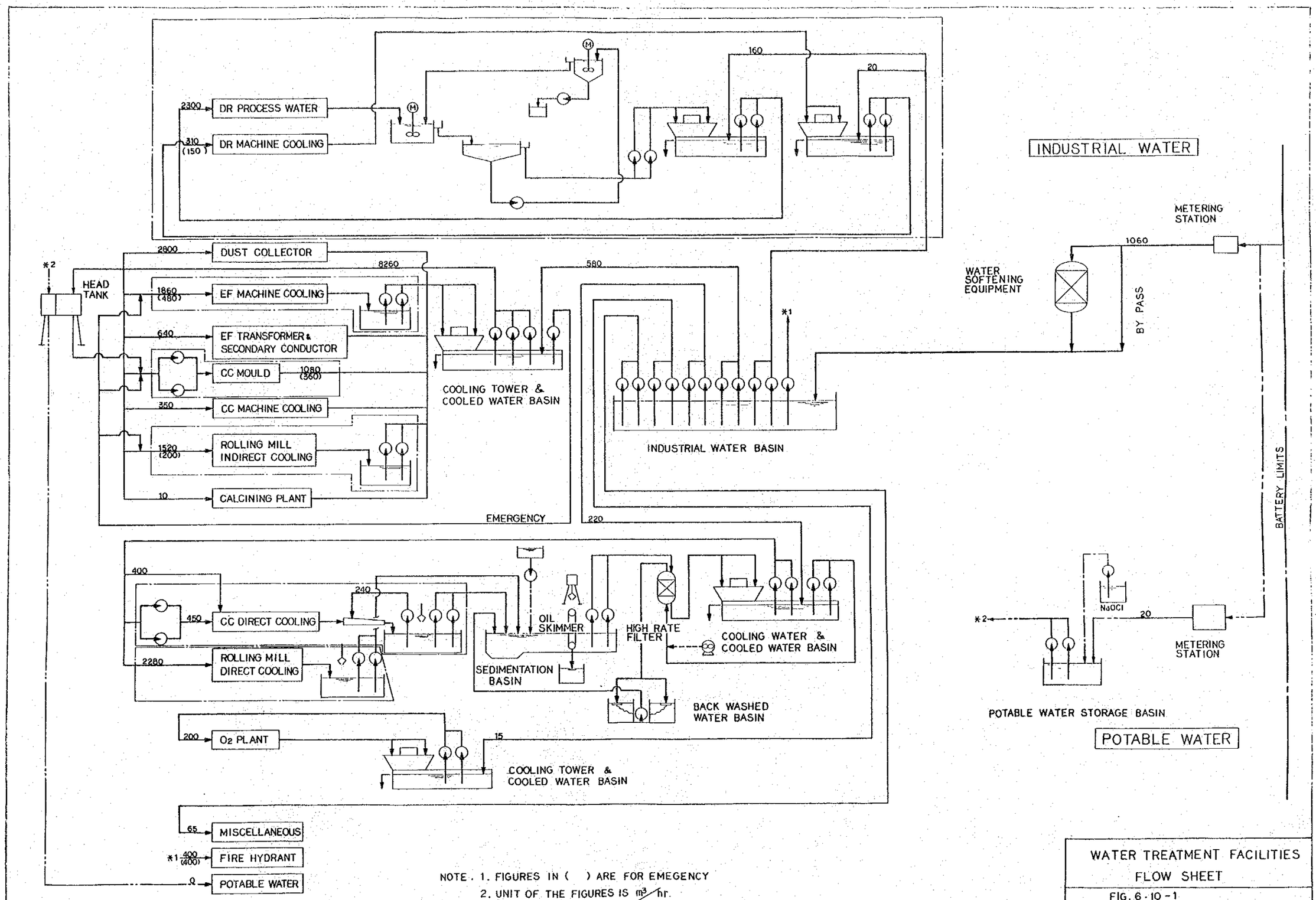
treatment and sewage treatment facilities is now planned to be 20 m^3/h each.

The water treatment facilities are mainly composed of the intake and storage basin, the indirect cooling water system and direct cooling system. A simplified flowsheet is shown in Fig. 6.10-1.

Firstly, the total hardness of the water supplied to the battery limits is softened to less than 75 ppm by the water softening equipment, then the water is stored in the storage basin. After that, the water is distributed to necessary points as make-up from this storage basin. The capacity of this basin is 6,000 m^3 and this is also utilized for the hydrant system.

In the direct reduction plant, the direct cooling water, which is called process water, is cleaned by removing suspended solid in the clarifier, and cooled by the cooling tower, while the indirect cooling water which is used for machinery cooling is cooled by another cooling tower. Both the direct cooling water and the indirect cooling water are reused as circulating water.

The indirect cooling water which is used in the electric arc furnace plant, the continuous casting



NOTE. 1. FIGURES IN ( ) ARE FOR EMEGENCY
2. UNIT OF THE FIGURES IS m^3/hr.

WATER TREATMENT FACILITIES FLOW SHEET

FIG. 6-10-1

DATE. APRIL. 1979

plant, the bar and rod mill and the calcining plant is also cooled by the cooling tower and recirculated. And the water which is used in the oxygen plant is also cooled by the other cooling tower and recirculated in the oxygen plant area.

Regarding the direct cooling water which is used in the continuous casting plant and the bar and rod mill, scale and oil are removed by the scale pit and oil skimmer respectively. Then after removing suspended solid by the high rate filter, the water is sent to the cooling tower and re-circulated. In addition, the head tank (capacity: 50 m^3) and the emergency pumps are planned for emergency situations.

The potable water, which is separated from the industrial water within the battery limits, is stored in the potable water storage basin. Then it is sterilized, pumped up to the head tank (capacity: $20m^3$), built common with the head tank of industrial water treatment system, and distributed to the necessary points by this head pressure.

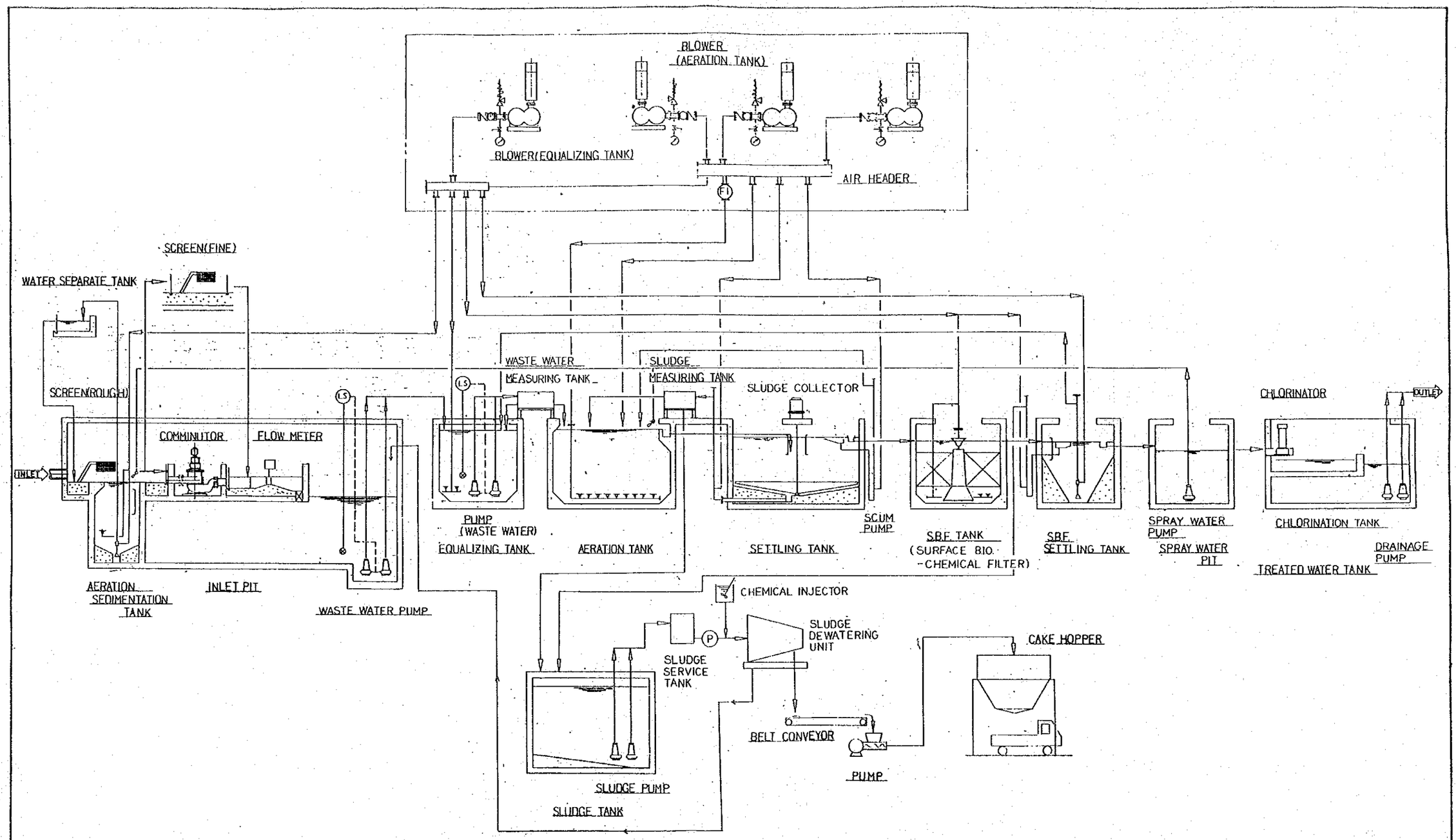
The drainage water such as rain water and blow

down water in the industrial water line is treated by the surface drainage ditch system. The sewage which is generated in this plant site is delivered to the sewage treatment facilities. A simplified flowsheet of these facilities is shown in Fig. 6.10-2.

Large debris in the sewage is removed by the screen and grit is removed in the aeration sedimentation tank. Then the sewage is stored in the inlet pit.

The sewage in the inlet pit is supplied to the equalizing tank, which is installed to minimize the variation of the flow rate and the characteristics, and to the aeration tank, where the sewage is biochemically decomposed with activated sludge. The water including the sludge is then delivered to the settling tank, where the sludge is separated.

At this point, the water shall be treated up to the level of BOD 40 ppm and SS 75 ppm. Moreover, the water is delivered to the S.B.F. (Surface Bio-chemical Filter) tank, where the extant organic matter is treated, and to the chlorination



SEWAGE TREATMENT FACILITIES
FLOW SHEET

FIG. 6.10-2

DATE. APRIL 1979

tank. The chlorinated water is pumped out to the battery limits. The characteristics of the treated water are shown in Table 6.10-2.

The separated sludge at the setting tank is returned to the aeration tank and the excess sludge is dewatered at the dewatering unit and disposed.

6.10.1.2 Operation Plan

(1) Characteristics of Water

The characteristics of the water supplied by the Alexandria Water Authority and those of the sewage are shown in Table 6.10-1 and Table 6.10-2.

And it is planned that the temperature of the water cooled by the cooling towers shall be about 32-33°C and that the treated sewage shall be ambient temperature.

