4.6 Limestone Supply and Handling System

(1) Main System Parameters

Reserve quantity	:	3 days
Consumption	:	18.4 t/h (Ca/S = 3)
Grain size	:	0~3 mm
Daily consumption	:	442 t/d
Daily receiving quantity	:	619 t/d
Receiving duration	:	7.5 h/d, 5 days /week
Storage capacity	:	3,000 t, 6.8 days
Storage silo	:	Raw limestone: 1,300 m^3 x 1
		Limestone grist: 1,700 m^3 x 1
Bulk density of raw limestone	:	1~1.2 t/m^3
Grain size of raw limestone	:	0~50 mm

(2) Location of the Limestone System

Layout of the limestone system is shown in Figure 4.6.1.

Preferably, the limestone system shall be installed close to the new boiler so as to ensure safe operation, but without obstructing the way of future development (possibly, installation of another unit of 150 MW)

The limestone system will be installed close to the south-east of Borsod Power Plant, or on the south-east from the railway No. I/a. Land procurement of 0.3 ha. is necessary as a site added for the buildings of the limestone system.

(3) Reception and Storage of Limestone

1) Reception of limestone

Four-axle, drop-bottom closed tankers of 38 m^3 capacity of type Tals were envisaged for the purpose of transporting limestone to the Power Plant.

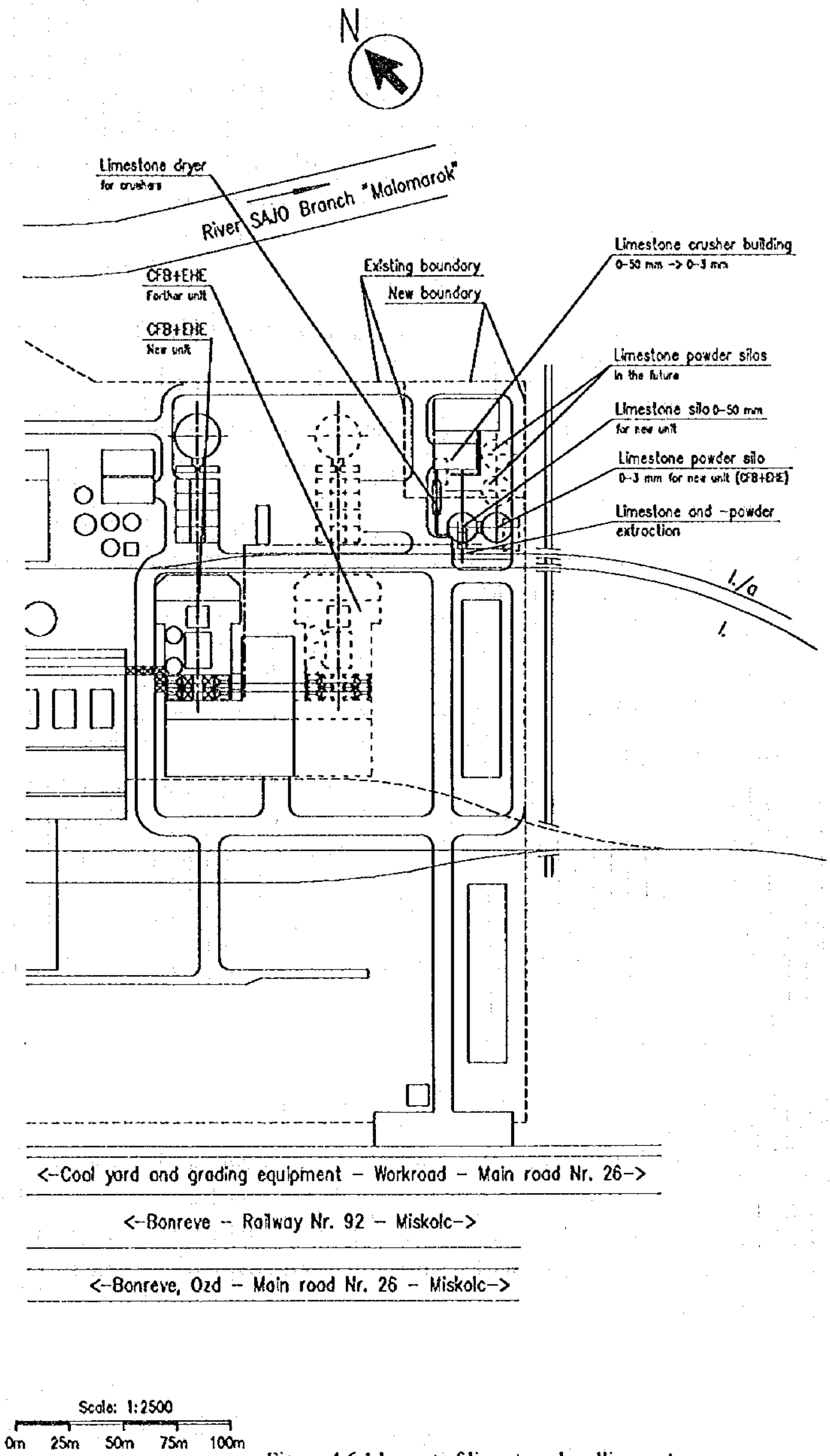


Figure 4.6.1 Layout of limestone handling system

The dry grinding technology detailed later in this section enables the safety of supply to be increased, by making the limestone supply system of the new boiler suitable for both receiving and pneumatic unloading of limestone grist transported in cement tankers. If necessary, the limestone grist will be transported in four-axle 4-vessel cement tankers of type Uaces or, possibly, dual-axle 2-vessel cement tankers of type Ucs.

The maximum quantity of limestone used by the boiler (CFB+EHE) of unit 150 MW will be:18.4 t/h x 24 h = 442 t/d.

With 5 days' supply a week, the quantity to be received each day will be 442 tons/d x 7/5 = 619 tons/d.

This means that 16 wagons, i.e. 1 to 2 trains shall be received a day. With single shift 8 hours service and 75% transport efficiency, the calculated capacity requirement of the reception system will be:

619 t /0.75 / 8 h = 103 t/h

Should, for reason of prolonged operating trouble in the limestone grist plant, limestone grist for the new boilers have to be procured and supplied, by using 4 discharge pipe stub each of 20 t/h capacity, 4 vessels (1 or 2 tankers, depending on the type) can be unloaded simultaneously. Thus, the time necessary for unloading the desired daily quantity of limestone will be approximately 7.5 hours.

2) Storage of limestone

A reserve quantity sufficient for at least 3 days shall be stored, in the form of limestone grist for the new boiler. Accordingly, the minimum storage requirements are as follows:

For 150 MW CFB+EHE unit, limestone grist: 3 x 24h x 18.4 tons/h = 1,325 t

In this case, it is reasonable to take 5 days' supply a week into consideration, therefore, the storage of a reserve for at least 2 days i.e. 1,210 tons of raw limestone with grain size 0 to 50 mm shall be provided for. In addition, due to the dry grinding technology surveyed later, it is also recommended to store at least 3 days' supply of limestone grist.

Both the raw limestone and the limestone grist ground to the desired grain size will be stored in reinforced concrete silos in a closed system. The silo used to store the raw limestone has a 12 m internal diameter; its height is 27 m. It's appearance shall be identical to that of the limestone grist silo. The center of its outlet is at level +8 m. The net capacity of the silo is approximately 1,300 m^3.

The limestone grist is stored in a reinforced concrete silo which is, for reasons of construction, also of circular section, with 12 m internal diameter and 27 m height. The center of the outlet is at level +12 m. The net capacity of the limestone grist storage silo is approximately 1,700 m^3.

Thus, the total storage capacity for limestone is:

3,000 t x 1 ton/m^3 = 3,000 t, which ensures the operation for 3,000 t/442 t/d = 6.8 days.

Storage capacity for raw limestone and limestone grist is as follows:

1,700 tons of limestone grist for new 150MWe is equivalent to the amount of consumption of 3.8 days.

(4) Outline of Limestone Handling System

The block diagram of limestone supply system is shown in Figures 4.6.2 and 4.6.3. The list of equipment is summarized in the Table 4.6.1.

1) Receiving the raw limestone

The drop-bottom type wagons will be unloaded on the discharge grate installed on unloading track No. I built next to the plant siding No. I/a. Below the discharge grid, 2 bunkers made of reinforced concrete receive the full load of the wagon. The reinforced concrete bunkers will be discharged by means of vibrating feeders which, in turn, feed 1 (one) ribbed belt elevator through discharge belts. The ribbed belt elevator feeds the limestone through the inlet opening of the limestone silo at the +27 m level into the raw limestone storage silo. The wagon discharge grate is located in a building of light structure, open at both ends sealed, however, by means of air curtain, in order to prevent the dust generated during the discharge of limestone from getting into the environment. The spaces of the wagon reception building located below the discharge bunkers as well as the dust emission points of the raw limestone storage silo are provided with bag-type dust exhaust system of

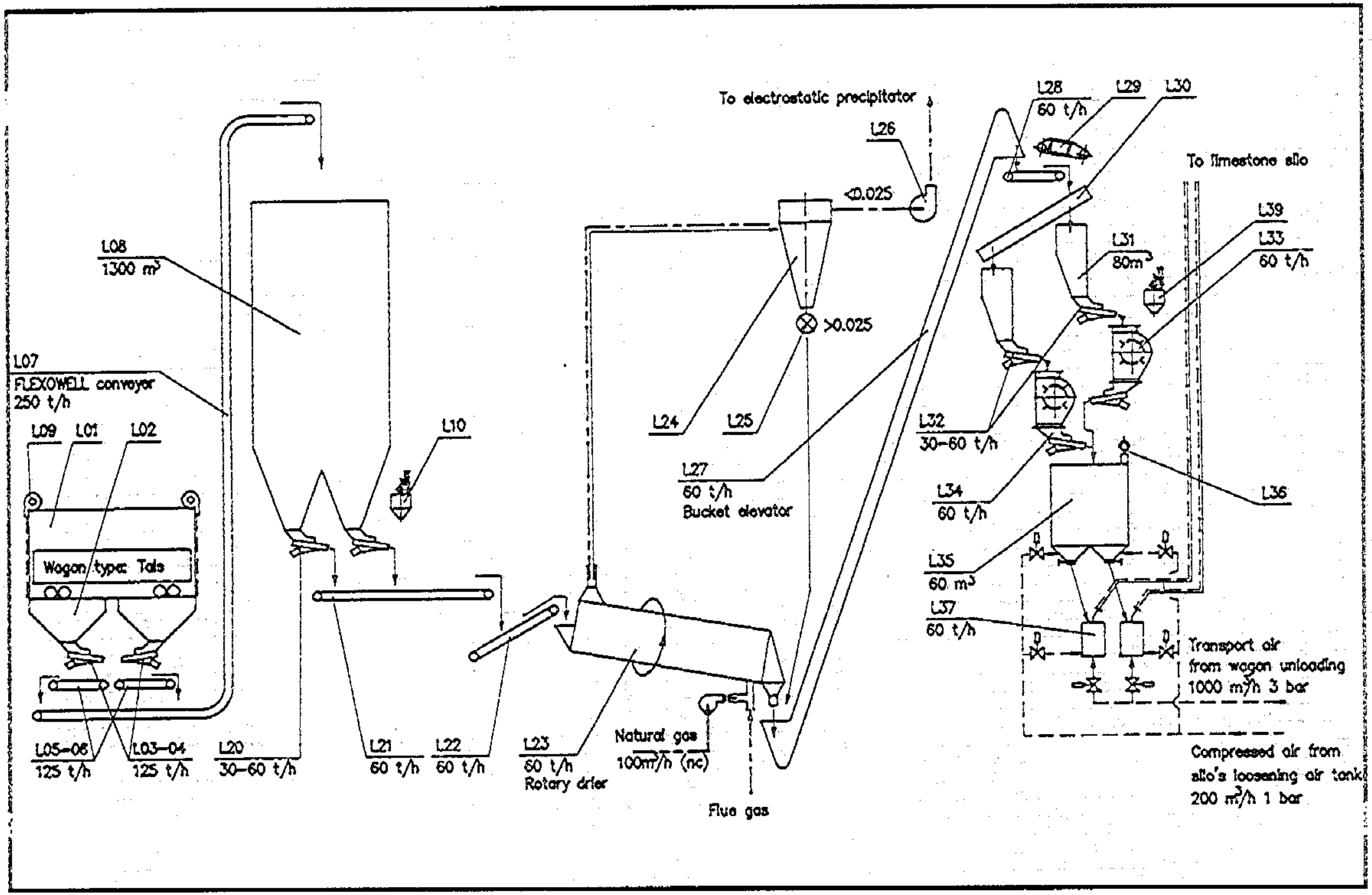


Figure 4.6.2 Limestone handling system, receiving, storage & crushing

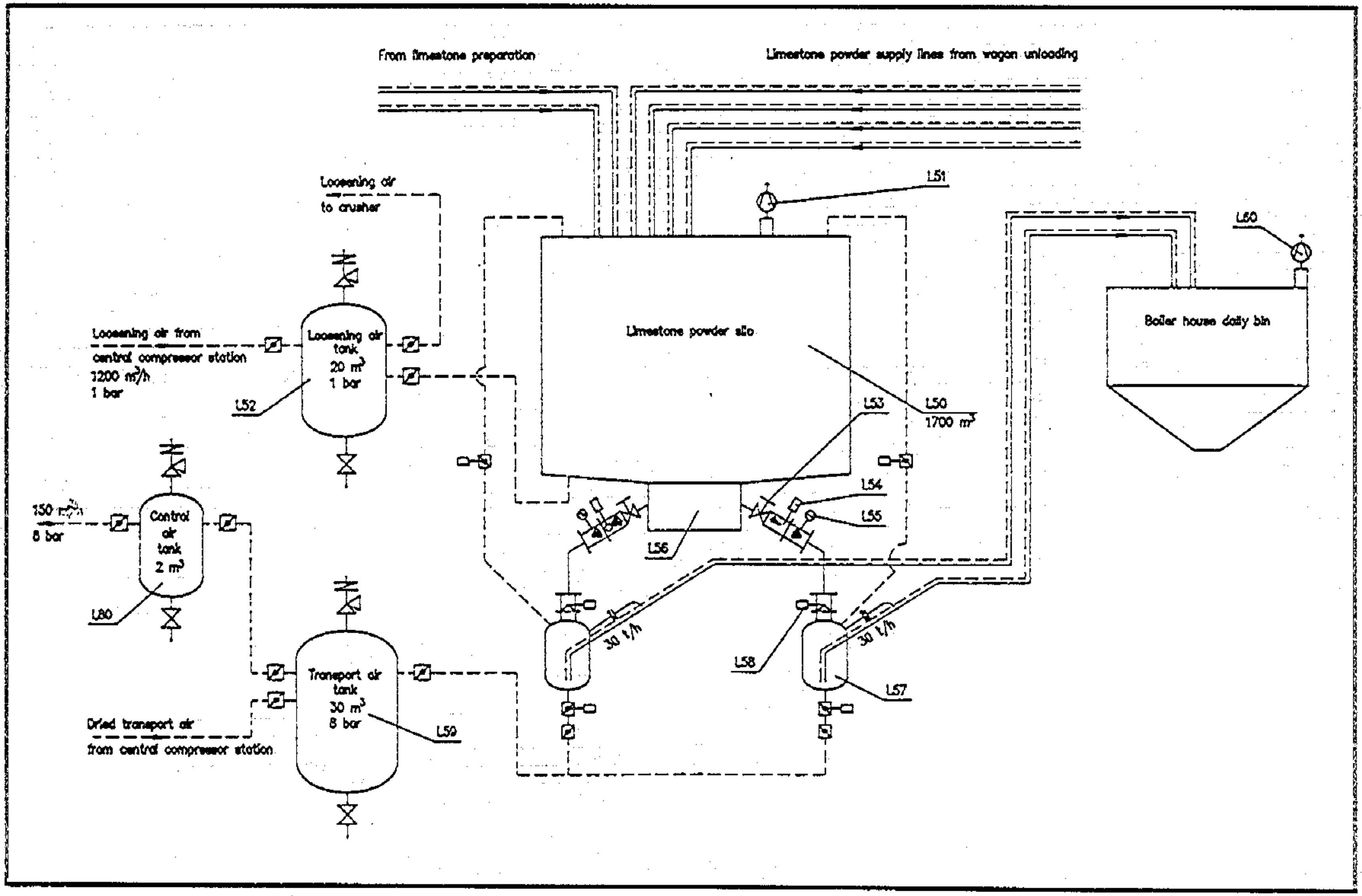


Figure 4.6.3 Limestone handling system, transport to boiler house daily bin

Table 4.6.1 Main parts of the limestone supply system

No.	Technological Unit	Code	Description	Quantity pcs	Capacity t/h	Technical data B mm	Technical data L m	Technical data H m	Technical data v m/s	Electric data Installed pcs	Electric data Working pcs	Nominal capacity kW/pcs	Total capacity kW 1011	Simultaneous load continues kW 685	Simultaneous load short kW 20
1	Limestone receiving														
2		L01	Wagon reception building	1											
3		L02	Unloading grate with bunker	2											
4		L03-04	Vibrating feeder	2	125 t/h					2	2	5.5	11	8	0
5		L05-06	Belt conveyor	2	125 t/h	650	7	0	2	2	2	5.5	11	7	0
6		L07	Conveyor	1	250 t/h	800	15	35	3.35	1	1	90	90	72	0
7		L08	Raw limestone silo 1300 m^3	1	1300 m^3										
8		L09	Air curtain fan	4	V=4000 m^3/h, p=250 dPa					4	4	5.5	22	16	
9		L10	Dust exhausting system	1	V=32000 m^3/h, p=250 dPa					1	1	64	64	64	9
10															
11	Limestone grinding														
12		L20	Vibrating feeder	2	30-60 t/h					2	2	1.35	2.7	2.7	0
13		L21	Belt conveyor with scraping chain	1	60 t/h	650	30	0	1.3	1	1	7.5	7.5	5.9	2.2
14		L22	Belt conveyor with scraping chain	1	60 t/h	650	30	6	1.3	1	1	18.5	18.5	13.8	2.2
15		L23	Rotary drier	1	60 t/h					2	2	55	110	110	0
16					Heat demand 750 MJ/h										
17		L24	Powder separator cyclone	1											
18		L25	Rotary feeder	1						1	1	7.5	7.5	0	6.5
19		L26	Flue gas fan	1	30000 m^3/h					1	1	37	37	37	0
20		L27	Bucket elevator	1	60 t/h		8	25	1	1	1	30	30	22	0
21		L28	Belt conveyor	1	60 t/h		4	0	1	1	1	5.5	5.5	4	0
22		L29	Magnetic separator	1						1	1	3.8	3.8	3.8	0
23		L30	Scarping chain conveyor	1	60 t/h		12	0	0.5	1	1	22	22	16	0
24		L31	Feeding container, reinforced concrete design 80 m^3	2											
25		L32	Vibrating feeder	2	30-60 t/h					2	1	1.35	2.7	1.35	0
26		L33	Hammer crusher	2	60 t/h	From 0-50 mm to 0-3 m				2	1	250	500	250	0
27		L34	Vibrating feeder (tube type)	2	60 t/h					2	1	1.35	2.7	1.35	0
28		L35	Feeding container with pneumatic loosening	1	60 m^3										
29		L36	Ventilation of the feeding container	2	V=4000 m^3/h, p=250 dPa					2	2	5.5	11	8	0
30		L37	Pneumatic transport vessel	2	60 t/h										
31		L39	Dust exhausting system	1	V=20000 m3/h, p=250 dPa					1	1	32	32	32	0
32															
33	Storage and feeding to the boiler house														
34		L50	Silo, reinforced concrete design 1700 m^3	1	1700 m^3										
35		L51	Filter of the silo ventilation	1	V=6500 m^3, p=250 dPa					1	1	11	11	8.3	0
36		L52	Air tank to the loosening air 30 m^3	1	V=1200 m^3/h, p=1 bar										
37		L53	Limestone powder gate valve	8											
38		L54	Limestone powder stop valve	8											
39		L55	Layer control	2											
40		L56	Diverter box	1											
41		L57	Pressure vessel	2	30 t/h										
42		L58	Bell type valve	2											
43		L59	Transport air tank 30 m^3	1	V=1200 m^3/h, p=8 bar										
44		L60	Boiler house daily bin ventilation	1	V=1400 m^3/h, p=250 dPa					4	1	2.2	8.8	2.2	0
45															
46	Wagon unloading														
47		L70	Air tank 30 m^3	1	V=1500 m^3/h, p=3 bar										
48															
49	Control air supply														
50		L80	Instrument air tank (2 m^3)	1	V=110 m^3/h, p=10 bar										
51															

automatic operation, which returns the dust thus collected into the raw limestone storage silo.

2) Production of limestone grist

The coarse limestone of grain size 0 to 50 mm shall be ground to limestone grist of grain size 0 to 3 mm. Considering that the coarse limestone may contain humidity exceeding as much as 10% as the case may be, drying is required for the purpose of subsequent pneumatic transport of the grist. For drying, a rotary drier is envisaged, in which the drying is implemented by means of the cleaned flue gas obtained from the electric precipitator of new boiler. The flue gas fed into the dryer will be recirculated through dust separator cyclone and flue gas booster fan to the inlet of the electric precipitator. The rotary drier is also provided with gas heating, which ensures the heat energy necessary for drying even if the new 150 MW unit is started or is out of service.

The raw limestone of grain size 0 to 50 mm is transported by means of a bucket elevator to the 2 reinforced concrete bunkers located at the upper level of the grinding plant and further on to the hammer crusher. Taking two-shift work during 5 days a week and 75% operating efficiency into consideration, the necessary crusher capacity will be 605 /(0.75 x 16) = 50.4 tons/hour, which can be ensured by using a single (1) hammer crusher.

For reason of sufficient redundancy, 2 crushers will be installed (1 of which is active and the other is in standby state).

The limestone grist of grain size 0 to 3 mm produced by the crusher will be collected in a closed distribution vessel provided with two outlets. From each one, the limestone grist will be transported continuously by means of the pneumatic transport vessel into the storage silo. The distribution vessel is provided with air loosening system and its venting is ensured by means of a bag filter unit and an exhaust fan.

The crusher building is in closed design, made of reinforced concrete, with 20 m x 18 m area. Maximum height: 28 m. Air space: approx. 6,700 m^3

A central exhaust system provided with bag type filter serves for the dust generated in the crusher plant during operation. The filters will be cleaned automatically, and the dust collected will be returned to the above mentioned distribution vessel.

Compressed dried air of 3 barG pressure is supplied by the existing central compressor station through a 30 m³ air reservoir to the pneumatic transport system. The air reservoir is installed at the ±0.00 level of the limestone grist storage silo. In the case of direct supply, this air reservoir is also used for discharging the railway tankers transporting the limestone grist.

A common air reservoir supplies the loosening air of 1 barG gauge pressure to the pneumatic transport system of the crusher plant and the loosening air to the limestone grist silo.

3) Transport to the daily bin of the boiler

Unloading of the limestone grist silo belonging to the new boiler is performed by a pneumatic loosening system. During the unloading, the internal air blow (loosening) channels operate continuously while the external ones operate cyclically. The loosening system is supplied with compressed air at 1 barG gauge pressure from the existing central compressor station via the pressurized vessel of 20 m³ volume mounted below the silo.

When loading and unloading, the silo is ventilated by means of an integrated exhaust fan and bag filter unit mounted on the top of silo. The filter bags are cleaned by compressed air in counterflow under automatic control.

The limestone grist from the silo is discharged through a grist gate valve, a pneumatically operated discharge valve and a motor driven layer controller (volume control) into an intermediate bunker.

Below each of the two discharge ducts of the intermediate bunker, a transport vessel of 30 t/h rated capacity is installed. On top of the bunker, a relief (safety) valve is mounted, the outlet of which is returned to the upper space of the limestone silo.

The limestone grist from the intermediate bunker is fed through a gate valve and a pneumatically operated bell valve into the limestone grist transport vessel. The transport line of each vessel delivers the limestone grist into the daily bin of the boiler. One of the transport vessels is working while the other is on standby. The compressed air of 8 barG necessary for the transport vessels as well as the loosening air required by the intermediate bunker, silo discharge- and layer control system will also be ensured by the central compressor station through an air reservoir of 20 m³ capacity.

The transport vessels operate under automatic control, depending on the level in the daily bin of the boiler.

The daily limestone grist bin of boiler forms an accessory to the boiler. The ventilation of the bin will be implemented by means of an exhaust ventilator provided with bag-type filter. The filter bags are cleaned by compressed air in counterflow under automatic control.

One (1) relief valve and an air intake safety valve shall be mounted on the top of the daily bin installed within the boiler house. The bin will be provided with one (1) level gauge of continuous operation (with maximum and minimum limit indicators) and one (1) maximum (alarm) level signaling device. The cleaning-air of the filter bags of the venting device in the boiler house will be delivered by its own compressor.

4) Facilities for receiving limestone grist from external suppliers

One of the most expensive items of equipment within the limestone plant is the rotary drier, the reserve system of which - including the associated transfer equipment - is very cost intensive. On the other hand, the mechanism of the drier drum is relatively simple, and any possible remedy can be usually implemented within 24 hours. Therefore, it is not reasonable to duplicate the provision of the rotary dier system.

Considering, however, that the possibility of failures that require a longer time for the remedy cannot be excluded, Therefore, it is recommended to provide the facilities for receiving limestone grist from external suppliers.

The compressed air necessary for discharging is ensured through the air reservoir also used to supply the pneumatic transport system of crusher plant by the existing central compressor station. Each silo will be provided with one (1) level gauge of continuous operation (with maximum and minimum limit indicators) and one (1) maximum (alarm) level signaling device. A relief valve is also envisaged to be mounted on the top of each silo.

The system block diagram is shown in Figure 4.6.4

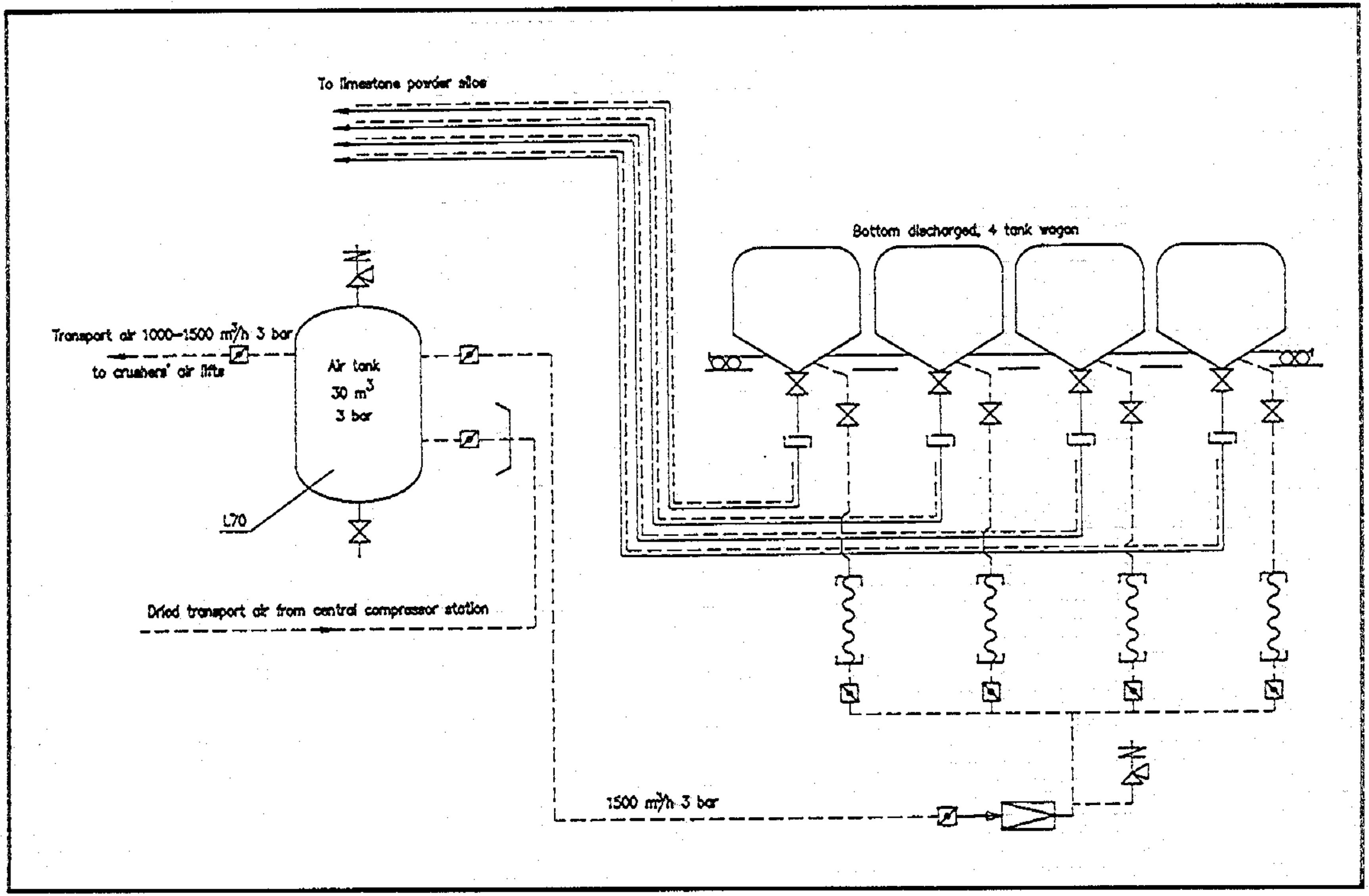


Figure 4.6.4 Limestone handling system, limestone powder receiving

(5) Quantity and Quality Measurements

The weighing of the arriving trains is performed within the area of coal grading plant of Berente by means of a railway bridge scale of 100 tons capacity, to be established for receiving hard coal. The chemical analysis of limestone grist can be verified in the laboratory of the Power Plant. Upon the arrival of the trains, the sampling of both the limestone grist and the raw limestone shall be performed manually.

