6.13 Air Service Equipment

6.13.1 Control Air Source

The instrument control air source for the air control of thermal power plant should be installed separately from the station service air sources as described below. However, the instrument air sources to be used exclusively for local equipment (for example, primary water treatment equipment, fuel storage facilities, waste water disposal equipment and other common equipment of power plant) should be installed individually according to these specifications.

(1) Instrument Control Air Piping System

Regarding the control air piping system, refer to Figure 6-13-1.

(a) Equipment configuration

The equipment configuration of the control air source piping system should be as listed below:

- Instrument control air compressors
- Instrument control air receivers
- Instrument control air dehumidifiers
- Air filters with mist separators
- Supply headers
- Auxiliary air receivers
- Local instrument boards (LB) and junction boxes (JB)
- Pressure reducing valves
- Piping and valves

(b) Backup system

a. Station service air connector pipe

① The backup piping from the station service air piping should be provided at the instrument control air receiver inlet.

② A separator (for oil, drain and dust separation) should be installed downstream of each air take-out point.

③ In preparation for automatic backup when the control air pressure has dropped, an automatic shut-off value, a pressure regulator valve and a pneumatic type pressure controller should be installed.

Moreover, a bypass valve should be attached to the pressure regulator valve.

b. Control air connector pipe with other unit (This pipe is not required in case it is installed as a common pipe for two units)

The pipes from the two power units should be connected to each other at the control air dehumidifier (dryer) outlet piping.

A limit switch should be installed to make it possible to monitor the opening/closing conditions of this connector valve in the central control room, and such conditions be input to the unit digital control system (DCS).

(c) Division of supply air sources

At the supply header, the control air sources should be divided into the following lines and taken out from the supply master pipe according to individual purposes.

① Boiler air piping
② Turbine and generator air piping
③ Common equipment air piping of unit

For supply of air to boilers and turbines, a supply master pipe should be arranged in a loop form on each floor. The piping should be divided in the respective floors as appropriate according to the amount of air consumed and piping route.

(d) Headers and auxiliary receivers

a. The respective headers should be installed at the following positions.

① Supply source header: To be installed at the air filter outlet piping.

② Supply air header: To be installed at the local instrument boards, local junction boxes, etc.

③ Control terminal header: To be installed on actuator of drive or valve units and so forth (in case the control piping has two or more cores)

b. Auxiliary receivers

In case the air pressure is estimated to drop because of excessive length of the supply master pipe from the supply header as well as due to rapid increase of air consumption in a particular area, an auxiliary receiver should be installed in the middle of such an air source system.

(e) Bypass valves

Bypass valves should be provided for the following equipment:

① Air dehumidifiers (dryers)
② Air filters
③ Pressure regulator valves for back-up of station service air, and drain separators

(f) Air pressure reducers

Instead of installing air pressure reducers by gathering supply headers into a group and gathering supply master pipes into another, etc., an air pressure reducer (with filter) should be installed on a per-controller basis and per-control terminal basis.

Should it be inevitable to install air pressure reducers by forming groups of headers and master pipes as mentioned above, such groups should not extend across more than one control system. [Specific example: Install one common pressure reducer (with filter) for the controller and transmitter of the steam pressure control system, and another common pressure reducer (with filter) for the diaphragm valves in the soot blower pressure control system, etc.].

(2) Piping Materials

(a) Instrument control air compressor - Air dehumidifier inlet:

Gas pipe (black), SGP (B)

(b) Air dehumidifier inlet - Air filter inlet:

Gas pipe (white), SGP (W)

The air dehumidifier inlet/outlet should be terminated with a flange.