Table 6.10-1 Characteristics of the Supplied Water

Turbidity (units)	2.6 - 3.0	Ca	29.13 - 44.70 ppm
Smelt	Normal	Mg	12.30 - 19.74 ppm
Taste	Normal	Na+K (as Na)	38.83 - 86.00 ppm
Color	Normal	Carbonate	75.48 -104.40 ppm
PH	7.3 - 7.4	Sulfate	34.44 - 52.90 ppm
Cl	32.00 - 95.00 ppm	Nitrate	1.90 - 4.80 ppm
Total Alkalinity (as $CaCO_3$)	138 - 159 ppm	Silica	7.00 - 18.80 ppm
		Dissolved Solid (110°C)	237.45 - 406.59 ppm
Total Hardness (as $CaCO_3$)	126 - 186 ppm	Electric Conductivity	350 - 560 $\mu\mho$/cm
Free NH_3	0.082 - 0.42 ppm	Pressure	2 kg/cm^2
Albuminoid NH_3	0.041 - 0.190 ppm	Temperature	
Absorbed O_2 (during 3 hours on 37°C)	0.87 - 1.20 ppm		30°C (Max.)

Table 6.10-2 Characteristics of the Sewage

	Before Treatment	After Treatment
BOD (Biochemical Oxygen Demand)	350 ppm	20 ppm (Ave.)
SS (Suspended Solid)	400 ppm	50 ppm (Ave.)

(2) Conditions of Required Water

The balances of the circulating water and the make-up water are shown in Table 6.10-3 and Table 6.10-4.

Table 6.10-3 Circulating Water Balance

Kind of Water	Plant Name	Type of cooling	Required Point	Flow Rate m^3/h (Max.)
Industrial Water	DR	Indirect	DR Machine Cooling	310
		Direct	DR Process Water	2,300
	EF/CC/RM & CAL.	Indirect	Dust Collector	2,800
			EF Machine Cooling	1,860
			EF Transformer etc.	640
			CC Mould	1,080
			CC Machine Cooling	350
			RM Indirect Cooling	1,520
			Calcining Plant	10
			Sub Total	8,260
	CC/RM	Direct	CC Direct Cooling	400
				450
			RM Direct Cooling	2,280
			Sub Total	3,130
	O_2	Indirect	O_2 Plant	200
			Miscellaneous	65
			Fire Hydrant	(400)
Grand Total				14,265

Note: The figure in ( ) is not included in the sub total and grand total.

Table 6.10-4 Make-up Water Balance

Kind of Water	System Name	Flow Rate m^3/h (Max.)
Industrial Water	DR Plant Indirect Cooling System	20
	DR Plant Direct Cooling System	160
	EF/CC/RM/CAL. Plant Indirect Cooling System	580
	CC/RM Plant Direct Cooling System	220
	O_2 Plant Indirect Cooling System	15
	Miscellaneous	65
	Fire Hydrant	(400)
	Sub Total	1,060
Potable Water	Potable Water	20
	Grand Total	1,080

Note: The figure in ( ) is not included in the sub total and grand total.

(3) Operation Time

The water treatment facilities shall be operated for 340 days per year, and the sewage treatment facilities for 365 days per year continuously.

(4) Unit Consumption for Water Treatment and Sewage Treatment

The quantity of the make-up water shall be planned at a rate of 1,060 m^3/h (Max.) as shown in Table 6.10-4, but the average requirement shall be 725 m^3/h. The unit consumption for the water treatment is calculated on the basis of the average figure and that for the sewage treatment is also on the basis of 12.5 m^3/h (Ave.).

Table 6.10-5 Unit Consumption

		Unit Consumption
Water Treatment	Electric Power	2.3 kwh/m^3
	Chemical Agents	
	40% NaOH	3.5×10^{-4} kg/m^3
	NaOCl	1.5×10^{-4} kg/m^3
	NaCl	0.17 kg/m^3
	Resin	2.54×10^{-4} ℓ/m^3
	Compressed Air	1.2×10^{-3} Nm^3/m^3
Sewage Treatment	Electric Power	2.3 kwh/m^3
	Chemical Agents	
	Flocculant	5×10^{-3} kg/m^3
	CaOCl	7.4×10^{-3} kg/m^3

(5) Manpower Requirements

Manpower requirements are shown in Table 6.10-6. These facilities shall be operated by 4 crews working 3 shifts.

Table 6.10-6 Manpower Requirements

Position			Day-Employee	Shift-Employee
Manager		1	1	
Engineer		3	3	
General Foreman		1	1	
Water Treatment Facilities	Shift Foreman	4		4 (1/shift x 4 crews)
	Operator	20		20 (5/shift x 4 crews)
Sewage Treatment Facilities	Shift Foreman	4		4 (1/shift x 4 crews)
	Operator	12		12 (3/shift x 4 crews)
Total		45	5	40

6.10.1.3 Equipment Specifications

Specifications of the main equipment are shown in Table 6.10-7. The water treatment facilities for the direct reduction plant are not included in Table 6.10-7. They are mentioned in the direct reduction plant.

6.10.1.4 Plant Layout

The layout of the water treatment facilities is shown in Dwg. No. JICA-6.10-01.

Table 6.10-7 Equipment List

(1) Water Treatment Facilities

Equipment	Q'ty	Main Specifications
1 Intake and Storage Basin		
1) Water Softening Equipment	6	Type: Vertical cylindrical Resin volume: 5,000 ℓ
2) Industrial Water Basin	1	Capacity: 6,000 m^3
3) Pumps	1 set	
2 Indirect Cooling Water System		
1) Cooled Water Basin (For EF,CC,RM,CAL.Plant)	1	Capacity: 4,200 m^3
2) Cooling Tower (For EF,CC,RM,CAL.Plant)	1	Capacity: 8,260 m^3/h Type: Mechanical induced draft, cross flow
3) Cooled Water Basin (For Oxygen Plant)	1	Capacity: 100 m^3
4) Cooling Tower (For Oxygen Plant)	1	Capacity: 200 m^3/h Type: Mechanical induced draft, cross flow
5) Pumps	1 set	
3 Direct Cooling Water System		
1) Cooled Water Basin	1	Capacity: 1,600 m^3
2) Cooling Tower	1	Capacity: 3,300 m^3/h Type: Mechanical induced draft, cross flow

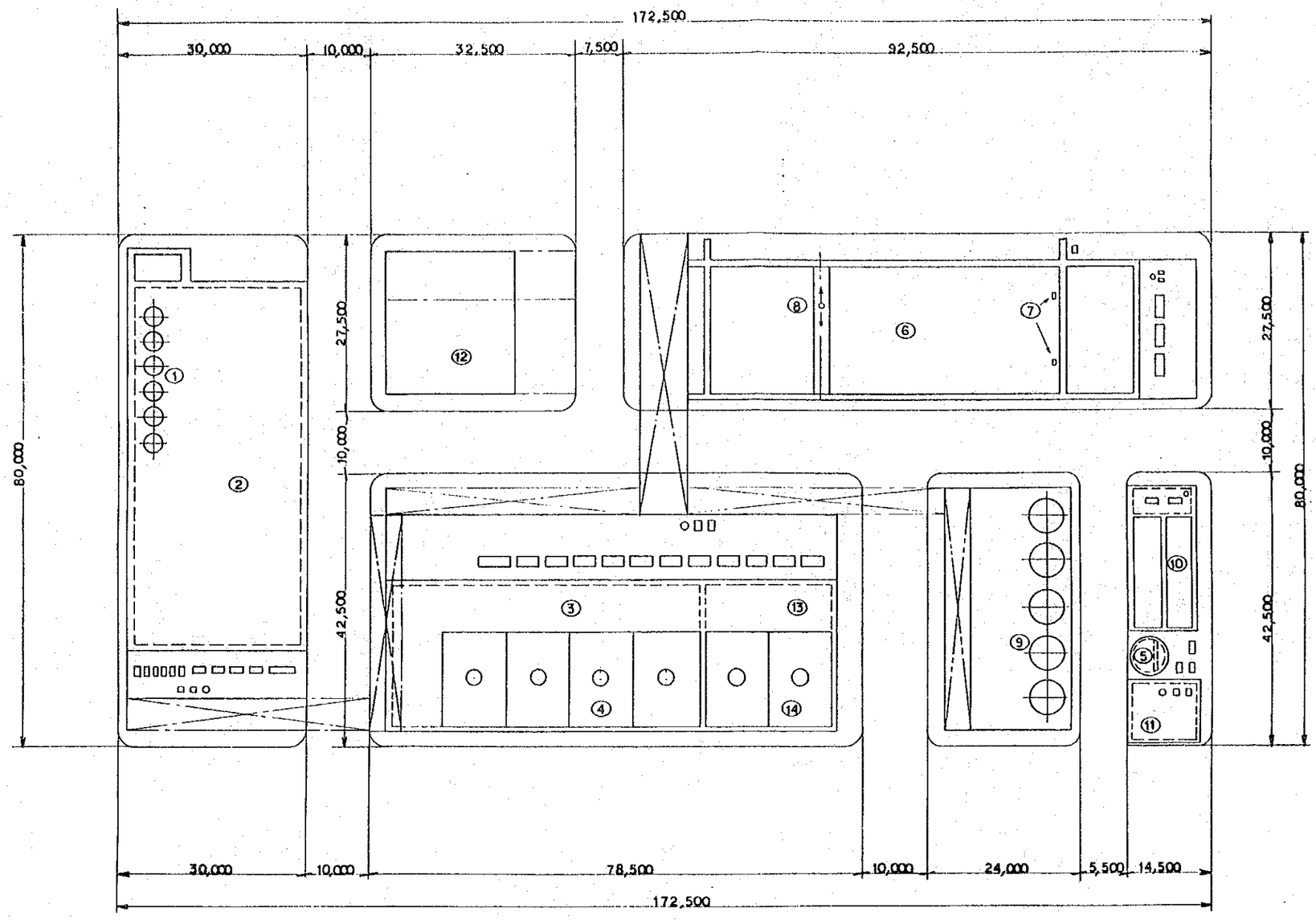
Equipment	Q'ty	Main Specifications
3) Sedimentation Basin	1	Dimension: 15,000W x 75,000L x 4,000H mm
4) PH Stabilizer	1 set	
5) Oil Skimmer	2	Type: Belt driving
6) Oil Separating Tank	2	
7) Bridge Crane	1	
8) High Rate Filter	5	Type: Vertical cylindrical
9) Blower	2	
10) Back Washed Water Basin	2	Capacity: 350 m^3
11) Pumps	1 set	
4 Emergency System		
1) Head Tank	1	Capacity: 50 m^3 Head: 30 m
2) Pump	1	
5 Valves	1 set	
6 Pipes with Accessories	1 set	
7 Instrumentation	1 set	
8 Electrical Equipment	1 set	

(2) Potable Water and Sewage Treatment Facilities

Equipment	Q'ty	Main Specification
1 Potable Water Facilities		
1) Potable Water Storage Basin	1	Capacity: 300 m^3
2) Sterilizer	1	
3) Head Tank	1	Capacity: 20 m^3 Built common with the head tank of industrial water treatment system
4) Pumps	1 set	
2 Sewage Treatment Facilities		
1) Screen (Rough)	1	Mesh: 50 mm
2) Screen Bucket (For Rough Screen)	1	
3) Aeration Sedimentation Tank	1	Dimension: 1,000W x 1,200L x 1,300D mm
4) Water Separate Tank	1	
5) Comminutor	1	
6) Screen (Fine)	1	Mesh: 20 mm
7) Screen Bucket (For Fine Screen)	1	
8) Inlet Pit	1	Dimension: 5,000W x 6,000L x 1,000H mm

Equipment	Q'ty	Main Specifications
9) Equalizing Tank	1	
10) Blower	1	
11) Waste Water Measuring Tank	1	Dimension: 600W x 1,200L x 600H mm
12) Aeration Tank	2	Capacity: 245 m^3 per one unit
13) Blower	3	
14) Settling Tank	1	Capacity: 82.6 m^3
15) Sludge Collector	1	
16) Sludge Measuring Tank	1	Dimension: 600W x 1,200L x 600H mm
17) S.B.F. Filter Tank	1	Capacity: 44.6 m^3
18) S.B.F. Filter	1	Capacity: 27.4 m^3
19) S.B.F. Settling Tank	2	Capacity: 14 m^3 per one unit
20) Spray Water Pit	1	
21) Chlorination Tank	1	Capacity: 4.5 m^3
22) Chlorinator	1	
23) Treated Water Tank	1	
24) Sludge Tank	1	