(6) Environmental Protection

As already mentioned in the description of the limestone supply system several times, the interrelated process units of the limestone handling are of closed design. The units are as follows:

- The reception building of wagons transporting raw limestone is sealed at its both ends by means of a pressurized air curtain. And a dust exhaust system provided with bag-type filters is installed within the building.
- The conveyors are provided with sealed mantles, central or local dust exhaust systems feed the dust generated at their transfer points into bag-type filters. Any litter accumulated at the bottom of conveyor mantles will be removed - in the case of short conveyors along their full length, while in the case of long ones along a section of 20 m length upstream to the outlet end - and transported by means of scraper chain to the transfer point. Thus, the space below the conveyor belt will be cleaned automatically.
- As a result of pneumatic transport technology, the transporting systems of limestone grist are completely sealed.
- Venting of storage bunkers is also performed through bag-type filters.
- When transporting raw limestone, the major part of limestone grist carried away by the flue gas flow will be separated by means of a cyclone, while unseparated fraction will be fed together with the flue gas into the electro-static precipitator of the boiler where it will be separated together with the fly ash.

4.7 Slag and Fly Ash Handling System

(1) Outline of System

1) Composition of firing residue

In the new CFB boiler, a mixture consisting of local brown coal of 50% and imported hard coal of 50% (as related to thermal equivalent) will be fired.

The composition of firing residue of coal, with no limestone grist jamming, is shown in Table 4.7.1.

Table 4.7.1 Chemical Composition of Firing Residue

Description	Brown Coal	Imported Coal
SiO_2	average 51%	40-80%
Al_2O_3	average 18.7%	14-37.5%
Fe_2O_3	average 13.1%	14-37%
MgO	average 4.8%	2.0-5.5%
CaO	average 7.9%	0.5-12%
Na_2O	average 0.7%	0.2-2.2%
K_2O	average 2.1%	0.3-5.0%
SO_3	average 1.7%	0.3-8.0%
TiO_3	-	0.6-3.2%
P_2O_5	-	0.02-2.5%

While on the composition of firing residue of the Borsod brown coal there are reliable data at our disposal, the data on imported hard coals can vary within a wide range, depending on the sources of procurement.

With limestone addition, calcium sulfate ($CaSO_4$), calcium sulfite ($CaSO_3$) and calcium oxide (CaO) will appear in the firing residue, depending on the sulfur content of the fuel used and on the quantity of the limestone added.

2) Quantity of firing residue produced

Quantity of firing residue produced in the boiler of the new 150 MW unit at mixed coal firing is shown in Table 4.7.2. The design value is 44.2 t/h.

Table 4.7.2 Firing Residues Produced by the New Boiler

State of load	Capacity	Mixed coal firing
1. Design state	(382.0 MW)	44.2 t/h
2. Optimum firing	(287.5 MW)	32.3 t/h
3. Minimum load	(135.8 MW)	15.7 t/h
4. Overall load	(382.0 MW)	44.2 t/h
5. Max. heat demand in winter	(388.0 MW)	45.0 t/h

(2) Collection of Slag/Bed Ash and Fly Ash

From the fluidized bed, ash is removed through the bed ash separator. The fly ash separated from the flue gas flow can be removed from the hoppers of both the electrostatic precipitator (EP) and the economizer.

Bed ash will be cooled either in the ash cooler or in the shell-cooled screw conveyors forwarding it to the buffer store. From the buffer store and the economizer and EP hoppers, bed ash and fly ash are transferred by means of an intermittent-mode air-operated equipment of the ejector type to the storage place of 100 m^3 capacity next to the boiler. Transfer is controlled by a program actuated by the level switches fitted in the hoppers. Bed ash and fly ash collected in the storage place belonging to the boiler are forwarded to the two silos of 300 m^3 capacity each, installed in the slurry center by means of a new pneumatic transfer system through a pipeline of DN 125/150. Each pneumatic transport vessel is connected to a separate pipeline. The transport vessel pairs belonging to the new boiler should be connected to the air tanks in the compressor station.

Flow diagram of slag and fly ash system is shown in Figure 4.7.1

(3) Slag and Fly Ash Storage Area

The Power Plant has an existing slurry area. Operation of the existing slag and fly ash storage area is supervised by the ÉKF and ÉRV.

a) The presently authorized deposition areas are the frames Nos. V/1, V/2 and VII/2. Overall surface area of the frames is about 55 ha at a volumetric capacity of approximately 5,000,000 m^3.

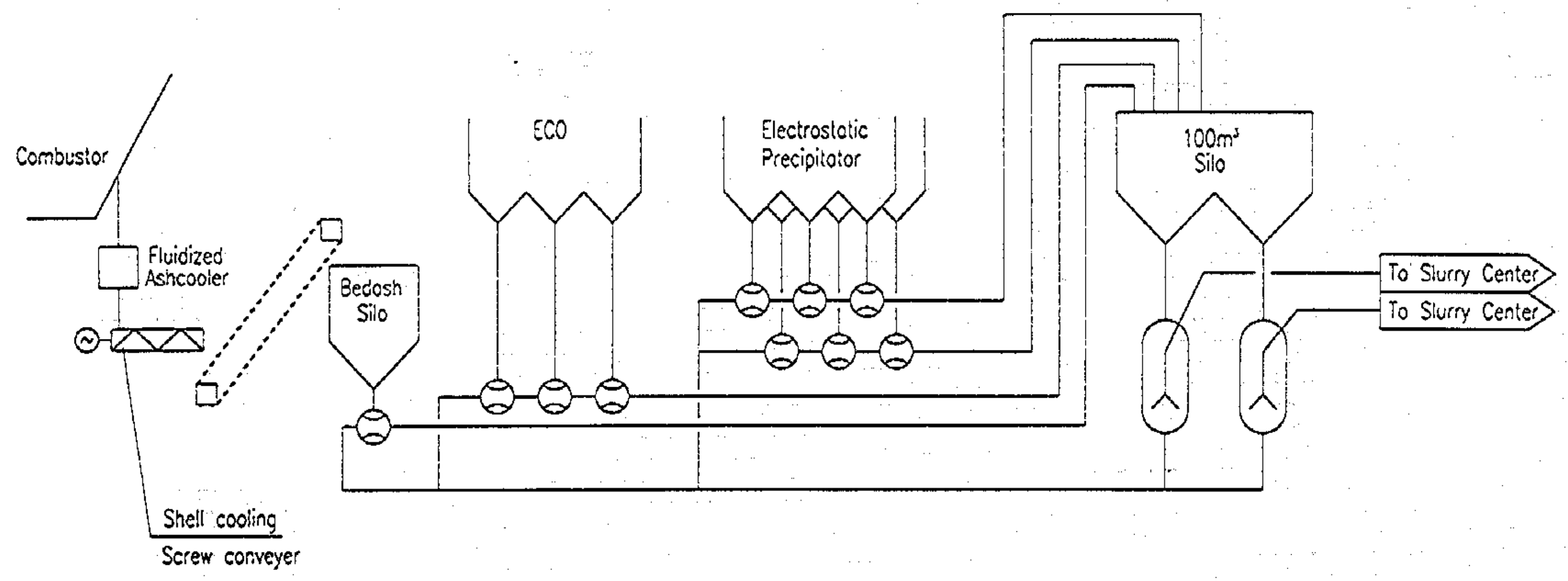


Figure 4.7.1 Flow diagram of slag and fly-ash system

b) To use frames VIII/1 and VIII/2 as new storage areas, a preliminary permit was obtained from ERV but the volumes of water leaking into the subsoil from the basic area of 342,000 m^2 of frames VIII/1 and VIII/2, respectively, was limited to 10 m^3/day.

c) Considering the present (1997) state of filling and the slurry areas that has not been cultivated yet, deposition of the firing residue emitted by the extended Power Plant is ensured for about another 25 years.

(4) Transport Air Supply System

To handle solids, pneumatic transporting systems are provided in the limestone handling system and at the new boiler of 460 t/h capacity.

1) Basic Design Data

Air pressure:	6 barG
Air volumes for:	
limestone fluidization	2,300 m^3/h
fly ash fluidization	1,500 m^3/h
total:	3,800 m^3/h

2) Specifications for the Major Units:

Compressor	Type	oil-injection type screw compressor equipped with silencing cover, inlet side air filter, oil separator and automatics
	Capacity	2,200 m^3/h
	Quantity	3 (2 x 50 %)
Air tank	Type	standing, cylindrical, welded construction
	Capacity	30 m^3
	Quantity	2
Air Drier	Type	absorption-type
	Capacity	2,200 m^3/h
	Quantity	3 (2 x 50 %)

3) The existing container-mounted screw compressors should be relocated. In the future, they will serve, in addition to supplying the existing pneumatic transporting system with air, as a reserve for the new transporting air supply system.

4.8 Electrical Facilities

The generator connected to the 150 MW unit is provided with both the main and auxiliary equipment necessary for the autonomous operation. The unit in normal operation mode provide electricity to all the auxiliary equipment of the generator and the boiler as well as to other external equipment necessary for the boiler operation. (Figure 4.8.1)

The electricity generated will be fed to the consumer network at a voltage of 120 kV. The unit can be started even without 120 kV voltage, by using a starting transformer of which power supplied by 35 kV. In the case of operation failure, the safe stopping procedure of the unit is ensured by means of batteries and a diesel generator.

The main components of the electrical main equipment are as follows:

(1) Generator and Excitation Equipment

The generator is a three-phase generator coupled directly with the turbine shaft and cooled by means of air/water heat exchanger.

Rated capacity:	187.5 MVA, cos fi 0.8
Rated voltage:	15.75 kV ±5%
Rated frequency:	50 Hz
Rated speed:	3000 rpm
Relevant standard:	IEC 34

The excitation equipment is of static type, with duplex power supply. The continuous power supply is ensured by means of automatic switch over between two feed lines.

(2) Transformers

Specifications of various transformers for the new unit are shown in Table 4.8.1.

1) Main transformer

The main transformer connected to the generator unit feeds the 120 kV network. The main transformer is oil insulated, with forced oil cooling connected to an oil/air heat exchanger. The voltage ratio can be changed under different load by a tap selector. The transformer terminals are connected to the generator terminals by means of separate sheathed bus-bars by phases.

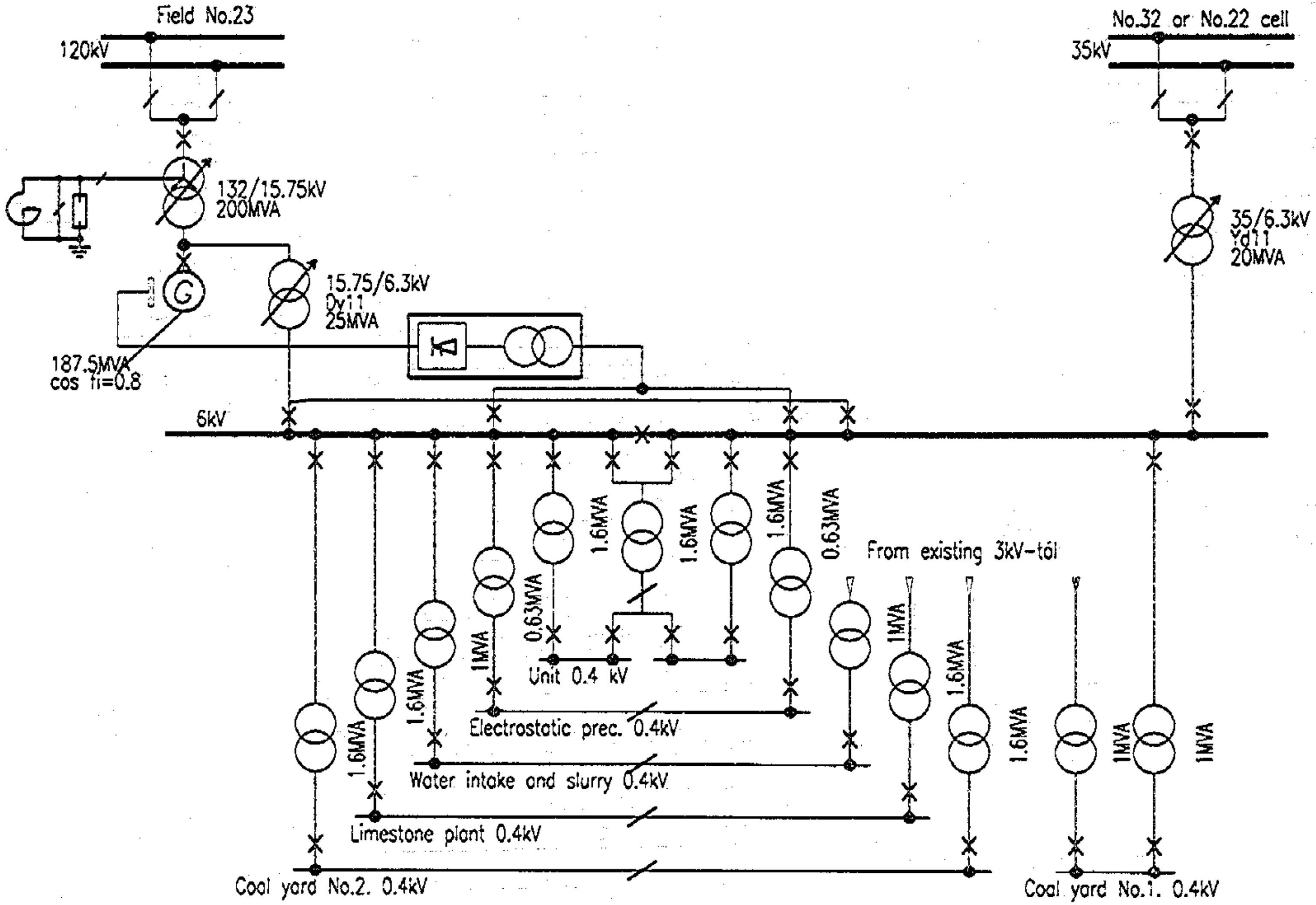


Figure 4.8.1 Overview of Electric Power Distribution

Table 4.8.1 Transformers

Transformers	Pcs	Capacity	Primary voltage	Secondary voltage	Switch group
Unit transformer	1	200 MVA	132 kV±15%	15.75 kV	Ynd 11
Auxiliary unit transformer	1	25 MVA	15.75 kV±15%	6.3 kV	Dy 11
Starting transformer	1	20 MVA	35 kV±15%	6.3 kV	Yd 11
Auxiliary service supply transformer	7	1.6 MVA	6.3 kV±5%	0.4 kV	Dyn 5
Auxiliary service supply transformer	2	1.6 MVA	2 x 3.15 kV±5%	0.4 kV	Dyn 5
Auxiliary service supply transformer	2	0.63 MVA	6.3 kV±5%	0.4 kV	Dyn 5

2) Auxiliary transformer

The auxiliary unit transformer supplies electricity to all auxiliary units in the plant. The transformer is connected to the generator - main transformer connection. It is of oil insulated design with forced oil/air cooling and provided with control facility. This transformer supplies power to the 6 kV main switch gear of the auxiliary units.

3) Starting transformer

Starting transformer ensures the start of the unit in the case of 120 kV network failure (abnormal condition). It is powered by the 35-kV switch gear. Its design is same as that of the main transformer.

4) Specifications for auxiliary power supply transformers

Specifications for auxiliary power supply transformers are summarized in Table 4.8.1. Each of them is of dry type and can be switched over to another voltage ratio under zero voltage condition. These transformers are used to serve the various 0.4 kV switching equipment.

(3) Auxiliary Switching Equipment

The total power requirement of the auxiliary unit amounts to 13 to 15 MW, distributed in either 6 kV or 0.4 kV voltages.

1) 6-kV switching equipment

The 6-kV switching equipment consists of two bus-bar sections interconnected with a sectioning switch. It receives power supply by two lines from the auxiliary unit transformer and by one line from the starting transformer. The feed points are provided with automatic switch-over devices. The speed of high-power motors that drive the feed water pumps, hot water circulating pumps, etc. can be controlled by static frequency converters powered by this switching equipment. This switching equipment also powers the 0.4 kV switching equipment through the dry transformers.

2) 0.4 kV equipment

The 0.4 kV equipment are connected to distributors which are grouped according to their tasks and location. These distributors are powered from the 0.4 kV switch-gears (7 in total). In addition to the above distributors, other consumers are also connected to certain switch-gears. These switch-gears receive power supply by two lines from transformers. In any case, one of the feed points is the 6 kV switch-gear as described in item 1) above. The second feed point consists of either the other side of the same switch-gear or the transformer that connects to the taps of the existing 3 kV equipment of the power plant. The feed points are provided with automatic switch-over facility.

3) 0.4 kV distribution system (Figure 4.8.2)

The consumers large in number but usually of low power consumption are connected to the 0.4 kV distributors (22 in number). The distributors are supplied by two feed points each through solenoid switches, providing 100 % duplication to each other. In normal operating mode, one of the feed points powers the distributor. A suitable device provides for the automatic switch-over to the standby feed point in the case the normal supply fails.

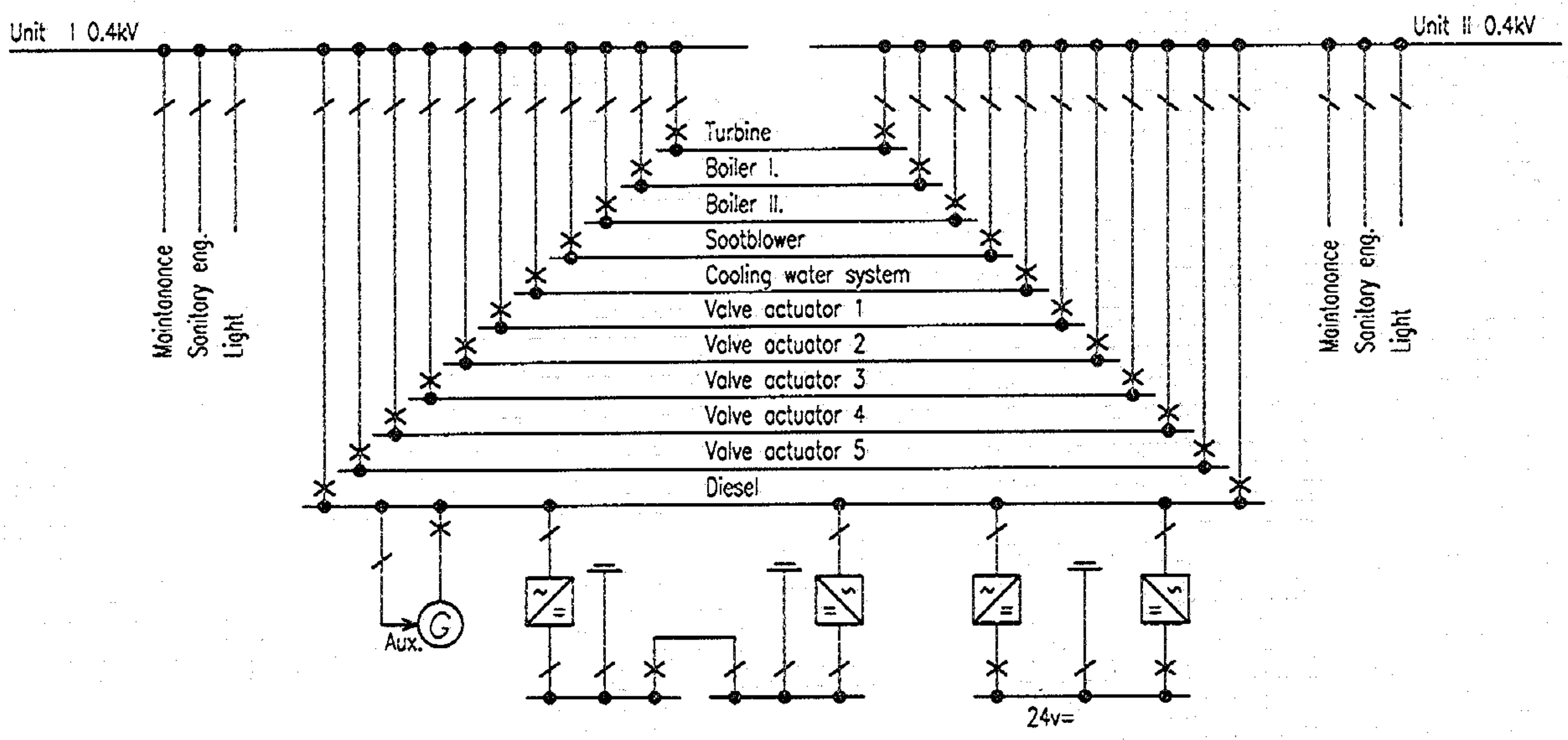


Figure 4.8.2 0.4kV Distribution System

4) Diesel generator

In the case of total operation failure (power failure) of diesel generator, it provides for the power supply necessary for the consumers of vital importance and for the emergency stopping procedure of the unit. The diesel generator is provided with all the safety and control devices necessary for maintain its functional ability and ensuring the proper operation.
It is connected to the "diesel" distributor that powers the consumers mentioned above.

The main parameters of the diesel generator are:

Engine power output:	320 kW
Generator power rating:	400 kVA
Voltage:	400/231 V
Frequency:	50 Hz

5) DC system

The 220 V DC system includes two battery sets, one distributor divided into two sections and two recharger units. At their AC side, the recharger units are connected to the diesel distributor. The 220 V DC network supplies the most important safety and actuating devices.

The 24 V DC system includes a battery set and two recharger units. At their AC side, the recharger units are connected to the diesel distributor. The 24 V DC network powers the instruments of the thermal system as well as the measuring and annunciation devices. The batteries are of solidified crystal - dryfit - system.

(4) Protective Measures (Figure 4.8.3)

1) Protection of the power unit

Protection of the unit shall be implemented in conformity with the relevant Hungarian standards and shall cover the following functions:

(a) Full protection of generator, covering the important components and the mode of operation.

(b) Full protection of the transformers (unit transformers, auxiliary unit transformers, starting transformers).

(c) Protection of bus bars at generator voltage.

The unit protection ensures the necessary NC connections to the central failure recorder equipment and the process control equipment.

2) Protections of the 6 kV switch-gear

(a) Overload protection (delayed and instantaneous)
(b) Voltage drop protection
(c) Protection against circuit breaker jamming
(d) Bus bar protection
(e) Earthing protection

3) Protections of the 0.4 kV switch-gear

(a) Quick overcurrent protection and overcurrent protection with current dependent delay in the feed circuit

(b) Overcurrent protection (fuse or circuit breaker) and overload protection in the branch circuits (motor circuits)

(5) Signaling, Measurement, and Activation of Devices

See Section 4.13 for signaling, annunciation (alarm signals) and measuring. Activation of devices are done as follows:

1) The devices of 120 kV system are activated from the dispatcher center.

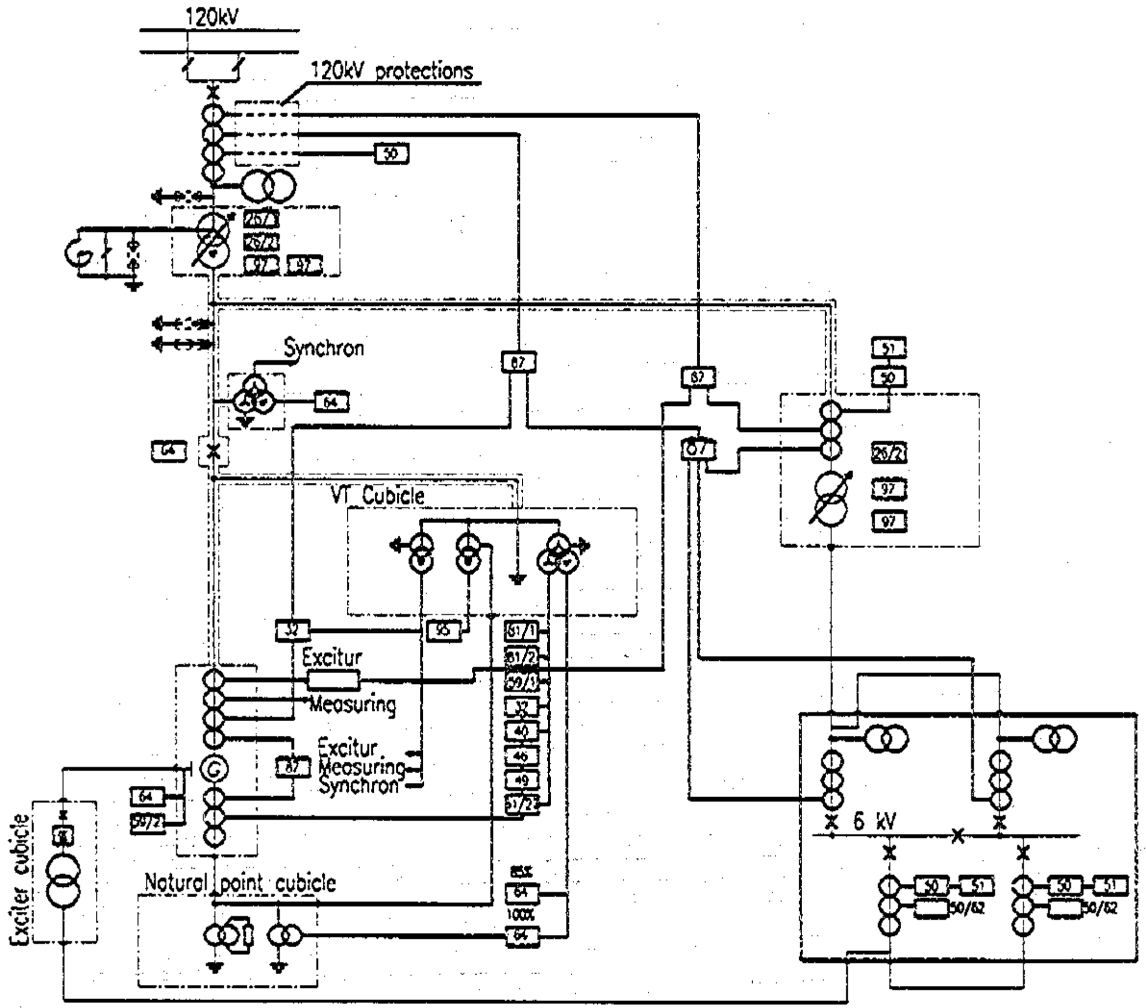
2) The circuit breakers of generator voltage and those of 6 kV voltage are activated from the control room of the unit.

3) The switching operations to be performed at the feed points of 0.4 kV switch-gears are controlled through the process control equipment from the control room of the unit.

(6) Synchronization

1) The synchronous switching will be performed by means of the circuit breaker of generator voltage when the auxiliary service is powered through the auxiliary unit transformer.

2) The unit can also be synchronized by using the circuit breaker of 120 kV.



Symbols:
26/1 Temperature of coil
26/2 Temperature of oil
27 Voltage break down
32 Load reversal
40 Fail of excitur
46 Assimetry
49 Over load
50 Quick overcurrent
51 Slow overcurrent protection
59/1 Voltage rising
59/2 Rotor overload protection
62 Breaker seizure protection
64 Earth leakage
81/1 Frequency cut
81/2 Frequency increase
87 Differential protection
95 Short circuit
97 Buchholz protection

Figure 4.8.3 Protection Block Diagram

3) The synchronization can also be performed manually or by means of an automatic synchronizing equipment.

