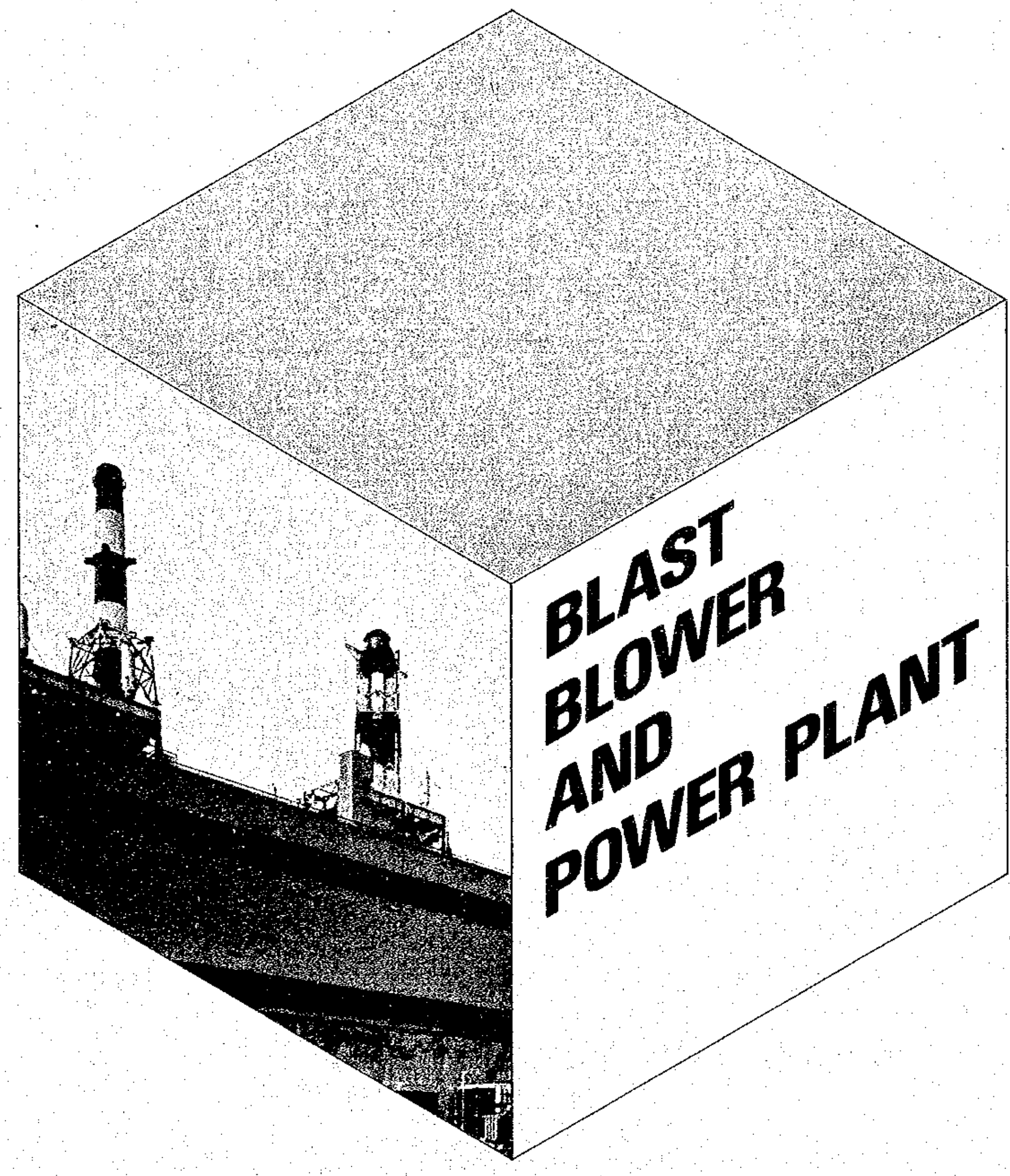
CHAPTER 13-12



13-12 Power and blast furnace blower plant

13-12-1 General

This plant consists of two sets of boilers, turbines, generators and blast furnace blowers, which are used to supply the electric power and blast blowing for use with the steelworks plants by making effective use of BFG, COG, and LDG generated in the steelworks.

For better plant efficiency, the steam used widely in the steelworks shall be supplied by the extracted steam from the turbine. The same steam turbine shall be used to drive the generator and the blower.

When one blast furnace (2 units) is in operation, one turbine (two units) may be used for the power generator/blower and the other for the power generator.

13-12-2 Preconditions

Based on the gas balance when the new steelworks in stage I is producing 1,500,000^{t} of crude steel per year, the power plant shall normally use an amount of BFG and COG equivalent to 80,000^{kW}.

Since the steelworks is assumed to produce 3,000,000$^{t/y}$ of crude steel in stage II, the power plant facilities shall be extended to meet the demand for generating 60,000^{kW} of electrical power.

For the blast furnace operations, the blast blower shall need a stand-by blower; a 2-unit system for stage I, and a 3-unit system for stage II.

The periodical maintenance of the power/blast furnace blower plant shall be needed every two years at least, for the purpose of the stable and trouble-free operations (the period of the periodical maintenance is approx. thirty days).

By-product gases shall be released during the time of this maintenance.

Such wasting of by-product gases, however, may be more economical than ocnstructing one more unit. Accordingly, the by-product gases shall be released during the time of the periodical maintenance of the power and blast furnace blower plant.

(1) Equipment capacity conditions

1) Steam turbine output

As for the capacity of the steam turbines, each of the two turbines to be installed in stage I shall have a capacity of 40,000^{kW} and one turbine in stage II shall have a capacity of 60,000^{kW}, in order to use the remaining BFG and COG which have been processed at each plant according to the gas balance and to use LDG exclusively for the power plant.

2) Blower capacity

The blowing amount and pressure at the inlet of the hot stove shall be calculated on the basis of the inner volume and top pressure of the blast furnace.

The blowing conditions shall be determined considering the resistance of the pipes installed between the power and blast furnace blower and the hot stove.

Required maximum shaft input of blower:

① Blown air temperature .... 35°C

② Relative humidity of blown air 75%

③ Blowing pressure .... $3.7^{kg/cm^3}$

④ Blowing amount .... $4{,}550^{Nm^3/min.}$

⑤ Adiabatic efficiency of blower 85%

The required maximum shaft input of blower shall be set at $21{,}000^{kW}$ by calculating these conditions above.

3) Use of T-G-BL and extracted steam

The blower needs a stand-by blower. The T-G-BL system shall be employed as the most economical method in making use of energy for the steelworks because the system is able to enhance the efficiency of the stand-by blower and supply the general steam used in the steelworks by means of extracting from the turbine.

According to the balance of the general plant steam, the amount of the extracted steam shall be max. $30^{t/hr}$ per unit.

4) Steam conditions

Considering the fact that steam conditions have a great effect on construction costs or thermal efficiency, the temperature and pressure of the turbine steam shall be 540°C and $100^{kg/cm^2}$ at the turbine inlet respectively.

These values are considered as the most economical for $40{,}000^{kW}$-class turbines.

(2) Operating conditions

1) Cooling water Type: Seawater

Temperature: Max. 30°C

2) Fuels

BFG:	Supplies up to 90% of the required heat input of boilers.
COG:	Supplies up to 100% of the required heat input of boilers.
LDG:	$12{,}500^{Nm^3/hr}$ of average consumption
Heavy oil:	Supplies up to 65% of the required heat input of boilers.

3) Air temperature and humidity

Maximum temperature .... 35°C

Relative humidity 75%

13-12-3 Equipment specifications

(1) Production

Table 13-12-1 shows the levels of the electric power and blowing that are produced under normal conditions in the power and BF blower plant.

Table 13-12-1 Power and blast generated by the power and B.F. blower plant

(Unit: KW)

		Turbine output	Blower shaft input	Output of generating terminal
Stage I	No. 1 unit	40,000	15,000	25,000
	No. 2 unit	40,000	* ——	40,000
	Total	80,000	15,000	65,000
Stage II	No. 1 unit	40,000	15,000	25,000
	No. 2 unit	40,000	15,000	25,000
	No. 3 unit	60,000	* ——	60,000
	Total	140,000	30,000	110,000

(2) Main equipment specifications

Table 13-12-2 shows the specifications of the main equipments.

Table 13-12-2 Equipment specifications

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
1) Boiler	2		1	
Steam generation		185 t/hr		255 t/hr
Steam pressure		103 kg/cm^2G		103 kg/cm^2G
Steam temperature		543°C		543°C
2) Steam turbine	2	Extracted and condenced turbine	1	Extracted and condenced turbine
Output		40,000 KW		60,000 KW
Rotation		3,600 rpm		3,600 rpm
Degree of vacuum		709 mmHg		709 mmHg
3) Generator	2		1	
Output		40,000 KW		60,000 KW
Rated voltage		11,000 V		11,000 V
4) Blast furnace blower	2		1	
Maximum blast volume		4,550 $Nm^3/min.$		4,550 $Nm^3/min.$
Maximum blast pressure		3.7 kg/cm^2G		3.7 kg/cm^2G
Normal blast volume		4,050 $Nm^3/min.$		4,050 $Nm^3/min.$
Normal blast pressure		3.2 kg/cm^2G		3.2 kg/cm^2G
Maximum shaft input		21,000 KW		21,000 KW
5) Extracted steam	2	30 t/hr	1	30 t/hr

Note: Under normal blowings, the required shaft input of the blower is 15,000 kW.

(3) Power and blast blower system

Fig. 13-12-1 shows the power and blast blower system.

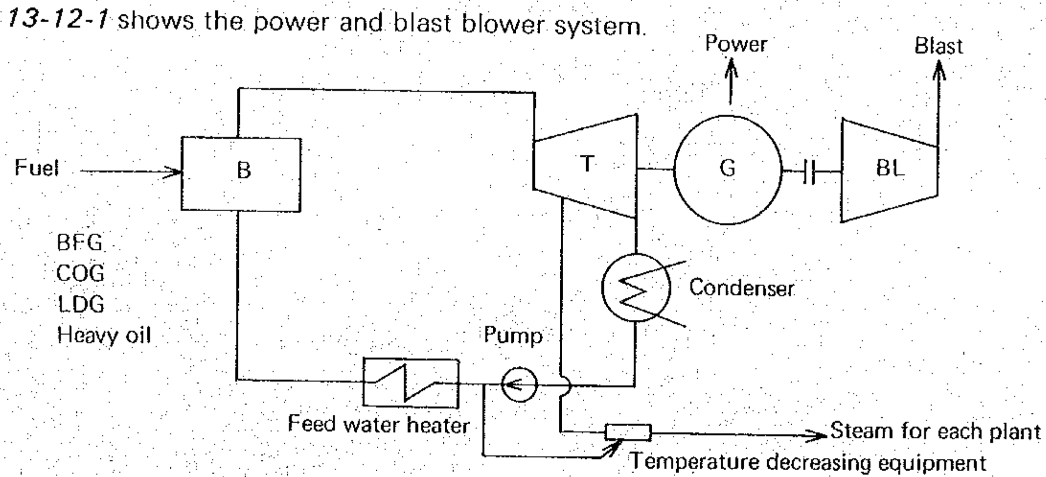


Fig. 13-12-1 Block diagram of the generator/blower

13-12-4 Layout of power and BF blast blower plant

Fig. 13-12-2 shows the layout of the power and BF blast blower plant.