Equipment	Q'ty	Main Specifications
25) Sludge Service Tank	1	
26) Chemical Injector	1 set	
27) Sludge Dewatering Unit	1 set	
28) Belt Conveyor	1	
29) Cake Hopper	1	
30) Air Compressor	1	
31) Pumps	1 set	
3 Valves	1 set	
4 Pipes with Accessories	1 set	
5 Instrumentation	1 set	
6 Electrical Equipment	1 set	



(NO.) NAME

① WATER SOFTENING EQUIPMENT
② INDUSTRIAL WATER BASIN
③ COOLED WATER BASIN (DIRECT WATER)
④ COOLING TOWER (— DITTO —)
⑤ HEAD TANK
⑥ SEDIMENTATION BASIN
⑦ OIL SKIMMER
⑧ BRIDGE CRANE
⑨ HIGH RATE FILTER
⑩ BACK WASHED WATER BASIN
⑪ POTABLE WATER STORAGE BASIN
⑫ ELECTRIC ROOM
⑬ COOLED WATER BASIN (INDIRECT WATER)
⑭ COOLING TOWER (— DITTO —)

ELDIKHEILA PROJECT	
DWG. NO. JICA – 6·10 – 01	
WATER TREATMENT FACILITIES LAY OUT	
SCALE 1/500	DATE APRIL. 1979

6.10.2 Natural Gas Facilities

6.10.2.1 Concept

The natural gas quantity required for this project shall be 43,130 Nm^3/h (Max.) and to meet the requirement, the capacity of the natural gas facilities is planned to be 45,000 Nm^3/h.

The primary source of the natural gas to be consumed for the project is the Abu Qir gas field approximately 45 km northeast of the El Dikheila plant site. It is assumed that the gas shall be delivered to the battery limits at a pressure of 9 - 11 kgf/cm^2G and the composition of the natural gas is shown in Table 6.10-8. The natural gas pressure reduction system is shown in Fig. 6.10-3.

The natural gas delivered to the battery limits, after the dust included in the gas is eliminated through a filter, shall be reduced to 7 kgf/cm^2G at the pressure reduction section. And then, the natural gas shall be supplied to the direct reduction plant and to the electric arc furnace plant, the continuous casting plant, the bar and rod mill and the calcining plant after it is measured.

Table 6.10-8 Approximate Composition of Natural Gas From Abu Qir

Composition	%vol.	%wt.
Nitrogen	0.17	0.27
Carbon Dioxide	0.53	1.34
Methane	93.85	86.15
Ethane	3.23	5.56
Propane	1.22	3.10
I-Butane	0.38	1.26
N-Butane	0.31	1.03
I-Pentane	0.11	0.45
N-Pentane	0.08	0.33
Hexanes	0.09	0.44
Heptanes plus	0.01	0.06
Water	0.01	0.01
	100.00	100.00

- Molecular weight 17.43
- Density g/L at N.T.P. 0.778
- " " 60°F & 14.696 psia 0.736
- Specific gravity (air = 1) at 60°F 0.602
- Sulfur content grains/100 cuft (max) 5
- Total sulfur (max) 75 ppm (calculated as H_2S)
- Organic sulfur (max) 2 ppm
- Dew point °C, at delivery conditions below 0
- Gross calorific value
  - BTU/lb 23,238
  - BTU/cuft at 60°F & 14.696 psia 1,072.5
  - at N.T.P. 1,133.6
  - $Kcal/M^3$ at 60°F & 14.696 psia 9,540
  - at N.T.P. 10,084

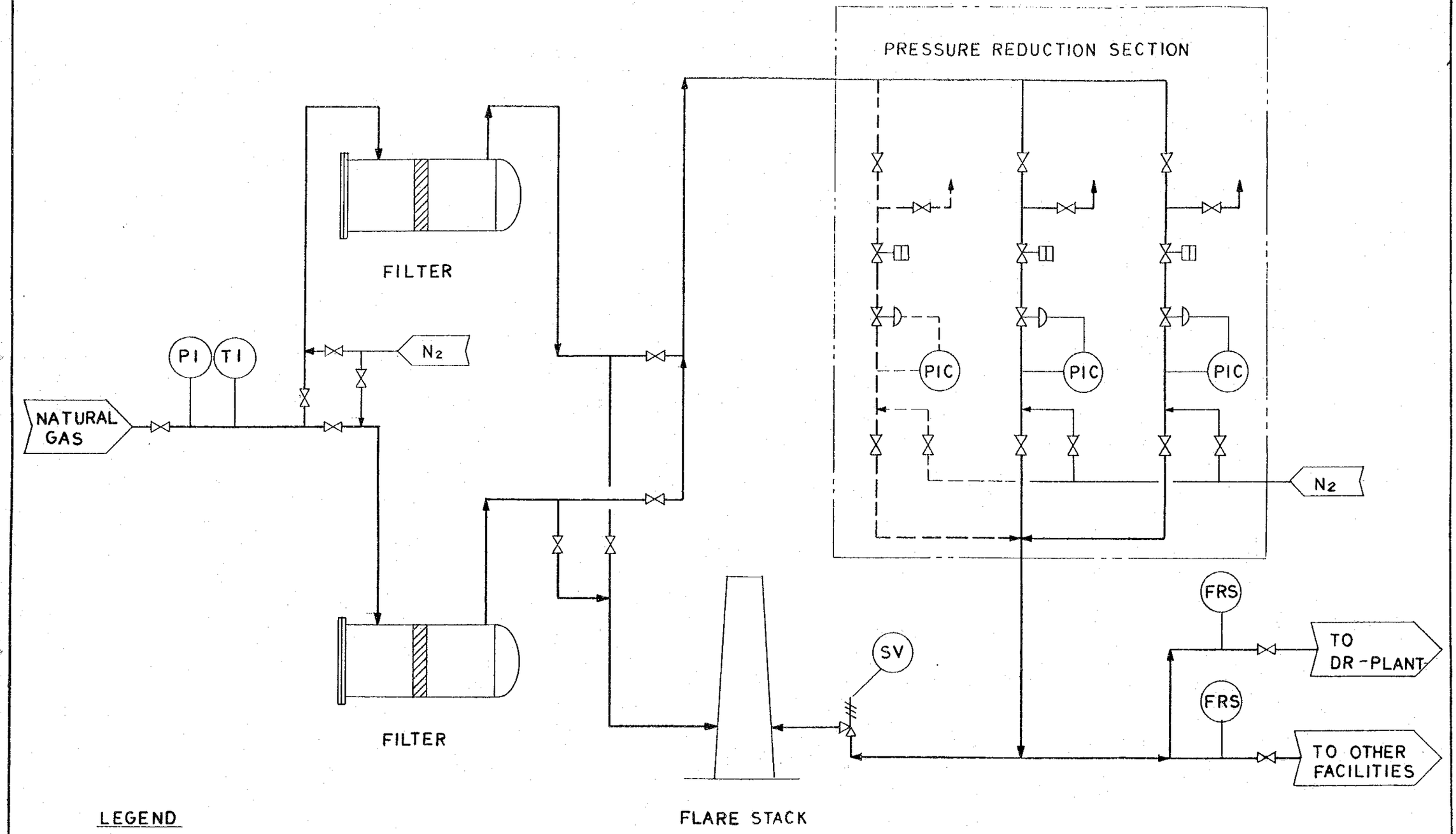
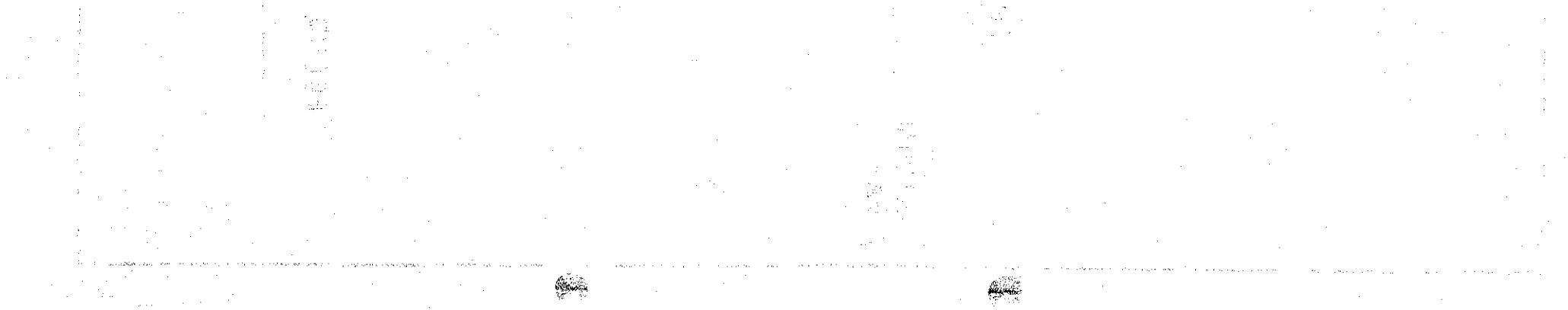


Fig. 6.10-3 NATURAL GAS PRESSURE REDUCTION STATION



Before the natural gas supplied to the direct reduction plant is consumed, the H_2S level shall be reduced to less than 1 ppm at the desulfurizing facilities. Two filters and two lines of the pressure reduction section are planned but each one of them shall be held in reserve. In addition, the emergency line shall be planned besides the main lines in the pressure reduction section.

In case of emergency, the flow of the natural gas in the main line shall be automatically changed to this by-pass line. Moreover, it is planned that the natural gas shall be released to a flare stack through the safety valves when the gas pressure gets extraordinarily high.

6.10.2.2 Operation Plan

(1) Capacity and Pressure

Capacity	:	45,000 Nm^3/h
Inlet Pressure	:	11 kgf/cm^2G
Outlet Pressure	:	7 kgf/cm^2G

(2) Operation Time

These facilities shall be operated for 340 days per year.

(3) Gas Balance

Natural gas balance is shown in Fig. 6.10-4.