(7) Voltages Applied

Network voltage:	120 kV
Generator voltage:	15.75 kV
Main switch gear of auxiliary service:	6 kV
Auxiliary service voltage of existing Power Plant:	3 kV
Starting transformer connection voltage:	35 kV
General auxiliary voltage:	0.4 kV
DC auxiliary service:	220 V and 24 V

4.9 Fresh Water Supply and Treatment System

4.9.1 Fresh Water Supply System

(1) Basic Design Parameters

Water demand

1) Waters taken at Malomárok of Sajó River

Untreated water

Cooling water for steam turbines, total	814 m^3/h
Drum filter flushing water	50 m^3/h
Warming-up for river in winter	250-600 m^3/h
Total	1,114 -1,464 m^3/h

Treated water

Bearing cooling water total	60 m^3/h
Bearing cooling water of the new unit	63 m^3/h
Make-up water of wet cooling system	507 m^3/h
Utility water for water treatment plant	120 m^3/h
Total	750 m^3/h

The total amount of water taken from Sajó River: 1864-2214 m^3/h

2) Water from Bódva River

Treated water for the purpose of

Demineralized boiler feedwater	270 m^3/h
Demineralized water	30 m^3/h
Ion free water	200 m^3/h
Utility water for water treatment plant	30 m^3/h
Total	530 m^3/h

3) Water discharged at Malomárok of Sajó River

Cooling water for steam turbines, total	814 m^3/h
Drum filter flushing water	50 m^3/h
Bearing cooling water, total	123 m^3/h
Warming-up water for river in winter	250-600 m^3/h
Total	1,237-1,587 m^3/h

The above amount will cover the water demand of the coal grading plant of around 100 m^3/h.

The blow down water and wastewater from the water treatment plant is transferred to the fly ash handling system.

Blow down water	162 m^3/h
Wastewater from the water treatment plant	30 m^3/h
Total	192 m^3/h

The water balance of the Power Plant is shown in Figure 4.9.1.

(2) Rehabilitation of the Intake Facilities

1) Intake pumps

In the water intake plant, there are 9 existing pumps:

- 5 lift pumps
- 3 cooling tower pumps
  (cooling tower is out of operation)
- 1 returning pump.

Lift pumps 1-3 shall be replaced by new ones. For this purpose, the existing machine foundations have to be demolished and the new foundation has to be prepared. In addition, also the necessary mechanical and civil repair works have to be performed.

Lift pumps

Type	centrifugal
Quantity	3 pcs (3 x 50%)
Delivery	2,214 m^3/h

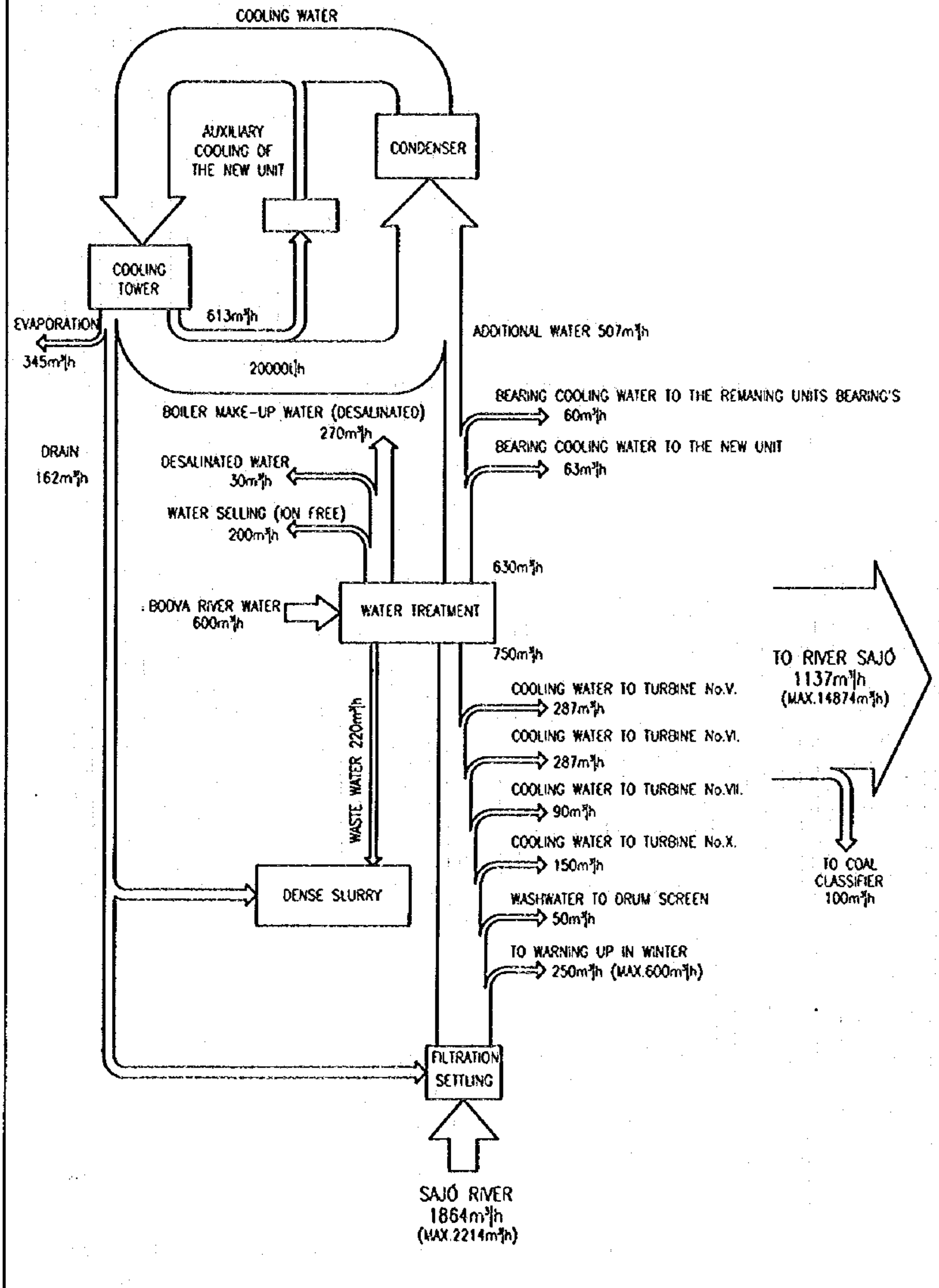


Figure 4.9.1 Water Balance of the Power Plant

2) Settling basins

On the basis of the hydraulic and structural examination to be performed on 5 settling basins, any defects found have to be eliminated and the system has to be renewed in terms of both concrete structures and water tight insulation. The renewal of the system includes the renewal of the control valves.

Quantity	5 pcs (1 standby)
(5 existing basins to be renovated)	

3) Drum filters (existing filters will be removed)

The existing drum filters are to be removed and 2 new filters to be installed, together with the required civil and mechanical works.

Quantity	2 pcs (2 x 100%)
Capacity	2,300 m^3/h/pc

4) Cooling water pumps for steam turbines No. V and VI

Type	centrifugal
Quantity	3 pcs (3x 50%)
Delivery	574 m^3/h

5) Cooling water pumps for steam turbines No. VII and X

Type	centrifugal
Quantity	3 pcs (3 x 50%)
Delivery	240 m^3/h

6) Warming-up pumps of auxiliary cooling system

Type	centrifugal
Quantity	2 pcs (3 x 50%)
Delivery	600 m^3/h

7) Pipelines

The new long distance pipe lines and the warming-up pipe line will be laid in the existing concrete trenches.

(a) Long-distance line between the filter house and turbines VII and X

Diameter	DN 200
Total length	200 m

(b) Long-distance line between the filter house and turbines V and VI

Diameter	DN 300
Total length	500 m

(c) Warming up pipeline

Diameter	DN 300
Total length	1,200 m

(d) Drain pipeline

Diameter	DN 400
Total length	600 m

(3) Description of Water Supply System

1) The demand of the Power Plant for make-up water is met by taking water from Sajó River and Bódva River. Considering water quality of the both rivers, demineralized water shall be produced from the water of Bódva. The maximum quantity, on the basis of the consumption figures laid down above, is 530 m^3/h. The quantity permitted by the environmental authorities is 5,470,000 m^3/year.

2) The required quantity of auxiliary cooling water is maximum 2300 m^3/h and it is taken from Sajó River. The quantity permitted by the environmental authorities is 64,000,000 m^3/year. The capacity of the existing water intake facility is much bigger than what is required for the whole plant including the new power plant. The capacity of the available pump station is 5 x 7200 m^3/h. Formerly, the system met a cooling water demand of 30,000 m^3/h.

3) Cooling water intake from Bódva River is particularly difficult in the summer when the water flow is small, although most of the water removed is returned.

4) Cooling water is taken from Sajó River. Three pumps with vertical shaft delivers water from " Malomárok" to the settling basins near the water intake plant. From here, fresh water flows to two new drum filters over a spill weir. The basins not only settle particles but also work as a buffer tank to balance the water quantity

difference between pumping and consumption. The basins are connected parallel. A part of the cooling water is delivered from the basin under the drum filters into the water treatment plant to provide, after proper treatment, cooling water to bearing cooling and make-up water to the wet cooling tower. The rest of the water serves, by 2 x 3 pcs cooling water pumps, the auxiliary cooling of the steam turbines No. VI, X and V, VI. From both pump groups, water flows to the auxiliary cooling system of the turbo-generator unit through a long pipeline installed in concrete trenches. Warmed-up cooling water is returned to Sajó River. The water demand of the coal grading plant is met by providing return water.

5) River Sajó may freeze in the winter. In order to obtain an adequate quantity of water with adequate temperature (12 °C) and to de-freeze the river water, warmed-up cooling water from the new unit's condenser is to be pumped to the upstream of the water intake point. In case the new unit's condenser is out of operation, warmed-up water is to be supplied by auxiliary condensers of operating boilers.

6) A part of the cooling water which is warmed up in the condenser is transferred through a water/water surface heat exchanger. On its cold side, the fresh water flows in the separate pipes. Therefore, the two kinds of water do not mix with each other and their quality does not change.

7) Warmed-up water is to be transferred by the transfer pumps to the basin located under the drum filters to ensure the adequate inlet ("cold") temperature of the auxiliary cooling water.

4.9.2 Water Treatment System

Flow diagram of proposed water treatment system is shown in Figure 4.9.2.

(1) Basic Design Parameters

1) Demand on demineralized water

The demand on demineralized water for the new 150 MW unit and the existing 100 t/h boilers of the Power Plant will be 500 t/h. Proposed water treatment plant can utilise existing water softening equipment of which capacity meets this demand. Raw water is supplied from Bódva River. In order to reduce treatment costs, raw water supply from the River Sajó is to be arranged.

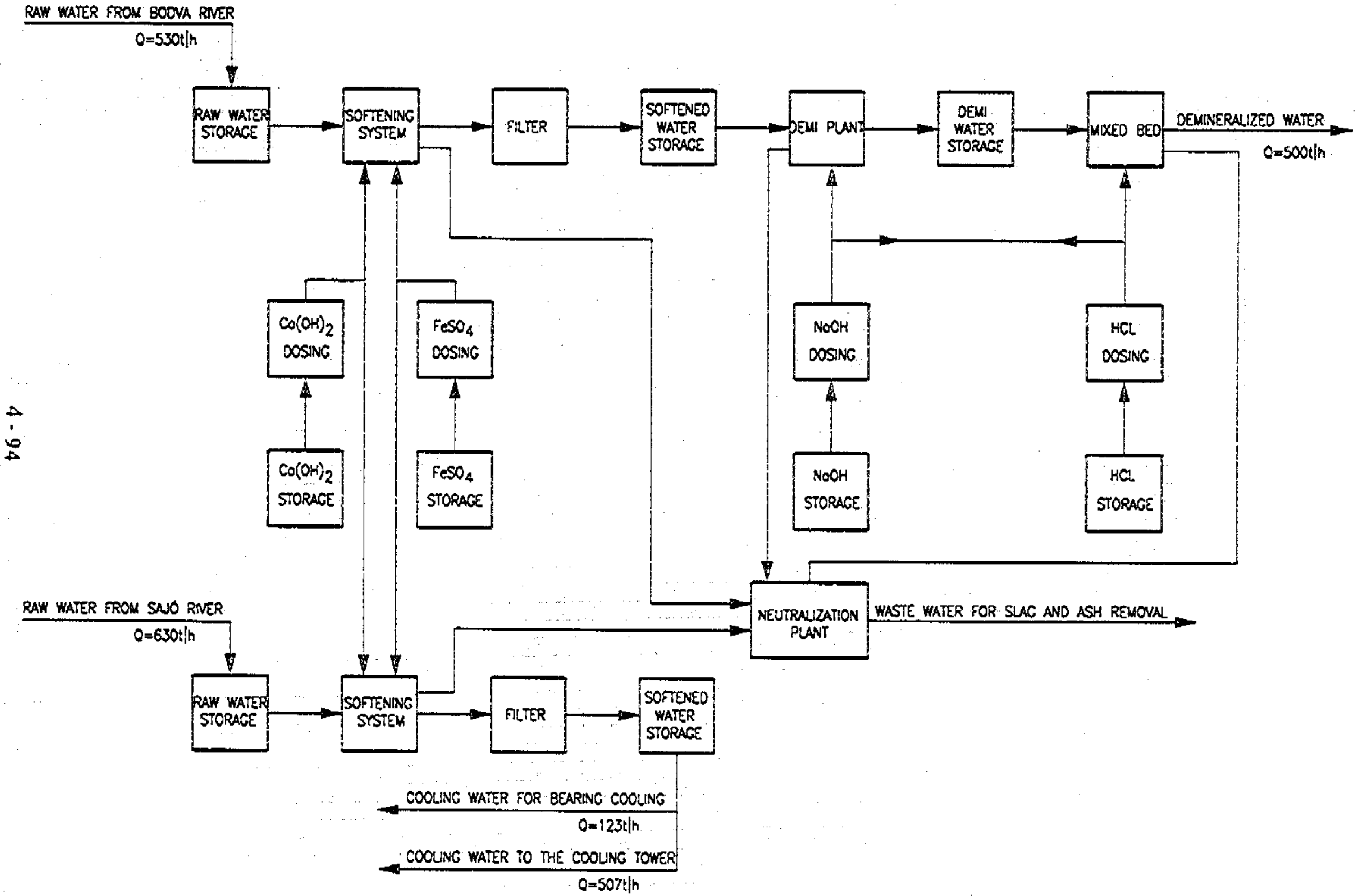


Figure 4.9.2 Water Treatment System Flow Diagram

2) Demand of softened water for cooling purpose

The demands of the softened water for the cooling purpose are as follows:

- 507 t/h make-up water to the cooling tower with 10 m pressure
- 60 t/h bearing cooling water to the existing equipment with 75 m pressure
- 63 t/h bearing cooling water to the new unit with 75 m pressure
- 630 t/h in total

Raw water will be supplied from Sajó River.

3) Water quality data

(a) Bódva water quality

Conductivity	(μS/cm)	544.6
$KMnO_4$ consumption	(mg/l)	12.16
	(nk°)	(me/l)
Total hardness	15.30	5.46
Carb. hardness	10.36	3.70
Ca hardness	11.84	4.23
Mg hardness	3.46	1.23
p-value		0
m-value		3.70

CATIONS		(me/l)
Calcium Ca^{++}		4.23
Magnesium Mg^{++}		1.23
Total:		5.46

ANIONS	(mg/l)	(me/l)
Bicarbonate HCO_3^-	225.70	3.70
Chloride Cl^-	33.20	0.93
Sulphate SO_4^{2-}	101.09	2.10
Silicate $SiO(OH)_3^-$	4.54	0.15
Total		6.88

Average total mineral content of softened water produced from Bódva River is 4.20 me/l.

(b) Sajó water quality

Conductivity	(µS/cm)	564.6
$KMnO_4$ consumption	(mg/l)	9.77
	(nk°)	(me/l)
Total hardness	14.76	5.27
Carb. hardness	9.56	3.43
Ca hardness	10.76	3.84
Mg hardness	4	1.43
CO_2 hardness	no data	
p-value		0
m-value		3.70

CATIONS		(me/l)
Calcium Ca^{++}		3.84
Magnesium Mg^{++}		1.43
Total:		5.27

ANIONS	(mg/l)	(me/l)
Bicarbonate HCO_3^-	208.60	3.42
Chloride Cl^-	44.65	1.26
Sulphate SO_4^-	105.14	2.19
Silicate $SiO(OH)_3^-$	4.15	0.14
Total		7.01

4) Cooling water quality requirements

Water quality to be maintained in the cooling water system are as follows;

pH		> 6.5)
free CO2	(mg/dm^3)	< 3
Carb. hardness	(me/dm^3)	1.4-4.4
Total hardness	(me/dm^3)	< 25
Mineral content	(mg/dm^3)	< 3000
Chloride content	(mg/dm^3)	< 1000
SO_4 content	(mg/dm^3)	< 300
Iron content	(mg/dm^3)	< 1
Suspended solids	(mg/dm^3)	< 20
SiO_2	(mg/dm^3)	< 100
Ammonia	(mg/dm^3)	< 1

Quality of cooling water produced from Saj6 water:

Carbonate hardness, max.	1 me/l
Sulphate content (SO_4)	105 mg/l

Blow-down loss of the cooling tower:

Calculated from carbonate hardness	29.4%
Calculated from SO_4	53.8%

Therefore, blow-down loss is determined by the SO_4 content of the cooling water.

5) Boiler water quality requirements
(with regard to the new unit)

Steam parameters:	p = 164 bar
	t = 540 °C
Max. steam generation:	460 t/h

(a) Feed water

pH on 25 °C		>	8.5
pH on 25 °C		<	9.5
Solved oxygen, max.	(mg/kg)	<	0.01
Total hardness, max.	(me/kg)	<	0.001
Total iron, max.	(mg/kg)	<	0.02
Total copper, max.	(mg/kg)	<	0
Oil + suspended matter			0

(b) Boiler water

pH on 25 °C		>	8.5
pH on 25 °C		<	9.7
SiO_2	(mg/kg)	<	0.35
p-value	(me/kg)	<	0.05
Na and K	(mg/kg)	<	
Conductivity (at 25 °C, after neutralisation)	(mS/m)	<	4.00
PO_4	(mg/kg)		6.00
$KMnO_4$ consumption	(mg/kg)	<	5.00

(2) Demineralisation System

The existing demineralisation system does not need to be modified and its capacity increase is not necessary. It has been renewed recently and is capable of producing enough demineralised water for the joint operation of the new unit and the existing boilers for the next 25 years.

(3) Necessary Changes in the Cooling Water Softening System

Breakdown of cooling water usage:

507 t/h to cooling tower	H=10 m pressure
123 t/h to bearing cooling	H=75 m pressure

1) Raw water supply will be arranged from the existing settling basins from Sajó River.

2) The capacity of the existing small water softener (φ 7,600 mm) shall be increased to Q=250 t/h. One new water softener will be installed (φ 13, 000 mm) with a capacity of Q=500 t/h.

   The water softener planned for cooling water production (total capacity 750 t/h) guarantees proper operational security for the maintenance period. It also facilitates the connection of the two softening systems operating with two different types of raw water.

3) Filter capacity

   The following filters serve the new 500 t/h water softener:

4 pcs existing bearing cooling water filters	(4x80 t/h)	(φ 3,150x3,000 mm)
3 pcs new filters	(3x80 t/h)	(φ 3,150x3,000 mm)
Total capacity:	7x80 t/h = 560 t/h	

   All 7 filters have to be equipped with pneumatic valves

   The following filters serve the existing 250 t/h water softener:

   4 existing filters 4x100 t/h = 400 t/h (φ 4,000x3,000 mm)

4) Filter washing

   For backwashing, 2 pcs of new filter washing pumps (Q=150 t/h, H=36 m W.G.) have to be installed.

As a water saving measure, a washwater settling basin (ϕ 7,600 x 8,000 + 3,800, 420 m^3) shall be installed. Used backwash water is transferred back to the water softener by a transfer pump operated by a level switch
(Q=25 t/h, H=32 m W.G., 1 operating, 1 stand-by).

5) Storage of softened water

For the purpose of storing softened water supplied as cooling water, one new softened water tank has to be installed with a capacity of 500 m^3.

6) Pumps installed for supplying cooling water

3 pcs cooling water pump for the cooling tower (3 x 50%)
Q=250 t/h
H=10 m

2 pcs cooling water pump for the bearings (2 x 100%)
Q=123 t/h (60+63)
H=75 m

7) Dosing of conditioning agent into the cooling water

In order to prevent corrosion, scaling, alga formation, conditioning agents have to be added to the cooling water.

Various chemicals are distributed for this purpose (e.g. NALCO agents, BONION family of agents, etc.).

For dosing chemicals, a chemical dosing apparatus has to be installed.

Scaling and corrosion prevention

Chemical:	Anti-scaling and corrosion agent
Dosing:	Dosing pumps

Algae growth prevention

Chemical:	Organic biocid
Dosing frequency:	Periodical

The chemical dosing apparatus:

2 pcs agent dosing tanks	ϕ 630x800
4 pcs agent dosing pumps	Q=10 l/min H=30 m
2 pcs chemical unloading pumps	Q= 30 l/min H= 5 m

8) Iron sulphate supply for the new water softeners

The saturated $FeSO_4$ solution is transferred from the existing storage tank to the dosing tank by a transfer pump. After dilution, the chemical is dosed in proportion with quantity by a dosing pump.

The iron sulphate dosing apparatus consists of:
2 pcs transfer pumps; Q=9 t/h H=12 m W.G.
2 pcs iron sulphate mixing tanks; ϕ 1600x3000, 6 m^3
2 pcs twin-piston dosing pumps
(lime-milk iron sulphate); Q_1=4500 l/h; Q_2=700 l/h; p=5 bar

9) Storage and supply of lime hydrate

For the new lime softener, 1 lime powder silo (220 m^3) and 1 lime powder metering tank shall be installed.

10) Lime milk supply

3 lime milk agitators (26 m^3) and 2 twin-piston dosing pump (lime milk - iron sulphate) have to be installed.

(4) Wastewater Treatment

Each day around 800 m^3 wastewater is produced in the water pre-softener, which is collected in a concrete basin and neutralised.

For the purpose of receiving and treating wastewater, a concrete basin with two parts (2x900 m^3), sunk in the soil and having a chemical-resistant coating, has to be installed. The wastewater collecting basin is equipped with an apparatus suitable for compressed air mixing and with 4 sewage pumps with vertical shafts (Q=100 t/h; H=20 m).

(5) System Layout

For the production of 630 t/h cooling water, also the existing filter system of the bearing cooling water is used, which will be supplemented by 3 new sand filters. The tanks are to be installed in the open air near the filter house, the row of valves will be located in the filter house. The location of the new facilities for the extension of the lime softener is shown in Figure 4.9.3. Equipment requiring permanent operation is located in a new building.

The water softener, the softened water tank, the lime powder silo, the lime powder measuring tank, and the washwater settling basin are built in the open air.

The wastewater collecting basin and the pump house on the basin are located at the site of the old water basin of 1000 m^3.

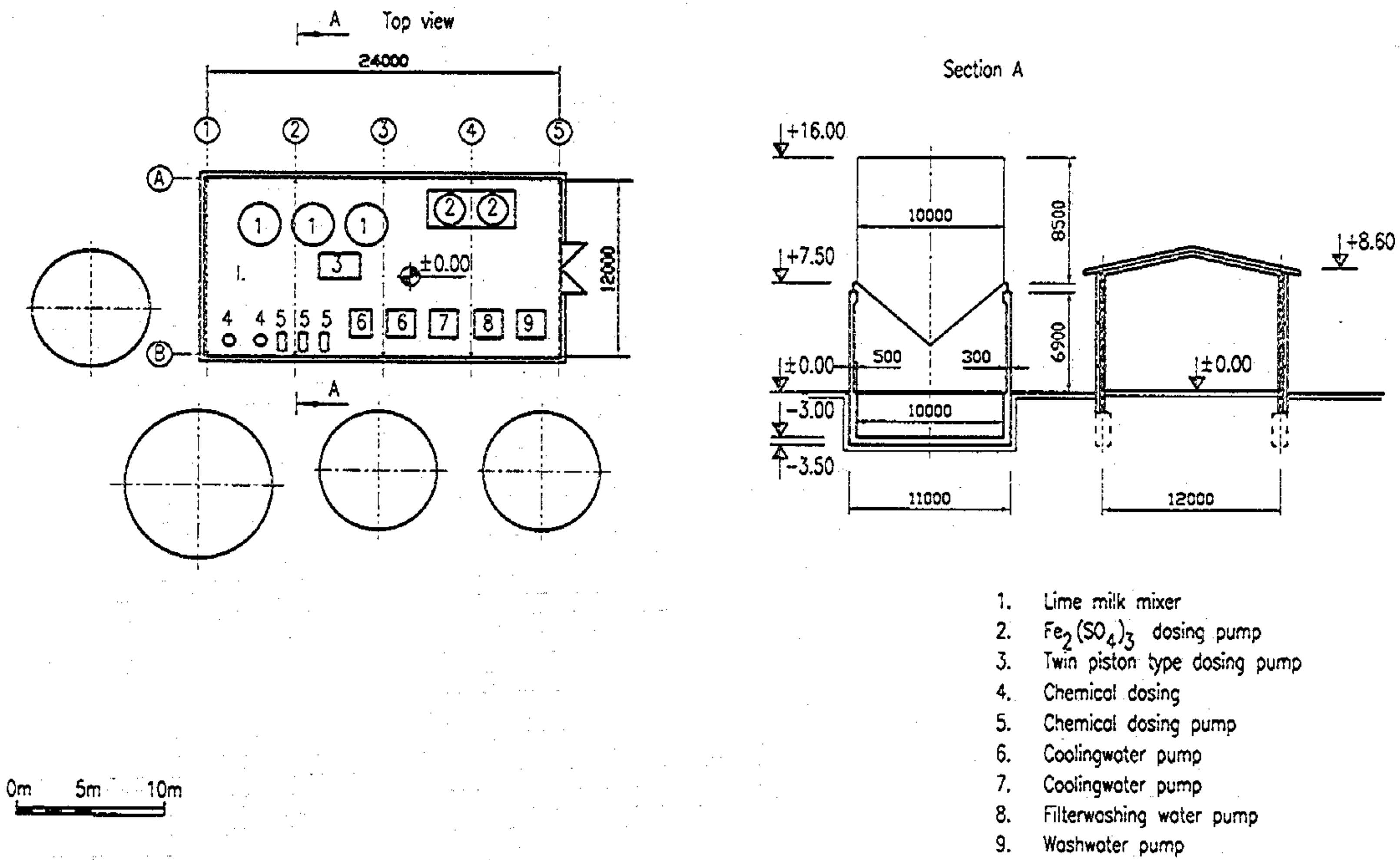


Figure 4.9.3 Water Treatment Plant Layout

4.10 Cooling System

Flow diagram of cooling system is shown in Figure 4.10.1.