(c) Air filter inlet valve - Local instrument board and junction box inlet (supply master pipe):

Seamless non-phosphorus deoxidised copper pipe
(thickness: 2 mm)

(d) Control air connector pipe with other unit:

Gas pipe (white), SGP (W)

(e) Air filter bypass pipe:

Seamless non-phosphorus deoxidised copper pipe
(thickness: 2 mm)

(f) Piping related to controllers downstream of local instrument boards and junction boxes

a. Control copper pipe (single, 2-, 3- and 4-cores), without communication cable
b. Raw pipe: Seamless non-phosphorus deoxidised copper pipe

(g) Header and so forth

Same material as that for supply master pipe

(h) Other

Although the standard piping materials are as listed in the present Item (2), the materials to be applied at the time of extension or modification work shall be selected taking into account co-ordination with existing equipment, ambient conditions in the case of outdoor installation including the design standards of NEK.

(3) Dimensions of Piping

In principle, the dimensions of piping should be determined according to the amount of control air consumed. In the case of the supply air master pipes, supply air pipes and control air piping downstream of the air dehumidifier outlet, however, the dimensions should be determined according to the following criteria:

(a) Air dehumidifier outlet - Master pipe on each floor (Refer to Figure 3-10-9)
2B (or over)

(b) Master pipe outlet on each floor - Local instrument boards and junction boxes:
3/4B, 1B, 1-1/2B

(c) Local instrument panel and junction box - Piping for controllers:

- 6.0^{OD} x 1.0 t
- 10.0^{OD} x 1.0 t
- 12.0^{OD} x 1.0 t

(d) Supply header: 3B

(e) Control air connector pipe with other unit:
2-1/2 B

6.13.2 Station Service Air Source Equipment

The station service air source equipment should be installed independently from the instrument control air source equipment to supply compressed air for multiple applications inside the power plant including construction and installation works and maintenance cleaning operations. Piping will be distributed in the power plant to make this air available in several points.

(a) Equipment configuration of station service air piping system

- Station service air compressors
- Station service air after-filters
- Station service air receivers
- Supply headers, branch valves
- Piping and valves

(b) Backup system

a. Backup system connector pipe for use in case of drop in the instrument control air pressure (including automatic valves)

b. Station service air system connector pipes to other power units.