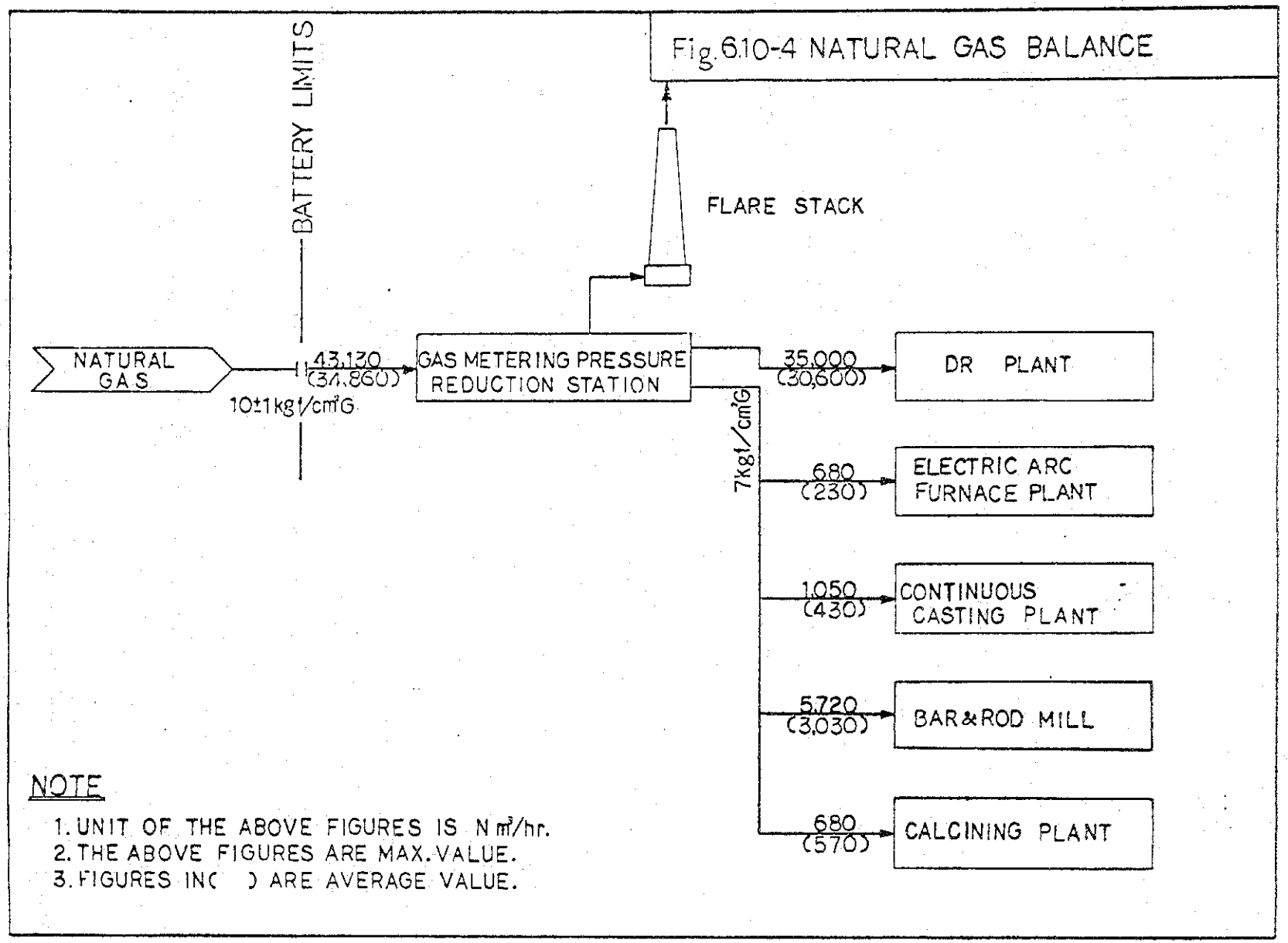


Fig.6.10-4 NATURAL GAS BALANCE
BATTERY LIMITS
FLARE STACK
NATURAL GAS
43,130 (34,860)
10±1kgf/cm²G
GAS METERING PRESSURE REDUCTION STATION
7Kgf/cm²G
35,000 (30,600)
DR PLANT
680 (230)
ELECTRIC ARC FURNACE PLANT
1,050 (430)
CONTINUOUS CASTING PLANT
5,720 (3,030)
BAR&ROD MILL
680 (570)
CALCINING PLANT
NOTE
1. UNIT OF THE ABOVE FIGURES IS N m³/hr.
2. THE ABOVE FIGURES ARE MAX. VALUE.
3. FIGURES IN( ) ARE AVERAGE VALUE.

(4) Manpower Requirements

Manpower requirements are shown in Table 6.9-3. These facilities shall be operated by 4 crews working 3 shifts.

6.10.2.3 Equipment Specifications

Specifications of the main equipment are shown in Table 6.10-9.

Table 6.10-9 Equipment List

Equipment	Q'ty	Main Specifications
1 Gas Pressure Reduction Station	1 set	Capacity : 45,000 Nm^3/h Inlet pressure : 11 kgf/cm^2G Discharge pressure : 7 kgf/cm^2G
1) Filter		
2) Valves		
3) Pipes with Accessories		
4) Flare Stack		
5) Instrumentation		
6) Electrical Equipment		

6.10.3 Compressed Air Facilities

6.10.3.1 Concept

The quantity of compressed air required for this project shall be 5,670 Nm^3/h, which shall be consumed mainly for operating air cylinders at the electric arc furnace plant, the continuous casting plant and the bar and rod mill.

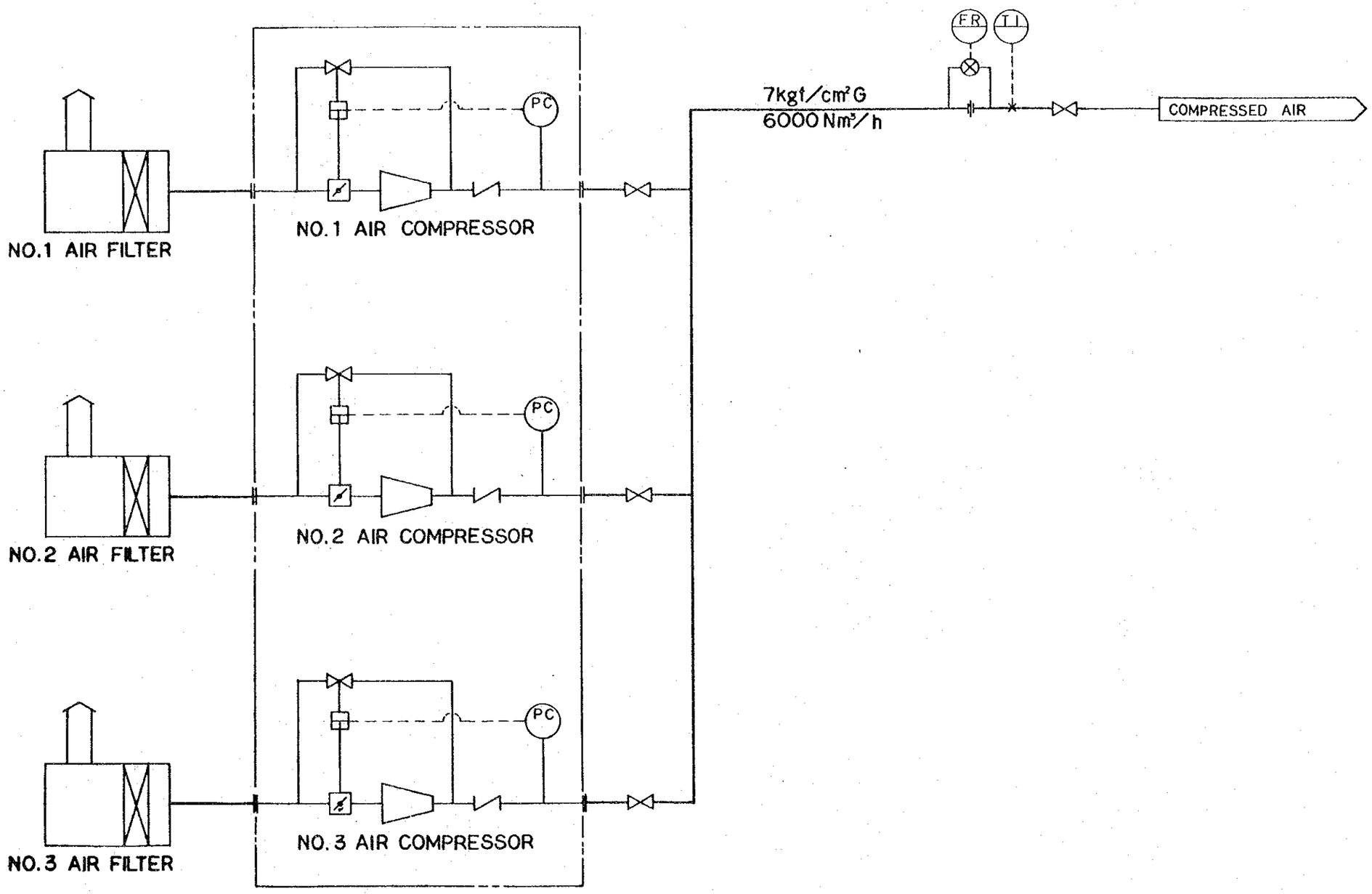
To meet the above requirement, three (3) air compressors, each having a capacity of 3,000 Nm^3/h, are now being planned and one of them shall be a stand-by unit. For the direct reduction plant, compressed air shall be required at a rate of ca. 1,500 Nm^3/h, but the facilities for that shall not be included in these facilities but planned in the direct reduction plant package.

The compressed air facilities shall be located in the oxygen plant and the general flowsheet of the facilities is shown in Fig. 6.10-5.

Air induced through the air filter is fed to air compressor, which is screw-type with two (2) stages. The compressed air at the first stage is fed to the second stage through an inter cooler.

The air is compressed up to the designated pressure,

Fig.6.10-5 GENERAL FLOWSHEET
FOR COMPRESSED AIR PLANT



and then enters an after cooler in order to attain the specified temperature.

Thereafter moisture and oil shall be reduced to the level required for shop air consumption. The compressed air shall then be distributed to necessary points at a pressure of 7 Kgf/cm^2G.

6.10.3.2 Production Plan

(1) Capacity and Pressure

Capacity : 6,000 Nm^3/h

Discharge Pressure: 7 Kgf/cm^2G

(2) Operation Time

These facilities shall be operated for 340 days per year.

(3) Unit Consumption

Electric Power : 0.13 Kwh/Nm^3

Industrial Water : 0.5ℓ/Nm^3

Note: 1. Industrial water means make-up water.

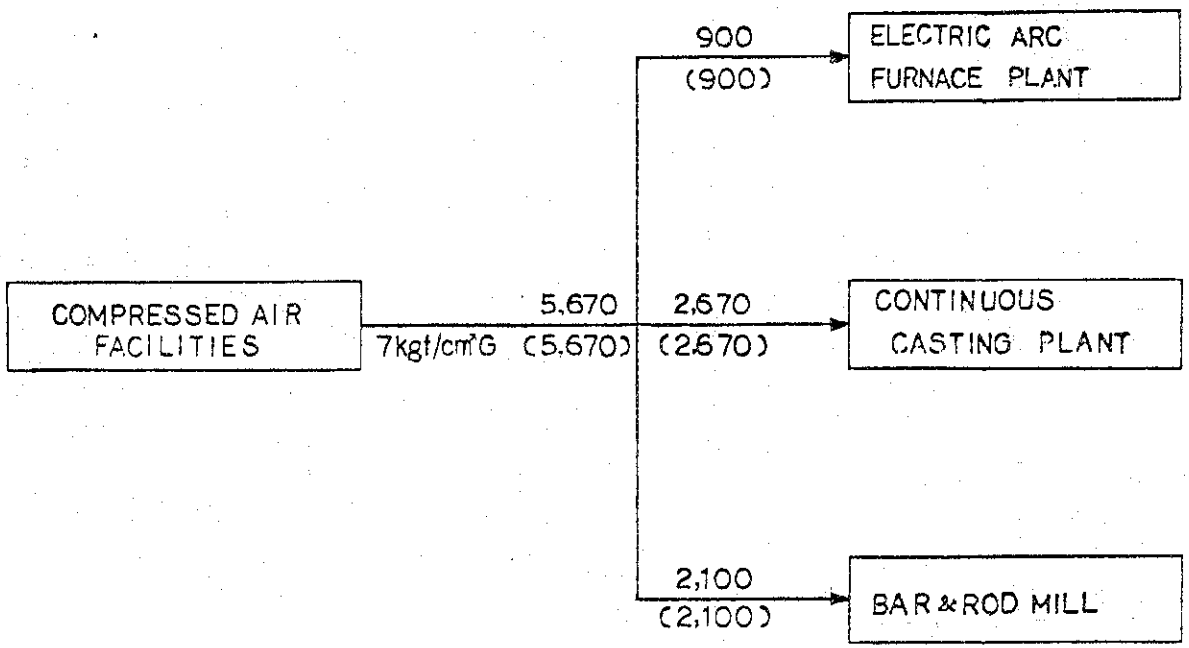
(4) Gas Balance

Compressed air balance is shown in Fig. 6.10-6.