(1) Basic Design Parameters

The amount of heat to be extracted from the condenser of the new 150 MW steam turbine: max. 184 MW

Cooling water demand

1) New steam turbine condenser : 20,000 m^3/h

2) Auxiliary cooling water demand :

(a) Steam turbine oil cooler	90 m^3/h
(b) Generator circuit air ventilation cooler	325 m^3/h
(c) Boiler bed ash screw conveyor	110 m^3/h
(d) Expander	86.4 m^3/h
(e) Sample cooler	1.6 m^3/h
Total auxiliary cooling	613 m^3/h
Total : 1) + 2)	20,613 m^3/h

Design parameters for the cooling system:

Cooling water flow	20,613 m^3/h
Inlet temperature of hot water	40 °C
Outlet temperature of cold water	32 °C
Dry temperature of ambient air	30 °C
Wet temperature of ambient air	21 °C

(2) Specification of Cooling Equipment

1) Cooling tower

Type	wet, counterflow
Number of cooling cells	4
Dimensions	
Floor area	4 x 18 m x 18 m
Height	12.5 m

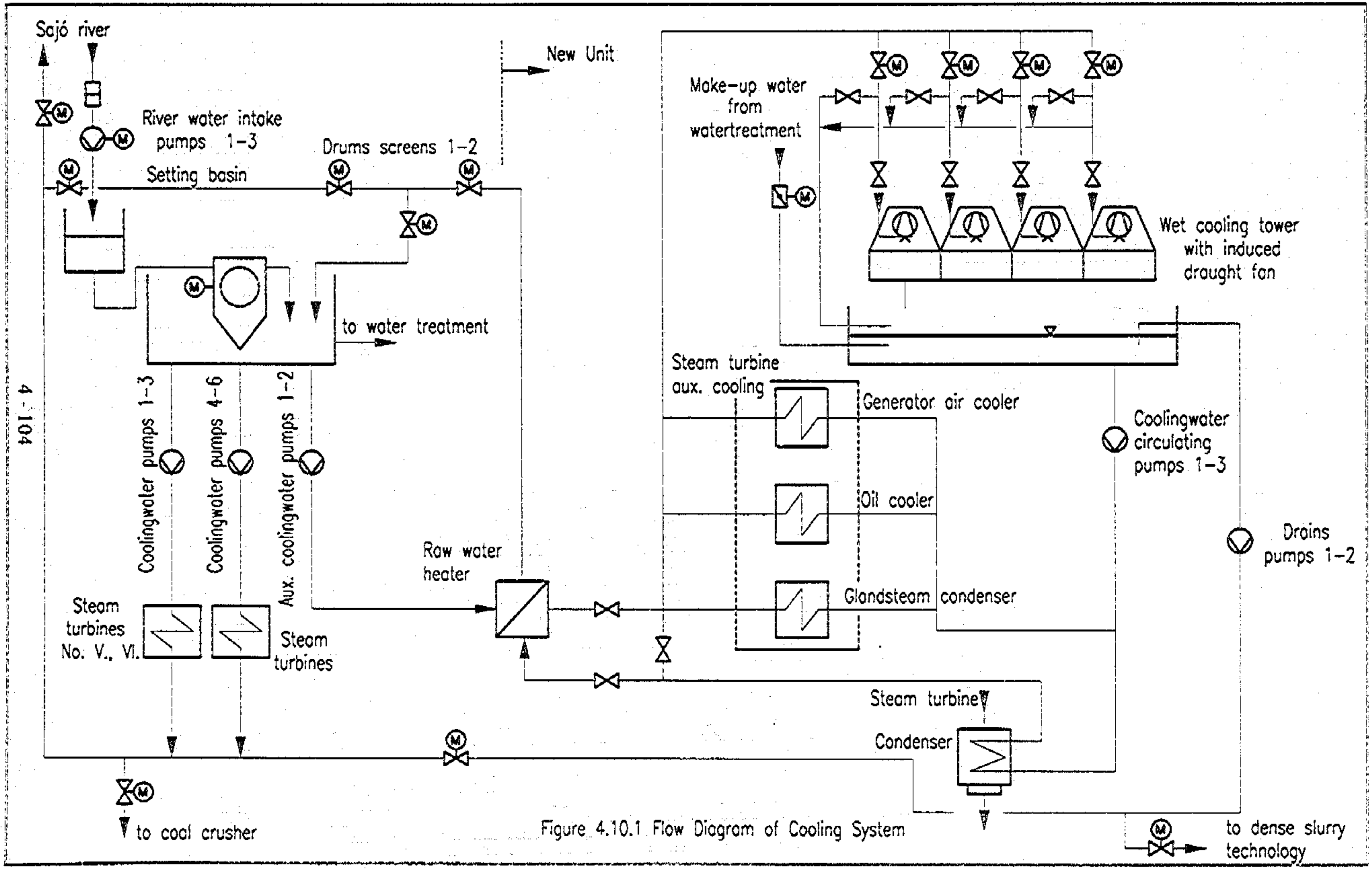


Figure 4.10.1 Flow Diagram of Cooling System

Amount of make-up water	507 m^3/h
Evaporation loss	345 m^3/h
Blow-down	162 m^3/h
Number of fans	4
Air delivery of a single fan	561 m^3/s
Capacity rating of a single fan	20/110 kW

2) Circulating pump

Type	centrifugal
Number of pumps	3 (3 x 50%)
Delivery	3 m^3/s

3) Blow - down pump

Type	centrifugal
Number of pumps	2 (2*100%)
Delivery	162 m^3/h

(3) Operation of the Cooling System

The cooling system for the new unit is independent from the fresh water cooling of the other units. The closed system has a wet cooling tower. Cooling water is delivered by circulating pumps from the basin below the cooling tower to the main and auxiliary cooling system of the new unit. From here, the warmed up cooling water is delivered back to the tower through a DN 1600 line, which branches off along the longitudinal side of the cooling tower according to the number of the cooling cells. Water sprayed from diffusers is cooled in the four cooling cells by counter air flow. At the top and bottom of the cooling cells, there are drop-producing cooling insertion screens. In between these cells, there are cooling insert blocks. The die-cast polyethylene screen has joint flaps that fasten the bars of the screen and keeps the adequate space. The perpendicular crossing bars ensure the formation of firm, rigid but light blocks.

The cooled water flows into the concrete basin located below the tower. The cooling water circulating pumps, which are to be located near the basin, will transfer cooled water to the condenser.

In case of an ambient temperature below 0 °C, the pumping of the cooling water to the cooling tower may become unnecessary. Consequently, there is a possibility to circulate it through a bypass line within the basin.

Air is sucked by axial fans installed at the top of the tower through louvres located at the bottom on the sides of the cooling tower. The air flows upward through the insertion, the water distribution system, and the condensation separator. Condensation separator blocks are made of adequately shaped PVC sheets glued to each other. The condensation separator blocks are placed upon the distribution pipes of the water distribution system.

Each cell has its own two-speed fan which provides proper air flow. The fan has a vertical shaft and provides axial flow. The blades can be re-adjusted. They have a bevel-gear which makes it possible that the asynchronous motor drive is located out of the flow of the wet cooling air, out of the tower. The motor is connected to the gear by a horizontal shaft.

The cooling performance is controlled by

- reducing the speed of the individual fans by 50 %
- stopping the fans individually
- isolating the individual cooling cells by closing the isolating valve of the cells
- making use of the by-pass line of the cooling system.

In order to ensure the adequate water quality of the cooling water, Blow-down is necessary. As vaporized water in the course of evaporation has low dissolved solids contents, most of dissolved solids remain in the system. Make-up water adds further minerals to the cooling water. Blow-down is needed in order to prevent building up concentration of minerals (and other impurities). Blow-down is performed by pumps and slurry will be transferred into the slurry depot. Such loss of cooling water will be supplemented by water from the pre-softening system.

The capacity diagrams of the cooling systems are shown in Figures 4.10.2 and 4.10.3.

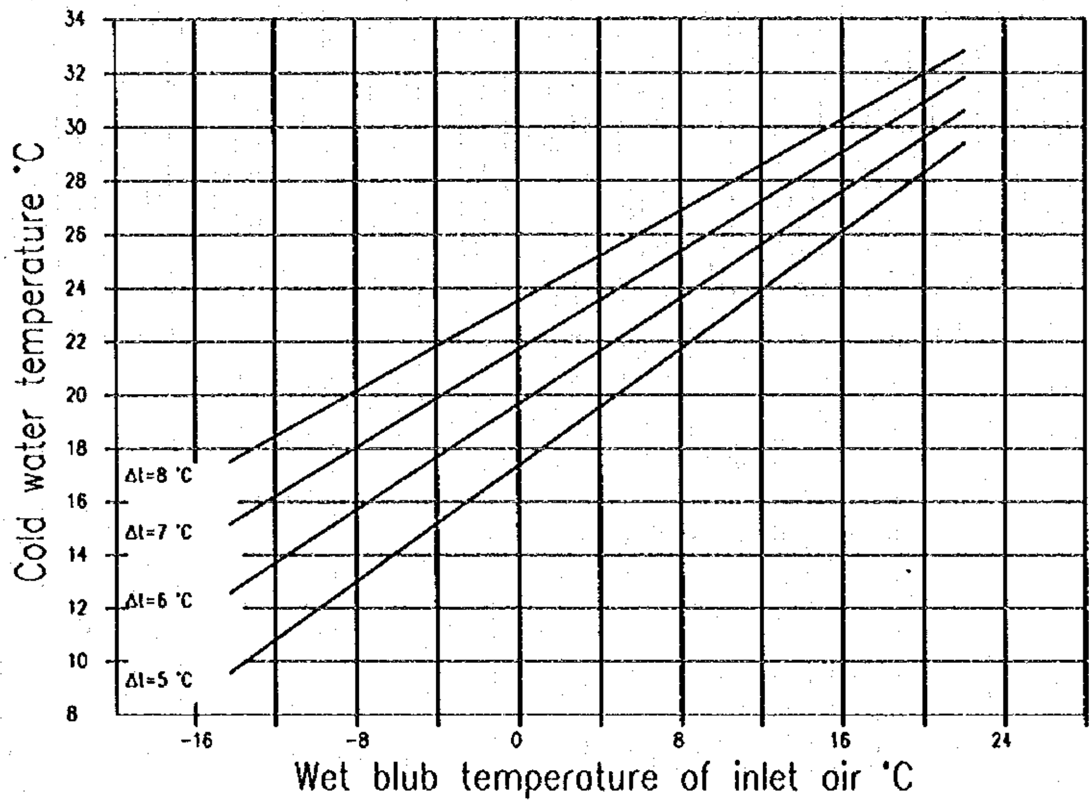


Figure 4.10.2 Capacity Diagram of 4 Cooling Cell Operation

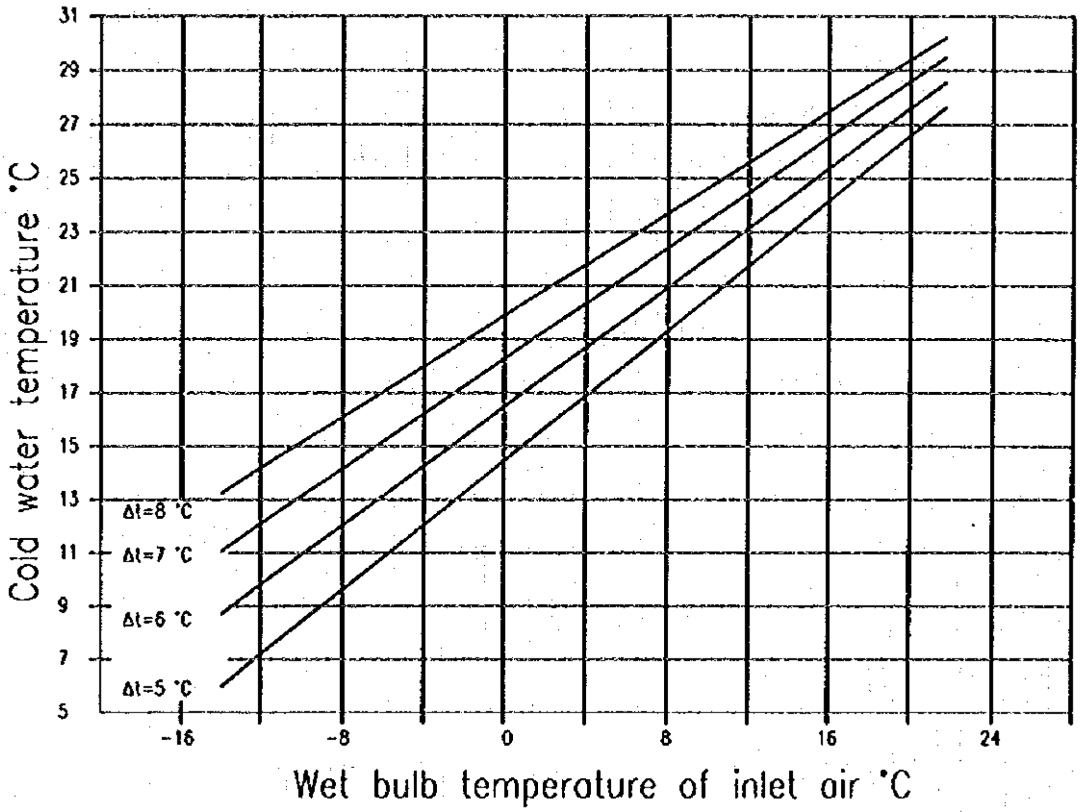


Figure 4.10.3 Capacity Diagram of 3 Cooling Cell Operation

4.11 Architecture and Civil Works

4.11.1 Design Conditions

The following conditions were studied to determine dimensions, shapes and structures of buildings and civil engineering installations:

- layout plan of equipment
- plan of transferring the materials
- system of access roads necessary for construction and maintenance
- layout of pipe and cable networks
- load conditions
- soil conditions
- adaptation to existing installations
- official regulations and standards in effect in Hungary
- implementation schedule

Investigations of the load bearing structures of the establishments and their stress calculations were carried out in compliance with the standard specifications.

Types and dimensions of foundations were determined based on the available soil mechanics data.

Seismic effects were taken into account in compliance with the Hungarian civil engineering specifications (MI - 04.133-81), according to which the site is at a slight risk from the earth quaking point of view. The strength of experienced/expectable earth quaking activity is number 6 according to the Medvedev-Sponheuer-Kárnik scale (MSK-64) adopted in Europe. In practice, scale MSK-64 registers the same effects as those registered by means of the Mercelli-Cancani-Sieberg (MCS) scale.

The following aspects were also studied or taken into consideration:

- The site belongs to an industrial zone

- Fire protection issues were investigated in compliance with the general and installation specifications of Fire Protection Code as well as with the Hungarian Fire Protection Standards in effect.

- The fire protection spacing between the establishments were assessed in compliance with Hungarian specifications.

4.11.2 Major Buildings

The existing Power Plant was built on a gravel terrace at the banks of Sajó River during the early 1950s. The power house of the existing Power Plant is the boiler house and machine hall complex having a NW-SE longitudinal axis of nearly 200 m long. The power house for the new 150 MW unit is to be placed at the SE end of the existing building.

The major buildings and foundations for the new unit are listed in Table 4.11.1, and construction and dimensions of respective buildings are shown in Tables 4.11.2 through 4.11.5.

The boiler house, turbine building, central control building, and feedwater building form a building complex for the new unit having appropriate connections as can be seen from Figures 4.11.1 through 4.11.6.

(1) Boiler House

Instead of a construction having floors covering the overall basic area, the boiler house for the out-door circulating fluidized bed boiler should be understood as a system of platforms and stairs for operation and for access to the pieces of equipment at different floors.

The boiler is covered by a light-weight metal construction roof. Heat-insulated sheet metal shells cover the lime and coal bunkers and those parts necessary to meet weather-proof requirements of the equipment. The overall axial dimensions of the boiler house are 31 m x 47 m. It has 12 floors, and the highest point is 54 m.

The present coal conveyors in the existing boiler house connect to the new boiler at a height of +30.0 m through the new inclined coal conveyors of 18 m span, which load the coal bunkers at elevation +45.0 m.

Constructions and dimensions of foundations of the flue duct, two flue gas fans, and the electrostatic precipitator are also shown in Table 4.11.1.

(2) Turbine Building (Machine Hall)

The turbine building is 60 m long, 27 m wide, and 27.00 m high with a 12 m spacing of main frames.
The height of the reinforced concrete table for the turbo-generator is +9.70 m.

Table 4.11.1 List of Main Buildings and Foundations of Open-air Equipment

	Description	Pcs	Construction	Width (m)	Length (m)	Height (m)	Note
Buildings	Boiler House	1	steel	31.00	47.00	54.00	partially enclosed
	Turbine building	1	steel	27.00	60.00	27.00	
	Control building	1	r.c.	24.00	30.00	15.00	
	Feedwater building	1	steel and r.c.	9.00	60.00	15.00	
Foundations	Turbo-generator supporting frame	1	r.c.	11.50	30.00	9.70	
	Electr. precipitator	1	r.c.	24.00	32.00	1.50	
	Unit transformer	1	r.c.	4.50	8.00	3.00	
	Aux.unit transf.	2	r.c.	3.50	5.00	3.00	
	Flue gas duct	2	r.c.	3.00	6.00	1.50	
	Combustion air fan	2	r.c.	3.00	7.00	3.00	
	Flue gas fan	2	r.c.	5.00	10.00	3.00	
	Pipe bridge (fly-ash)	50	r.c.	3.00	5.00	1.50	
	Pipe bridge (limestone)	20	r.c.	3.00	5.00	1.50	

Table 4.11.2 Features of the Boiler Unit

Description	Specifications	Note
1. Built-up footing area (m^2)	1457.00	
2. Height (m)	54.00	
3. Number of floors	12	access and operating passages only will be built
4. Overall area of floors (m^2)	2800.00	
5. Built-in volume (m^3)	78678.00	
6. Superstructure	Steel frame construction	
7. Understructure	R.c. block and slab	
8. External finishes		
roof	Corrugated steel sheet	*heat-insulated if necessary
wall	Plastic-coated steel sheet	
9. Internal finishes		
floor	Checker floor	acc. to the use of room
partition	Checker plate	

Table 4.11.3 Features of the Turbine Building (Machine Hall)

Description	Specifications	Note
1. Built-up footing area (m^2)	1620.00	
2. Height (m)	27.00	
3. Number of floors	2	
4. Overall area of floors (m^2)	3240.00	
5. Built-in volume (m^3)	43740.00	
6. Superstructure	Steel frame structure	
7. Understructure	R.c. point/slab foundation	
8. External finishes		
roof	Double-shell thermo-insulated steel fluted sheet	
wall above floor No. 2	Plastic-coated sheet metal	
below floor No. 2	Prefabricated r.c. panel	
9. Internal finishes		
floor	P.V.C. or vynil tile	acc. to use of room
partition		
10. Others	Ventilation system Heating system Lighting system Bridge crane for 50 tons	

Table 4.11.4 Features of the Control Building

Description		Specifications	Note
1. Built-up footing area (m^2)		861.00	
2. Height (m)		15.00	
3. Number of floors		5.00	
4. Overall area of floors (m^2)		3804.00	
5. Built-in volume (m^3)		12913.00	
6. Superstructure		Monolithic r.c. frame	
7. Understructure		R.c. slab and machine foundations	
8. External finishes	roof	Flat roof with water/damp/heat insulation	roof slope of 3%
	wall	Prefabricated r.c. panel or metal construction curtain wall	
9. Internal finishes	floor	Vynil/ceramic tiles	
	partition	Brick wall with air holes	
10. Others		Central heating system Contr. room, air-conditioned Ventilating system Sanitary equipment	

Table 4.11.5 Features of the Feedwater Building

Description		Specifications	Note
1. Built-up footing area (m^2)		540.00	
2. Height (m)		15.00	
3. Number of floors		2	
4. Overall area of floors (m^2)		1080.00	
5. Built-in volume (m^3)		8100.00	
6. Superstructure		Steel frame structure with r.c. slabs	
7. Understructure		R.c. point foundations	
8. External finishes	roof	R.c.	
	wall	Plastic-coated thermo-insulated metal sheet	
9. Internal finishes	floor	Cement screed	
	partition	Plastic-coated metal sheet	
10. Others		Heating/ventilation Lighting Bridge crane for 10 tons	