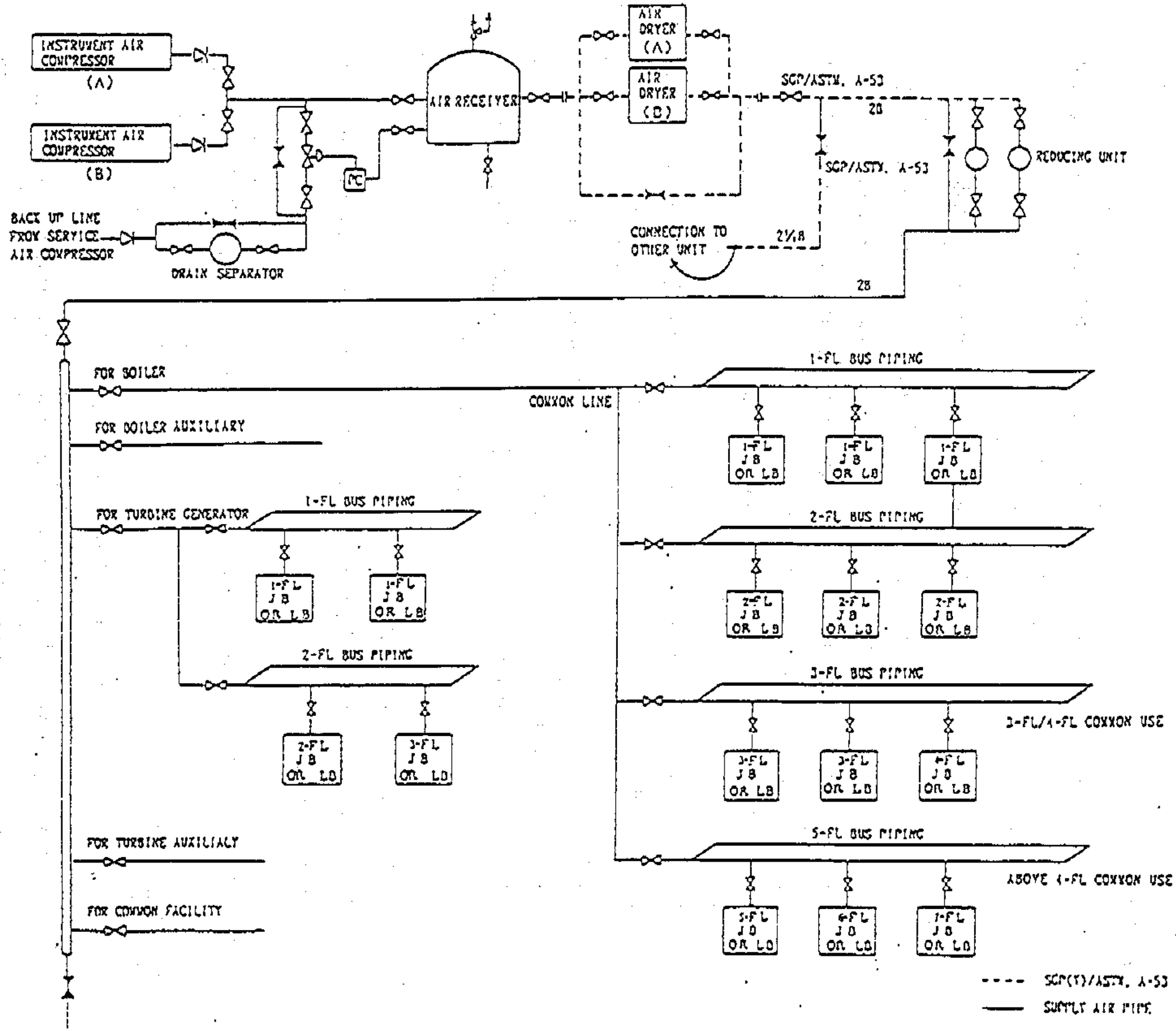


Figure 6-13-1 INSTRUMENT AIR PIPING LINE

6.14 Storage and Transportation Facilities of Fuel and Limestone

6.14.1 Coal Facility

(1) Coal Storage Facility

(a) Study parameters

1) The former No. 1 ash disposal yard (already leveled) shall be used for storage coal instead of the existing coal storage yard.

2) Coal shall be received via freight cars. The currently coal is received as follows:

a. There are 3 systems in the reception facility, one of which is scheduled to be removed.
b. The capacity of a freight car is 55 tons (coal). 1 freight unit is 7 to 10 cars.
c. Coal is received 8 to 10 times a day (each takes 1 hour). We have a number of personnel enough to receive coal 12 hours a day.
One receiving operation takes 15 minutes with 10 cars.

3) Following matters shall be taken into account for clay content (so-called black clay) in received coal.

a. Remove black clay lumps from coal as far as possible by visual inspection when coal freight is received.
b. Sort out sizes of coal after crushed and separate uncrushable lumps before storage.
c. Coal shall be stored in structure protected from rain or snow.

4) Minimum coal storage: 23 days
The minimum amount of storage shall be the least amount required for days as specified by the Bulgarian standard.

5) Coal consumption of reconstructed plant: 840 t/h (420 t/h x 2 units), 20,200 t/h

(b) Study result

1) Design specifications based on the above are as follows:

a. The existing railroad track to be branched out and a coal receiving area shall be set up close to the new coal storage facility.

b. The coal reception equipment has a capacity for two systems in which a single reception affords two freight units (10 cars x 55 t/car x 2 units). Total loading amount of the 2 freight units is 1,100 tons and their treatment time is 40 minutes (including come-in and out). The reception of coal is conducted 19 times per day and coal unloading time is 13 hours.

c. The capacity of coal reception is 2,200 t/h which is carried by 2 freight units and can be fed for 30 minutes. Because two reclaimers are provided, each capacity is 1,100 t/h.

d. The capacity and method of each coal storage yard shall be as follows.

- Coal storage capacity: 465,000 ton [23-day amount ≒ (20,200 t/d) · (23d)]
- Coal storage method: 4-row piles (natural deposit: 441.6 m^2 in cross section, 330 m/pile long)

e. Following equipment shall be as follows to cope with mixture of clay content.