(5) Manpower Requirements

Manpower requirements are shown in Table

Fig.6.10-6. COMPRESSED AIR BALANCE



NOTE

1. UNIT OF THE ABOVE FIGURES IS Nm³/hr.
2. THE ABOVE FIGURES ARE MAX. VALUE.
3. FIGURES IN( ) ARE AVERAGE VALUE.

6.9-3.

These facilities shall be operated by 4 crews working 3 shifts.

6.10.3.3 Equipment Specifications

Specifications of the main equipment are shown in Table 6.10-10.

6.10.3.4 Plant Layout

The compressed air facilities shall be located in the oxygen plant and the layout is shown in Dwg. No. JICA-6.9-01.

Table 6.10-10 Equipment List

Equipment	Q'ty	Main Specifications
1. Air Filter	3	Capacity: 3,000 Nm^3/h per one unit
2. Air Compressor	3	Capacity : 3,000 Nm^3/h Type : Screwed Discharge pressure : 7 Kgf/cm^2G
3. Valves	1 set	
4. Pipe with Accessories	1 set	
5. Instrumentation	1 set	
6. Electrical Equipment	1 set	

6.11 Intra-Transportation

6.11.1 Introduction

This chapter describes the following items:

(A) Storage and handling of raw material and other materials after arrival

(B) Intra-transportation of products

(C) Disposal and transportation of waste produced

(D) Others

6.11.2 Object Items and Quantity

Object items, quantity, details of handling, and work location, which are described in this chapter, are shown on Table 6.11-1.

Table 6.11-1

No.	Item	Amount technical handled data	Work description	Location
		(T/Y)		
1	Limestone	135,000	Yard arrangement, charging	Calcining plant
2	Burnt lime	61,000	Transportation	C. Plant ⟶ EAF

No.	Item	Amount handled	technical data	Work description	Location
		(T/Y)			
3-(1)	Fe-Mn	4,860		Yard arrangement, charging material into bag, bag loading on truck, transportation	Ferro alloy warehouse ——→ EAF
(2)	Fe-Si	4,050			
(3)	Coke breeze	3,240			
(4)	CaF_2	1,620			
4-(1)	Al	410			
(2)	Refractories	22,000	EAF: 7 kg/ steel T Repair: 11 Tundish: 5 Ladle: 4.5	Unloading after arrival, re-arrangement in yard, loading on truck, transportation	Warehouse for bricks ——→ EAF
(3)	Electrode	4,000	5 kg/ steel T	Yard arrangement, loading on dump truck, trans-portation	Stock yard ↓ EAF
5	Purchase Scrap	142,000		Yard arrangement, loading on dump truck, trans-portation	Stock yard ↓ EAF
6	Home scrap	79,000	EAF: 8,000T CC: 32,000T Mill: 39,000T	Transportation	EAF,CC,Mill ↓ EAF, Scrap, Shop
7	Products Rod Bar	723,000 (578,400) (144,600)	 80% 20%	Transportation	Mill ↓ Warehouse

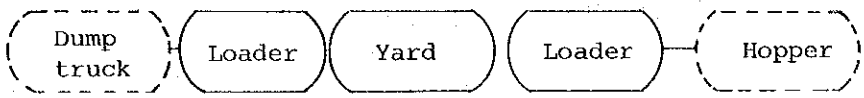
No.	Item	Amount handled	technical data	Work description	Location
		(T/Y)			
8	Lime fines	14,000		Transportation	C. Plant → Dump site
9	Oxide fines	55,800	5.5%	Loading on truck for outside destination	D.R. Plant
10	Slag	170,000	EAF: 200 kg/ steel T CC: 10 pcs.	Slag pan transportation, Crushing, Loading, Transportation	EAF.CC ↓ Slag processing yard ↓ Dump site
11	Waste bricks	9,700	12 kg/ steel T	Transportation	EAF.CC → Dump site
12	(Burnt lime fines)	3,000		(Loading on truck for outside destination from plant hopper)	
13	(Scale)	16,000	CC: 8,000T Mill: 8,000	Loading on truck for outside destination with plant crane	
14	General material, maintenance parts			Transportation	Inside works

6.11.3 Description of Work and Equipment

6.11.3.1 Limestone

(A) Amount handled 135,000 T

(B) Handling flow



(C) Equipment

(a) Wheel loader 2 m^2 Type

Work condition:

Efficiency	:	50 T/h
Operation ratio	:	70%
Work hours	:	21 H/D x 360 D/Y (3s without weekly holiday)

Required quantity:

$$\frac{135{,}000^{T} \times 2 \text{ times (including piling)}}{50^{T} \times 0.7 \times 21^{H} \times 360^{D}}$$

$= 1.02 \longrightarrow$ 1 set

(b) Stock yard : Open-air storage

Stock condition:

Stock period	:	15 days
Stock capacity	:	2 T/m^2

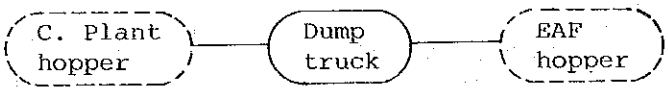
Required area:

$$\frac{135{,}000^{T}}{360^{D}} \times 30^{D} \div 2^{T} = 2{,}800\ m^2$$

6.11.3.2 Burnt Lime

(A) Amount handled : 61,000 T/Y

(B) Handling flow



(C) Equipment

Dump truck : 10T type, with closed special vessel (8 m^2)

To avoid moisture, the truck used must be equipped with closed type special vessel.

Work condition : 2 times/H, 70%, $21^{H} \times 300^{D}$ (with weekly holiday)

Required quantity:

$$\frac{61{,}000\ T/Y}{10^{T} \times 2\ times \times 0.7 \times 21^{H} \times 300^{D}}$$

$= 0.69 \longrightarrow 1$ set

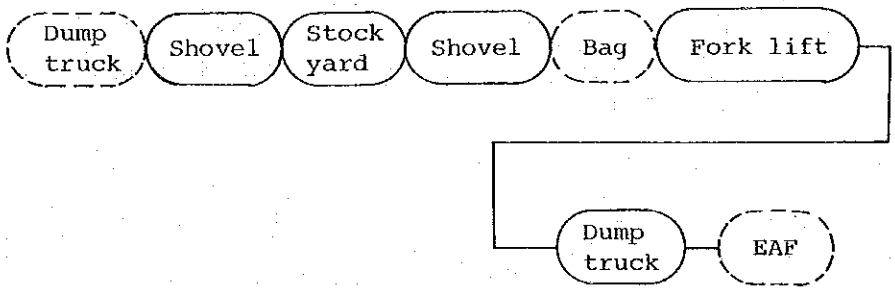
When this type of truck cannot be used due to failure, either a general dump truck covered with sheet is to be used for transportation or the transportation is to be suspended temporarily during rainy days while accommodating the EAF hopper stock for EAF operation.

6.11.3.3 Fe-M_2, Fe-Si, Coke Breeze, CaF_2

(A) Amount handled

Fe-M_n	4,860 T/Y	Total 13,370 T/Y
Fe-Si	4,050	
Coke Breeze	3,240	
CaF_2	1,620	

(B) Handling flow



(C) Equipment

(a) Stock yard

To prevent rain water, the stock yard has to be housed by the building. Details of builidng are as shown on Table 6.11-2.

Table 6.11-2

Item	T/Y	Average stock	Averaged amount of stock	Peak ratio	Max. stock	Capacity	Ware-house area
		(days)	(T)		(T)	(T/m^2)	(m^2)
Fe - M_2	4,860	90	1,215	1.3	1,579	1.5	105.0
Fe - Si	4,050	90	1,012	1.3	1,316	1.0	132.0
Coke breeze	3,240	30	270	1.3	351	0.3	117.0
CaF_2	1,620	60	270	1.3	351	1.0	35.0
Total: -	13,770		2,767		3,597		389.0

The warehouse is installed in conjunction with that for refractories to be described later.

(b) Tractor shovel : 1.4 m^3 type

Work condition : 12 T/H, 70%, $14^H \times 300^D$ (2^S with weekly holiday)

Required quantity :

$$\frac{13{,}370^T \times 2 \text{ times}}{12 \text{ T/H} \times 0.7 \times 14^H \times 300}$$

$= 0.76 \longrightarrow$ 1 set

(c) Bag : Loading capacity: 1.5T (internal volume 1 m^3, light weight 1T)

The bag belongs to EAF plant.

(d) Work lift : 6T type

Work condition : 2 bag/truck, 4 times/H, 70%, $14^H \times 300^D$

Required quantity :

$$\frac{13{,}370\text{T/Y} \times 2 \text{ times (empty bags included)}}{1.5^T \times 2 \text{ bags} \times 4 \text{ times} \times 0.7 \times 14^H \times 300^D}$$

$= 0.76 \longrightarrow$ 1 set

(e) Truck : 11T type

Work condition : 2 bags/times, 2 times/H, 70%, 14^{H} x 300^{D}

Required quantity :

$$\frac{13,370\ T/Y}{1.5^{T} \times 2\ bags \times 2\ times \times 0.7 \times 14^{H} \times 300^{D}}$$

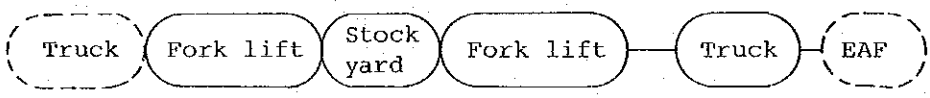
$= 0.76 \longrightarrow 1$ set

6.11.3.4 Al, Refractories, Electrode

(A) Amount handled :

Aℓ	:	400	Total 26,400
Refractories	:	22,000	
Electrode	:	4,000	

(B) Handling flow



(C) Equipment

(a) Stock yard

Indoor storage is needed. Details of building are as shown on Table 6.11-3.

Table 6.11-3

Item	T/Y	Average stock	Average amount of stock	Peak ratio	Max. stock	Capacity	Ware-house area
		(days)	(T)		(T)	(T/m^2)	(m^2)
Aℓ	400	30	33	1.3	43	1.0	40
Refractories	22,000	60	3,667	1.3	4,767	1.5	3,170
Electrode	4,000	60	667	1.3	867	1.0	860
Total	26,400		4,367		5,667		4,070

Warehouse layout including other ferro alloy (c.f., Table 6.11-2) required the area of about 8,000 m^2. Besides, the warehouse for general material and maintenance parts is also needed. Accordingly, the layout includes two warehouses of 30m x 150m for secondary raw materials and one warehouse of 30m x 150m (with a 10T crane).