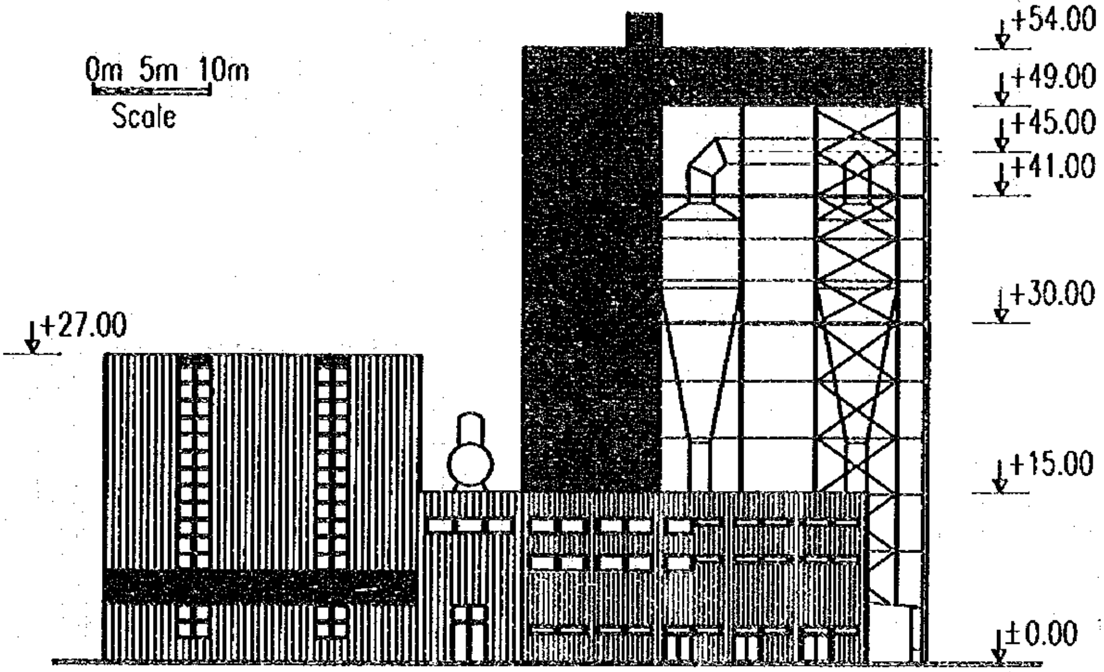


Figure 4.11.1 SE Front Elevation

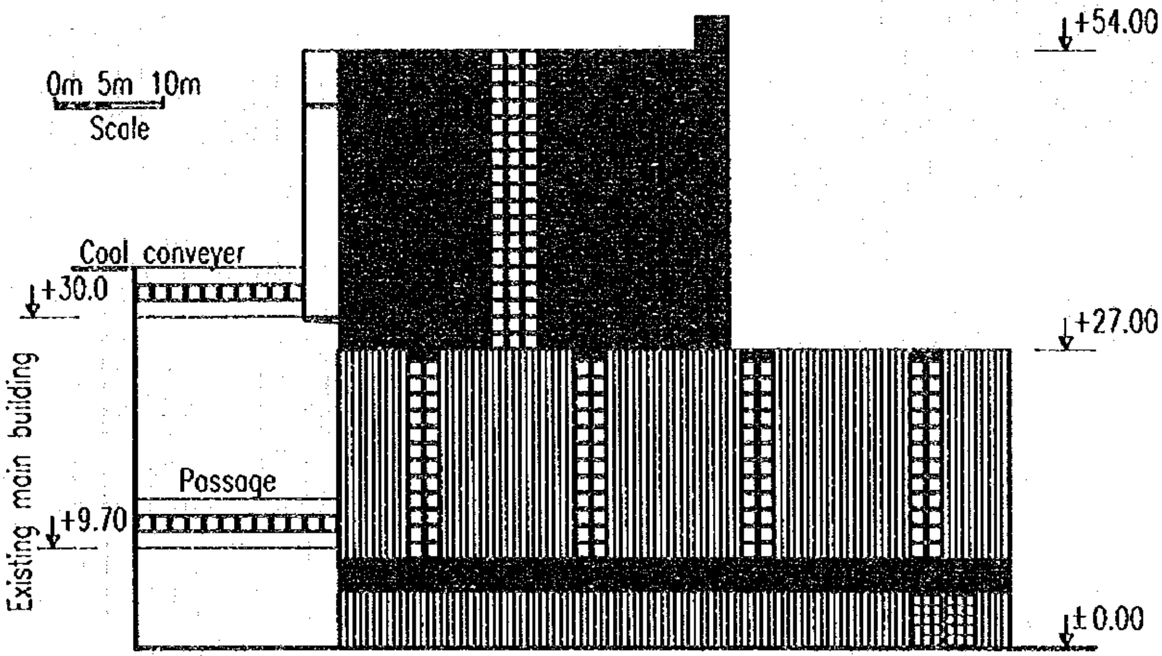


Figure 4.11.2 SW Front Elevotion

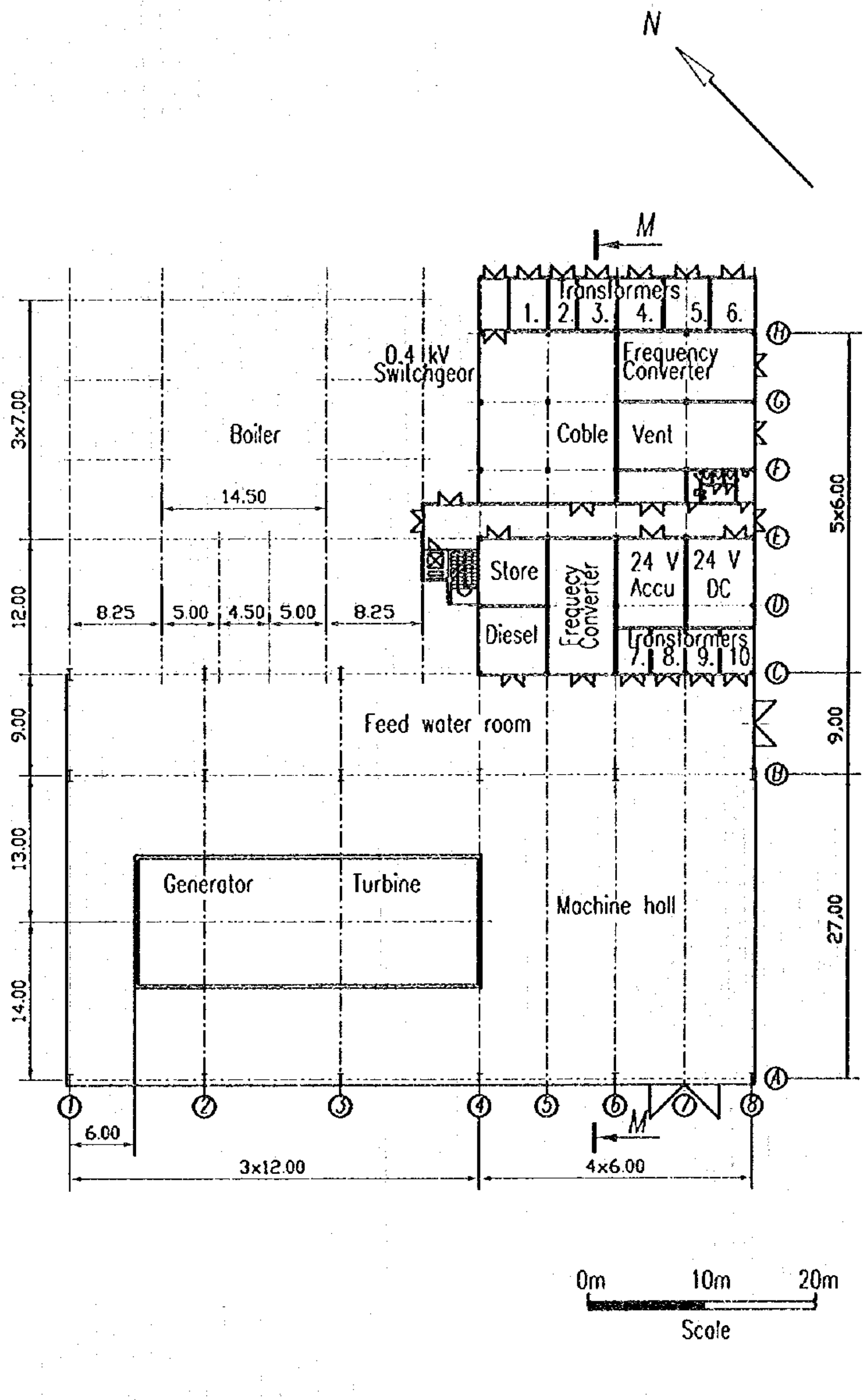


Figure 4.11.3 Foot Plan of the Floor at Elevation ±0.00m

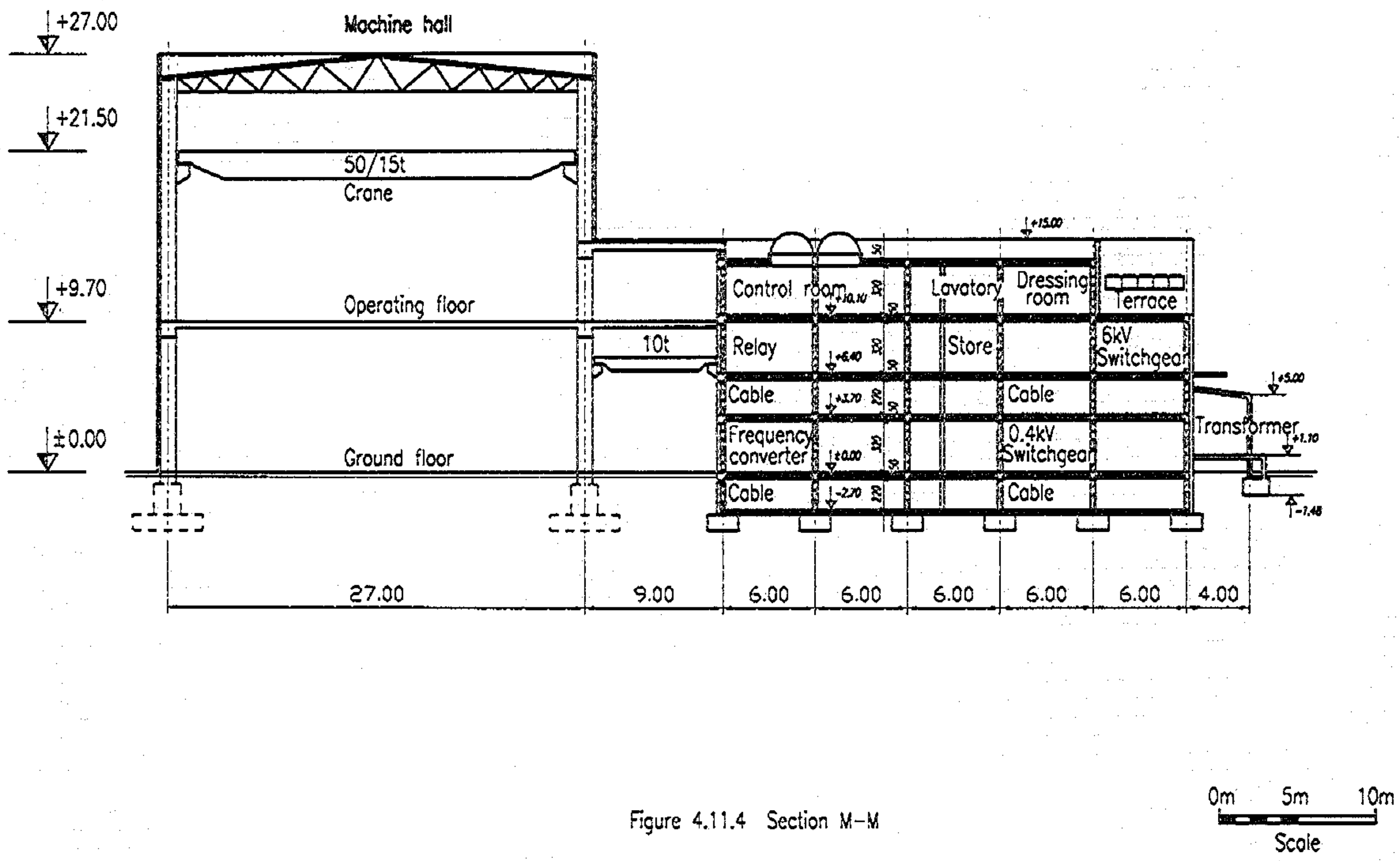


Figure 4.11.4 Section M–M

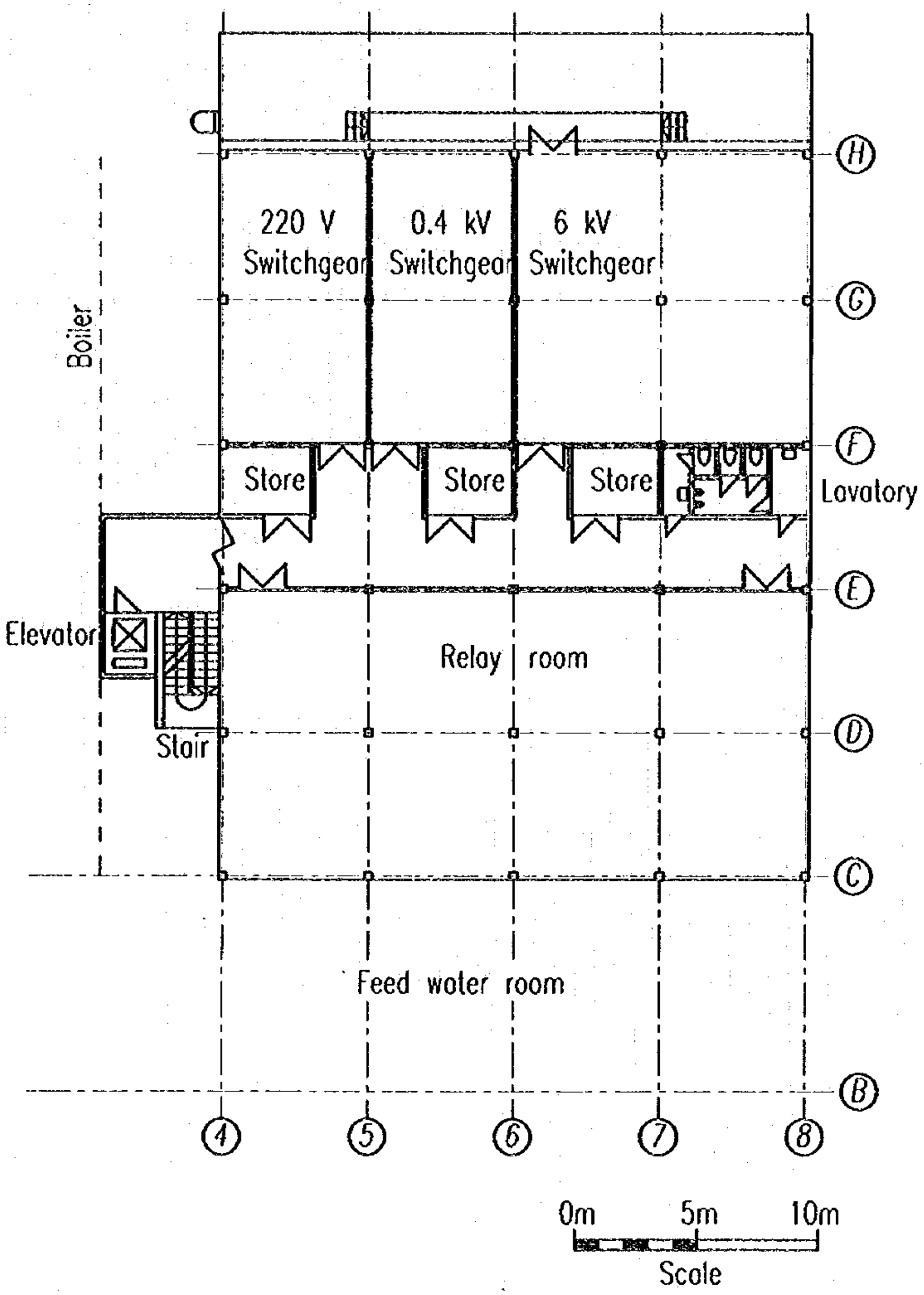


Figure 4.11.5 Foot Plan of the Floor at Elevation +6.40

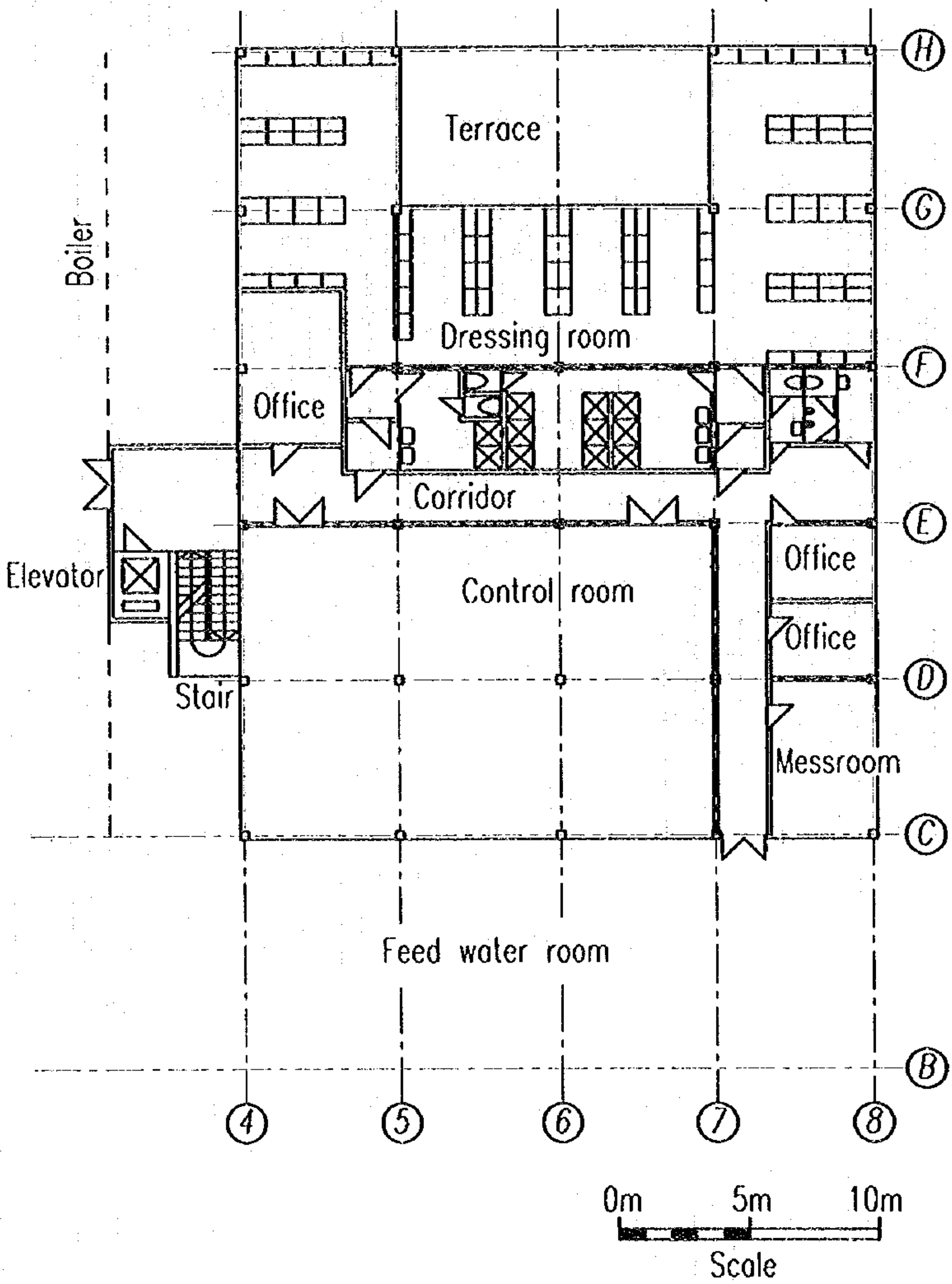


Figure 4.11.6 Foot Plan of the Floor at Elevation +10.10

The load-carrying capacity of the bridge crane having a span of 24.50 m is 50 tons at the main hook and 15 tons at the auxiliary crab.

Since the railway siding line in the existing machine hall provided for delivering the heavy-weight parts of the machine units is removed, clearance gauge and basic area of the turbine building cannot be utilized for other purposes. The major parts are transported on road by trailer trucks.

To ensure personal traffic between the new and the old machine houses, a cross-over bridge of about 18.00 m span for pedestrians is installed at elevation +9.70 m.

(3) Central Control Building

Of the overall length of 60.0 m of the turbine building, the adjacent boiler house will cover a width of 31.0 m. The central control building of 24.0 wide is built at the remaining area. The length of the control building is 30.0 m.

In the remaining area of about 5.0 m wide, the stairway of reinforced concrete slabs and the shaft of the elevator for carrying cargo and personnel are installed to provide vertical access. The elevation of the top level of the elevator is the same as the roof level of the boiler unit at +54.00 m.

The control building consisting of a monolithic framework has five floors (that is, the cellar, the ground floor and three floors). Its height is 15.00 m. It serves mainly for accommodating the electric switch gears, the transformers (10 units), the control room and the relay zone. The uppermost floor (+10.00 m) accommodates the central control room, offices, a canteen, and cloakrooms and bathrooms for men and women. The ratio between the basic areas of men's and women's locker rooms can be adjusted according to the actual ratio between male and female employees. The said floor is, in practice, at the same height as the control floor of the turbine building. In order to ensure a better natural illumination and a more effective ventilation, a terrace will be built on its roof by recessing the wall plane.

The cellar and the intermediate floor (walkable with a 2.20 m clear height) serve for cable arrangement purposes.

(4) Feed Water Building

The feed water building is 60.0 m long and 9.0 m wide located between the turbine building and the boiler house.

The reinforced concrete slabs of the feed water building are attached to the pillars of the adjacent buildings at the elevations of +9.70 m and +15.00 m, respectively.

On the ground floor, a crane runway is provided with a rail top height of 7.00 m for a 10 ton crane, which will be used to move transformers, pumps, etc.

On the uppermost slab of the elevation 15.00 m, the feedwater tank (150 m^3) with the deaerator is placed outdoors. The uppermost slab is of a terrace-type provided with the necessary thermal and rainwater insulation and a walkable finish.

The side walls of the feed water building are finished with the plastic-coated sheet steel perimeter-wall provided with necessary thermal insulation.

(5) Related Facilities

1) Water supply and sewerage

The buildings are supplied with water for sanitary facilities (lavatories, showers and toilets) and room cleaning. Water and sewage pipes of the buildings can be connected to the respective existing network.

No cost-effective central cold/hot water piping is feasible owing to the long distances between the buildings scattered in a large area. Therefore, production of utility hot water is expedient to be produced individually in each building, at the particular points of use.

As a result of introduction of the new unit, the increase in drinking water demand is 7.5 m^3/d with hourly peak rate of 1.85 m^3/h. The methods of fitting water and swage pipes are conventional.

The pipe types to be used are as follws:

for drink water	:	zinc-plated steel pipe
for sewerage	:	PVC/steel pipes

2) Central heating system

There is steam as heat transfer medium at disposal in the area.

Heating of the main building complex consisting of the boiler house, the turbine building, the feed water building, and the central control building is proposed to be provided according to the individual demands. The covered portions of the boiler unit requiring heating as well as the turbine building and the feed water building are provided with thermo-fan heating through steam-heated unit heaters.

Thermo-fans will be also used for the necessary fresh air supply. In summer, they can be operated as ventilating devices with their integrated air heaters disassembled.

For the heating of the central control building, a central hot-water radiator system is employed. The system uses hot water with 90/70°C produced in the heating center, which is provided inside the building. The method of fitting is conventional.

Installed heating capacity	:	Q = 3940 kW.
Type of pipes	:	seamless steel pipes with welded joints

3) Air conditioning and ventilation

The central control room is air-conditioned with the following parameters:

ti (winter)	:	+20°C
ti (summer)	:	+24°C
humidity	:	40%

The air conditioning appliances have hot water heating and freon-type cooling functions. There will be an over-pressured atmosphere in the rooms. Relative humidity will be maintained by a steam generator.

The removal of the heat released from the transformers, cables and the equipment in electricity-related rooms and air change are facilitated by the forced ventilation system. A central ventilation machine room is provided to operate the forced ventilation system.

The major part of the cables, fittings and pieces of equipment can be obtained in the domestic market and they can be installed by conventional methods.

4) Illumination and power supply

The rooms of various purposes require various types of illumination and lighting intensity. The central control room is illuminated at 300 lux on the horizontal surfaces and 200 lux on the vertical surfaces (instrument board) using energy-saving type lighting fittings. In the switchboard zones and cells, edge-type lights mounted on the edges of cell walls are proposed.

4.11.3 Other Buildings and Structures

A list of other buildings and structures is shown in Table 4.11.6.

(1) Cooling Tower (see Table 4.11.7 and Figure 4.11.7)

The water cooling unit consists of four assemblies of 18x18 m in a series arrangement. The four cooling assemblies are connected to one another via a water storage basin at level -1.00 m.

To the end wall of the 72 m long building, the pump house having a sunk floor level of -3.40 m is attached. At the second floor of the pump house having a footing area of 12.0 m x 18.0 m, the servicing rooms (offices, locker rooms, lavatory, etc.) are provided.

The building height is 10.15 m. The building is constructed by prefabricated reinforced concrete pillars and beams.

The pillars are arranged in a raster shape of 4 m x 4 m and 5 m x 6 m, respectively, and they are erected on the sleeve foundations constructed as an integrated part of the basin.

At the two longitudinal sides, the opening of the inlet air made of prefabricated reinforced concrete, equipped with a fixed shutter is provided.

The limiting walls at remaining parts of the building are also made of prefabricated reinforced concrete panels.

The outer wall of the pump house is a brick-covered packwall.

(2) New Water Treatment Plant Building (see Table 4.11.8 and Figure 4.9.3)

It is a steel frame construction building, and its roof and walls are of thermally insulated sheet metal. The building accommodates the lime milk agitators, iron sulphate and conditioning agent dispensers.

The floor should be covered by an acid-resistant and lime-resistant finish to meet actual demands.

Built-up surface area	:	288 m^2
Built-in volume	:	2,592 m^3

Table 4.11.6 List of Other Buildings and Structures

	Description	Qty	Const-ruction	Width (m)	Length (m)	Height (m)	Note
Buildings/Structures	1) Cooling unit	1	r.c.	18.00	84.00	10.15	
	2) New water treatment bldg.	1	steel	12.00	24.00	8.60	
	3) Waste water treatment basin with pump house	1	r.c.	14.00	24.00	8.30	
	4) Raw limestone silo	1	r.c.	12.00		27.00	round-shape
	5) Limestone powder silo	1	r.c.	12.00		27.00	round-shape
	6) Limestone reception bldg.	1	steel	6.00	25.00	6.00	
	7) Crusher plant (limestone)	1	r.c.	12.00	20.00	28.00	
	8) Wagon tippler (hard coal yard)	1	r.c.	14.15	61.60	11.50	(depth)
	9) Slit coal bunker	1	r.c.	5.80	178.00	3.00	(depth)
	10) Oil storage pump house	1	brick	4.00	6.00	3.60	
	11) Watchman's lodge	1	brick	4.00	6.00	3.60	
Foundations	1) Wash water settling tank foundation	1	r.c.	8.60	-	11.00	round-shape
	2) Pre-softened water tank foundation	2	r.c.	9.00	-	11.00	round-shape
	3) Reactor tank foundation	1	r.c.	11.00	-	11.00	round-shape
	4) Fly ash silo foundation	1	r.c.	12.00	12.00	1.00	
	5) Limestone reception bldg. with bunker	1	r.c.	6.60	24.00	6.00	(depth)
	6) Raw limestone storage silo foundation	1	r.c.	13.00	-	2.00	D=13 d=11.5
	7) Drying kiln foundation	1	r.c.	16.00	4.00	1.50	
	8) Grist storage silo foundation	1	r.c.	18.00	-	2.00	D=13 d=11.5
	9) Coal conveyor foundations	26	r.c.	2.00	8.00	3.20	985 m
	10) 1000 m^3 Oil tank foundation	1	r.c.	14.00	-	2.00	D=14 d=11.0
	11) 2000 m^3 Oil tank foundation	1	r.c.	19.00	-	2.00	D=19 d=16.0

Table 4.11.7 Features of Cooling Unit

Description		Specification	Note
1. Built-up footing area(m^2)		1512.00	
2. Height (m)		10.15	
3. Number of floors		3 resp. 2	
4. Overall floor surface area(m^2)		2988.00	
5. Built-in volume (m^3)		17520.00	
6. Superstructure		R.c. framework	
7. Understructure		Monolithic r.c. slab foundation	
8. External finishes			
	Roof	R.c. slab	
	Wall	Prefabricated r.c. fixed shutters/brick-covered packwall	
9. Internal finishes			
	Floor	PVC/ceramics finish	(in the service rooms)
		Watertight cement plaster	(in basins)
	Partition	Perforated brick	(in the service rooms)

Table 4.11.8 Features of the Water Treatment Building

Description		Specification	Note
1. Built-up footing area(m^2)		288.00	
2. Height (m)		9.00	
3. Number of floors		1	
4. Overall floor surface area(m^2)		288.00	
5. Built-in volume (m^3)		2592.00	
6. Superstructure		Steel frame	
7. Understructure		RC foot foundations	
8. External finishes	Roof	Plastic coated thermo-insulated metal fluted sheet	
	Wall	Double-layer thermo-insulated metal fluted sheet	
9. Internal finishes			
	Floor	Acid and alkaline-resistant finish	
	Partition	Partition wall of perforated brickwork tiled as necessary	
10. Others		Heating system	

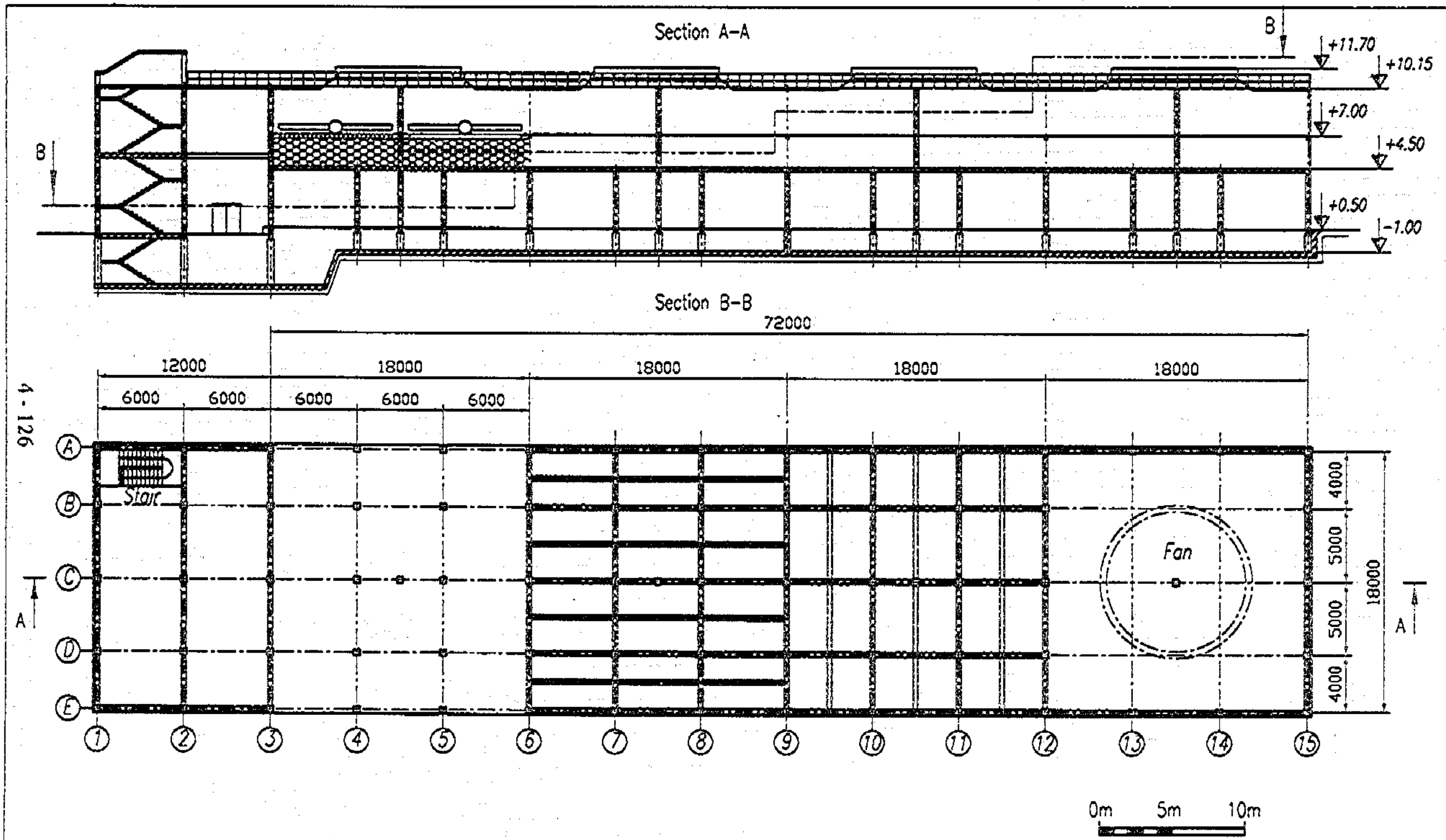


Figure 4.11.7 Cooling Unit

At the open space next to the building, an additional reactor, a flush water settling tank, and two softened water tanks are to be installed.

(3) Wastewater Collecting Basin (see Table 4.11.9 and Figure 4.11.8)

For collecting and neutralizing the wastewaters generated through the water treatment process, one covered r.c. basin of 900 m^3 capacity is installed. A pump house is placed on the slab of the basin .

The r.c. basin should be lined with acid- and alkaline-resisting finish. Externally, an insulation layer should be applied to protect it against groundwater.

(4) Buildings and Structures for the Limestone Handling System

1) Limestone reception building (see Table 4.11.10)

The limestone reception building, which accommodates the limestone dumping grid, is a single-floor steel construction building having open ends and covered with light sheet steel panels. To prevent dusts being released into the environment, air curtains are applied at the open ends of the building.
The footing area of this building is 6.0 m x 24.0 m, and its height is 6.00 m.

2) Raw limestone silo

The limestone silo is reinforced concrete construction of round shape with the inner diameter of 12 m, the height of 27.0 m, and the net capacity of about 1,300 m^3. It has two outlets inclined about 50° at the height of +8.00 m.

3) Rotary drier foundation

The foundation of the outdoor rotary drier is reinforced concrete construction of 16.0 m long, 4.0 m wide, and 1.50 m deep.

4) Crusher plant building (see Table 4.11.11)

The limestone crusher plant is accommodated in the enclosed building of reinforced concrete frame construction. It is 20.0 m long, 12.0 m wide, and 28.0 m high, consisting of a ground floor and four additional floors. It accommodates the following facilities:

- bucket elevator (lifting level : +23.00 m)
- 2 bunkers for storing dried limestone with outlets at +15.00 m level
- 2 hammer type crushers

Table 4.11.9 Features of the Wastewater Collectig Basin

Description	Specification	Note
1. Built-up footing area(m^2)	336.00	
2. Height (m)	0.80 resp.8.30	together with pump house
3. Number of floors	2	only underneath the pump house
4. Overall floor surface area(m^2)	406.00	
5. Built-in volume (m^3)	2306.00	Rated capacity 900 m^3
6. Superstructure	Monolithic RC	
7. Understructure	RC slab foundation	
8. External finishes		
Roof	Walkable RC floor	
Wall	Insulation against soil moisture	
9. Internal finishes		
Floor	Acid and alkaline resistant finish	
Partition	Acid and alkaline resistant finish	

Table 4.11.10 Features of the Limestone Reception Building

Description	Specification	Note
1. Built-up footing area(m^2)	144.00	
2. Height (m)	6.00	
3. Number of floors	2	
4. Overall floor surface area(m^2)	240.00	
5. Built-in volume (m^3)	864.00	
6. Superstructure	Steel frame structure	
7. Understructure	Monolithic RC	discharge bunker
8. External finishes		
Roof	Plastic-coated sheet metal	5% roof pitch
Wall	Plastic-coated sheet metal	
9. Internal finishes		
Floor Partition	Dump screen/cement screed	
10. Other	Anti-outdust air curtain Local dust extraction	

Table 4.11.11 Features of Limestone Crusher Building

Description	Specification	Note
1. Built-up footing area(m^2)	240.00	
2. Height (m)	28.00	
3. Number of floors	5	
4. Overall floor surface area(m^2)	960.00	
5. Built-in volume (m^3)	6700.00	
6. Superstructure	Monolithic RC frame	
7. Understructure	Concrete strip and foot foundation	
8. External finishes Roof Wall	 RC slab Packwall of perforated brickwork covered with sheet steels	
9. Internal finishes Floor Partition	 Cement screed Partition of perforated brickwork	
10. Other	2 integrated RC bunkers	

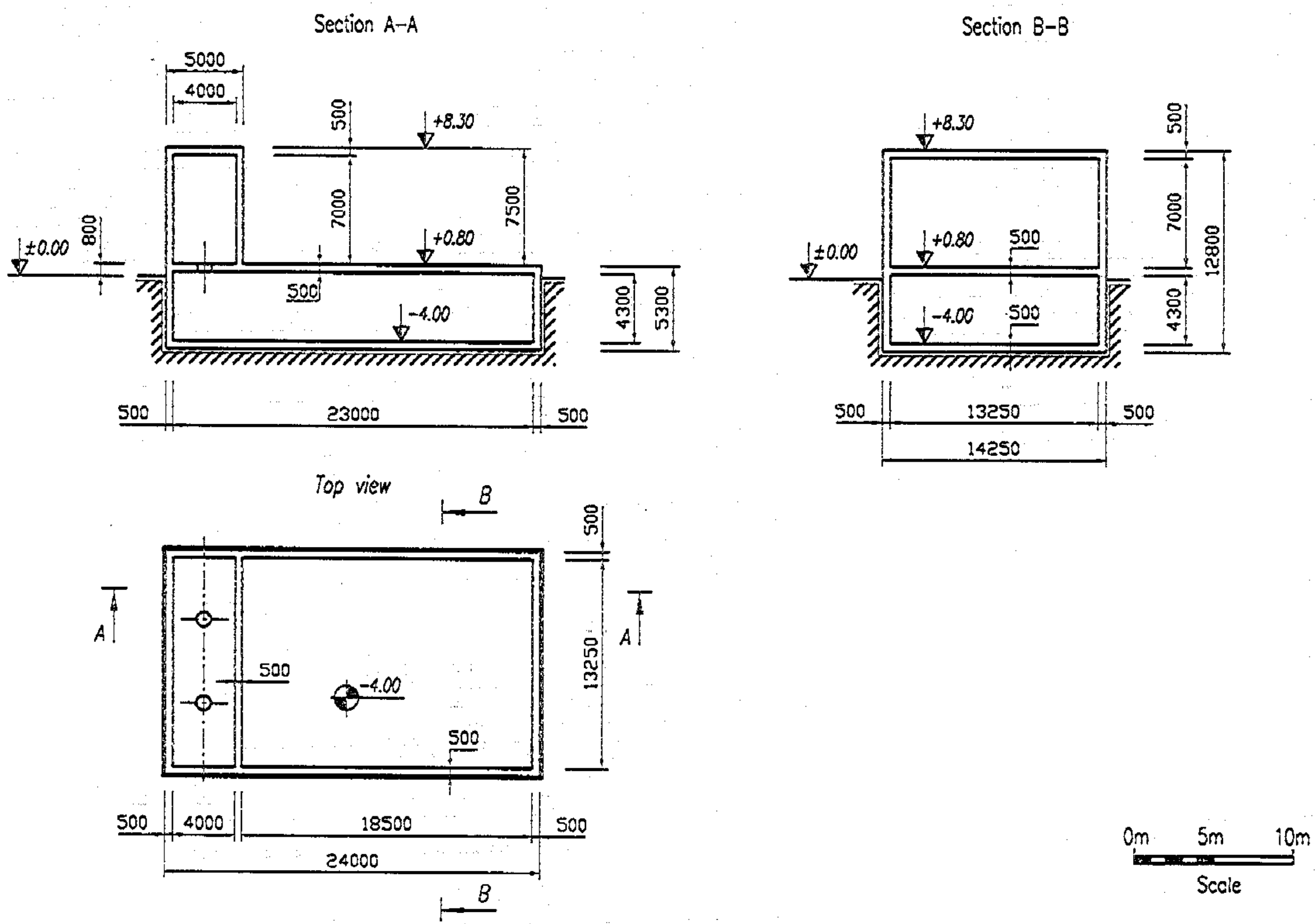


Figure 4.11.8 Waste Water Collecting and Neutralizing Basin

5) Limestone grist silo

The silo for crushed limestone is a round-shaped reinforced concrete silo with an inner diameter of 12.00 m and a height of 27.00 m. One outlet fitted to its bottom plate of slight buckling is at level +12.00 m. Net volume is about 1,700 m^3.