13-12-5 Technical explanation

Given below are the technical comments.

(1) The power and blast blower plant is almost perfect, technically.
No technical problem shall arise if the specialized maker constructs the power and blast blower plant.

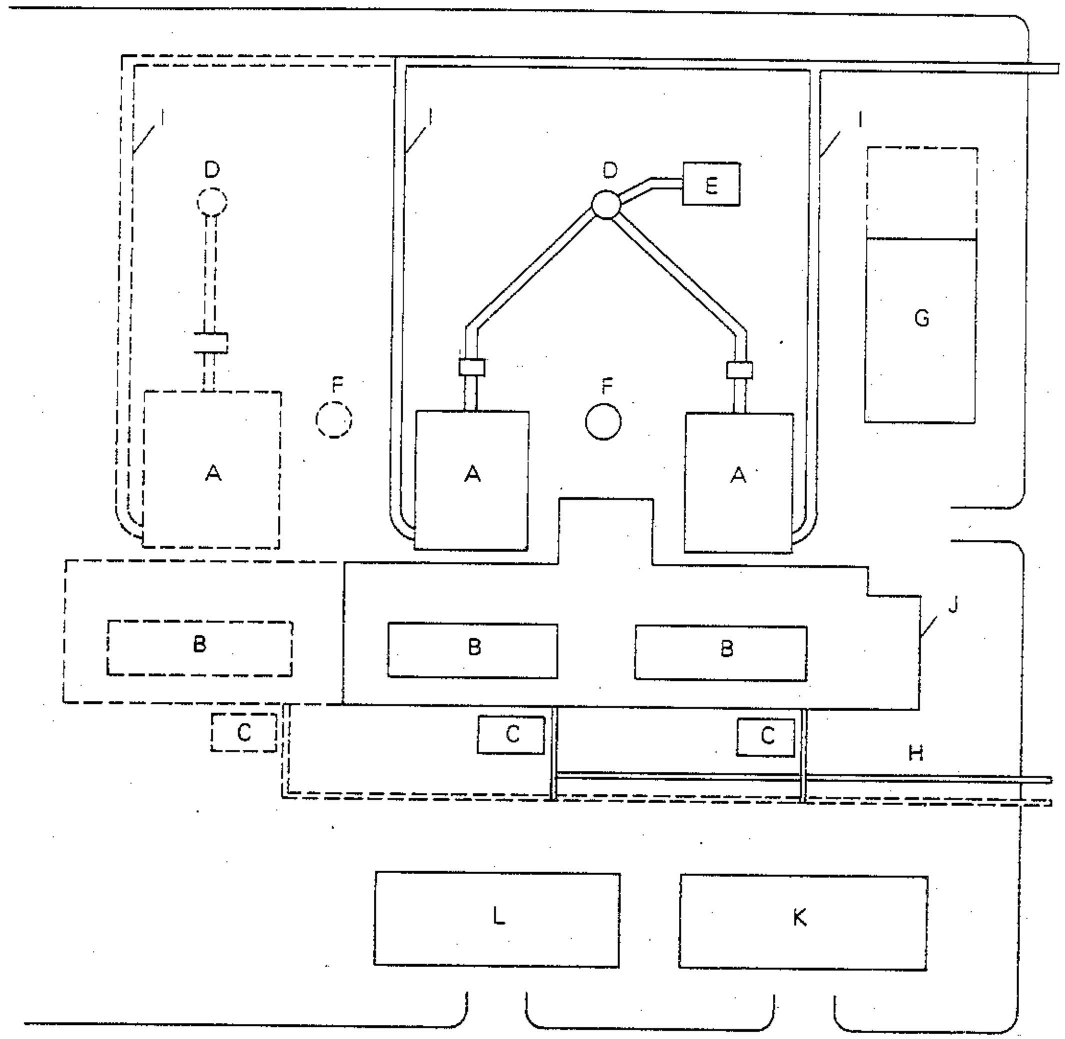
(2) Making installation plans of the blast furnace blower requires a full understanding of the blast furnace characteristics (blowing pressure and amount). In order that the blast furnace blower provides its best working efficiency under normal working conditions, the installation plan must consider such an abrupt shock as rapid reducing of blast pressure and scaffolding removing or take into consideration the maneuvering for handling such shocks.

(3) The operation of a blast blower is greatly affected by the situation of the blast furnace. Since the fluctuations of the blast blower operation may cause surging, the blower shall have to be equipped with highly reliable protective equipment to protect itself from surging damage.

(4) Technically consideration must be given to the availability of a DC power source, or an interlock circuit for safe operation, because the breakdown of the blast furnace blower shall affect the blast furnace operations to a considerable extent.

(5) For maintaining a constant and stable flow of blast to the blast furnace under normal operation, the blast furnace blower shall be equipped with a constant blast flow control device.
The function of the power plant is important for the effective use of the gases generated in the steelworks. The switchover of by-product gases and heavy oil shall be so designed as to be remotely controlled and, of course, it must be done without difficulty. (this is the difference from the features of ordinary power plants)

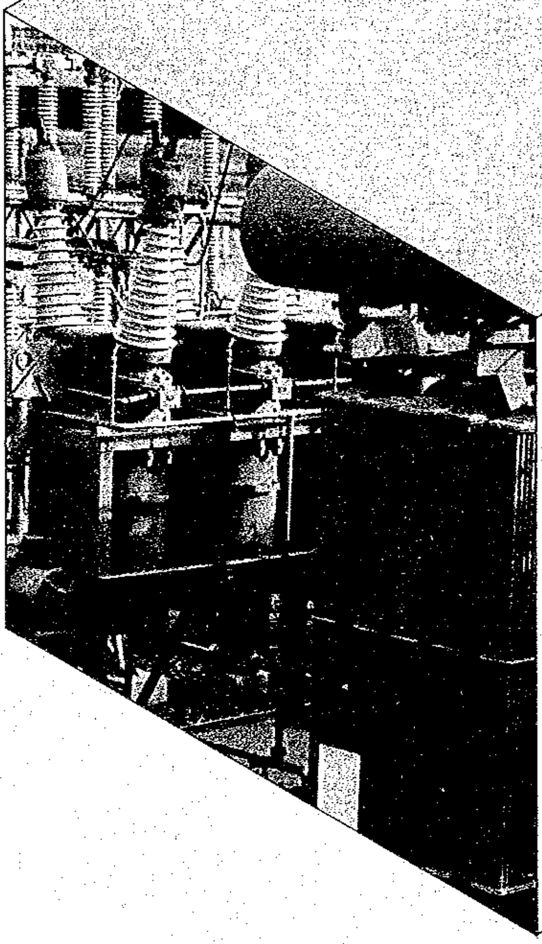
(7) BFG shall present a danger of explosion when the calorific value being released suddenely changes due to the blast furnace slip and the temporarily extinguished boiler leaves sources of ignition. To prevent this from happening, a minimum amount of COG shall be mixed.



	NAME
A	Boiler
B	Turbine, Generator, Blower
C	Bag filter
D	Stack
E	Low pressure boiler
F	Oil lank
G	Water treatment
H	Blast pipe
I	Fuel pipe
J	Turbine room
K	Energy center office
L	Sub office

Fig. 13-12-2 Power/B.F. blower plant general layout

CHAPTER 13-13



POWER RECEIVING AND DISTRIBUTION EQUIPMENT

13-13 Power receiving and distribution equipment

13-13-1 General

Power receiving and distribution equipment includes equipments for distributing purchased and in plant generated power to each electric room, road illumination equipment, telephone equipment and temporary power supply equipment for construction. 138^{KV} and 34.5^{KV}, which are used most in the Philippines, are used for the power receiving voltages and power distribution voltages. It is favorable to set up the power receiving and distribution equipment in the center of the load considering the cost and function. Therefore, they are set up next to the power plant which is placed at the center of the load.

13-13-2 Equipment plan

(1) The summary of the equipment specifications

1) Power receiving equipment

① The characteristics of the equipment

A certain characteristic transformer is planned to use to minimize the voltage fuluctuations caused by the load fluctuations. Also the load systems are divided into the important and ordinary, and an attention is taken not to stop the important ones.

② Electric current capacities of power receiving circuit breakers and bus bars

Assuming the maximum power demand during half an hour in stage-II is 152^{MW} current capacities of power receiving circuit breakers and bus bars are designed $1{,}000^{A}$.

③ Three phase short circuit capacity at the receiving point

Three pahse short circuit capacity at the receiving point is regarded as $3{,}500^{MVA}$, based on the expected power capacity of the Mindanao Power System around 1985.

④ Specifications for power receiving transformers

Taking into consideration the estimated power of 71.2^{MW} at the whole stop of inplant generating power and the conveniences of maintenance and inspections, two 50^{MVA} power receiving transformers are planned. On-load tap changer is equipped to absorb long-time voltage fluctuations, and its covering extent is set at $138^{KV}\pm7.5\%$ because the fluctuation range on the power supply voltage is unknown.

⑤ Insulation design

Insulation strengths are as follows

138^{KV} circuit. . . . . BIL 650^{KV}

34.5^{KV} circuit . . . . BIL 200^{KV}

Neutral point of receiving transormer . . . . BIL 200^{KV}

⑥ Bus system

The bus system is double bus system for easiness in maintenance and inspection and the need to separate the purchase power and the inplant generated power systems from each other. Also the 138^{KV} line is the outdoor type due to economical reasons, but the 34.5^{KV} line is the indoor type because this bus is very important in the whole distribution system.

⑦ 34.5^{KV} grounding system

The neutral point resistance grounding system is employed to suppress the abnormal voltage and induction troubles on grounding troubles. A 200-A resistance grounding system is planned.