(b) Fork lift : 2.5T type

Work condition : 25^{T}/H, 70%, 14^{H} x 300^{D} (2^{S}, with weekly holiday)

Required quantity:

$$\frac{26{,}400 \times 2 \text{ times (loading \& unloading}}{25^{T} \times 0.7 \times 14^{H} \times 300^{D}}$$

$= 0.72 \longrightarrow 1$ set

(c) Truck : 11T type

Work condition : 1 time/H, 70%, $14^{H} \times 300^{D}$

Required quantity:

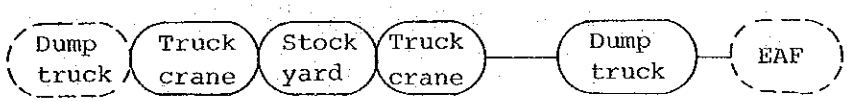
$$\frac{26,400}{11^{T} \times 1 \text{ time} \times 0.7 \times 14^{H} \times 300^{D}}$$

$= 0.82 \longrightarrow 1$ set

6.11.3.5 Purchased Scrap

(A) Amount handled : 142,000 T/Y

(B) Handling flow:



(C) Equipment

(a) Stock yard

Presupposition:

Average stock period	:	60 days
Peak ratio	:	150%
Capacity	:	3 T/m^2
Utilization ratio (height, etc.)	:	70%
Yard efficiency (passage, etc.)	:	70%

Yard area:

$$\frac{\frac{142{,}000^{T}}{360^{D}} \times 60^{D} \times 1.5}{3^{T} \times 0.7 \times 0.7} = 21{,}000\ m^2$$

(b) Truck crane : 30T type

Lifting magnet : 1,100ø with generator

Work condition : 40 T/H, 70%, $14^{H} \times 300^{D}$ (2^{S} with weekly holiday)

Required quantity:

$$\frac{142{,}000^{T} \times 2 \text{ times (yard piling included)}}{40^{T} \times 0.7 \times 14^{H} \times 300^{D}}$$

$= 2.41 \longrightarrow 3$ sets

(c) Dump truck : 15T capacity

(With vessel improved version of that for 11T type)

Work condition : 15 T/times, 1.5 time/H, 70%, $14^{H} \times 300^{D}$

Required quantity:

$$\frac{142{,}000\ T}{15^{T} \times 1.5 \text{ times} \times 0.7 \times 14^{H} \times 300^{D}}$$

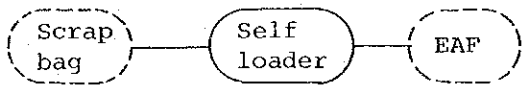
$= 2.15 \longrightarrow 3$ sets

6.11.3.6 Home Scrap

(A) Amount handled:

Scrap from EAF	:	8,000 T/Y	Total 79,000 T/Y
Scrap from CC	:	32,000 T/Y	
Scrap from Mill	:	39,000 T/Y	

(B) Handling flow



(C) Equipment

Self loading and dumping truck : 27 T type

Bag : Loading capacity: 10T
(Inner volume : 10 m^3,
Light weight : 6T)
Bag belongs to respective plant.

Work condition : 10T/times, 2 times/H, 70%, 14^H x 300^D

Required quantity:

$$\frac{79{,}000^T}{10^T \times 2 \text{ times} \times 0.7 \times 14^H \times 300^D}$$

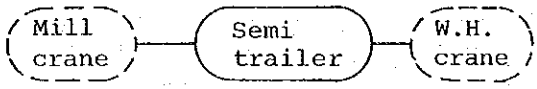
$= 1.34 \longrightarrow 2$ sets

6.11.3.7 Products

(A) Amount handled:

723,000 T/Y	Rod	80%	578,400
	Bar	20%	144,600

(B) Handling flow



(C) Equipment

Semi trailer : 20T type, Bed 12m

Work condition : 20 T/times, 1 time/H, 70%, 21^{H} x 300^{D} (3^{S}, with weekly holiday)

Required quantity:

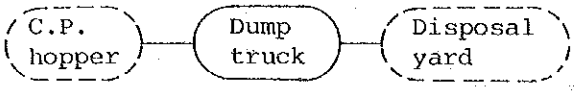
$$\frac{723{,}000^{T}}{20^{T} \times 1 \text{ time} \times 0.70 \times 21 \times 300^{D}}$$

$= 8.20 \longrightarrow 9$ sets

6.11.3.8 Lime Fines

(A) Amount handled : 14,000 T

(B) Handling flow



(C) Disposal yard

It is assumed that the disposal yard is located within one-hour distance (one way) from the plant and that no cost is incurred in this yard. (In accordance with the memorandum on March 16, 1979)

(D) Equipment

Dump truck : 11T type

Work condition : 11 T/times, 4 times/D, (operating ratio included), 300^{D}

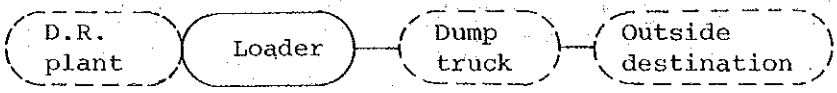
Required quantity:

$$\frac{14{,}000^{T}}{11^{T} \times 4 \text{ times} \times 300^{D}} = 1.06 \longrightarrow 1 \text{ set}$$

6.11.3.9 Oxide Fines

(A) Amount handled : 55,800 (Ratio 5.5%)

(B) Handling flow



(C) Presupposition

For outside destination by delivery loaded at yard.

(D) Equipment

Wheel loader : 2.0 m^3 type

Work condition : 50 T/H, 70%, 17^H x 300^D

Required quantity:

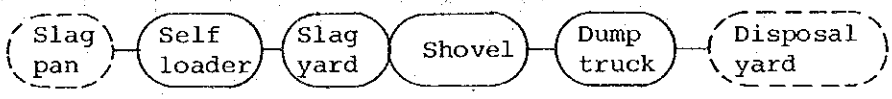
$$\frac{55,800}{50^T \times 0.7 \times 7 \times 300} = 0.76 \longrightarrow 1 \text{ set}$$

6.11.3.10 Slag

(A) Amount handled:

EAF	200 kg/steel T	162,000	170,000 T/Y
CC	10 kg/steel T	8,000	

(B) Handling flow



(C) Equipment

(a) Slag pan

Inner volume 10 m^3, Light weight 10T,

Stag 14T(70^T x 0.2)/Heat can be loaded.

Slag pan belongs to EAF.

(b) Self-loading and dumping truck (35T) exclusively for slag pan

Work condition : 14 T/times, 1.5 times/H, 70%, 21^H x 360^D

Required quantity:

$$\frac{170{,}000^T}{14^T \text{ x } 1.5 \text{ times x } 0.7 \text{ x } 21^H \text{ x } 360^D}$$

= 1.53 ⟶ 3 sets

Total of 3 trucks including one stand-by to cover increase in the number of transportations due to decrease in the loading amount for slag from CC.

(c) Tractor shovel : 1.5 m^3

Work condition : 50 T/H, 70%, 14^H x 300^D

Required quantity:

$$\frac{170{,}000^{T}}{50^{T} \times 0.7 \times 14^{H} \times 300^{D}} = 1.15 \longrightarrow 2 \text{ sets}$$

(d) Dump truck : 11T type

Work condition : 11 T/times, 4 times/D, 300^{D}

Required capacity:

$$\frac{170{,}000}{11^{T} \times 4 \text{ times} \times 300^{D}} = 12.88 \longrightarrow 13 \text{ sets}$$

(D) Disposal yard

It is assumed that the disposal yard is located within one-hour distance (one way) from the plant and that no cost is incurred in this yard. (In accordance with the memorandum on March 16, 1979)

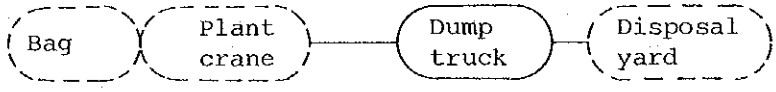
(E) Steel from slag yard

Steel from the slag yard is to be handled by means of truck crane with lifting magnet and dump truck assigned to the purchased scrap yard.

6.11.3.11 Waste Bricks

(A) Amount handled : 9,600 T/Y

(B) Handling flow



(C) Equipment

Dump truck : 11T type

Work condition : 11 T/times, 4 times/D, 300^{D}

Required capacity:

$$\frac{9,600}{11^{T} \times 4 \text{ times} \times 300^{D}} = 0.73 \longrightarrow 1 \text{ set}$$

(D) Disposal yard

It is assumed that the disposal yard is located within one-hour distance (one way) from the plant and that no cost is incurred in this yard. (In accordance with the memorandum on March 16, 1979)

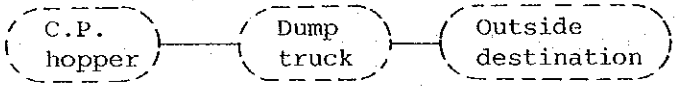
6.11.3.12 Burnt Lime Fines

(A) Presupposition

For outside destination by delivery loaded at yard.

(B) Amount handled : 3,000 T/Y

(C) Handling flow



6.11.3.13 Scale

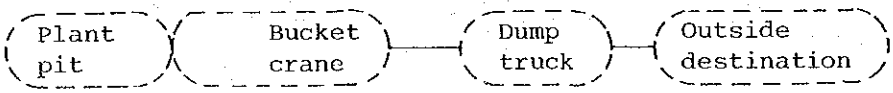
(A) Presupposition

For outside destination by delivery loaded at yard.

(B) Amount handled : 16,000 T/Y

CC	8,000 T/Y
Mill	8,000 T/Y

(C) Handling flow



6.11.3.14 General Material and Maintenance Parts

5T trucks (5 trucks) are provided for the intra-transportation of general material and maintenance parts.

6.11.4 Weighing Machine

50T truck weighing machine is provided in the works to weigh raw material, part of products to be shipped, home scrap for the yield control, etc.

6.11.5 Personnel and Work System

Personnel arrangement as determined from the equipment plan and capacity so far described is shown on Table 6.11-4.

Table 6.11-5 shows the work system.

6.11.6 Equipment for Transportation

Equipment list is shown in Table 6.11-6.

Table 6.11-4 Personnel arrangement for intra-transportation

Item	Work description	Work condition	Personnel	
Limestone	Wheel loader	21^{H} x $360^{D/Y}$	1 x 4	4
Burnt lime	Dump truck	21 x 300^{D}	1 x 3	3
Secondary material	Tractor shovels	14^{H} x 300	1 x 2	14
	Fork lift	14^{H} x 300	2 x 2	
	Truck	14^{H} x 300	2 x 2	
	Warehouse control	14^{H} x 300	2 x 2	
Scrap	Yard	14 x 300	1 x 2	18
	Truck crane		3 x 2	
	Dump truck		5 x 2	
Products	Semi trailer	21^{H} x 300	9 x 3	27
Lime fines	Dump truck	8 x 300	1 x 1	1
Oxide fines	Wheel loader	7 x 300	1 x 1	1
Slag	Slag pan self loader	21^{H} x 360	2 x 4	25
	Tractor shovel	14 x 300	2 x 2	
	Dump truck	8 x 300	13 x 1	
Waste bricks	Dump	8 x 300	1 x 1	1

Item	Work description	Work condition	Personnel
Trans-portation	Truck	7 x 300	5 x 1 5
Weighing		21 x 360	1 x 4 4
Operational plan		21 x 360	1 x 4 5 1 x 1
Supervisor		21 x 360	1 x 4 4
Total: -			6 x 4 112 10 x 3 18 x 2 22 x 1

Table 6.11-5 Work system for intra-transportation

Foreman	Work class	Sub-Foreman	General	Total
1 x 4	Cargo machines	(1 x 2)	1 x 4 8 x 2 1 x 1	21
	Dump truck	(1 x 2)	1 x 3 5 x 2 15 x 1	28
	Truck	(1 x 1)	2 x 2 5 x 1	9
	Slag loader	(1 x 4)	2 x 4	8
	Trailer	(1 x 3)	9 x 3	27
	Planning and weighing	(1 x 4)	2 x 4 3 x 2 1 x 1	15
1 x 4		(2 x 4) (1 x 3) (2 x 2) (1 x 1) (16)	5 x 4 10 x 3 18 x 2 22 x 1	4 108

Table 6.11-6 List of Equipment

No.	Item	Q'ty	Specification
1	Building of secondary		
	Buildings	1 set	30m x 150m x 2 buildings
	Crane	1 set	10T overhead type
2	Weighing machine	1 set	50T truck weighing machine with control house
3	Cargo and transportation machine		
	1) Truck 11T	2 sets	
	2T	5	
	2) Dump truck 15T	3	11T vessel improved for scrap
	11T	15	Universal
	10T	1	Closed type special vessel (10 m^3) for burnt lime
	3) Semi trailer 20T	9	Bed: 12m
	4) Self loader 27T	2	

No.	Item	Q'ty	Specification
	5) Bag exclusively for self loader	9 pcs.	10 m^3
	6) Self loader for slag pan 33T	3	
	7) Truck crane 20T	3	
	8) Lifting magnet	3 pcs.	1,100ø with generator
	9) Fork lift 10T	4	
	6T	1	
	2T	1	
	10) Wheel loader 2m^2	2	
	11) Tractor shovel 1.4m^2	3	
	Total:	13 pcs. 54 sets	

6.11.7 General Purpose Road connected to the Plan

Raw materials excluding pellet and products to be shipped, are carried in and out of the works on trucks or trailers. Besides, the general road running to the north of plant is the main road to Matrouh, where the traffic is rather thick. It is advisable therefore to specify the size and number of vehicles to and from this works as well as to improve the road beforehand while taking the construction work for the plant.