(6) Buildings and Structures for Coal Supply System

1) Hard coal unloading bunker

The hard coal unloading bunker receives coal from wagons through 2 x 100 tons capacity wagon tippler, and/or from self-dumping wagons. The bunker made of reinforced concrete is 14.15 m wide, 61.60 m long, and 11.5 m deep.

2) New transport belt conveyor system (belt conveyor bridges, transfer buildings)

The new transport belt conveyor system running in the bridges of steel construction stretching from the sampler building and running in front of the kitchen and canteen buildings is connected to the bridge of inclined conveyors at machine house No. III through the hard coal yard. The new belt conveyor bridges are installed on steel feet supported by concrete slabs. The conveyor system includes the new covered machine rooms Nos. V, VII and VIII and the machine house of the hard coal unloading conveyor. The latter also accommodates the water technology room serving for watering the hard coal and water spraying.

The new conveyor bridge of 18 m length is built between the existing boiler house and the new boiler unit.

3) Hard coal yard (former emergency coal yard)

The area planned for the hard coal yard is a land of grown soil of about 3.6 ha. Ground leveling and soil compaction will be made, and fences, 2 gates, a watchman's lodge, site lighting will be provided for security reasons. The required total length of fences is about 500 m.

4) Slit bunker for hard coal

The slit coal bunker has a length of about 178 m (with cross-section of 5.80 m x 3.00 m). It has a concrete "collar" along its perimeter below the ground level, having a sloped upper surface of about 70 cm thick.

5) Access to Coalyards

Each bunker tunnel, machine house and reception building are made accessible by transport vehicles and truck-mounted cranes.

For the purpose of coal loading supported by bulldozers, access roads will be constructed within the areas of both coalyards. Where required, the pillars of the various establishments will be protected by curbstones to resist the impacts that bulldozers may develop. A passage between the hard coal and the brown coalyards will be provided.

(7) Oil Storage Plant

The oil storage plant consists of one oil storage tank of 1,000 m^3 capacity and another one of 2,000 m^3 capacity.

Before their installation, the reinforced concrete ring foundations for the tanks and an oil pump house of about 6.0 m x 4.0 m footing area will be built.

(8) Access Roads, Fences, Gatekeeper's Office

In order to facilitate access to and between the establishments, roads of 6.00 m path width in a total 700 m length, and that of 4.00 m path width in a total of 700 m length will be constructed. They should have ballast beds of 20 cm thick and concrete roadway topping of 18 cm thick.

The new fences of 500 r.m. length and the 2 gates mentioned with the hard coal yard are complemented by replacing of the Power Plant's fence at a total length of about 140 r.m. and establishing two additional gates.

(9) Water Intake Plant

The existing water intake is refurbished. Three pumps are replaced. That involves demolishing of the old foundations and construction of new ones. The existing scum collector screens before the pumps are heavily corroded, therefore, they are replaced. Renovation of the existing settling basins and renewal of their water-insulating lining are also necessary.

4.11.4 Stack

(1) Design Conditions

The following conditions were examined to determine the specifications of the stack:

- flue gas flow rate
- flue gas velocity
- flue gas temperature
- stack height (130 m)
- emission limit values

The stack, as an object outstanding considerably from the terrain and the overall level of the environment, must be provided with the following according to Hungarian architectural regulations (OÉSZ Annex 3).

- air traffic obstruction marker in compliance with the aviation authority's rules
- lightning protection

(2) Specifications

Specifications and dimensions of the stack are shown in Tables 4.11.12 and 4.11.13.

Flue gas is discharged through a reinforced concrete stack of 130 m height. The temperature of the flue gas will be about 150 °C, therefore, the inside of the stack is lined with refractory bricks at a depth of half brick.

Inner diameter of the lined stack	:	4.00 m
Min. thickness of the stack wall at top	:	0.20 m
Max. outer diameter of the stack at foot	:	8.00 m

The stack foundation is a round-shape reinforced concrete slab of about 20 m in diameter. The presently available soil mechanic data are not sufficient to prepare the foundation plan. Therefore, a boring test should be conducted at the geometric center of the stack foundation in the detailed design stage.

4.11.5 Fire Fighting

(1) Fire Fighting Water System

The amount of fire fighting water necessary for the new unit can not be provided by the existing pumps because of the low capacity.

Table 4.11.12 Specification of Stack

Description	Meas. unit	Values	Note
Turbine output	MW	150.00	
Temperature	°C	150.00	
Flue gas volume-flow	1000 m^3/h (n.c.)	605	
	m^3/sec (n.c.)	168.06	
Qg =	m^3/sec	261.00	at actual gas temperature
Flue gas density	kg/m^3 (n.c.)	1.307	
rg=	kg/m^3	0.849	
Proposed stack dia.	m	4.00	internal, at top
Proposed stack section	m^2	28.26	internal, at top
Flue gas velocity	m/sec	9.20	at outlet
Flue duct cross-section	m^2	20.00	(4 x 5) m
Flue gas velocity	m/sec	13.00	at outlet
Intake at base	m^2	28.00	(4 m x 7 m)
Flue gas velocity	m/sec	9.30	at stack inlet
Air density	kg/m^3	1.185	at 25°C ambient temp.
Natural draft (Z)	mm W.G..	43.7	
Pressure loss (1)	mm W.G.	6.3	stack outlet loss
Pressure loss (2)	mm W.G.	4.3	stack friction loss
Pressure loss (3)	mm W.G.	2.2	stack in let loss
Total pressure loss	mm W.G.	12.8	
Resulting draft	mm W.G.	31.6	

Table 4.11.13 Features of the Stack

Description	Specification	Note
1. Height (m)	130.0	
2. Virtual height (m)	GL + 177.0	
3. Internal diameter (m) at top at bottom	 4.00 8.00	
4.Wall thickness (cm) at top at bottom	 20.00 60.00	
5. Heat-resistant lining	refractory brick	
6. Structure	r.c.	
7. Foundation shape diameter (m) depth (m)	r.c. slab round 20.00 2.50	Subject to revision at the detailed design stage
8. Others	Aviation obstr. mark Lightning protection Galleries and footsteps	 3 lightning arresters int./ext. footsteps

The amount of fire fighting water required by the dominant fire section is 6000 l/min. Therefore 2 additional pumps, each having a capacity of 3500 l/min with 80 m head, should be added to the existing pumps. At the surface hydrant located farthest from the pump, an outlet pressure of 5 bar should be provided. At the farthest and highest located wall hydrant, an outlet pressure of 2 bar should be provided in compliance with relevant Hungarian standards.

Two fire fighting water pumps (one in operation, one standby) have a capacity of 220 m^3/h and 8 bar pressure. The task of the main pumps is to provide sufficient amount of fire fighting water. The existing booster pump will circulate water in the storage tank and cover the water consumption if 1 or 2 hydrants are in use, and will meet the water demand of the sprinkler system.
Pumps are started automatically one after another through the network pressure monitoring system to meet varying water demand.

The material of the piping of the fire fighting water network is KM-PVC with foam pieces of PN16 and PN10 pressure stages. Gate valves are installed in the pipes to enable the shut-off of sections of the system.

20 wall hydrants will be installed in the areas of the technological equipment. The number of new surface hydrants around the new unit and in the coal yard is 15, with DN 100 size, providing at least 1200 l/min of water.

The special water system of the coalyard (to be used for watering coal and extinguishing fires in case of self ignition) will be branched off from the fire fighting water network (one feed point at both of the eastern and western side of the yard).

(2) Foam-Sprinkler System of Inclined Coal Conveyor

Fire protection will be provided to two inclined belt conveyors of about 100 m length and 3 m width. The level difference of the conveyer is about 35 m.

Specific water flow	:	5 m^3/min
Protection area	:	144 m^2
Operation period	:	60 min, of which 10 min in foam mode
Max. spray area	:	10 m^2

For the protection of the inclined belt conveyors, about 30 spray heads are required for each conveyor bridge.

With the new set of pumps that will be installed with the 150 MW unit, the required amount of fire fighting water is provided.
The sprinkler system will have its own 20 m^3 capacity starting pressure tank.

(3) Fire Alarm System

As required by the operational safety of the new unit, an intelligent fire alarm network where the number of false alarms is minimal, practically zero, will be installed in the area of the new unit and technological equipment and systems directly connected to the operation. (See Figure 4.11.9)

The existing old conventional system and its center should be integrated as a subsystem in the new fire alarm network. The conventional fire alarm loop can be addressed by using master sockets, sensors or concentrators. In the area of the new unit, each room, cable marshalling room, cable trench and dangerous technological equipment, etc. are protected by addressable sensors in order to send an early fire alarm if fire breaks out. The new intelligent fire alarm center is expedient to be located in the central control room.

The fire alarm system to the professional fire brigade of the municipality should be established.

4.11.6 Demolition and Relocation Works

Demolition and relocation works related to the construction of the new 150 MW unit are as follows.

(1) Demolition Works in the New Plant Site

1) Warehouses and service buildings of conventional construction.

2) 7 single-floor buildings of brickwork construction (workshops and warehouses) with a total ground area of about 4000 m^2.

3) Open-air r.c. waste container of about 400 m^2 ground area.

4) Paving and yard finishes of 1200 m^2 ground area.

5) Rail line (existing track in the turbine building) with its understructure of about 250 m.

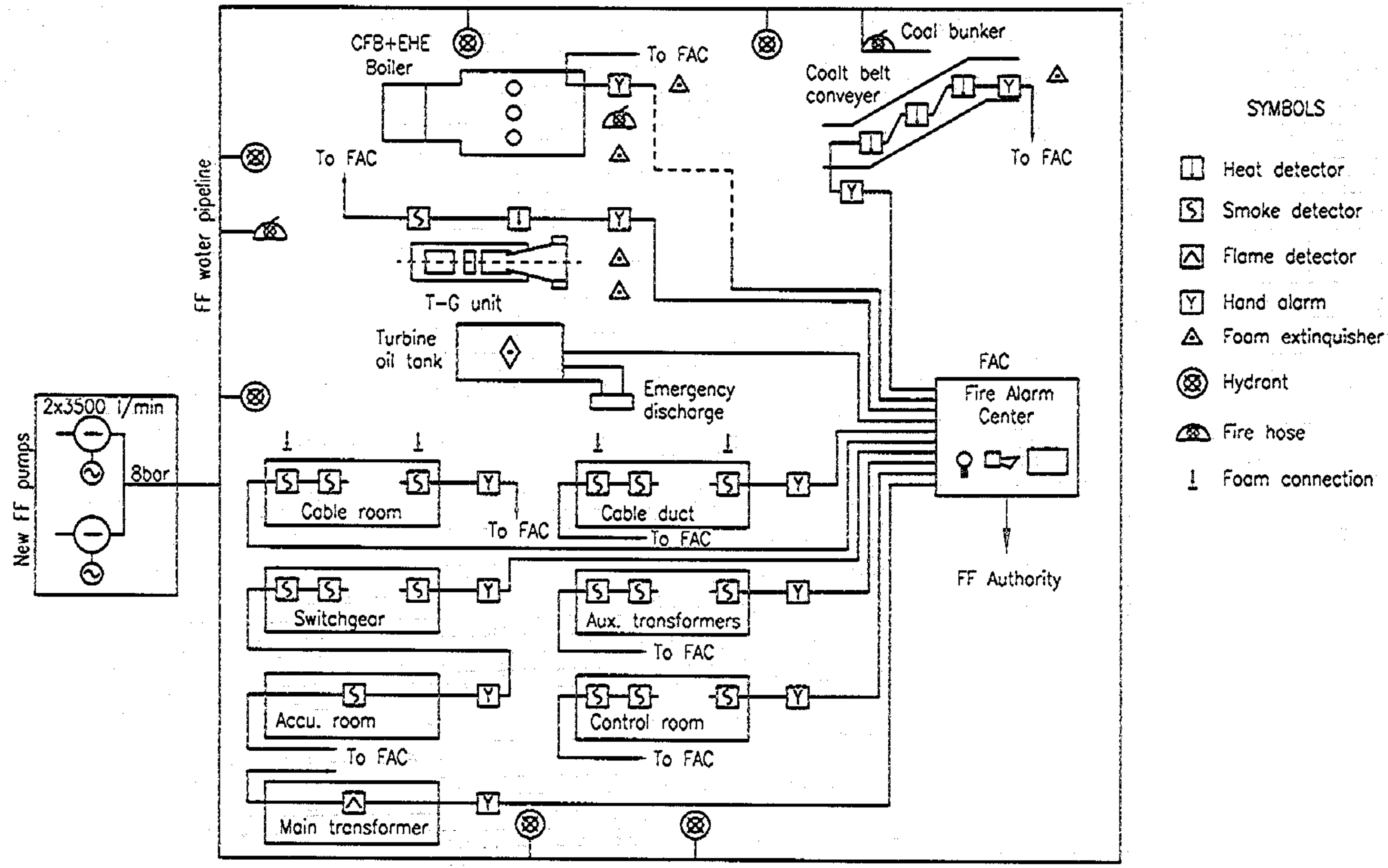


Figure 4.11.9 Fire Alarm Scheme

6) Various types of piping poles together with their footing; reinforced concrete of about 200 m^3.

7) Yard lighting and roads

(2) Relocation of Objects in the New Plant Site

1) Part of the drinking water and fire water pipelines to be demolished and remaining part to be relocated or diverted

2) Sewer pipes and drain pipes of the public sewerage and drainage system to be relocated

(3) Demolition of Wagon Tippler

Demolition of the existing wagon tippler along with the r.c. pit of about 6 m deep from ground level and the superstructure of steel construction.

4.12 Railway Siding Network

(1) Present Conditions

The railway siding network of the Power Plant is connected to the nearby main line No. 92 Miskolc-Bánréve-Ózd. From the main line parallel to the longitudinal axis of the Power Plant area, there are branching points at the freight-yard of Berente, leading to both the siding network of Berente grading plant located at the south-east end of the freight-yard, and back to the siding network of the Power Plant located in front of the grading plant. The road traffic has an access to the Power Plant through the main road No. 26 Miskolc-Kazincbarcika-Bánréve. Both the railway lines and the main roads can be considered to be in good condition. The siding network of the grading plant and the Power Station is shown in Figure 4.12.1.

The railway siding of the Borsod Power Plant was originally planned to receive coal and serve the outdoor transformer station as well as receive other goods for internal use of the plant. The current rail traffic consists primarily of acid/alkali and gas/oil shipments. This means 14 to 15 wagons a month, which are unloaded by means of drawing off along the section of rail track No. I between the segments 8+00 and 9+00 behind the main building .The plant siding is served by the station master's office of Berente, MÁV coal-yard, by using a locomotive of type M44 in push mode. The superstructure of the track is old, and its drainage system fails to function because of the muddy bed.

(2) Transport Plan Within the Plant

The railway network of the plant has been planned to fulfill the highest demand of transporting coal and limestone.

1) Railway traffic for coal supply

The problem of receiving hard coal in the quantity 2300 to 2800 tons a day transported by rail during 120 days of the summer period at the railway station Berente is considered to be solved as follows:

(a) Coal arriving in two-axle front-discharge wagons can be unloaded by means of the existing wagon tipplers of 2 x 50 tons lifting capacity on the rail tracks No. I-II-III-IV of the railway station.

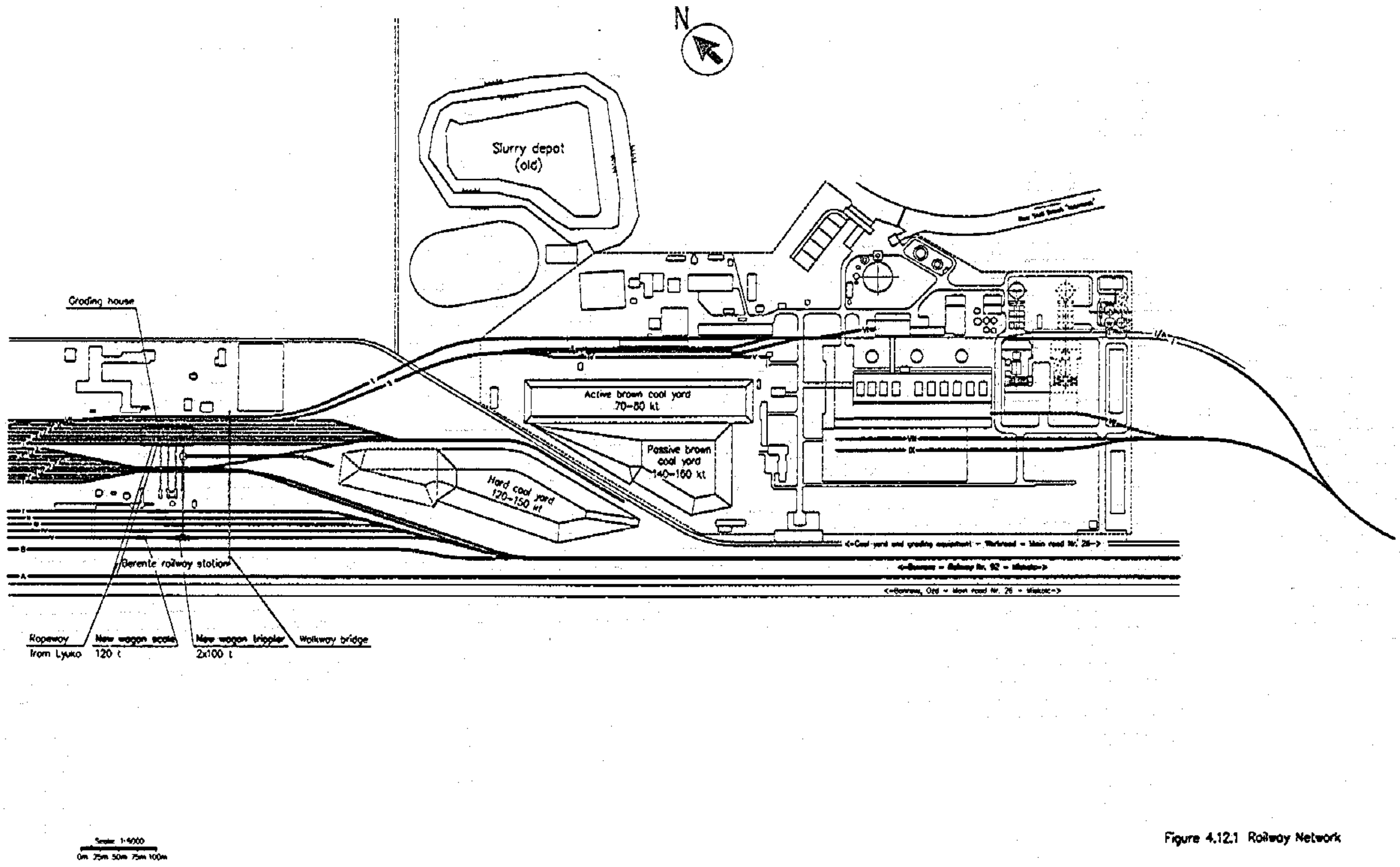


Figure 4.12.1 Railway Network

(b) To solve the problem of receiving four-axle wagons continuously, a new twin wagon tippler of 2 x 100 tons lifting capacity will be installed in place of the existing wagon tippler No. VI installed on the track No. V. This new wagon tippler is provided also with a discharge grate suitable to receive four-axle drop-bottom wagons.

(c) For the purpose of quantity control of coal transported in four-axle wagons, a railway bridge balance of 120 tons capacity will be installed in the vicinity of the new twin wagon tippler.

(d) If necessary, the front tipplers of 42 tons lifting capacity installed along the rail tracks No. III and IV also allow to receive coal transported in two axle wagons. The traffic of wagons to be unloaded and those already unloaded can be implemented on these two tracks and the nearby track No. II. Therefore, the traffic associated with the limestone supply described below will not be disturbed.

2) Railway traffic for limestone supply

The plant must receive raw limestone 7 days a week, with a daily average quantity equivalent to 27 of the Tals-type, closed, drop-bottom wagons of 38 m^3 capacity.

In the case of a prolonged operational trouble of the limestone processing plant, limestone grist will be purchased and received in 5 days a week, in a daily quantity equivalent to 13 railway tankers of the type Uaces (or 26 railway tankers of the type Ucs) of either four or two vessels.

The limestone receiving station is located on the new tail track No. I/a laid close to the reinforced concrete storage silos next to the fence of the Power Plant. The limestone receiving station receives wagons selected in pairs from the train shunted to the nearby section of the rail track No. I. The loaded wagons push the empty wagons backwards to the wagon parking section of the track.

3) Total railway traffic within the area of Power Plant

(a) Within the Power Plant, the railway traffic does not exceed 28 to 30 wagons as a daily average with any combination of material supply. This quantity can be received by distributing it to the rail tracks I and II; however, the railway traffic requires well organized railway service. The tracking locomotive of type M28 owned by the Power Station is suitable to move 8 to 10 wagons.

(b) In the case of limestone transport reaching or exceeding the average quantity, drawing-off of acid/alkali liquids and oil can be restricted to the third (night) shift on the rail track No. I.

(3) Modification of the Existing Railway Siding Network

To meet the increased traffic, part of the existing railway siding network is modified, and the tail track No. I/a is newly installed. The tasks relating to the rail tracks are shown in Figure 4.12.2.

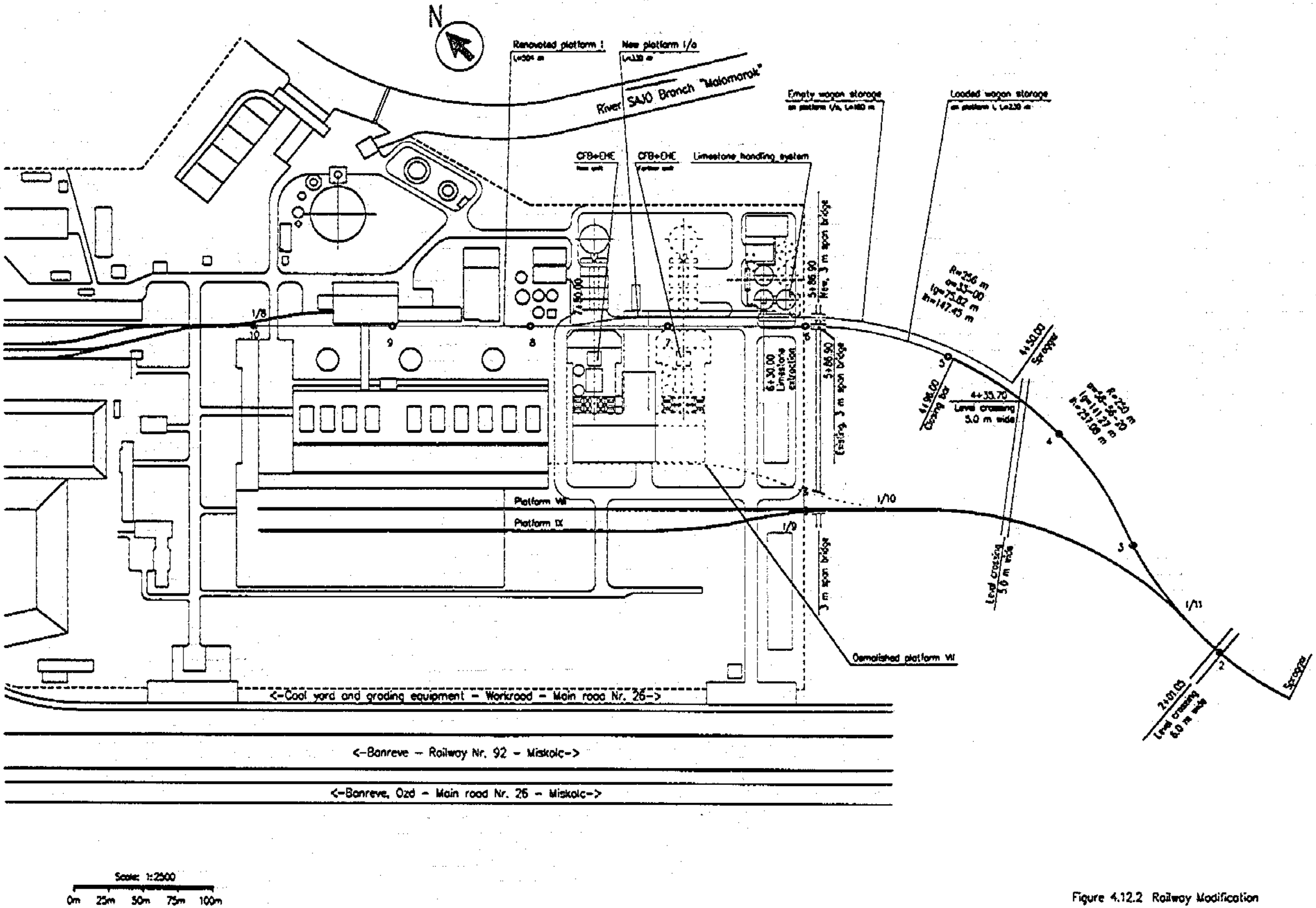
1) On the section of 504 m long of track No. I between the segments 4+96 and 10+00, a new superstructure will be constructed and a new longitudinal catchwater along the full length of the track will be established. A rail track stop barrier will be installed in the segment 4+96. Thus, the rail track No. I becomes the parking track of about 160 m in length for loaded wagons from the shunt of the new rail track I/a.

2) Rail track No. I/a of 330 m length will be established starting with and 6.00 m away from the segment 7+80 of rail track No. I, with a shunt of system 48. Within the segment 5+87 of the track, a bridge of 3.00 m span over the watercourse made of reinforced concrete will be built with a broadened gate in the fence in front of the bridge and with a rail track stop barrier within the segment 4+50. The unloading building common for both the drop-bottom wagons and those with pneumatic discharge facility will be built along the segment 6+30 of the rail track. The rail track section of about 160 m following the building is used as a parking track of wagons unloaded or drawn off in pairs.

3) Rail track No. VII and shunt No. I/10 laid in the existing old plant building will be removed for a length of 400 m.

(4) Construction of Roads

A suitable new road network will be established within the Plant connected to the external service road, and a new gate and an entrance building are established as shown in Figures 4.12.1 and 4.12.2. Since rail track No. VII is removed, large size equipment will be transported to the existing and new main buildings through this road network.



Scale: 1:2500

0m 25m 50m 75m 100m

Figure 4.12.2 Railway Modification

4.13 Control and Instrumentation

(1) Specifications and Requirements

The control and instrumentation system has the task of controlling the processes in a reliable manner in both manual and automatic mode. The automatic mode includes both the open loop and closed loop control tasks. The control and instrumentation system is also aimed at providing an overview of the process under control and ensuring the safe operation even with small number of staff. It shall also ensure the quick response to load changes, while observing the response time limits specified to the process, as well as the improvement of process efficiency and fulfillment of environmental requirements.

The control and instrumentation system shall also ensure that the power unit meets the UCTPE recommendations relating to the corrective response to network disturbances as well as the power and frequency control. This also applies to the control tasks necessary in both the primary and the secondary stage during the network control. The control system of the unit shall enable the unit to participate in the network control by means of either indirect dispatcher intervention or on-line dispatching action.

It shall be emphasized that the control and instrumentation system properly designed for the process shall ensure the safety of heat supply.

The recognition of process disturbances within short time and the quick operator response shall also be ensured.

The tasks outlined above shall be implemented in a cost effective way, by using up-to-date, high-level technologies.

The most important requirements set to the control and instrumentation system are the operational safety and ease of maintenance.

Some further requirements such as the expandability, low energy dissipation, ease of installation, low space requirement of hardware, insensitivity to interference, climatic resistance and long service life shall be satisfied.

The level of automation is determined by the requirements as follows.

1) continuous operation under automatic control including the automatic response to load variation.

2) safety actions in any operating mode without operator intervention.

3) although starting and scheduled stopping of the 150 MW unit as well as any set point adjustment is performed by operators, the unit is operated with a minimum number of staff.

4) The steam turbine is started and stopped by pressing the proper push-button under sequence control program.