⑧ Protective relay system

(see *Fig. 13-13-1*)

a) Power receiving line

To prevent inplant generating power stop due to the influence of the receiving line accidents, high response speed and reliability pilot wire relays are used as the main protective method. (Wires are not included)

b) 34.5^{KV} bus

To minimize the evil effect on bus accidents, high response speed and reliable grouped/divided system for protection relays are employed.

c) Transformer

To detect the internal troubles of transformers, differential relays and Buchholtz's relays are employed. Overload protective relays are also provided.

d) 34.5^{KV} line

High speed overload relay is employed for short circuit protection and ground fault protection.

e) Main transformer in electric room

Since elephant type transformers are employed in the interests of economy, substation circuit breakers are tripped by the signal transferring systems for protection in case of internal troubles and overload of main transformers in each electric room.

2) Power distribution equipment

Cables are used for all the 34.5^{KV} distribution lines and the laying method is direct burial. (Refer to *Fig. 13-13-2.*)

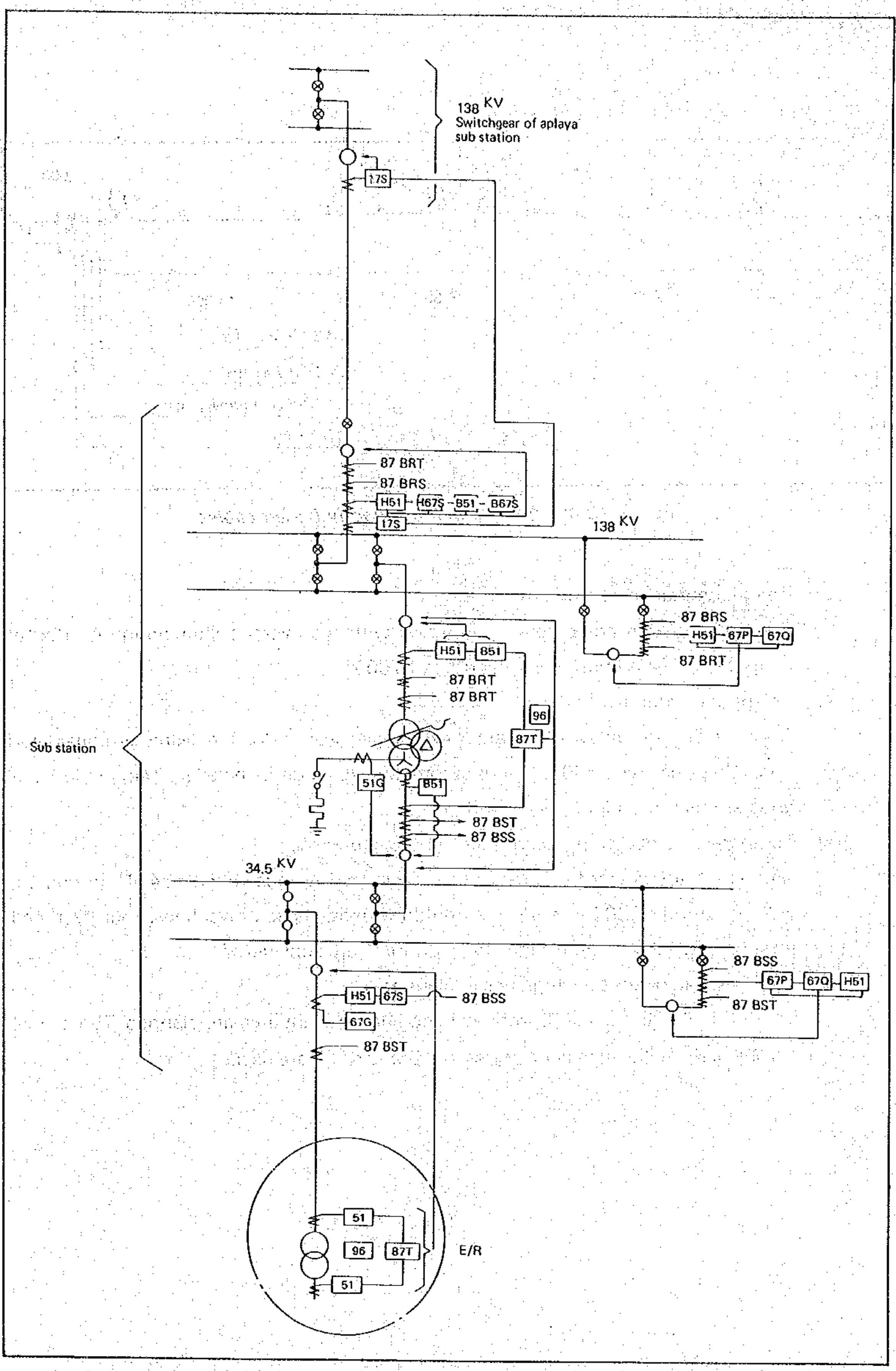


Fig. 13-13-1 Protective relaying system diagram

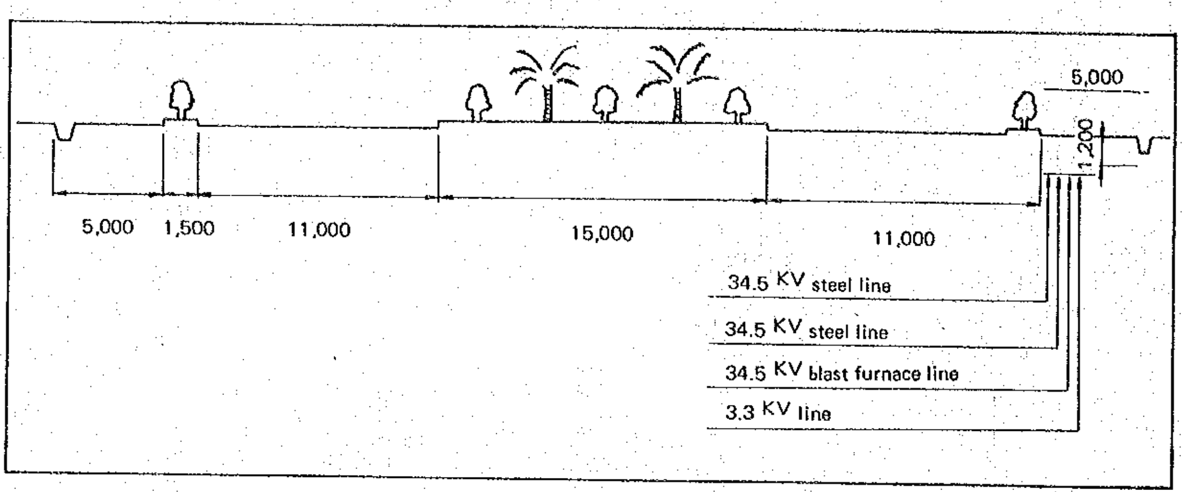


Fig. 13-13-2 An example of directly buried cables

3) Road illumination equipment

Road illumination equipment is designed with the average illumination of 1Lx for main roads. The proposed road length is $15{,}000^{m}$.

4) Telephone equipment

Only the private automatic branch exchanger system for the works is considered here. Cross-bar type 500 channel automatic exchange is installed. Telephone trunk lines are laid in underground conduits.

5) Temporary power supply equipment for consturction.

The temporary power for construction is planned to receive with 34.5^{KV} in coming voltage, and the 3.3^{KV} power is distributed with overhead power lines. Four overhead lines having a distribution capacity of $1{,}500^{KVA}$ are considered.

6) 138^{KV} aerial power receiving lines in plant area

The 900^{m} of 138^{KV} aerial power receiving lines in plant area are planned. Three steel towers are installed and aerial wires of ACSR 330^{mm^2} are used.

Table 13-13-1 Equipment specifications

Equipment name	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
(1) Receiving station				
1) Circuit braker	5	138 ^{KV} ACB 1,000 ^{A}	1	138 ^{KV} ACB 1,000 ^{A}
2) Main trans.	2	138 ^{KV}/34.5 ^{KV} 50 MVA	1	138 ^{KV}/34.5 ^{KV} 70 MVA
3) Circuit braker	24	34.5 ^{KV} 1,500 ^{A}	10	34.5 ^{KV} 1,500 ^{A}
(2) Distributing equipment				
1) Power cable	7,680 (m)	34.5 ^{KV} CV 60 $^{mm^2}$ x 3 C	2,340 (m)	34.5 ^{KV} CV 60 $^{mm^2}$ x 3 C
2) – do –	2,850	34.5 ^{KV} CV 100 $^{mm^2}$ x 3 C	3,590	34.5 ^{KV} CV 100 $^{mm^2}$ x 3 C
3) – do –	7,840	34.5 ^{KV} CV 150 $^{mm^2}$ x 3 C	780	34.5 ^{KV} CV 150 $^{mm^2}$ x 3 C
4) – do –	3,880	34.5 ^{KV} CV 250 $^{mm^2}$ x 3 C	1,065	34.5 ^{KV} CV 250 $^{mm^2}$ x 3 C
5) – do –	300	34.5 ^{KV} CV 1,000 $^{mm^2}$ x 1 C		
6) – do –	1,630	3.3 ^{KV} CV 60 $^{mm^2}$ x 3 C		
7) – do –	510	3.3 ^{KV} CV 100 $^{mm^2}$ x 3 C		
8) – do –	2,170	3.3 ^{KV} CV 150 $^{mm^2}$ x 3 C		
(3) Lighting equipment (Main road only)		Road length 15,000 ^{m}		3,000 ^{m}
(4) Communication equipment				
1) PA BX	1	Cross bar type 500 circuits	1	Cross bar type 120 circuits
2) Telephone	500		120	
(5) Temporary power equipment for contruction				
1) Transformer	1	34.5 ^{KV}/3.3 ^{KV} 6 MVA		
2) Aerial wire	11,000 ^{m} x 3	OC 80$^{mm^2}$		
(6) Incoming line in works				
1) Steel tower	3	138^{KV} 1 route 2 circuits		
2) Aerial wire	900 ^{m} x 3	ACSR 330 $^{mm^2}$		

(2) Layout of equipment

Layout of the equipment is described as below.

1) Receiving station *Fig. 13-13-3.*

2) Incoming line and receiving station *Fig. 13-13-4.*

3) Power cable installation *Fig. 13-13-2.*

(3) Connections with stage II equipment

1) When the expansion in stage II is only the power increase of stage I, the capacity of distribution equipment in stage I includes the capacity of stage II.