Table 6.11-7 Estimated number of vehicles (at Stage 1)

Item	Q'ty (T/Y)	Transported lot (T/set)	Vehicles/ year	Vehicles/ day (300D/Y)	Vehicles/ hour (7H/D)	Peak ratio	Max. vehicles/ hour
Limestone	135,000	10	13,500	45			
Secondary material	40,180	10	4,018	14			
Scrap	142,000	15	9,467	32			
Product	723,000	10	72,300	241			
Waste residue	268,000	10	26,850	90			
Passenger cars, etc.	-	-	-	200			
Total: -				622	89 sets	3.0	267 sets

As is evident from the table, car traffic is concentrated to 7 hours in the daytime. Particularly, with the peak ratio during rush hours in the morning and evening being 300%, about 540 cars (coming in 270 cars and going out 270 cars) passes per hour.

Largest cars expected is a trailer of 2.8 mW x 15 mL to transport bars of 12m length.

6.12 Maintenance Shop Facilities

6.12.1 General Description

6.12.1.1 The maintenance activities should be carried on by establishing a proper maintenance system which primarily will lend itself to improve the production economy while conforming to the content of equipment and the state of production from the economical viewpoint. In this sense, they may contain what is termed as Productive Maintenance. With the recent enlargement of production scale and progress of mechanization, the maintenance activities are now gradually coming to play a decisive role respecting to the quality, efficiency and costs in the operating plant. Also, the cost of maintenance is steadily increasing its weight within the overall production cost because of the nature of this industry depending largely upon the installed facilities. In view of such circumstances, the maintenance activities should be considered to function as an integral part closely tied up to the production activities, and should contribute to the achievement of the abovementioned factors, it is desirable for the maintenance organization of this works to follow the line-and-staff system and then to cope

with the future equipment additions by flexibly making partial modifications or readjustments or the like as may become necessary to carry on effective and economical maintenance activities.

6.12.1. On the basis of the proposed installation of an integrated iron and steel works having a capacity of producing 800,000 tons of crude steel per year, one thing essential for providing the production schedule with a sufficient maintenance is to set up the policy of the department in charge of productive maintenance. This policy should cover the breakdown of the basic policy of the management with respect to the equipment control. In order to improve the profitability of enterprise, a drastic cut-down of the production cost may well be needed. Therefore, as a part of the effort in this direction, control activities should be continued in every respect to reduce the maintenance cost. The control policy of the productive maintenance department will comprise the following items:

1) Maintenance schedule pointed to the vital points and its practice.
2) Improvement of maintenance technique and encouragement of the willingness to the betterment.

3) Training of the maintenance staff to be able to cope with the technological innovations.

4) Improvement of control technique.

Table 6.12-1 Relationship - - - - - - - - - Operator and Maintenance people

Typical failure patterns of equipment

	Characteristics	Relation with maintenance	Maintenance countermeasure	
Initial failure period (Decrease in failure rate)	Initially the failure rate is high and failure occurs in defective facilities, but the rate decreases with time and facilities relatively high in reliability remain in use.	No preventive maintenance is planned. Since selection of facilities is done with time, what is necessary is to exchange defective ones. After intermediate inspection or modifications the same phenomenon is often observed temporarily.	1) To optimize maintenance system at the start of operation 2) To improve the skill of operators at an early stage 3) To analyze the cause of failure and cope with it as quickly as possible.	M O M
Random failure period (constant failure rate)	The failure rate per hour is constant, but the place and time of failure occurrence are quite unpredicted. This type of failure occurs in case that component failure patterns are different and that components are changed every time failure occurs or that stress is loaded at random.	Preventive maintenance is not very effective. For better working rate failure downtime must be reduced. In other words, it is necessary to reduce failure detecting time, actual repairing time and the delay time of spare parts supply.	1) To improve the failure detecting ability of maintenance workers 2) To improve the actual reparing ability of repair workers 3) To be well-equipped with spares 4) To reduce the failure rate through improvement design 5) To carry out redundancy design which serves for better maintenance.	M R M M M
Wear-out failure period (increased failure rate)	This failure is the phenomenon of abrasion of parts, and this type of failure stems from what is called the end of service life of things. This type is characterized by the concentration of failure occurrences at a certain time point due to abrasion or aging.	It is effective to change parts before the concentration of failure occurences in the sense of preventive maintenance. For this purpose, periodical inspection is required to grasp deterioration tendency.	1) To improve the inspection ability of maintenance workers 2) To improve the repairing ability of repair workers 3) To improve the reliability of spares and delivery control 4) To clean, oil and adjust parts to slow down deterioration speeds 5) To carry out the improvement design of parts.	M R M OM M

O : Operator M : Maintenance R : Repair

6.12.1.3 Basic Plan

1) To correspond with the production facilities of
   800,000 T liquid steel/year
   723,000 T bar and rod production/year
2) To be mainly on repair of iron and steel making facilities. Spare parts are to be procured from outside.
3) Maintenance organization will consist of 3 departments : Maintenance Control, Maintenance and Repair.
4) Required man power was calculated on the basis of main maintenances being done by own maintenance department.

6.12.1.4 Rationalization of Equipment Maintenance Activities

1) It is desirable that the checking and inspection performed by local inspectors having special technical ability be confined only to the important part of equipment, leaving the rest to operators for moving, testing and oiling to fill up the details as an effective measure of preventive maintenance. (See table 6.12 - 1)
2) Member of the local inspection team will consider the repair cycle of the existing period

from the inspection results and the work schedule, and will inform the desirable date of the next month periodical repairs, the hours to be required and major work item which was decided by the member of team to the repair work personnel. In this way the schedule of periodical repairs is usually fixed, but anyhow maintenance is always an accumulation of actual records and performances.

3) Repair personnel are not allocated to local areas, and it has better adopt a policy of centralization with higher maneuverability.

6.12.2 Plant Program

Installations of integrated iron and steel works may be generally classified into machinery, electrical, instrument and others.

In order to improve the productivity of those equipment, it is necessary to make once-a-year major and/or medium repair and once-or-twice per month periodical repair or routine repairs, admitting that the above repair cycles would be different from one plant to another. The following maintenance plants are to be prepared to suffice the above repair requirement.

6.12.2.1 Maintenance Shop:

1) Machine shop
2) Overhaul and assembly shop
3) Steel frame shop (Include piping, welding, forging casting works)
4) Electric repair shop
5) Meter maintenance shop
6) Locomotive, wagon car repair shop

6.12.2.2 Machine Shop

1) Maintenance facilities cover 30% to total manufacturing volume for maintenance. (Emergency 20%, periodical repair 10%) Spare parts are to be procured from outside.
2) Machine Shop have not gear cutting machine. Then gear cutting are to be outside.
3) Surface grinder ----- future
4) Special Surface Treatment are to be outside.

6.12.2.3 Overhaul and Assembly Shop (Repair Shop)

1) Emergency and accidental repairs are made in principle by in-company workers who are therefore expected to have multiple skills. Job scheme consists of 3 shift organization to cope with the operating plant and of

a day-time concentrated force task force.

2) Assembly Shop have hydraulic test equipments.

3) Special repair facilities (ex boiler periodical repair, etc.) are to be outside.

6.12.2.4 Steel Frame Shop

1) Forging and casting works are considered in steel frame shop. Casting works are made by crucible. (only brass and bronze casting)

2) Heating furnace utilize for heat treatment after welding.

3) 15 T Truck crane is used outside repair works.

6.12.2.5 Electric Repair Shop

1) Facilities are to have the ability to repair DC motors up to 100 KW and AC Motors up to 220 KW.

2) Repair facilities for transformers are to be makers.

3) Repair and reassembling of switch parts can be made.

4) Inspection of relay meters and repair of those can be made.

5) Electrical apparatus testing equipment. Un-loaded test repaired DC. 100 KW and AC 220 KW can be made.

6.12.2.6 Meter Repair Shop

1) Instruments are estimated as will be needed when EF is put into operation.
2) Inspection of purchased instruments at the time of delivery should be enforced (for industrial instruments in general).
3) Enforce the maintenance, repair and inspection work to those equipment in which instruments are installed.

6.12.2.7 Car Repair Shop

Facilities having the capacity of

a) monthly inspection
b) vital part inspection
c) overall inspection
d) extraordinary inspection

with locomotives and flat cars.

- Diesel locomotives or track mobile
- Truck
- Car

6.12.3 General Layout of Maintenance Shop

Maintenance shop layout shows Fig 6.12 - 1.

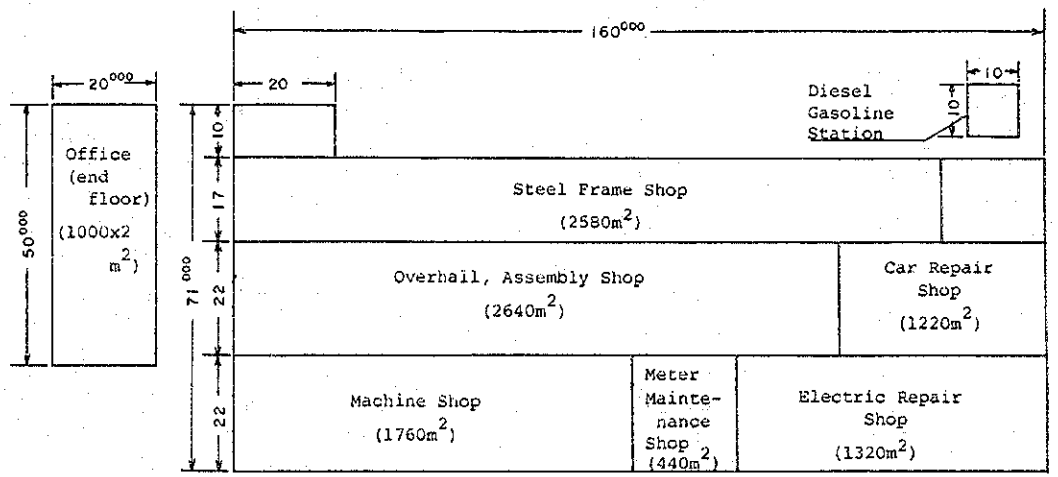


Fig. 6.12 - 1 Maintenance Shop General Layout

6.12.4 General Specification of Maintenance Shop

Fig. 6.12 - 2 shows the list of required facilities and the general specification.