(2) Features of Control and Instrumentation System

The unified control and instrumentation system of the 150 MW unit to be established within the Power Plant will be Distributed Control and Information System (DCIS) with the main features as follows.

Both the closed loop and open loop control as well as the safety tasks common to the circulating fluidized bed fired boiler and the unit will be performed by the unified process control system. The process-end equipment including those controlling the boiler, the electric equipment, feedwater + hot water + cooling water systems together with the devices interfacing the subsystems shall consist of general purpose devices designed for industrial use that are connected to the system bus.

The control and safety subsystems of steam turbine that requires extremely short response time and high reliability (e.g. speed control, load control, starting, turbine protection, heat load analyzer) are built with process control hardware components of high reliability and specially designed for use in Power Plants. These devices are connected through a relatively small number of both analogue and binary inputs and outputs to the process control of steam turbine + generator which, in turn, is connected to the system bus, thereby interfacing the steam turbine+generator control subsystem to the unified DCIS.

The unit is provided with an unified process control subsystem of which components are connected together via high-speed links (system bus). By combining control devices designed specifically for power plants and devices for general industrial use, a system can be established at favorable investment costs, while also fulfilling the reliability requirements of the specific part of the process.

(3) Design Concept

In conformity with the present requirements and the needs for the future, the process control system will be an up-to-date system of hierarchical structure with distributed intelligence, using a data bus of high transfer rate and high reliability.

Within the hierarchical structure, the process control system is divided into various levels in respect to both functions and locations as follows.

Function	Location
- Unit operator level	- Unit control room
- Central electronics unit	- Central electronics room
- Process equipment (subsystem) operator level	- Local operator center or central control room
- Subsystem electronics unit	- Subsystem, or central electronics room
- Power switch	- MCC (switch gear field)
- Process	- Field

The distributed intelligence means that certain tasks of the system are implemented on the site or within the equipment installed close to the site concerned and only the most important data, preprocessed if necessary, will be transferred to the unit operator level. As a result, the system will be of fast response, with the optimum utilization of data transfer capacity.

The 150 MW unit is operated from the unit control room while the old boilers and the subsystems are managed from the local control room by using computer (keyboard, touch pen etc.). Basically, the data will appear on monitors except the control rooms where the most important analogue and binary parameters of objects are displayed on annunciation boards by means of traditional devices (analogue indicators, lamps). The failure signalling equipment displays and prints the failures; nevertheless, certain failure signals also appear on the annunciation boards by means of lamps. Basically, the analogue data will be archived by means of logs and archive files. In addition, the annunciation boards will also be provided with several traditional recorders.

The main parts of the DCIS are as follows (see Figures 4.13.1, 4.13.2 and 4.13.3).

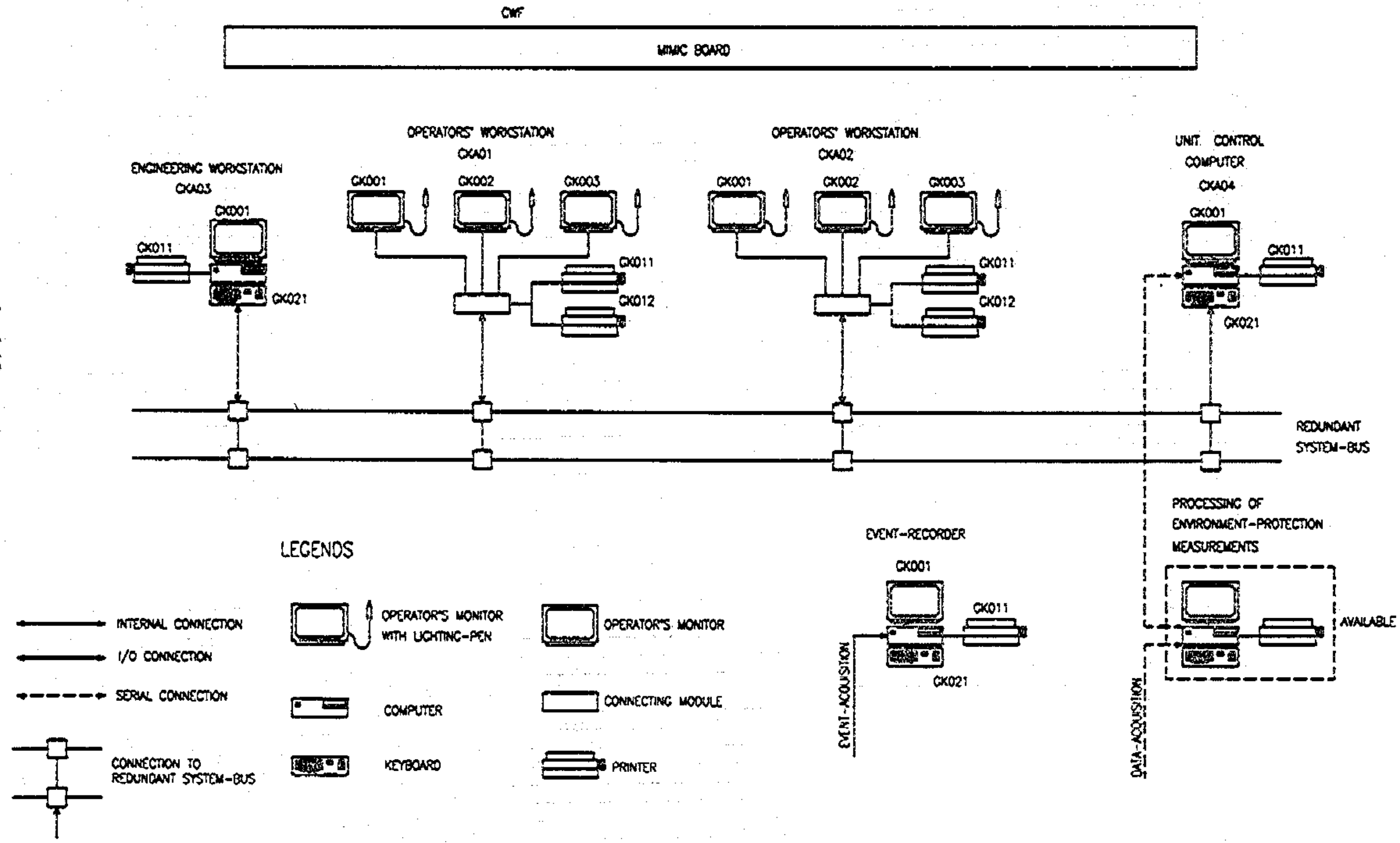


Figure 4.13.1 DCSI System (1/3)

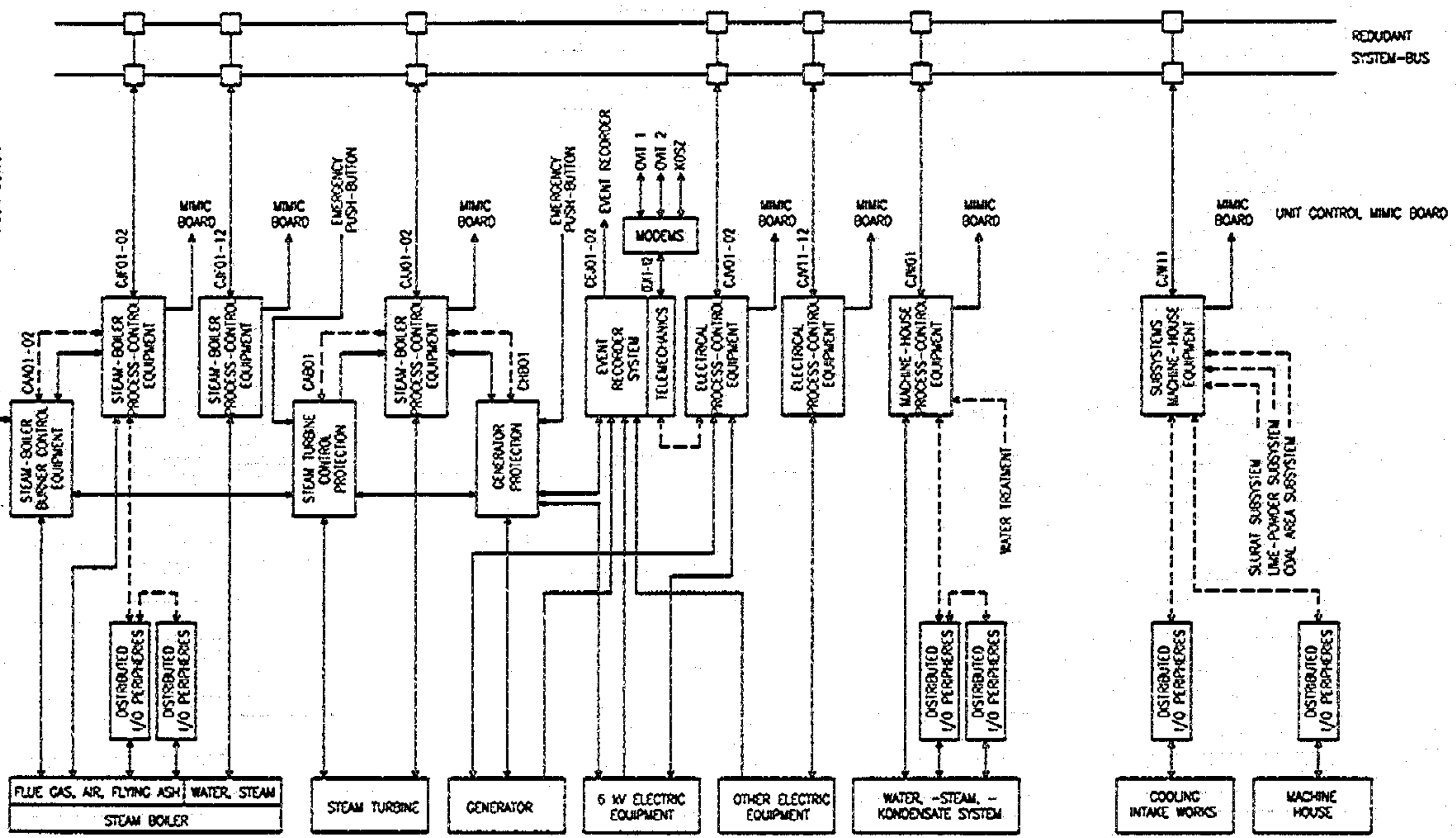


Figure 4.13.2 DCSI System (2/3)

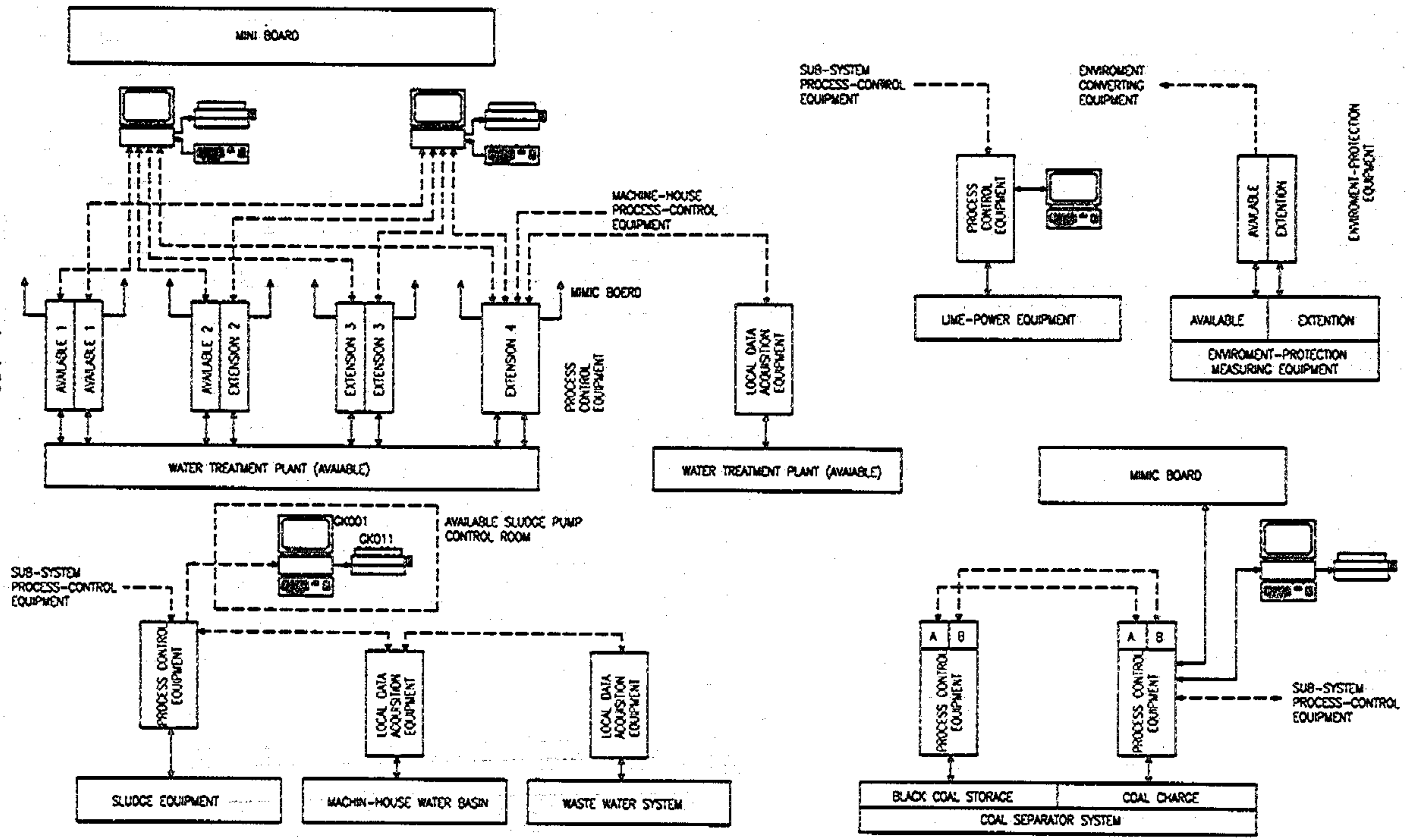


Figure 4.13.3 DCSI System (3/3)

1) The process control subsystem of circulating fluidized bed fired boiler performs the control tasks associated with the boiler, maintains the contact with the combustion control and cooperates with the appropriate steam turbine control circuits. In conformity with the local official provisions, the combustion control unit is built with two central units, with double redundancy at input/output side and provided with synchronization monitoring which, by means of PLC (Programable Logic Controller), initiates the appropriate control action in the case of any deviation.

2) Steam turbine and generator process control subsystem, which performs open loop and closed loop control functions and ensures the connection to the unified control system. This system is also connected to the control circuits fulfilling the special tasks of control and protection for both the steam turbine and the generator.

3) The process control subsystem of electric equipment controls the operation of switch gears associated with the unit and acquires the measured data of electric parameters.

4) The process control subsystem of feed water plant and cooling water supply performs the data acquisition and control functions of steam and water supply, the condensate systems in the feed water building as well as the dosage of chemicals. This system also ensures the connection to the other subsystems.

5) The failure signaling function is implemented by the unified process control system. The unified failure signals and events appear on the screen and are also indicated on the annunciation board. In addition, the failure signals and events can also be printed in the form of an event log.

   For the sake of better overview, only the most important and collective failure signals are indicated on the annunciation board.

6) The failure recorder consists of an event recorder device with high polling frequency and high storage capacity, used for archiving short-time events (electric parameters) that are unable to be processed by the process control system in an optimum manner (post mortem log).

   The clocks built in the failure recorder and the process control system will be synchronized automatically at regular intervals.

7) Operator workstations serve for displaying signals and logging events associated with the unit and, in addition, enable certain operator interventions to be performed.

8) Engineer's workstations perform the supervisory tasks relevant to the subsystems under their control while ensuring the software maintenance and improvement.

9) Supervisory computer for the unit acquires data from the systems and subsystems of the unit as well as from other connected process control equipment through the data transfer lines. Based on these data, prepares logs and archives, performs post-mortem functions as well as certain economic calculations (efficiency, specific fuel consumption etc.)

10) Data acquisition and processing computer for environmental measurements acquires the data of emission measurements and sewage analyzers. In conformity with the official requirements, the measured data will be processed, entered into logs, archived. In addition, certain data will be transferred through serial lines to the supervisory computer.

11) Subsystems are parts within the Power Plant process that, for technologic reasons, shall be operated from places other than the unit control room. The data acquired from these subsystems are transferred through serial lines to the process control subsystem of the feed water and cooling water supply, then to the unified process control system. Such subsystems are as follows:

(a) Water treatment

The make-up water supply to the unit and the remaining part of the Power Plant will be ensured by the existing water treatment plant which is to be expanded. The existing water treatment facility will be completed with new tanks and remotely controlled devices. Certain parts of the process will be renewed. Its automatic control equipment recently renewed is of up-to-date design; the control tasks are performed by PLCs connected to PC based operator consoles and a traditional annunciation board. This can be well adapted to the concept of this study. By increasing the number of PCL inputs and outputs as well as improving the control software, the control subsystem of water treatment shall be upgraded and connected to the unified process control system of the unit and the power plant.

(b) Coal and limestone handling

The control tasks associated with the coal and limestone handling consist of the actuation of switching devices for the most part. The subsystem is operated from the annunciation board in the local operator room established within the switchboard house located at the site. The relay based control equipment of the existing coal handling system shall be replaced by PLC based control equipment which also performs the control tasks of the new handling equipment. Special attention shall be paid to the sensors and switches mounted near the belt conveyors, as the wet coal may stick to the components. The PLC controls the coal transport, allowing the operator intervention by using the switches on the annunciation board. Due to the character of the process and the material transported, the full remote control of the subsystem without personal attendance is not recommended. The signals acquired by the PLC will be transferred through serial lines to the control room of the unit.

(c) Slag and fly ash handling

The thick slurry technology shall be selected for slag and fly ash removal, the associated control tasks can be best solved by using PLC. The PLC is connected through a serial line to the process control system of the unit. Operator actions are initiated with the keyboard of the process control system.

(4) Technical and Economic Aspects

Technical and economic aspects described below shall be emphasized due to their importance.

1) Although systems of different origin can be interfaced with each other; nevertheless, it shall be aimed at establishing an unified process control system in order to obtain an optimum data transfer rate and to limit the variety and number of spare parts as well as to ensure the possibility of future expansion. As the hardware development is different by systems, combination of several different systems require larger professional expertise. Interfacing different systems is performed usually by using serial lines and a protocol more or less standardized (e.g. Modbus, Profibus), however, their data transfer rate and reliability is limited. Their implementation sets difficulties in almost every case, and the result obtained are not commensurate with the significant effort required.

2) The turbine manufacturers often offer their products with well developed turn-key electric and control systems of autonomous operation. It is recommended to use them as far as possible since the standard solution is sold at a favorable price, while the subsequent alterations or custom tailored systems are much more expensive. It is recommended to build the process control system with components that enable the complete DCIS to be established so as to fulfill the requirements.

(5) Process Control Computer

For the establishment of the DCIS, process control equipment designed for general use and specifically for power plant can be used. In any case, the high level of operational safety and reliability are achieved by using redundancy as well as strict quality control of both the components and subassemblies. It can be stated that the DCIS developed for use in power plants fulfil the above requirement, however these involve higher prices. Their additional advantage is that the requirements relating to the quick response necessary in power plants (e.g. turbine control, protection) are also fulfilled.

There are manufacturers which can provide equipment capable of connecting two different systems together, by using the same data bus of high data transfer rate, under the control of an unified supervisory control system at a higher level of hierarchy. This enables the unit to fulfill the requirements relating to both the response time and the reliability in a most reasonable way.

Regarding planning and selection of the DCIS, the redundant solutions listed below are recommend to be used.

1) Power supply to the process control system shall be implemented from two independent sources and the operator workstations shall be powered by using an uninterrupted power supply (UPS).

2) In the case of safety measures implemented in the process control computers as well as in the turbine control, the inputs and outputs shall at least be doubled, while the processors performing the data processing shall use control based on doubled program controlling synchronism or two-of-three logic.

3) The high-speed data bus (system bus) and the connecting points shall be doubled. The communication protocol shall be provided with error control facility.

In the design of operator workstations, the redundancy described below is recommended.

The operator consoles are connected to a control computer which, in turn, is directly connected to the bus. These operator consoles are able to manage each of the process control subsystems and process equipment. In the unit control room, at least two computers that serve an each operator group would be reasonable to be installed, while the local control rooms require at least one computer. Basically, an operator console is allocated to each process unit, however, the consoles within a group are capable of replacing each other to the full extent.

The products shall show the reliability indices as follows.

1) The MTBF (Mean Time Between Failures) that basically determines the reliability shall be at least 16,000 hours for each unit built with CPU and 40,000 hours for equipment required to be of high availability.

2) The diagnostic feature and mechanical design of product shall ensure that the MTTR (Mean Time to Repair) shall not exceed 2 hours.

3) The allowed average storage time of spare parts of products shall be at least 10 years.

4) The average service life of control and instrumentation devices that represents their durability shall be at least 15 years.

For the other important technical parameters, the minimum requirements listed below are recommended.

1) The basic error for the analogue inputs and outputs of process control equipment shall not exceed 0.4 %, for the PLC: 1 % and for failure recorder: 1 %.

2) Data specifying the processing speed and dead time of the process control system are:

   (a) System bus data transfer rate shall be at least 250 kbit/s, for serial line at least 9600 bit/s.

   (b) Time of changing pictures at the operator consoles shall not exceed 2 s, and the time of updating the screen shall not exceed 1 s.

   (c) Basic cycle time for process control system shall be max. 200 ms, for PLC: max. 50 ms, for failure recorder: max. 1 ms.

The test requirements listed below relating to the devices and equipment used in the safety and automatic switching systems also apply to the process control equipment:

1) Power supply voltage error:+10/-20 % for DC and +15/-15% for AC

2) Dielectric strength: 500 V 50 Hz for 1 min (IEC 255-5)

3) Dielectric strength for voltage surge:1 kV, 1.2/50 ms (IEC 255/5)

4) 1 MHz HF disturbance test: 2.5 kV in longitudinal and 1 kV in transversal direction (High Frequency Disturb. Test IEC 255-22-1)

5) Electrostatic discharge test: 8 kV (ESD Test IEC 255-2 and IEC 801-2)

6) Radiated electromagnetic field test: 10 V/m (Radiated Electromagnetic Field Test, IEC 255-22-3 and IEC 801-3)

7) Fast transient brush test: 1 kV (FTB Test, IEC 801-4)

(6) General Principles of Establishing Measuring Circuits

The measuring circuits necessary for the process control tasks use transmitters of 4 to 20 mA output signal range in two-wire system. SMART transmitters can also be used. In any case, transmitters that can be further developed to SMART system shall be used. The analogue input boards of the DCIS must be galvanically isolated. The input and output boards shall be selected so as to maintain at least 10% of channels unused (reserved). For the complete measuring circuits the following basic errors are allowed depending on the character and purpose of the measuring tasks:

1) equipment supervision, general overview	:	±4.0 %;
2) stress in mechanical structures	:	±2.5 %;
3) limit value monitoring and control	:	±1.5 %;
4) process balance and efficiency	:	±1.5 %

In the case of measuring circuits with output signals used in other equipment in addition to the data acquisition of the DCIS and the channels of input boards of the DCIS are not galvanically isolated one by one, a separate galvanic isolation shall be used.

The transmitters shall be mounted on supporting consoles at the site; while the galvanic isolation circuits, if necessary, and power supply units shall be installed preferably in the relay room.

The indicating instruments mounted in the annunciation boards shall be provided with digital display with minimum and maximum limit indication in the case of vital parameters (e.g. Hz, MW), while those indicating the other parameters shall be of analogue design. The indicating instruments of pressure and temperature shall be connected directly to the mA output of the transmitters, while those measurements subject to calculation and correction such as flow and levels shall be connected to the analogue outputs of the process control equipment. The normal value of the parameters to be measured shall be between 50 and 80 % of the measuring range of indicating instruments.

The sensitive and important parameters (e.g. main line pressure) shall be recorded by chart recorders.

For temperature measurement about up to 400 °C, resistance thermometers Pt 100 with double cartridges are recommended to be used, provided that no vibration occurs at the point of measurement. The resistance thermometers shall be connected either directly to the Pt100 inputs on the DCIS input boards or indirectly to the mA inputs through temperature transmitters. In case of control tasks or measuring important parameters, the use of transmitters is recommended. For resistance thermometers, 3-wire or 4-wire circuits shall be used. For measuring higher temperature, thermocouples connected to mV transmitters shall be used with cold junction compensation. If it is allowed by the environment and the parameter to be measured, transmitters integrated with temperature sensors shall be used.

For pressure measurements, pressure transmitters provided with gauge valve are to be used. At the sampling stubs, a single shut off valve shall be used below 64 bar rated pressure, while double shut off valves are to be used for higher pressure. If the temperature of medium is above 50 °C, water trap shall be used. In the case of gaseous media with pulsating pressure, pneumatic or electronic damping facility shall be used.

The flow measurements in the case of raw water, feed water, steam and natural gas shall be implemented by using ring-chamber orifices tapped at corners, or ANNUBAR probes in large size air ducts, while standard flow meters are used for fuel flow measurement. In the case of differential pressure meters used for flow measurement of steam and gaseous media, pressure and/or temperature correction shall be used if necessary. The correction shall be implemented by means of the DCIS equipment.

In the case of aggressive media with high electric conductivity, the use of electromagnetic flow meters can be envisaged. Flow meters with minimum pressure loss shall be selected.

Level measurements of water/steam media under pressure are proposed to be implemented by using differential pressure measuring devices with correction if necessary. For oil tanks, ultrasonic level measurement with temperature compensation is envisaged. In the case of reservoirs containing chemicals for water treatment, the use of capacitance or ultrasonic measuring circuits is recommended. The limit level switches are of float type or based on electric conductivity, with measuring circuits provided with self-diagnostic feature.

For conductivity and pH measurement, measuring devices with flow through probes, while for the other analyses (e.g. SiO_2 measurement) special purpose devices are recommended.

(7) Legally Required Measurements

The "Act XLV of 1991 On the Measures" classifies the measurements of legal consequences into the categories as follows:

- measurements used for accounting
- personal safety measurements
- environmental measurements
- material safety measurements

1) Measurements for accounting purposes

For displaying the results of measurement used for accounting purposes, indicating devices (indicating instruments, recorders, counters) independent from the DCIS shall be installed.

When installing measuring circuits for accounting purposes, other requirements beyond the general measuring aspects listed above shall also be fulfilled. The accuracy class of devices used in measuring circuits shall be suitable for the given task. The devices shall be regularly tested by the Hungarian National Office of Measurements (OMH with Hungarian initials). During the planning phase, the configuration of measuring circuits shall be agreed with OMH.

The display devices and meters of the authentic steam and hot water acceptance measurements are used for accounting purposes, while the instantaneous values in the form of current signal (mA) are connected to the DCIS in order to allow an overview of all the thermal processes.

2) Environmental measurements

The environmental measurements have two important tasks. The quantity of pollutants emitted into the atmosphere is verified on the one hand and data for the improvement of the process technology and increasing its efficiency are supplied on the other hand.

In order to implement the tasks outlined above, a stationary equipment for measuring flue gas emission shall be installed, consisting of gas analyzers capable of sensing several gas components (CO, NO_X (NO_2), SO_2) and dust, measuring devices for measuring reference parameters (O_2, temperature, pressure, flue gas flow velocity) as well as a complex emission data acquisition and evaluation computer. The data acquisition and evaluation computer performs corrections, calculates time averages, displays concentration and mass flow values, exceeding of limit values, trends as well as archivation.

The establishment of a system of this kind is already in progress for the existing three stacks of Borsod Power Plant. The analyzers and sensors listed above shall be mounted on the stack of the new unit, and to connect their output signals to the existing computer used for evaluation. This enables the flue gas emission to be measured for the power plant as a whole.

In the measurement and evaluation of flue gas emission, the limit values specified in the Environmental Protection Act planned to be put into force in 2004, shall be taken into consideration.

In addition to flue gas emission data, the computer used for environmental data acquisition and processing shall also be capable of receiving other signals from sewage water analyzers and measuring devices of basic meteorological data, in order to allow the environmental impacts on the power plant to be evaluated in a complex manner.

The devices of environmental measurements and data acquisition as well as their data processing equipment shall be capable of operating even independent from the DCIS system of the unit, and are subject to official calibration.

(8) Control Structures

The schemes specified by the engineering contractor and the suppliers of the main subsystems are implemented in the software of process control system and PLC respectively. The use of backup control and compact control in the unit control room is unnecessary with the main subsystems. Any deviation from this basic principle is only permitted if the scope of delivery offered by e.g. the supplier of turbo-generator aggregate includes the automatic control equipment as a standard configuration. In respect of the control equipment of subsystems, the simplest way shall be found. Thus, it is also possible to use only PLCs and compact control equipment.