2) When the expansion in stage II is separated from stage I, the power distribution equipments in stage II are planned in time of stage II

3) The arrangement of receiving and distribution equipments in stage I is designed to use the additional space for stage II effectively. (Refer to *Fig. 13-13-3* and *13-13-4.*)

13-13-3 Technical explanation

(1) Voltage fluctuation rate

The whole capacity of the electirc power based on NPC schedule in Mindanao Grid in 1985 is 1,600^{MW}. Assuming the power transmission line between Abaga (Agus V) and Aplaya is the current one route, two circuits, the volatage fluctuation at the receiving point will be 1.84% under the operation of two(2) inplant generating plant. When the inplant generating plant is not in operation, the voltage fluctuation at the receiving point will be 2.36%. According to the current NPC regulation, the voltage fluctuation within a five(5) cycle period is stipulated below one(1) percent. Therefore, it is desiable to admit these voltage fluctuation rate as the special cases.

(2) The reason of power receiving transformer capacity being 50^{MVA} X2

The electric power consumed in the new steelworks in time of production at 1.5 million$^{t/y}$ is 71.2^{MW}. On the other hand, to keep the voltage fluctuation rate within ±3% at the time of rolling load, and the convenience for maintenance and inspection of transformers must be considered. Therefore, when the first priority is given on the voltage fluctuation of 34.5^{KV} line under the following operation schedule, 50^{KVA} X2 become the reasonable capacity and number.

Home power plant units in operation	Power receiving transformers in operation	Voltage fluctuation rate of 34.5 KV system at time of hot rolling
40 ^{MW} x 2	50 MVA x 2	2.17%
40 ^{MW} x 2	50 MVA x 1	2.56%
40 ^{MW} x 1	50 MVA x 2	2.94%