- Screen and crusher (400 → 150 mm ϕ) shall be provided in receiving system.
- Roof (with no side walls) is provided in the coal storage yard.

2) Outline of major facilities based on the above design specifications are as follows:

The flowchart is shown in Figure 6-14-1-1.

a. Receiving facility

- Coal car station: Coal is dropped from 10 cars (55t/car) x 2 trains.
- Receiving reclaimer: Bucket wheel type [1,100 t/h x 2 sets]
- Receiving conveyor: Belt conveyor (BC-1A,1B) [1,100 t/h, 1,400 mm]
- Transfer conveyor: Belt conveyor (BC-2,3,4,5) [2,200 t/h, 2,000 mm]

b. Coal storage facility

- Building: Half-roofed (roof only)
- Tripper: 2,200t/h x 5 sets
- Tripper conveyor: Belt conveyor (BC-6A, 6B, 6C, 6D) [2,200 t/h, 2,000 mm]

c. Other auxiliary facilities

- Screen: Grid-shaft type [2,200t/h x 1 set]
- Crusher: Hammer type [400 t/h x 2 sets]
- Magnetic separator, Sampling device

(c) Items to be considered for carry out the plan

1) Since coal (465,000 tons) and heavy facilities such as receiving and reclaining facilities will be set up in the former coal ash disposal area, possible subsiding of the land must be considered. The investigation of the land structure and land reforming may be required depending on geological and land features.

2) Under the present plan (4 piles, 23 days) there will be no problems for the storage area. But we will have problems in the operation of car transportation such as number of cars in 2 trains (20 cars), number of receiving (19 times/day), hours required for transportation (13 hours or longer) and receiving coal burned in the existing plant.
Therefore, the coal company, limestone suppliers and power plant must make a detailed plan for car operation and to establish a coordination and communication system between the three.

(2) Coal Transporting Facilities

(a) Study parameters

1) A system between the new coal storage yard and reconstructed coal bunker.
2) Providing a crusher in the system that is used to crush coal into 40m/m in diameter or smaller lumps that are to be thrown into the coal bunker.
3) Coal transfer time shall be 24 hours the same as the present rate and the capacity of the bunker shall be the amount of coal burnt in 6 hours.
4) Belt conveyors shall be used for transporting coal.
5) Coal consumption of reconstructed plant: 840 t/h (420t/h x 2 units).

(b) Study result

1) Design specifications based on the above are as follows:

a. The capacity of the discharge reclaimer is 420 t/h x 4 sets.
b. The capacity of coal reclaiming system is 420 t/h x 2 systems (1 system reserved).

2) The outline of major facilities based on the above design specifications shall be as follows:
The flowchart is shown in Figure 6-14-1-1.

a. Reclaining facilities

- Reclaimer: Portable scraper [420t/h x 4 sets]
- Reclaiming conveyor: Belt conveyor (BC-7A, 7B, 7C, 7D) [420 t/h, 1,000mm]

b. Transport facilities

- Transport conveyor: Belt conveyor (BC-8A, 8B, 9A, 9B) [840 t/h, 1,200mm]
- Bunker conveyor: Belt conveyor (BC-10A, 10B) [840 t/h, 1,200mm]
- Scraper: Belt lifting [1,200mm]

c. Other auxiliary facilities

- Screen Grid-shaft type [840 t/h x 1 set]
- Primary crusher: Hammer type [400 t/h x 1 set]
- Secondary crusher: Hammer [400 t/h x 1 set]
- Recycle conveyor: Chain conveyor [20 t/h x 2 sets]
- Magnetic separator, Sampling device

6.14.2 Limestone Facilities

(1) Study Parameters

(a) The existing coal receiving system that were scheduled to be removed shall be used for receiving limestone via freight cars.
The car-load capacity shall be one 10-car unit (55 tons/car).

(b) The diameter of limestone to be received shall be 50 m/m or smaller.