Maintenance Shop

Fig. 6.12-2 SPECIFICATION OF MAIN FACILITIES

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
	Macine Shop			
1	5 M Lathe	1	Swing 820 Length 5200 (center distance) Main spindle velocity range 12 ∿ 1200 rpm	
2	3 M Lathe	1	Swing 750 Length 3000 Main spindle velocity range 20 ∿ 1500 rpm Attachable grinding head at tool head	
3	1.5 M Lathe	1	Swing 500 Length 1300 Main spindle velocity range 25 ∿ 1500 rpm	
4	1 M Lathe	1	Swing 400 Length 800 Main spindle velocity range 25 ∿ 1500 rpm	
5	Boring Machine (Radial)	1	Main spindle 110ϕ 20 ∿ 1000 rpm Rotary table 1200 x 1200 Table cap. wt 1000 kg Stroke in-out 650 up-down 1200 table 1400	
6	Planer	1	Material size 1000W x 1000H x 3000L Left-right forward 0 ∿ 24 mm/stroke Tool forward 0 ∿ 10 mm/stroke	
7	Milling Machine	1	Universal type #2 Table travelling stroke Left-right 700 Forward-back 250 Up-down 450 Main spindle 60 ∿ 1800 rpm (12 steps)	

SPECIFICATION OF MAIN FACILITIES

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
8	Shaper	1	Max stroke 650 x wide 650 Table size 350 x 400 x 400	
9	Slotter	1	Max stroke 310 Table size 550φ	
10	Drilling Machine	1	Radial type, drill dia. 50φ Distance colume surface ∿ Main spindle 1300 Arm up-down stroke 820 Main spindle up-down stroke 400	
(11)	(Grinder)	(2)	(Surface grinder ..... future) (Cylindrical grinder ... future)	
12	High Speed Cutting Machine	1	Cutting material dia max 300φ Cutting speed 16 ∿ 45 m/min	
12	Tool Grinding Machine	1	Grinding cap. drill dia 12φ ∿ 80φ Top Angle 70° ∿ 145° Grinding disc dia 150φ x 63	
13	Double Wheel Grinder (for tool grinding)	2	Grinding disc dia 20.5φ x 16 3000 rpm	
15	Bench Drill	2	Drill dia 13φ table dia 255φ	
16	Marking Table	1	2000 x 4000	

SPECIFICATION OF MAIN FACILITIES

Maintenance Shop

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
	Overhall & Assembly Shop			
1	Press Drawing Machine	1	Horizontal type Capacity 200T Stroke 500 Machine inside size 1500W x 4000L Hyd. pump 140 kg/cm^2 plunger speed 500 mm/min	
2	Levelling Plate	1	Rail-type 3000 x 5000	
3	Levelling Plate (Surface Plate)	1	2000 x 4000	
4	Hydraulic Test Equipment	1	Pump, valve, cylinder etc. test equipment Hyd pump 140 kg/cm^2 200ℓ/min Tank capacity 1000ℓ	
5	Hydraulic Pump and Jack	1 set	Pump max 350 kg/cm^2 x 5ℓ/min 1 set Jack 100T x 300 stroke 2 sets 50T x " 4 sets 10T x " 4 sets	
6	Drilling Machine	1	Upright type 50φ Table dia 600φ Swing 650	
7	Double Wheel Grinder	2	Grinding disc dia 305φ x 25 1500 rpm	
8	Magnet Drilling Machine	2	Drill dia 13φ 30φ portable type	
9	Bench Drilling	1	Drill dia 13φ Table dia 255φ	
10	Balancing Machine	1 set	i) Static balancing machine Rail type levelling plate 3000 x 3000 1 set Horizontal base 2 sets Height 800, Length 2000 use 15 kg/m ii) Portable static balancing instrument 1 set	

SPECIFICATION OF MAIN FACILITIES

Maintenance Shop

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
11	Travelling Car (Track)	1	Capacity 10T Rail gauge 1600 Motor drive	
12	Other Equipments	1 set	i) AC Arc Welder 300 A 2 sets ii) Winch, Electric type 1 TON 2 sets iii) Chain block, Electric type 5 TON x 4M 2 sets iv) Pipe screw cutter 50φ 1 set	
13	Bar and Rod Mill Maintenance Room Equipments	1 set	i) Electric Heating Box 1 set 10 KW max 200°C ii) Cooling Fit Box 1 set 1000 x 1000 x 1000 use liquid CO_2 -75°C iii) Small size drilling machine 1 set Drill dia 13φ table dia 255φ iv) Double wheel grinder 1 set grinding disc 305φ x 25 1500 rpm v) Jib crane 2 TON Arm Length 4000 1 set vi) AC Arc Welder 300A 1 set vii) Gas cutter 1	

SPECIFICATION OF MAIN FACILITIES

Maintenance Shop

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
	Steel Frame Shop			
1	Heating Furnace	1	Heating and Normalizing furnace Heating for material of forge Normalizing for stress relief after welding Batch type, car type Furnace inside length 3000 x 3000 x 3000 H Fuel oil Air atomize Car capacity 3T, Rail gauge 1600 Motor drive (only pull out)	
2	Forge Furnace	1	Batch type, fixed type Furnace inside length 1000 x 1000 x 1000H Fuel oil Air atomize	
3	Air Hammer 1/2T	1	Capacity 1/2T Max stroke 785, Hammering 110 numbers/min Effective material dia 300ϕ Rain pallet 150 x 250	
4	Swage Block	1	2000 x 3000 For forge, pipe & angle bending	
5	Anvil	1		
6	500 T Press	1	Capacity 500T Hydraulic type Stroke 700 Daylight 1000 Table size 2000 x 2000	

SPECIFICATION OF MAIN FACILITIES

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
7	Welding Units	1 set	i) Unionmelt welder 1 set Side beam type 300 ∿ 1000A Wire dia 2.4ϕ ∿ 6.4ϕ ii) AC Arc welder 500A 2 sets iii) 300A 5 set iv) TIG welder 1 set ACHF type High frequency 2MC. 2000 ∿ 3000 Volt Tungsten electrode dia 3.2ϕ	
8	Bending Roller	1	3 rollers type Bending capacity 2500W x 20T (SS)	
9	Angle Bender	1	Max cap. L 13t x 100 x 100 Pipe 100ϕ x 6.5t	
10	Drilling Machine	1	Upright type 50ϕ Table dia. 600ϕ Swing 650	
11	Bench Drilling	1	Drill dia 13ϕ Table dia 255ϕ	
12	Double Wheel Grinder	3	Grinding disc dia 305ϕ x 25t 1500 rpm	
13	High Speed Cutting Machine	1	Cutting material dia 200ϕ Cutting speed 16 ∿ 45 m/min	
14	Levelling Plate	1	2000 x 4000	
15	Crucibel	1	Fixed, top open type Crucible cap 200 kg/1 charge Fuel oil Graphite crucible	

SPECIFICATION OF MAIN FACILITIES

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
16	Sand Mill (Mixer)	1	Vertical roller type Barrel dia 1000ϕ	
17	Gate Cutting Machine	1	Band saw type	
18	Carpentry Wood Pattern Manufacturing	1 set	(i) Wood rathe ... 1M (ii) Band saw ... Endless band (iii) Hand Plane machine (iv) Wood boring machine (v) Bench drill 30ϕ	

SPECIFICATION OF MAIN FACILITIES

Maintenance Shop

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
1	Electric Repair Shop			
	Motor Winding Equipments	1 set	i) Coil winder Motor drive, center height 790 ii) Coil winder Hand type, center height 300 iii) Band winder	
2	3 M Lathe	1	Swing. 750 Length 3000 (center distance) Main spindle vel. range 20 ∿ 1500	
3	Cutter	1 set	i) Cutter Motor drive, capacity 1000W x 5t ii) Cutter Foot type, capacity 1000W x 2t	
4	Milling Machine	1	Universal type #0 Table travelling stroke Left-right 450 Forward-back 150 Up-down 300	
5	Portable Milling Machine	1	30φ Main spindle rpm 390 ∿ 880 rpm	
6	Bench Drilling	1	Drill dia 13φ, Table dia 255φ	
7	Double Wheel Grinder	1	Grinding Disc dia 305φ x 25, 1500 rpm	
8	Drying Furnace	1	Steam type Furnace inside 4000L x 2500W x 2500H Steam header (3"φ) installed inside Max temp 160°C Steam press. 5 ∿ 7 kg/cm^2 Car capacity 2T (non drive)	

SPECIFICATION OF MAIN FACILITIES

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
9	Varnish Treatment	1		
10	Testing Equipment	1 set	AC Motor test panel 3 KV 220 KW " " " " 220 ∿ 400V 100 KW DC test SCR " 100 KW IVR (Induction Voltage Regulater) Test surface plate - rail type 3500 x 6000 Instruments (Recorder others)	

SPECIFICATION OF MAIN FACILITIES

Maintenance Shop

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
	Car Repair Shop			
1	Lifting Jack	5	Capacity 25T Mr type Portable type (Handle) Stroke (claw lift) 1200 Claw min height 600 Up and down speed 300 mm/min	

SPECIFICATION OF MAIN FACILITIES

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
	Meter Maintenance Shop			
1	Hand Balance	1	0 ∿ 10T accuracy 1/1000	
2	Standard Balance	1	0 ∿ 1T accuracy 1/10000	
3	Levelling Plate	1	2000 x 4000	
4	Weight	1 set	10T - 6 sets 5T - 6 sets 2T - 10 sets 1T - 10 sets 500 kg - 5 sets 20 kg - 10 sets	
5	Heat Instruments Inspection	1 set	i) Black body furnace Range 1000 ∿ 2000°C Horizontal tube 45φ ii) Black body furnace Range 400 ∿ 1200°C Horizontal tube 65φ iii) Thermostatic bath Two bath type -50 ∿ 300°C iv) Surface temp. inspection furnace Range 400 ∿ 1000°C	
6	Meter Inspection Equipment	1 set	i) Standard balance 20 kg - 1 set 5 kg - 1 set 200 gr - ii) Special Levelling table 1000 x 1000 (Inspection of gauge) iii) Recorder Pen drawing oscillograph Others	

Specification of Main Facilities

Maintenance Shop

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
	Others			
	Levelling Plate	1	3000 x 4000 Inspection of spare parts	Warehouse
	Drawing Printing Machine	1	Dry Printing machine size up to 1189 x 841	Maintenance sub office 1st floor
	Diesel and Gasoline Station	1 set	Under ground tank 10kℓ 2 sets (for gasoline) 2kℓ 1 set (for Engine oil) 1 set (for drain oil) Oil supply machine 3 sets	

SPECIFICATION OF MAIN FACILITIES

Maintenance Shop

NO.	EQUIPMENT	Q'TY	SPECIFICATION (GENERAL)	REMARKS (GENERAL)
	Cranes			
1	10T x 20M Crane	1	Operating on floor	
2	3T x 20M Crane	1	Operating on floor	
3	15T/5T x 20M Crane	1	Operating in cage and on floor Cage position is steel frame work side	
4	3T x 20M Crane	1	Operating on floor	
5	15T/3T x 15M Crane	1	Operating on floor	
6	3T x 15M Crane	1	Operating on floor	
7	0.5T Hoist	1	Rail Height 5000	
8	2T Jib Crane	6	Arm Length 4000 chain trolley	
9	0.5T Portable Crane	1	Arm Length 3000 Portable Jib Crane	
10	15T Truck Crane	1	Hydraulic Type	
11	Fork Lift	1	1 TON	
		1	0.5 TON	
12	Truck	1	12 TON, Low body type	