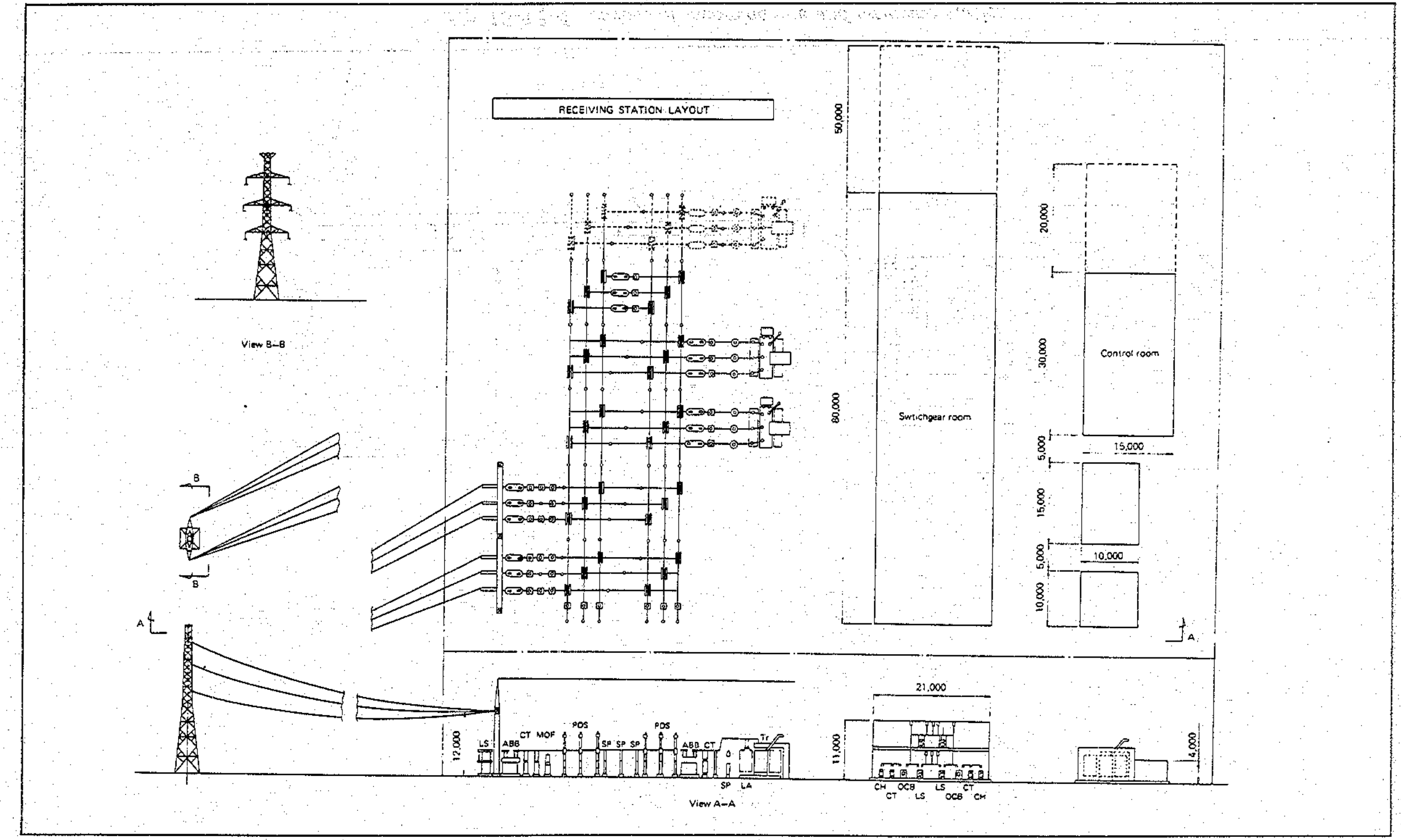


Fig. 13-13-3 Receiving station layout

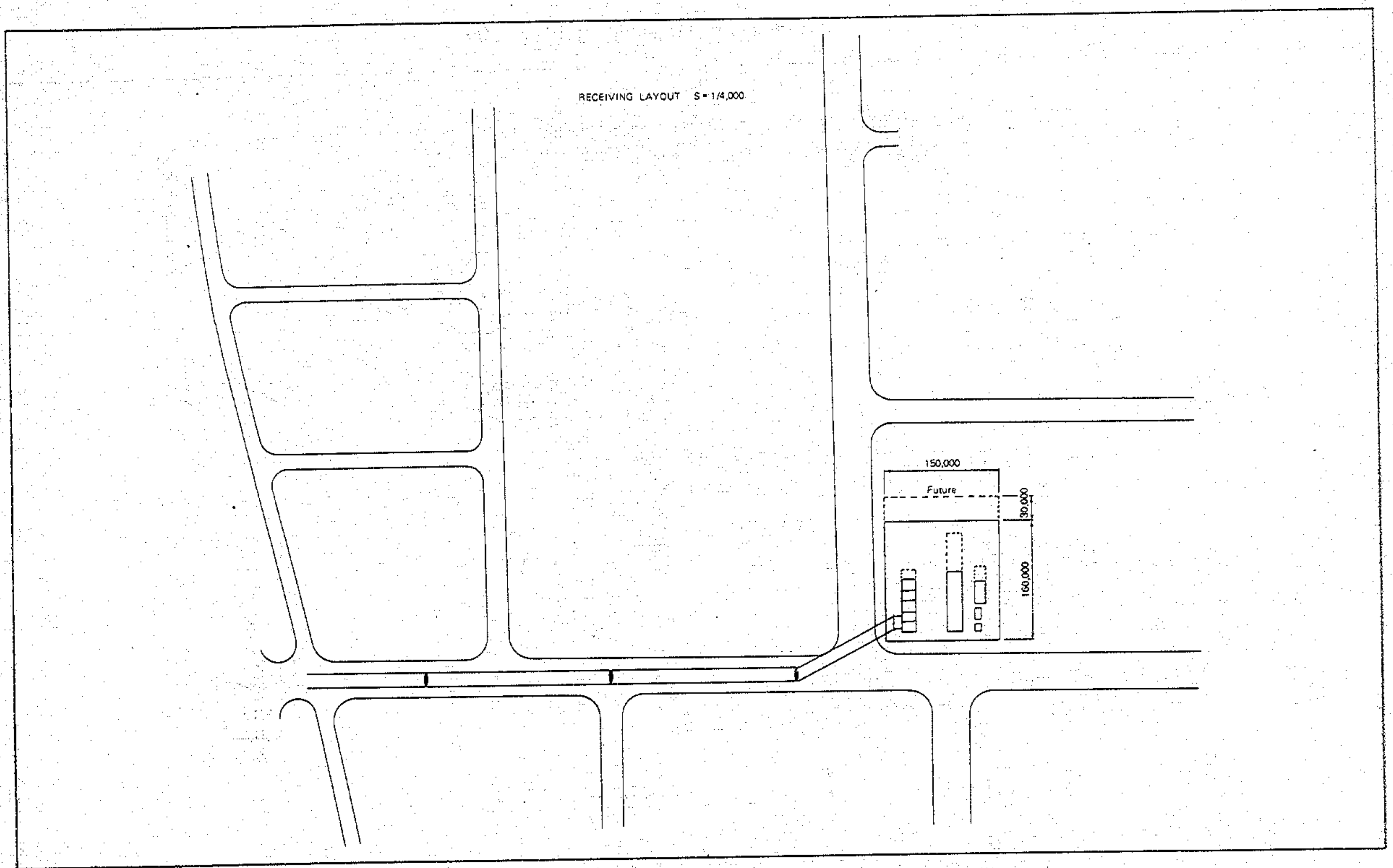


Fig. 13-13-4 Layout of incoming line and receiving station

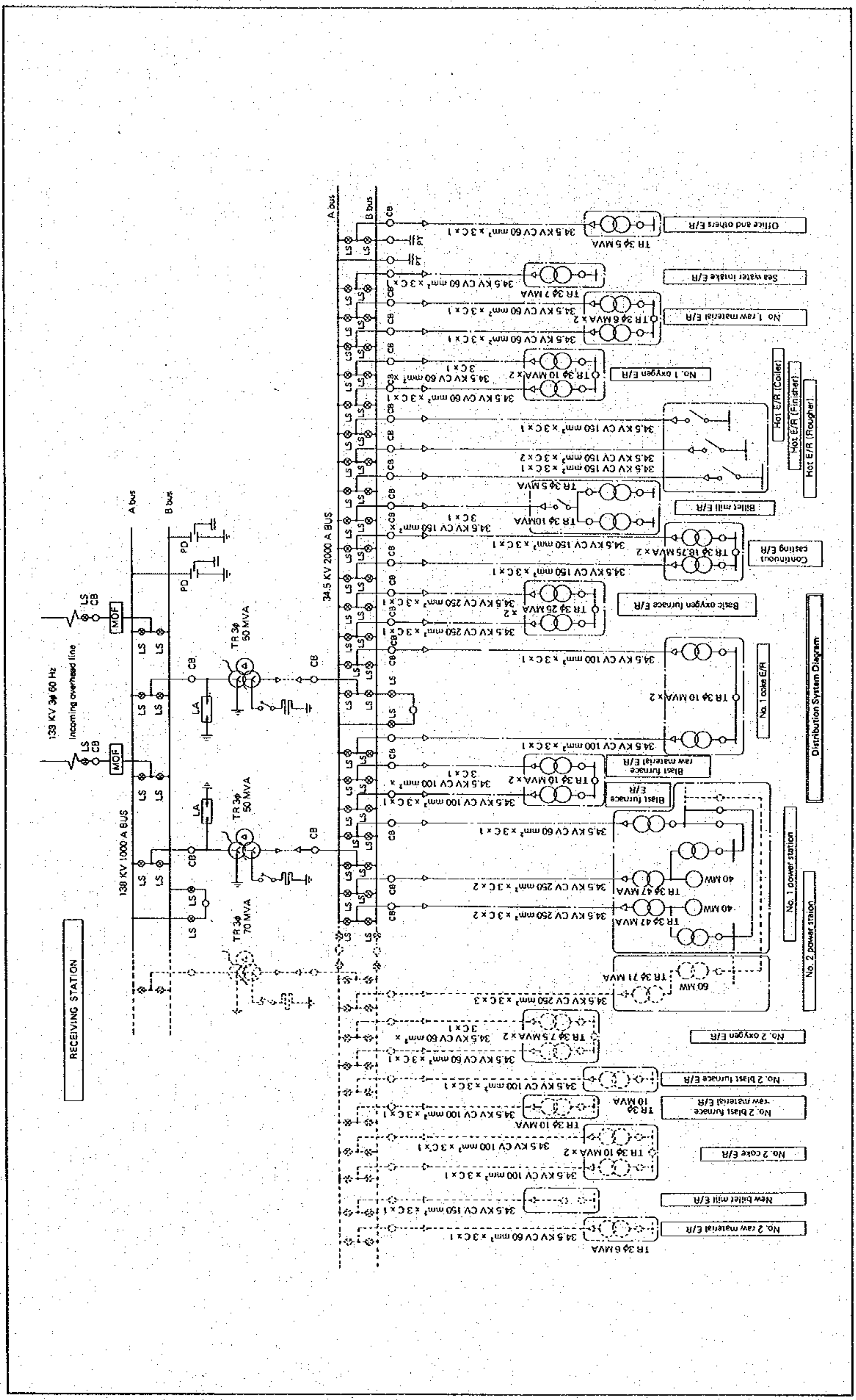
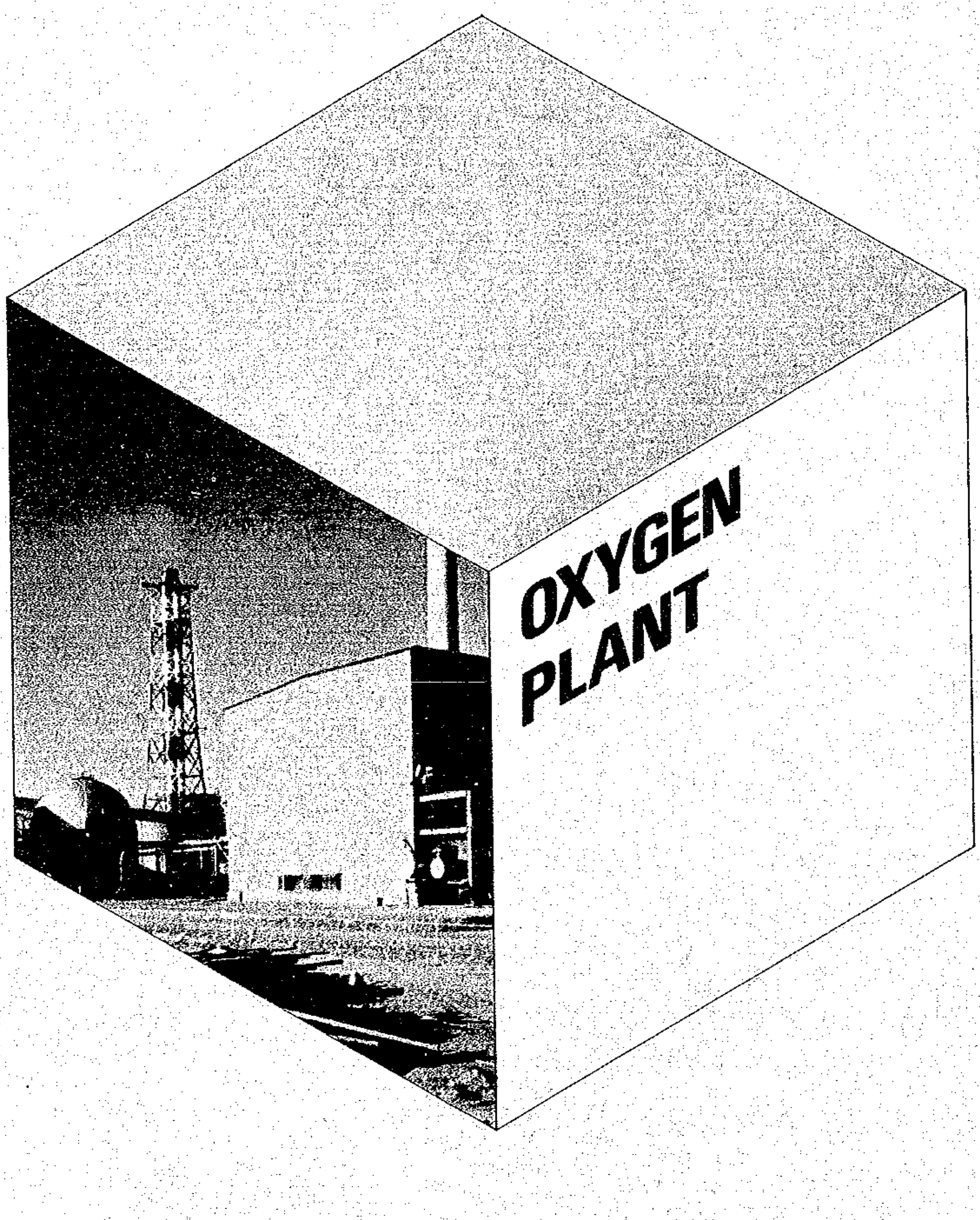


Fig. 13-13-5 Distpibution system diagram

CHAPTER 13-14



13-14 Oxygen generating equipment

13-14-1 General

This plant is intended to manufacture and distribute oxygen, nitrogen and argon gases required in various steel-making processes. The oxygen plant consists of an air separator, oxygen compressor, nitrogen compressor, liquefied oxygen equipment, liquefied argon equipment and gas tanks.

13-14-2 Preconditions

It seems logically possible that a single plant (two plants at stage II) will be enough to meet the requirements for oxygen, nitrogen, and argon of the new steelworks with a production capacity of 1,500,000$^{t/y}$ at stage I and 3,000,000$^{t/y}$ at stage II in terms of crude steel. Should any trouble occur, or at times when the singly installed equipment is subjected to scheduled maintenance, however, the result will be total paralysis of the integrated steelworks. This consideration has led us to plan a dual plant configuration and, in addition, a liquefied oxygen plant so that about 70% of the total oxygen requirement can be satisfied by the remaining one even when either one is shut down.

(1) Capacity of oxygen gas

The production capacity of oxygen gas has been planned at a level that will satisfy all the oxygen requirements of B.O.F and C.C plants as well as those for construction work and other non-productive purposes.

(2) Capacity of nitrogen gas

It has been planned that each oxygen plant can produce 6,700$^{Nm^3/hr}$ of nitrogen gas so that it can meet the nitrogen gas requirements of the steelworks as a whole even when either one of the plants is shut down.

(3) Argon equipment

The argon equipment has been planned to be capable of meeting the argon requirement of the C.C plant and of analyzing. If it is for the C.C plant use only, the argon purity can be about 98%, but for analysis the purity will have to be higher, according to the purity demands of the analysis. Argon shall be produced as liquefied argon and vaporized when required for distribution to each user. The planned liquefied argon storage tank has a capacity of a five-day supply.

(4) Liquefied oxygen plant

This plant is planned with a goal of a capacity which can meet 70% of the total oxygen gas requirements of the entire steelworks when either one of the proposed oxygen plants is shut down. Usually, 5% or less of gaseous oxygen will be taken as liquefied oxygen and stored in the liquefied oxygen storage tank in amounts equal to a ten-day supply.

(5) Stand-by equipment

Since two air separation plants have been planned, as already stated, for safety considerations, only one reciprocating compressor each has been planned as a stand-by, necessary during ordinary maintenance.

13-14-3 Equipment plan

(1) Capacity, purity, and pressure (see *Table 13-14-1*)

Table 13-14-1 Capacity, purity, and pressure of each gas

	Purity (%)	Pressure (kg/cm^2)	Capacity (Nm^3/hr)		Remarks
			Stage 1	Stage 2	
Oxygen gas	99.6	30.5	16,600	33,200	
Liquefied oxygen	99.6	–	800	800	Pressure after evaporation 7 kg/cm^2
Nitrogen gas	99.999	9.5	6,700	13,400	O_2 = 0.1%
Liquefied argon	99.999	–	60	120	Pressure after evaporation 15 kg/cm^2

(2) Component equipment and their specifications (see *Table 13-14-2*)

Table 13-14-2 Equipment specifications

Equipment	Quantity		Specifications
	Stage I	Stage II	
1) Air separator	2 sets	2 sets	NR 51 type
Air absorption tower	1 unit	1 unit	Constructed of steel plate, 30^{m} high
Air filter	2 units	2 units	Type: Bag filter Capacity: 51,500 Nm^3/hr
Air compressor	2 units	2 units	51,500 $Nm^3/hr \times 5.1\ kg/cm^2$
Trickling cooler	2 sets	2 sets	Capacity: 51,500 Nm^3/hr
Expansion turbine	2 sets	2 sets	12,000 $Nm^3/hr \times 4.8\ kg/cm^2$ x blower type brake
Reversing heat exchanger	2 sets	2 sets	Capacity: 51,500 Nm^3/hr
Rectifying column	2 units	2 units	Capacity: 51,500 Nm^3/hr
Liquefied oxygen circulating pump	2 units	2 units	8,500 $Nm^3/hr \times 20^{m}$
De-icer	1 set	1 set	
2) Argon equipment	1 set	1 set	
Argon refining equipment	2 sets	2 sets	60 Nm^3/hr
Argon refining equipment	1 set	1 set	60 Nm^3/hr
Liquefied argon storage tank	1 unit	1 unit	10^{t}
Liquefied argon pump	1 unit	1 unit	60 Nm^3/hr
Liquefied argon vaporizor	1 unit	1 unit	60 Nm^3/hr
3) Oxygen gas compressor			
Medium-pressure oxygen compressor	2 units	2 units	8,300 $Nm^3/hr \times 7\ kg/cm^2$ Turbo type
High-pressure oxygen compressor	3 units	2 units	8,300 $Nm^3/hr \times 30.5\ kg/cm^2$ Reciprocating type
4) Nitrogen gas compressor	2 units	1 untis	6,700 $Nm^3/hr \times 9.5\ kg/cm^2$ Turbo type
5) Liquefied oxygen equipment	1 set		
Liquefied oxygen storage tank	1 unit		$1,000^{t}$
Liquefied oxygen pump	1 unit		3,320 $Nm^3/hr \times 7\ kg/cm^2$
Liquefied oxygen vaporizor	1 unit		400,000 kcal/hr