(c) Minimum limestone storage: 23 days (same as coal)

(d) Time required to transport limestone to the bunker shall be 24 hours same as in the case of coal.

(e) Belt conveyors are used for transfer

(f) Limestone consumption of reconstructed plant: 180 t/h (90t/h x 2 units), 4,400 t/d

(2) Study Result

(a) Design specifications based on the above as follows:

1) The existing coal receiving track will be used and the storage area set up adjacent to the new coal storage yard.

2) Limestone reception per day is 8 times and transportation time is 6 hours from consumption of limestone, loading amount of a freight unit (10 cars x 55 t/car) and treatment time of a freight unit (including come-in and out).

3) The capacity of limestone receiving system is 540 t/h (8 hr for transportation).

4) The limestone storage place is as follows.

- Storage amount: 100,000 ton [23-day amount ≒ (180 t/h) · (24 h) · (23 d)]
- Limestone storage method: 1-row pile (natural deposit: 212 m^2 in cross section, 345 m in length) The pile shall be indoor type to avoid rainfall.

5) The capacity of limestone reclaiming system shall be 180 t/h with 2 systems (one reserved).

(b) Outline of major facilities based on the above design specifications are as follows:

The flowchart is shown in Figure 6-14-2-1.

1) Receiving facility

Limestone car station: Existing coal receiving area that were scheduled to be removed shall be used for receiving limestone.

- Rotary plow: Plow-rotating [540 t/h x 1 set]
- Receiving conveyor: Belt conveyor (LBC-1) [540 t/h, 650mm]
- Transfer conveyor: Belt conveyor (LBC-2,3) [540t/h, 650mm]
- Magnetic separator Suspended (650mm)

2) Storage facility

- Building: Indoor steel framed building
- Tripper: 540 t/h x 1
- Tripper conveyor Belt conveyor (LBC-4) [540 t/h, 650mm]

3) Reclaining facility

- Reclaimer: Portable scraper [180 t/h x 1 set]
- Reclaining conveyor: Belt conveyor (LBC-5A, 5B) [180 t/h,500mm]

4) Transport facility

- Transport conveyor: Belt conveyor (LBC-6A, 6B) [180 t/h, 500mm]
- Bunker conveyor: Belt conveyor (LBC-7A, 7B) [180 t/h, 650mm]
- Scraper: Belt lifting [650mm]
- Magnetic separator: Suspended [500mm]

(3) Items to be considered for carry out the plan

(a) Since heavy facilities such as receiving and reclaining for handling limestone (100,000 tons) will be set up in the former coal ash disposal area, possible subsiding of the land must be considered. The investigation of the land structure and land reforming may be required depending on the geological and land features.

(b) Under the present plan (1 pile, 23 days) there will be no problems for the storage area. But we must consider the following points since car operation is expected to become complicated as in the case of coal reception.

1) Careful plan for car operation
2) Coal company, limestone suppliers and power plant must discuss and establish a coordinating and communication system between the three.
3) Increase safety personnel for complicated car operations.

6.14.3 Heavy Oil, LPG Equipment

(1) Study Parameters

(a) The situation of equipment currently provided is as follows.

1) Although there are heavy oil equipment (reception, storage, supply) and diesel oil equipment (reception, storage, supply), there is no LPG equipment.

2) A supplier for this plant is Burgas/chemical complex (Nefthin: imported from Arab). Oil is received through railway transportation. The reception system is as follows.

- Heavy oil: 5-car freight unit (50t/car) → existing pump → tank (1,000m^3+250m^3 x 4)
  → new pump → tank (2,000m^3 x 2)
- Diesel oil: 5-car freight unit (50t/car) → pump → tank (250m^3 x 4)

3) The operation of existing heavy oil combustion system is as follows.

- The heavy oil system is always warmed up by continuous running of the pump.
- The pipe capacity was conventionally enough for supply to #1 - #10 boilers.

4) New heavy oil equipment comprises tank (2,000m^{3}x2), receiving/supply pumps, heater and strainer, etc. and new supply pipe is connected to existing burner pipe (90t/h).