According to the principle of distributed intelligence, the signal processing is always be performed by the processor nearest both to the signal source and the destination of the signal already processed, using the shortest possible signal path. The manual control of manual/automatic mode, set point, actuating signal can be performed from the operator console. The operator is not allowed to perform any alteration on the control structure and settings. Actions of this kind are reserved for software maintenance personnel authorized for accessing higher level of hierarchy, namely primary engineer's workstations.

(9) Open Loop Controls and Protective Actions

Units/devices used for protective actions shall be approved and certified by an institution of international qualification and accepted by Hungarian authorities.

In the case of binary signals, the input/output level is 24 V DC. During planning, approx. 10 % reserve of inputs/outputs shall be maintained to cover the excess demand that may arise at the time of commissioning and possible minor expansion. Open loop control and safety tasks can be implemented by using process control equipment or PLCs (e.g. water treatment, coal and limestone handling). The principles described in "(8) Control Structure" also apply here, in respect to the actions that can be implemented from the operator console.

The turbo-generator, the associated electric equipment and major consumers are provided with their own usual protection and secondary protection. These safety devices are of traditional wired design and, in the case of turbines, oil-hydraulic, mechanical or electrical actuation.

The safety measures to be implemented by means of process control computers and PLCs shall be planned by using the redundancy described in "(5) Process Control Computer." Signals from protective devices and starting condition signals between different types of process control computers and PLCs can only be connected as a binary signal, transfer of signals of this kind is not allowed on serial line of data bus. In the case of unified DCIS system and redundant data bus, the connection of signals from protective devices shall be subject to special consideration.

(10) Servo Drives and Actuators

Part of the servo drives of control mechanisms supplied together with the steam turbine are of hydraulic system connected through hydraulic signal converters to the DCIS. In the case of boilers and other process units, the servo drives are of electric or pneumatic operation. Pneumatic servo drives are usually connected through an electro/pneumatic signal converter integrated with position control device to the DCIS. The signal level of pneumatic servo drives ranges between 20 and 100 kPa and the power supply level is between 400 and 600 kPa. The electric servo drives are usually connected directly to the appropriate output boards of the DCIS.

In the water treatment plant, the built-in two-state (open/close) servo drives are of pneumatic operation, controlled by means of solenoid valves operated directly from the DCIS. The gate valves, on/off valves and control valves not included in the control circuits are electrically operated through power relays controlled directly from the DCIS. These power relays form part of the electric power transmission equipment. The position of valves, their limit positions and states will be signalled to the DCIS. The electric motors are also operated through power relays operated directly by the DCIS. The state signals from motors are also fed to the inputs of the DCIS.

(11) Power Supply, Shock Protection and Earthing System

The power supply voltages to the process control system are 3-phase 380/220 V AC 50 Hz and 24 V DC. The 24 V DC power supply is based on two battery sets, provided with rechargers and appropriate filters. Basically, the DCIS is powered by 24 V DC. The DCIS is permanently connected through diodes to both battery sets. Equipment that shall be operated without interrupt and require 220 V 50 Hz power supply, will be powered from UPC (uninterrupted power supply) of appropriate capacity. Equipment not required to be operated without interrupt will be powered from 380/220 V network.

For the pneumatic servo drives, an air supply system of 700 kPa pressure shall be established with the suitable compressors, air tank and all other devices necessary to produce compressed air of proper quality. The supply pressure of 140 kPa necessary for the pneumatic control functions will be ensured using the main air supply system.

The hydraulic power supply equipment together with all their accessories necessary for the hydraulic system of the turbine are delivered by the suppliers of the main machinery.

The shock protection and earthing system is adapted to the system established in connection with the electric power transmission. All the devices of supply voltage or input voltage higher than the specified contact voltage shall be connected to this shock protection system. The green/yellow cores of cables shall be collected together by cabinets on the earthing rail and the latter connected to the steel frame of cabinet in a visible manner.

(12) Cabling

The cables of field devices are to be collected within the field junction boxes and led through the multi-core collecting cables to the DCIS. The junction boxes shall be at least of IP 54 protection and provided with door locks. The analogue signals, binary signals and the power supply shall be transferred by separate cables. In case of measuring points very far from the process control equipment, intelligent remote terminals can also be used. The remote I/O units communicate with the centre through the special serial line of the process control computer.

When specifying the cable track, the aspects of noise protection shall be taken into consideration and appropriate distance between the cables shall be maintained. The cable bushings between building sections shall be provided with fire barrier in order to prevent any cable fire from being propagated.

The signal cables shall be shielded, with copper cores of at least 0.75 mm^2, twisted in pairs, provided with color codes or numbers. When selecting the cables, the requirements of interfaces (terminal bar, maxi termi-point, wire-wrap etc.) shall also be taken into account.

In order to ensure the noise protection, the shielding of cables shall be collected on a separate trunk galvanically isolated from the shock protection trunk. The shielding system thus established shall be connected to the earthing system only at a single point (24 V power input).

(13) Environmental Conditions

The unit control room shall be air conditioned and artificial illumination shall be used. The set point of temperature control shall be adjustable between 20 and 25 °C, with relative humidity between 50 and 60 %. An air flow of 5 to 10 times volume of room per hour shall be ensured The noise level of environment must not exceed 55 dB(A)

The relay room requires appropriate heating and ventilation (temperature between 10 and 30 °C, humidity between 35 and 60 % recommended) with artificial illumination. Due to the dust generated within the power plant, special attention shall be paid to the air filtering in both the dispatcher room and the room of electronic equipment. By using pressure ventilation, the infiltration of dust can be avoided. Relating to the equipment of the unit, an automatic fire alarm system shall be established. (Refer to Section 4.11.5)

Within the water treatment building, a control room of appropriate heating and ventilation was established for the water treatment subcenter.

When selecting the field devices to be installed within the water treatment building, the acid vapors that may be present shall be taken into consideration.

For the coal and limestone handling subcenter, a separate room shall be provided with appropriate ventilation and cooling

The electrical and automatic control devices of the subsystem used for slag and fly ash removal shall be designed so as to leave sufficient place for the switching devices and process control equipment, and be suitable for operator attendance. All the control devices to be installed here must be provided with dust-proof casing (min. IP 54 protection), provided that the thick slurry technology is selected.

4.14 Grid Connection

The connection voltage level of the new 150 MW unit, considering the unit capacity and the existing 120 kV switching equipment of the power plant, shall be 120 kV.
The new unit is connected to the outside networks at two points:

1) The generated power is transmitted through the unit transformer to the 120 kV network

2) The starting transformer is connected to the 35 kV network in case of no voltage on 120 kV at the time of unit start.

(1) Source and Consumer Data

1) Source data:

(a) Power to be transmitted to the 120 kV network

i) In winter

- new unit	150 MW
- existing units V, VI, X	36 MW
- output power on generator terminal	186 MW
- self-consumption (new unit CFB + EHE)	25 MW
- power output to the 120 kV network	161 MW

ii) In summer

During the summer loading period, the above output data practically remain unchanged and 155 MW is used for load calculations.

(b) Connection of the new unit to the 35 kV network (Figure 4.14.1)

i) The starting transformer of the new unit shall be connected to field No. 22 and 32 of the 35 kV switching equipment.

ii) It is used only for a short period in case of having non-operational wire conditions.

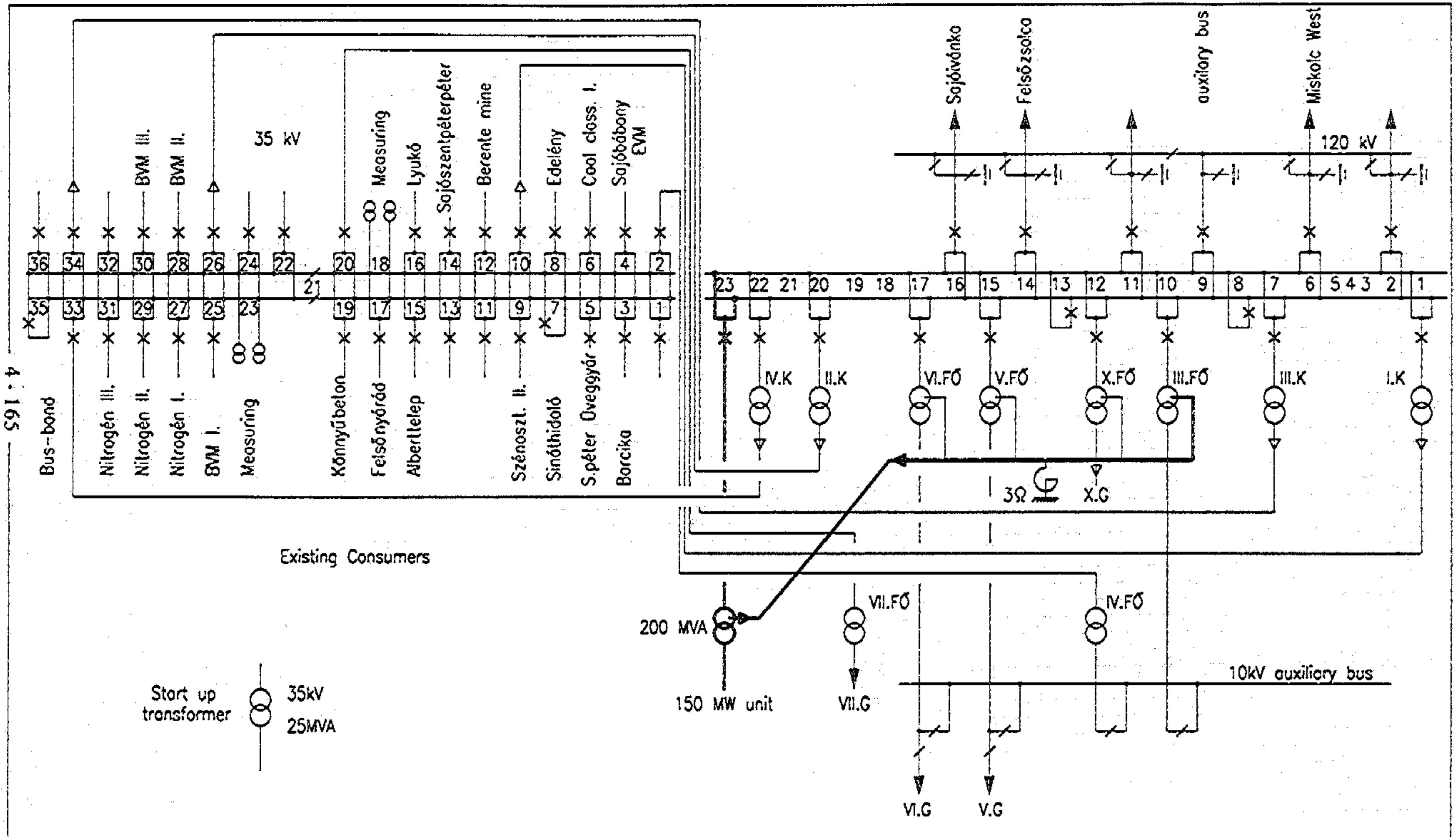


Figure 4.14.1 Single Line Connection Diagram

2) Consumer data

It is expected that the demand on the 35 kV bus-bar of Borsod power plant by the BVK will be 22-23 MW and the demand by ÉMÁSZ will be 20-22 MW (altogether 42-45 MW) in 1997. The above demands are practically identical during the winter peak load period and during the summer minimum load period because of the character of 35 kV consumers. For calculations, 42 MW is used as consumer demand.

(2) Calculations on Power Output Distribution

Power output distribution on the transmission of 161 and 155 MW output, which is fed to the 120 kV network in the Borsod power plant has been examined. The power output distribution calculations are prepared on the basis of the internationally approved (n-1) principle, which requires that output has to be securely transmitted for whatever reason even if a network element is missing.

1) The 120 kV bus-bar of Borsod power plant is connected to the network by the following 120 kV long-distance power transmission lines:

(a) Borsod-Sajóivánka, Borsod-Felsőzsolca is a line with 250 mm^2 cross-section which is a branch of one of the systems of the Sajóivánka-Felsőzsolca 2x3x250 mm^2 line.

(b) Borsod-Miskolc West 1x3x150 mm^2 line.

2) Considering the local 42 MW consumption, the above power transmission lines are capable of transmitting without overload the output of the new 150 MW unit and the existing V, VI, X units both in the winter and in the summer. The operational power output distribution is shown in figures 4.14.2 and 4.14.3.

3) Among the independent 120 kV operational disturbances, the most serious one is the tripping of the Borsod- Sajóivánka 120 kV line. In this case, during the winter load period, Borsod-Miskolc West line transmits 82 MW and is loaded up to 82%.

4) In case of the above operational disturbance during the summer load period, the transmission of the Borsod-Miskolc West line is more favourable because it transmits only 61 MW and is loaded up to 72%.

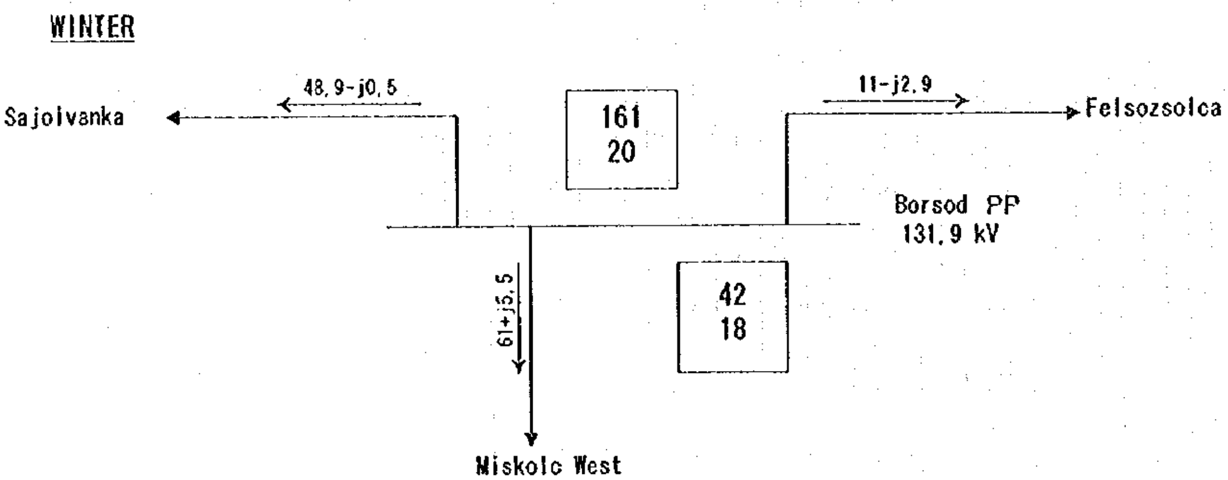


Figure 4.14.2 120 kV Bus-Bar Operation in Winter

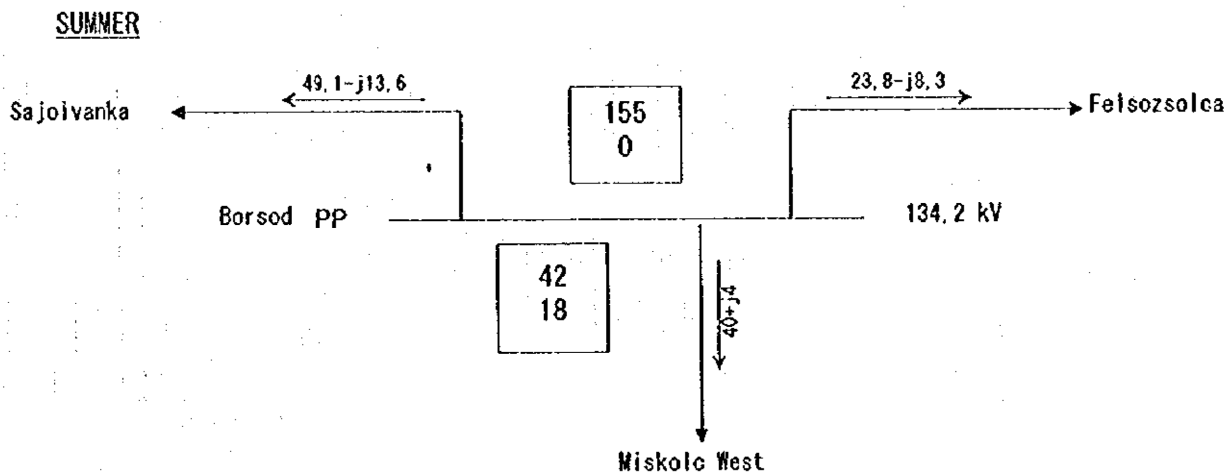


Figure 4.14.3 120 kV Bus-Bar Operation in Summer

5) In addition to the above, the separate trips of Felsõzsolca-Diósgyõr and Sajószöged-Nyékládháza 120 kV power transmission lines have been examined. In this case, the power output coming from Felsõzsolca and Sajószöged is supplemented by the Borsod 120 kV bus-bar. The operational disturbances do not result in the overloading of the Borsod-Miskolc West line neither in the winter nor in the summer load period.

6) On the basis of the calculations on power output distribution, the transmission of the power output of the new 150 MW unit is ensured in case of a single disturbance from the 120 kV bus-bar of the Borsod Power Plant, with the existing network connection. The introduction of the new unit is favorable from the viewpoint of the relation between the 120 kV network voltage and the reactive power.

7) The unit may be connected to the 120 kV field No. 23 which is opposite to the existing unit transformer (see Fig.4.14.1).

8) The connecting field is not appropriate from the viewpoint of the bus-bar transmission but the bus-bar for 1000 A and of 640 mm^2 is not overloaded even in case of the worst operational failure. (In case of connecting to another field, the connection can be implemented only with a 120 kV cable, which would be a disadvantage and a very expensive solution in the intensively utilized power plant area).

(3) Short Circuit Fault Examinations for 120 kV Star Point Connection

1) The operational status with regard to the winter peak load from the viewpoint of the fault stress has been examined. The sub-transient values of the three-phase and single-phase earth faults occurring at the 120 kV bus-bar of the Borsod power plant have been determined on the basis of the loaded network.

2) The short circuit fault safety of the 120 kV switching equipment of the Borsod power plant is 4000 MVA. The unit transformers of the existing units V, VI and X, which remain in operation in the power plant are earthed by a joint star point choke of 3.03 ohm.

3) The star point of the 120/35 kV coupling transformers is directly earthed. The calculations are basically influenced by the 120 kV bus-bars of the 400/120 kV feed points at Sajóivánka and Felsõzsolca, of which bus-bars are electrically close to

the Borsod 120 kV bus-bar. The bus-bar at Sajóivánka operates tied together and the one at Felsőzsolca operates separately. (see Fig. 4.14.4).

4) According to the result of the calculation, the 3F fault current 17 kA does not exceed the permitted value of 18.75 kA.

5) The value of the single phase short circuit fault current is 19.9 kA if only the units connected to the 3.03 ohm star point choke are units V,VI and X. This value exceeds the permitted 18.75 kA. The single phase short circuit fault current can be reduced to 18.5 kA by choking the star point of the new unit transformer. Considering this, the star point of the transformer of the 150 MW unit is to be earthed through the 3.03 ohm common star point choke.

(4) Evaluation Summary of Connectivity of the New Unit to 120 kV Network

1) As the results of the network examination regarding the new 150 MW unit in the Borsod power plant, the transmission of the output of the unit may not cause overloading during normal operation and in case of a disturbance. Therefore, there is no need to extend the 120 kV network. From the viewpoint of the relation between voltage and reactive power, the proposed location of the unit is appropriate.

2) From the viewpoint of the bus bar transmission, connection to the 120 kV field No. 23 is permissible and the existing bus-bar of 1000 A and 640 mm^2 is suitable for connection.

3) On the basis of the short circuit fault calculations the star point of the unit transformers of the new unit is recommended to be earthed through the existing 3.03 ohm choke.

4) The new unit has to comply with the requirements of the UCPTE connection with regard to primary control, reserve power output maintaining and voltage-reactive power control.

(5) Extension of 120 kV Switching Equipment

The generator of the new 150 MW unit is connected to the existing 120 kV switching equipment through a unit transformer (see Fig. 4.14.1). The arrangement of the existing 120 kV switching equipment is an open-air twin-bus + auxiliary bus system. Devices are the traditional Ganz makes i.e. circuit-breakers, instrument transformers, interruption keys (models OTKF 4001-120/1000, AOK 123, FFOK 123, respectively).

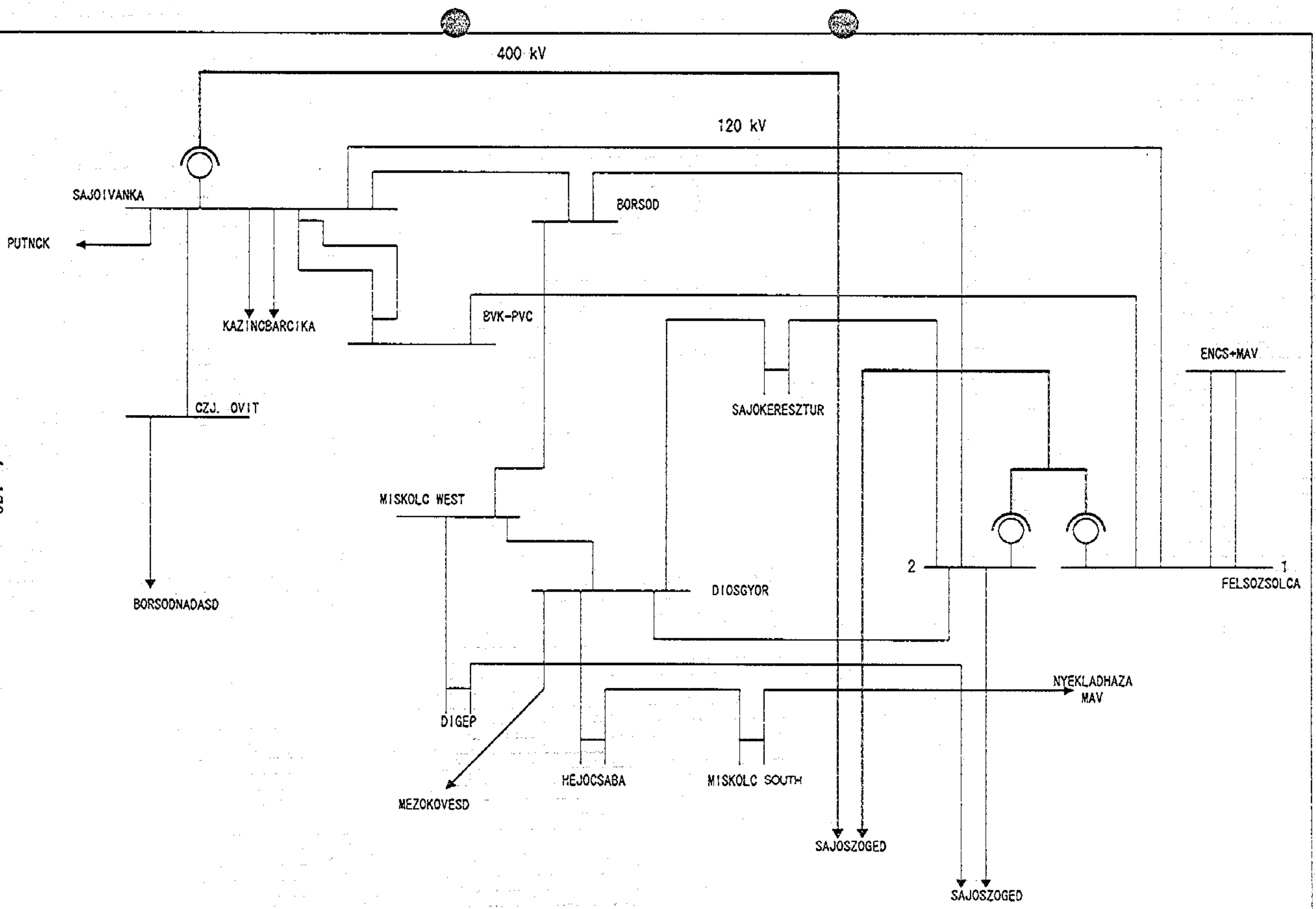


Figure 4.14.4 Outside Connection of 120 kV Bus-Bar

Buses are made of aluminum cables of 1x640 mm2 fastened by means of glass insulators. The average age of the existing 120 kV units ranges from 10 to 15 years.

Circuit-breaker shall be located at the currently vacant field No.23 of 120 kV connection of the new unit

(a) The receiving field can be located at the nearest point of the new unit. In addition, the unit transformer can be connected to the receiving field through a cable.

(b) During the complete installation work of the receiving field, a regular operation of the existing switching equipment can be maintained.

(c) When selecting the devices for the branch, installation of the latest circuit breaker with extinction agent SF6 is recommended.

(d) As for the instrumentation of the receiving field, the read-out current meter shall be located at the 120 kV side of the unit transformer.

(e) The 120 kV star point of the new unit transformer shall be connected to the existing choke of 3.03 ohm (model ACT 1x485/35). The transformer and the choke can be interconnected by a cable.

(6) Investigation of 35 kV Equipment for Consumer Demands (see Fig. 4.14.1)

1) The 35 kV bus is made of aluminum with the dimension of 1 x 120 x 10 mm. The circuit breakers shall be brand-new of model EIB (fn = 1250 A, fz = 50 kA).

2) Feeding the 35 kV bus of BVK

The 35 kV consumer demand of BVK ranged from 22 to 23 MW can be provided even at a twofold transformer shortage through the 120/35 kV coupling transformers Nos. IIK, IIIK and IVK. The main transformers Nos. I and II connected to the 35 kV bus of BVK can be removed.

3) Feeding the 35 kV bus of ÉMÁSZ Rt.

(a) With the elimination of units Nos. IV and VIII, direct electric generator feeding will be provided by unit No. VII. A consumer demand of 20 to 25 MW at the 35 kV bus can be met through coupling transformer No. I of 120/35 kV from the 120 kV voltage network by unit No. VII.

(b) If the coupling transformer is broken, the 35 kV consumers can still be supplied through units Nos. V and VII through main transformer No. IV of 35/10 kV. The precondition for this is an operational feeding of the ÉMÁSZ bus by means of unit No. V and a joint isle mode of unit V with unit No. VII on the 35 kV network.

(c) During summer load periods or when unit No. V is out of order and no transformation 120/35 kV is available, the ÉMÁSZ bus is required to be fed either from the 35 kV or 120 kV network. Possible solutions for the problem are as follows:

i) Joining the 35 kV buses of both BVK and ÉMÁSZ with the existing isolators. This, however, will present an operational limitation owing to the different star point management of the two 35 kV bus and, in addition, earth leakage may be increased.

ii) Feeding the ÉMÁSZ bus through one of the transformers by one of the BVK 35 kV buses. This is unfavorable for BVK because of the necessity of using a single-bus mode.

iii) Removal of one of the 120/35 kV coupling transformers of BVK from its existing connection points and connecting it to the ÉMÁSZ bus.

From operational view point of both the 120 kV and the 35 kV buses, using transformer No. IV is preferable.

(d) In principle, 120 kV is fed through main transformers No. IV of 35/120 kV and No. III of 120/10 kV, and through the auxiliary bus. This solution, however, is not recommended either from the operational viewpoint or from the viewpoint of protection serviceability.

(e) It is recommended that ÉMÁSZ's consumption will be transfered either to the 120/35 kV coupling transformers supplying BVK by joining the 35 kV buses of BVK and ÉMÁSZ or to one of the transformers.

In order to prevent possible power interruption during the load transfer, one of the coupling transformers should be reconnected to the ÉMÁSZ bus.

It is advantageous that main transformer No. III of 120/10 kV is kept operational. It ensures feeding to 120 kV through the 10 kV auxiliary bus when the unit transformer of any of units Nos. V and VI fails.

4) Star point management of the 35 kV network

In addition to ensuring a reserve feed-in capacity for unit No. V and ÉMÁSZ bus, main transformer No. IV is necessary for star point management of the 35 kV network. Star point management is ensured during the outage of main transformer No IV, provided that main transformer No. VII and the generator are retained in operation.

(7) Connection of Starting Transformer of 25 MVA to the Network

In the places of the main transformer fields to be vacant on the 35 kV bus, the starting transformer can be connected. Considering the three coupling transformers of 120/35 kV installed on the BVK bus, the starting transformer is proposed to be connected either to field No. 22 or field No. 32.

(8) Protection and Automation for Network Connection

1) In order to facilitate connection of the generator - transformer unit connecting in field No. 23 to the protection system of the 120 kV switching equipment, the following items are required:

(a) impedance decrease protection of independent delay
(b) autonomous over-current protection of zero order (reserve protection)
(c) three-phase autonomous over-current protection of zero order (reserve protection)
(d) connection to the (existing) circuit breaker seizure protection system
(e) connection to the (existing) bus protection system
(f) connection to the unit protection system

2) The transient ability tests of the power plant shall be carried out. The results of tests may necessitate the supplementation of the protection system of the wires connected to the Borsod bus of the 120 kV (protection acceleration, provision of protection signal transmission paths).

Chapter 5

Preliminary Design for Renovation of Existing Facilities