Equipment	Quantity		Specifications
	Stage I	Stage II	
6) Electrical equipment	1 set	1 set	16,200 kW
7) Building and ceiling cranes			
Building	1 set	1 set	Compressor room 2,450 m^2
Ceiling crane	1 set		$20^t \times 18^m$, $10^t \times 14^m$
8) Gas tanks			
Oxygen gas tank	2 units		1,000 m^3 x 30 kg/cm^2
Nitrogen gas tank	1 unit		500 m^3 x 9.5 kg/cm^2
Argon gas tank	1 unit		100 m^3 x 15 kg/cm^2

(3) Gas flow

1) Oxygen gas flow (See *Fig. 13-14-1*)

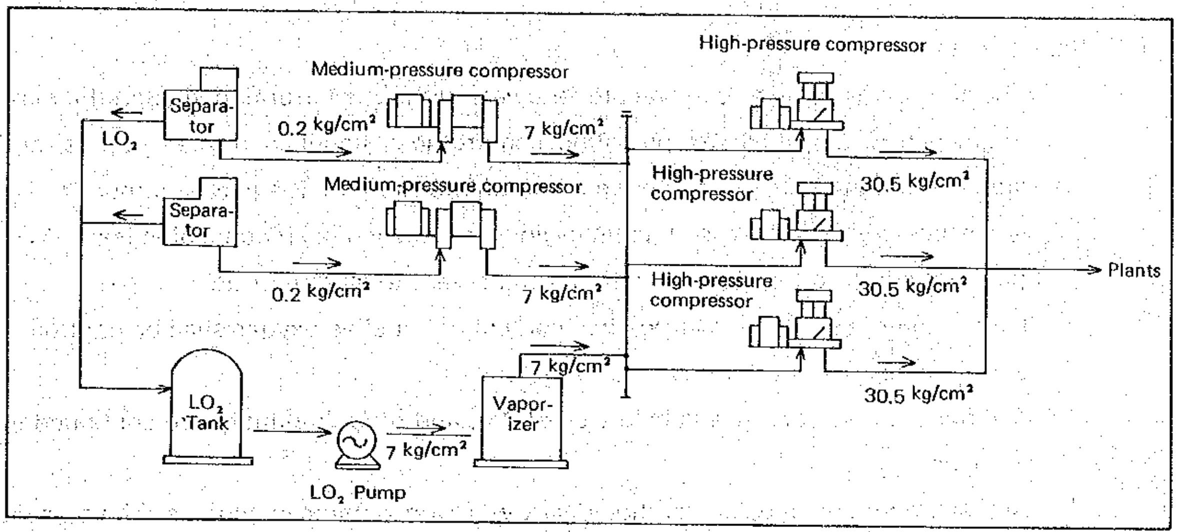


Fig. 13-14-1 Oxygen gas flow

2) Nitrogen/argon gas flow (See *Fig. 13-14-2*)

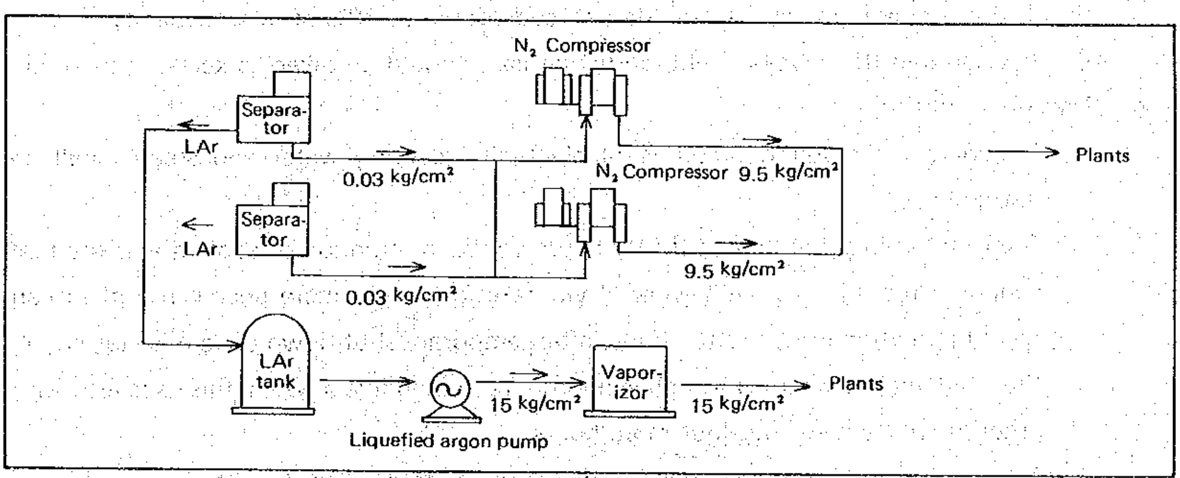


Fig. 13-14-2 Nitrogen and argon gas flow

13-14-4 Technical explanation

(1) Special notes

1) The air separation plant can operate for a year without interruption, though the maximum period for which reciprocating compressors, liquefied oxygen pumps, and liquefied argon pumps can operate on an uninterrupted basis will be a month.

2) It is necessary to discharge at all times liquefied oxygen in amounts of at least 1% of the total output of oxygen gas in order to prevent explosion or fire.

3) For the same reason, the hydrocarbon content of liquefied oxygen shall be controlled to 40^{mg} or less per liter of liquefied oxygen.

4) The purity of nitrogen gas is below $O_2=0.1\%$, and other impurities are contained in nitrogen.

5) Actual production of each gas should vary with atmospheric conditions. (The present plan assumes atmospheric temperature at 30°C, atmospheric pressure at 760^{mmHg} and relative humidity at 80% RH.)

6) Up to $8{,}000^{Nm^3/hr}$ of nitrogen gas and up to $150^{Nm^3/hr}$ of argon may be taken from each plant if required.

7) The air separators can be operated at loads down to 70% of rated capacity.

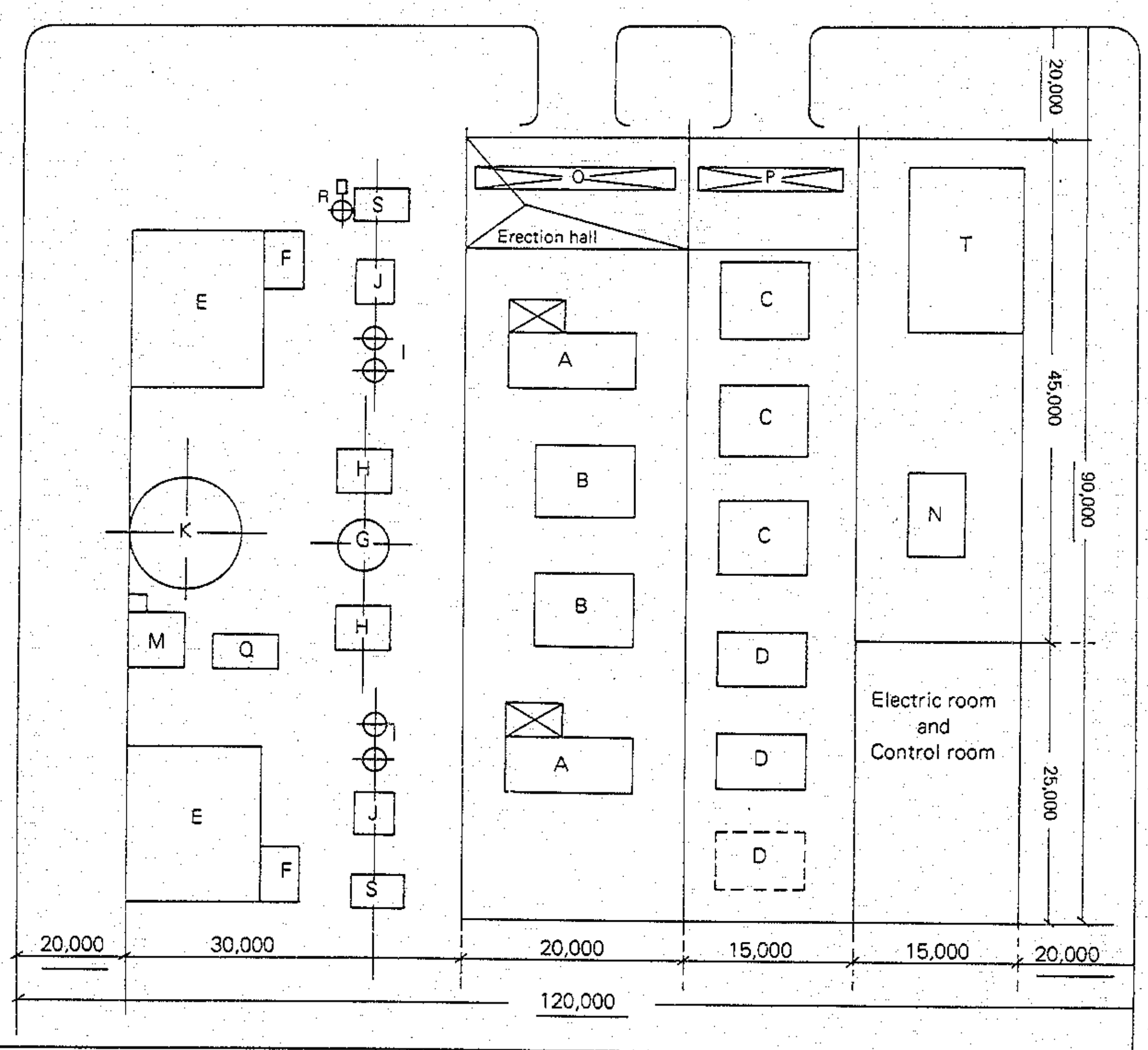
8) In operating the oxygen plant, particular care should be taken to keep it free of oil.

(2) Start-up conditions

1) Prerequisites: required amounts of electricity, cooling water and steam shall be available.

2) Start-up time: It will be about fifty hours between initiation of cooling and the first supply of product gas (with argon it will take forty-eight more hours). The plant can restart operation in two to ten hours after temporary shut-down once it is started up. (Such a temporary shut-down shall not run more than five days.) In this case also with argon it will take twenty-four more hours.

3) The total time required to de-ice will be approximately 24^{hr} per plant.



No.	Name
A	Air compressor
B	Oxygen compressor
C	"
D	Nitrogen compressor
E	Air separator
F	Expansion turbine
G	Air absorb tower
H	Air filter
I	Sprey cooler
J	Silencer
K	Liq oxygen storage tank
L	Liq oxygen pump
M	Liq oxygen vaperizer
N	Sea water filter
O	15T crane
P	5T crane
Q	Gel regenerating heater
	and dryer
R	Liq argon storage tank
	and vaperizer
S	Argon refining equipment
T_1	H_2 vessel place

Fig. 13-14-3 Oxygen plant layout

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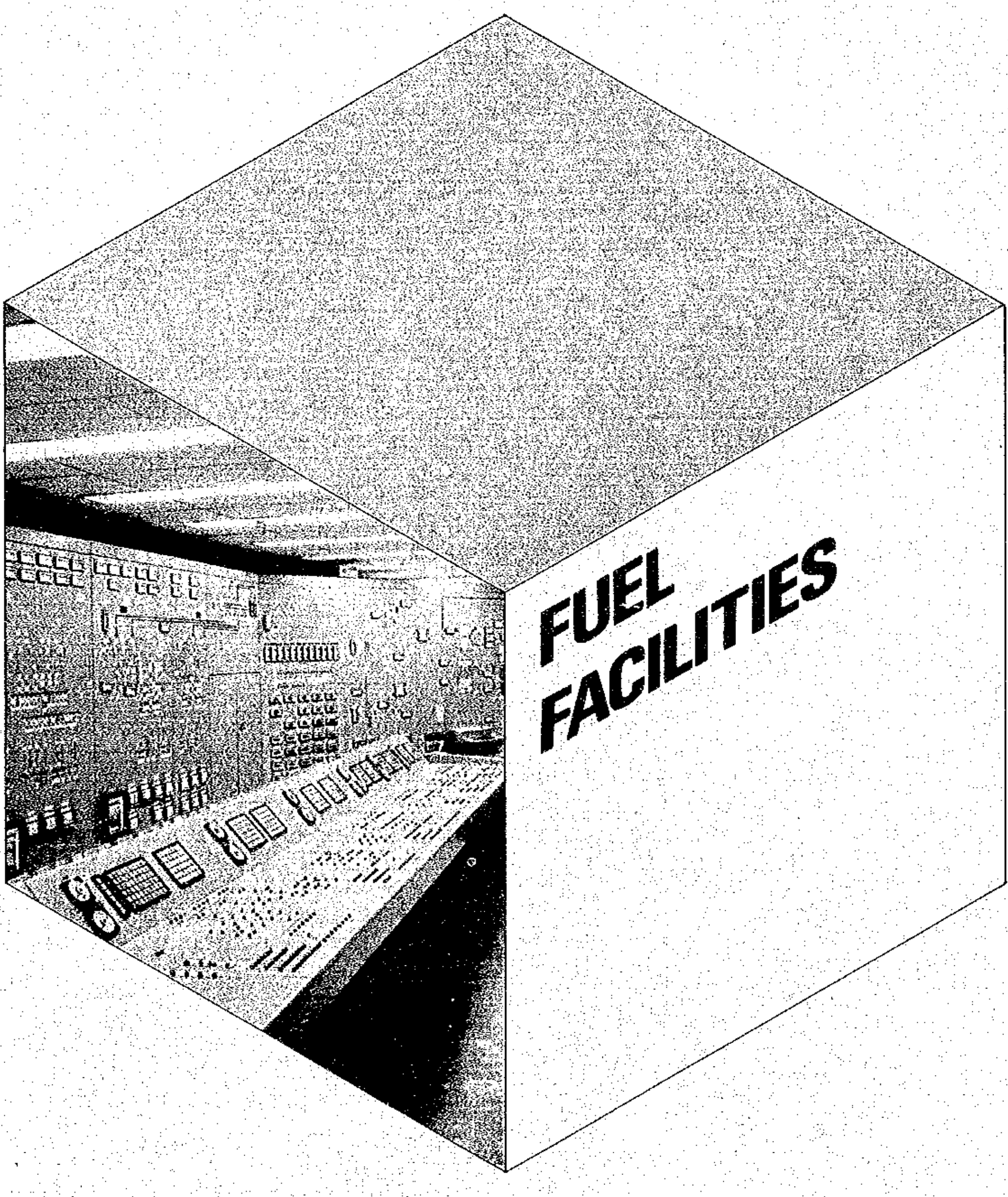

13-15 Fuel facilities

13-15-1 General

Fuel facilities comprises equipment for supplying blast furnace gas (BFG), coke oven gas (COG) and LD converter gas (LDG) generated in the works and heavy oil as a purchased fuel for each user plant.

13-15-2 Preconditions

To cope with fluctuation in generation of the BFG, COG and LDG which are generated from the steelworks and with the fluctuations in fuel consumption in each user plant, gas holder equipment and gas flare equipment are planned as indicated below to ensure the effective use of fuels.

Also, as fuel supply equipment to cope with the conditions of the users, heavy oil equipment and gas booster equipment are planned.

(1) The capacity of the BFG holder has been set at 100,000m^3, taking into consideration stage II.

(2) The capacity of the COG holder has been set at 40,000m^3, taking into consideration the capacity required for users to switch over fuels. A new 30,000m^3 holder will also be set up in the planning of stage II and will be used at all times for COG and will act as a substitute holder for times when the BFG holder stops.

(3) The capacity of LDG holders has been set at 50,000m^3 taking into consideration stage II.

(4) Flare equipment is planned when there is a surplus of BFG and COG, the capacity of the BFG flare stack has been set at the quantity obtained by deducting consumption in the hot stove from BFG production, and the capacity of the COG flare stack has been set for the total amount of COG production.

(5) The capacity of the heavy oil tank has been set by taking into consideration normal consumption and the size of ships (coastal tankers) and plans to have thirty days worth of normal consumption stock capacity as a goal.

At the time of stage II planning, an extra unit will be added and will be planned to cope with the periodical opening inspection.

(6) The pressure of the gas holder will be used to supply the BFG and COG to the hot stove and boiler, however, gas blowers will be set up to supply the coke oven and hot strip mill etc. Two types of gas blowers will be planned, one for a mixture of BFG and COG, and the other for COG only. Each will have one preparatory gas blower. Also for the gas blower for the mixed gas, two units will be operating while one unit will be for preparatory use considering stoppage of the hot strip mill and billet mills.

(7) For the LDG, the gas blower will be set up after the holder with the holder pressure on low, taking into consideration the dust collecting ability of the OG equipment. An electric dust

collector will be set up to make the dust content in the LDG below $10^{mg/Nm^3}$ which will be supplied to the electric power plant.

(8) In the fuel distribution center, each fuel's demand and supply will be monitored and controlled, and the fuel supply facilities will be remote controlled. However, electricity and steam will be controlled in the power blower plant and O_2, N_2, and Ar in the oxygen plant.

(9) General service steam can be maintained by extracting from the power generating turbine, but one low-pressure boiler unit with a capacity of $7^{t/hr}$ will be set up with consideration given to conditions at start-up time of the new steelworks.

13-15-3 Equipment plan

(1) Equipment specifications

Specifications for fuel facilities are shown in *Table 13-15-1.*

Table 13-15-1 Main specification

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
1) B-gas holder	1	Capacity: 100,000 m^3 Pressure: 600 mm H_2O		
2) C-gas holder	1	Capacity: 40,000 m^3 Pressure: 600 mm H_2O	1	Capacity: 30,000 m^3 Pressure: 600 mm H_2O
3) LD-gas holder	1	Capacity: 50,000 m^3 Pressure: 300 mm H_2O		
4) B-gas flare stack	1	Discharge capacity: Max. 250,000 Nm^3/hr Height: 50 m Diameter: 1,800 mmφ	1	Same as left
5) C-gas flare stack	1	Discharge capacity: Max. 50,000 Nm^3/hr Height: 50 m Diameter: 800 mmφ	1	Same as left
6) Heavy oil tank	1	Capacity: 6,000 t Inside diameter: 22,000 mmφ Height: 18 m	1	Same as left
7) M-gas blowers (For billet and hot rolling use)	3 (2+1)	Capacity: 35,000 Nm^3/hr Delivery pressure: 1,500 mm H_2O		
8) C-gas blowers (For coke oven M-gas use)	2 (1+1)	Capacity: 6,500 Nm^3/hr Delivery pressure: 1,300 mm H_2O	1	Same as left
9) C-gas blower (For general use)	2 (1+1)	Capacity: 6,500 Nm^3/hr Delivery pressure: 1,300 mm H_2O	1	Same as left

Equipment	Stage I		Stage II	
	Quantity	Specifications	Quantity	Specifications
10) LD-gas blower	2 (1+1)	Capacity: 20,000 Nm^3/hr Delivery pressure: 1,000 mm H_2O	1	Same as left
11) Electric dust collector for LD-gas use	1	Capacity: 20,000 Nm^3/hr Efficiency: 95%	1	Same as left
12) General low pressure boiler	1	Amount of evaporation: 7 t/hr Steam pressure: 12 kg/cm^2G Fuel: heavy oil		

(2) Fuel system flow

1) BFG flow

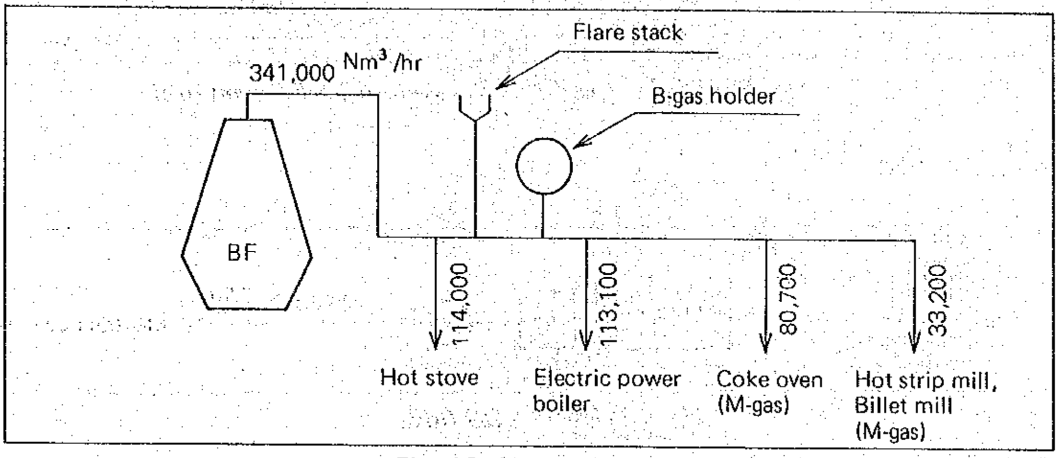

Fig. 13-15-1 BFG flow

2) COG flow

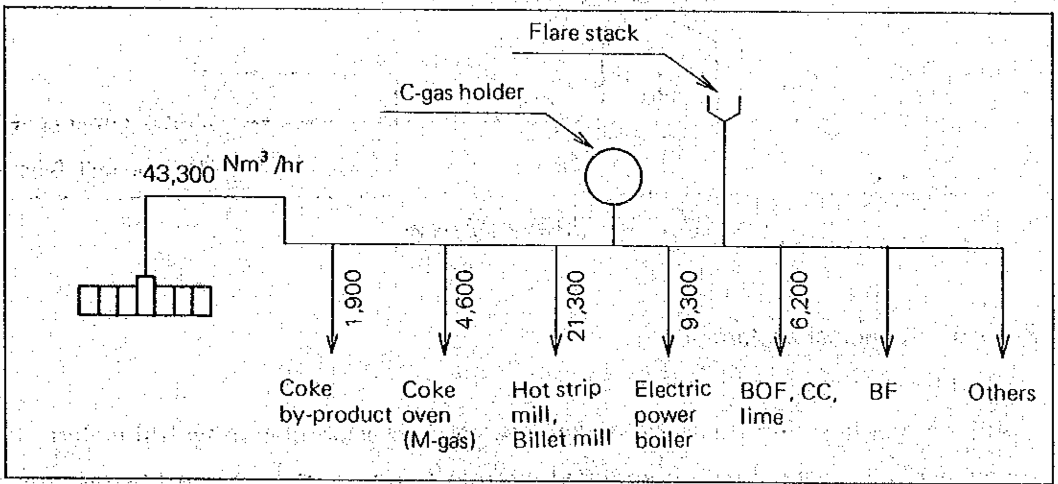

Fig. 13-15-2 COG flow

3) MFG flow

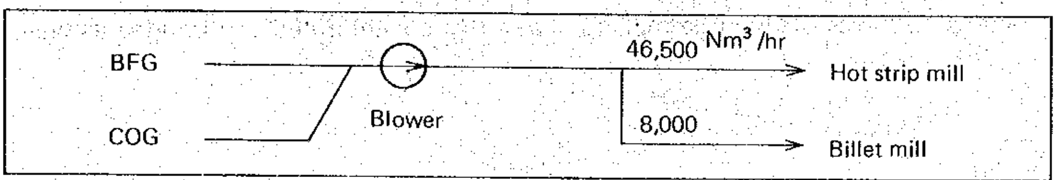

Fig. 13-15-3 M-gas flow

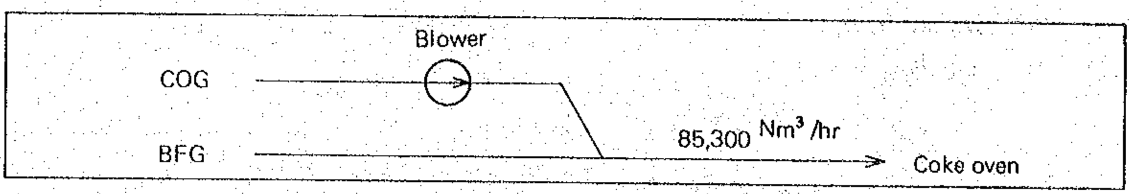

Fig. 13-15-4 1,000 kcal/Nm³ system (Coke oven use)

4) LDG flow

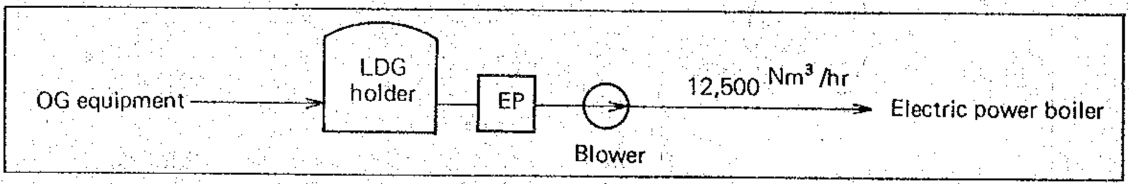

Fig. 13-15-5 LDG flow

5) Heavy oil flow

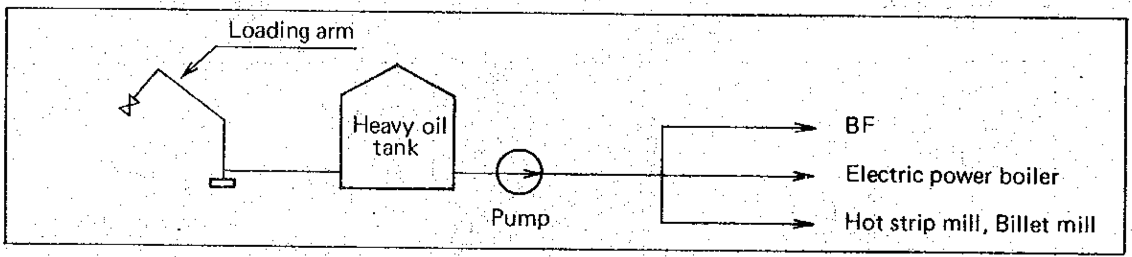

Fig. 13-15-6 Heavy oil flow

13-15-5 Technical explanation

(1) Conditions at start-up

Among fuel facilities, heavy oil equipment has a special relation with the start-up of the power plant. It should be completed, therefore, one month before the test run of the power plant.

(2) Control of fuel demand and supply

Concentrated control will be taken over the demand and supply of fuel so as to make the best use of BFG, COG and LDG generated in the steelworks. The layout of each piece of equipment was planned by making use of this concentrated control idea as well.

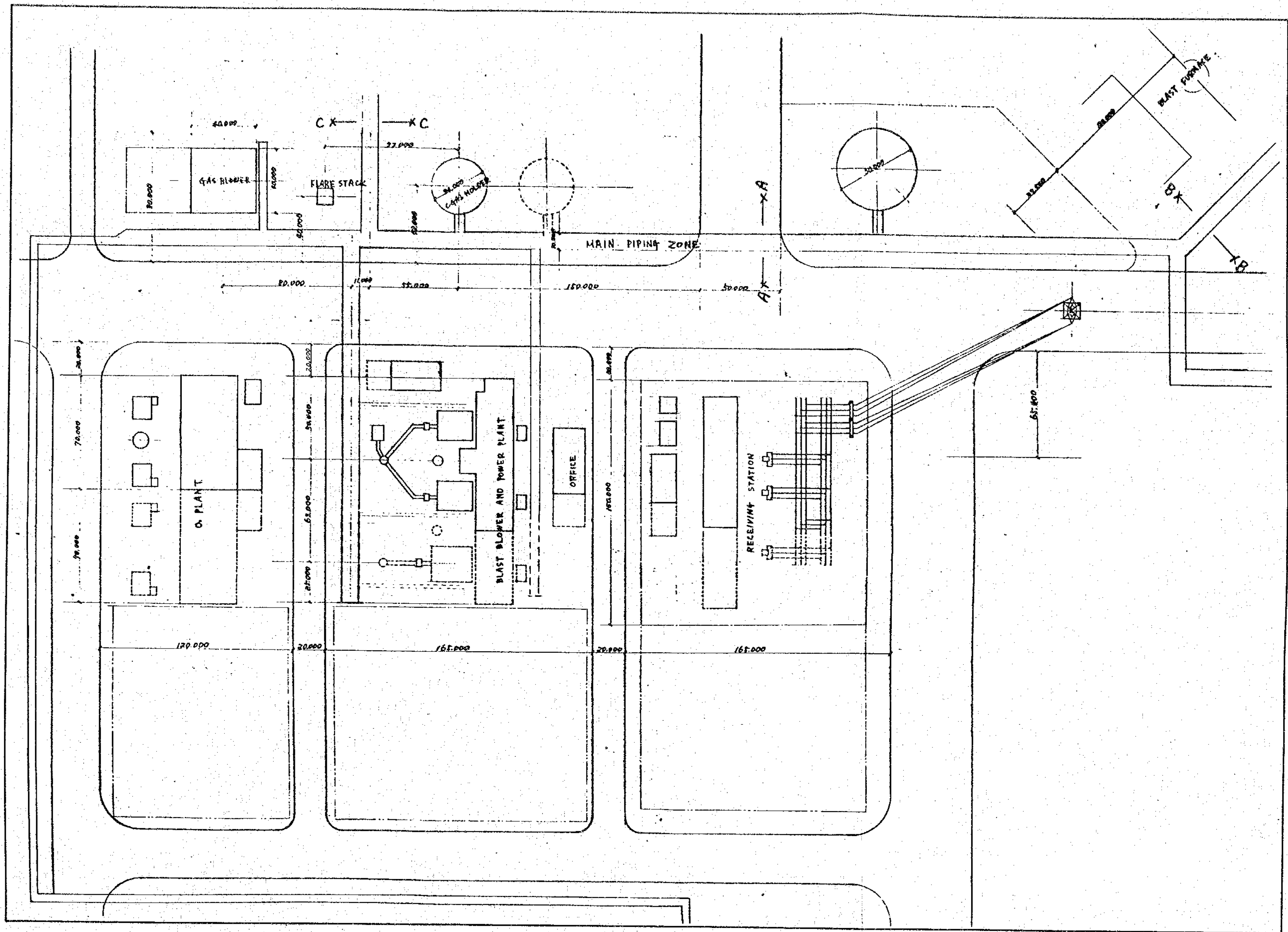

Fig. 13-15-7 Utility equipment layout

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