- New pump specification → Receiving pump: 119t/h, 55kW x 2
  Supply pump: 58t/h, 35bar, 58kW x 2
- Figure 6-14-3-1 shows an outline system of new heavy oil reception/discharge.
- Table 6-14-3-1 shows properties of heavy oil.

(b) Expected use amounts of heavy oil and LPG (for igniting heavy oil) to be used for start and stop of a fluidized bed combustion boiler are calculated under the following condition.

- A single unit is shut down per year for periodic inspection.
- A single unit is shut down twice a year for other reason than scheduled shutdown, such as accidents.
- Two units are not started at the same time.
- The use amount for cold start and shutdown serves as a basis for this calculation.

(2) Study Result

(a) Design specifications are assumed as follows according to the above mentioned study parameters.

1) The expected yearly consumption amount is as follows.

[Heavy oil] Cold start and stop (1 time) Consumption amount (1 unit)

Startup = air-heating furnace burner: 75t = 10t/h x 7.5h
furnace burner: 25t = 20t/h x 1.25h

Shutdown = furnace burner: 10t = 20t/h x 0.5h

∴ Expected yearly consumption amount (2 units) = 660t/y [680m^3/y]

(75 + 25 + 10) t/h x (1+2) time/Y = 330 t/y/1 unit

330 t/Y ÷ 0.986 ≒ 340 m^3/Y/1 unit

[LPG] Ignition burner capacity is assumed to be 4% heavy oil burner capacity.

330 t/ x 0.04 = 13.2 t/Y (Heavy oil basis)

13.2 t/ x 9.525 kcal/t ÷ 11.84 kcal/t ≒ 11 t/Y (LPG basis)

11 t/Y ÷ 0.8 ≒ 14 m^3/Y (LPG basis)

However, because the ignition timings of the ignition burner and heavy oil burner are not the same, the use amount is assumed to be the same ratio of the ignition timing.

[Heavy oil: 8.75 hr (525 min), LPG: 3min/burner]

∴ Expected yearly consumption amount (2 units) = 1.0 m^3/Y

14m^3/y x 3min/burner x 6 burner ÷ 525 min ≒ 0.5m^3/y/1 unit

2) For the reason of yearly heavy oil consumption amount (680m^3/y), new installed heavy equipment will be used and new LPG equipment will be constructed near each boiler building.

A legally assembly bottles is specified so that nonflammable walls are provided, they are contained in nonflammable cabinet and the total capacity is less than 1.0kℓ.

3) LPG is received by means of bottle (80ℓ). The expected yearly consumption amount is 14 bottles (2 units).
[0.5 kℓ ÷ 80ℓ/bottle ≒ 7 bottles/1 unit → 14 bottles/2 units]

(b) The outline of major equipments based on the above mentioned design specification is as follows.

1) Heavy oil

a. Receiving equipment: Substitution by new equipment

b. Storage equipment: Substitution by new equipment

c. Supply equipment: Substitution by new equipment

2) LPG

a. Receiving equipment:
Bottles (80ℓ) are carried in by trucks.

b. Storage equipment:
Bottles (7) are stored in a nonflammable cabinet near nonflammable wall of each boiler building.

c. Supply equipment:
Following equipment is installed within a nonflammable cabinet of each unit.
Pressure adjusting valves, safety valves, pressure gauge, etc.

Table 6-14-3-1 Heavy Oil Properties

Item		Bulgarian Standard	Acceptable Properties
Calorific value (HHV)	MJ/kg	39.8	39.88
	(Kcal/kg)	(9,506)	(9,525)
Kenematics viscosity	mm^2/s	115	—
Density	g/cm^3	1.015	0.968
Ash content	Weight %	0.15	0.068
Sulfur content	Weight %	3.5	2.99
Moisture	Volume %	1.0	—
Impurities	Weight %	0.5	—
Flash point	℃	110 or more	120 or more
Pour point	℃	25 or less	7 or less

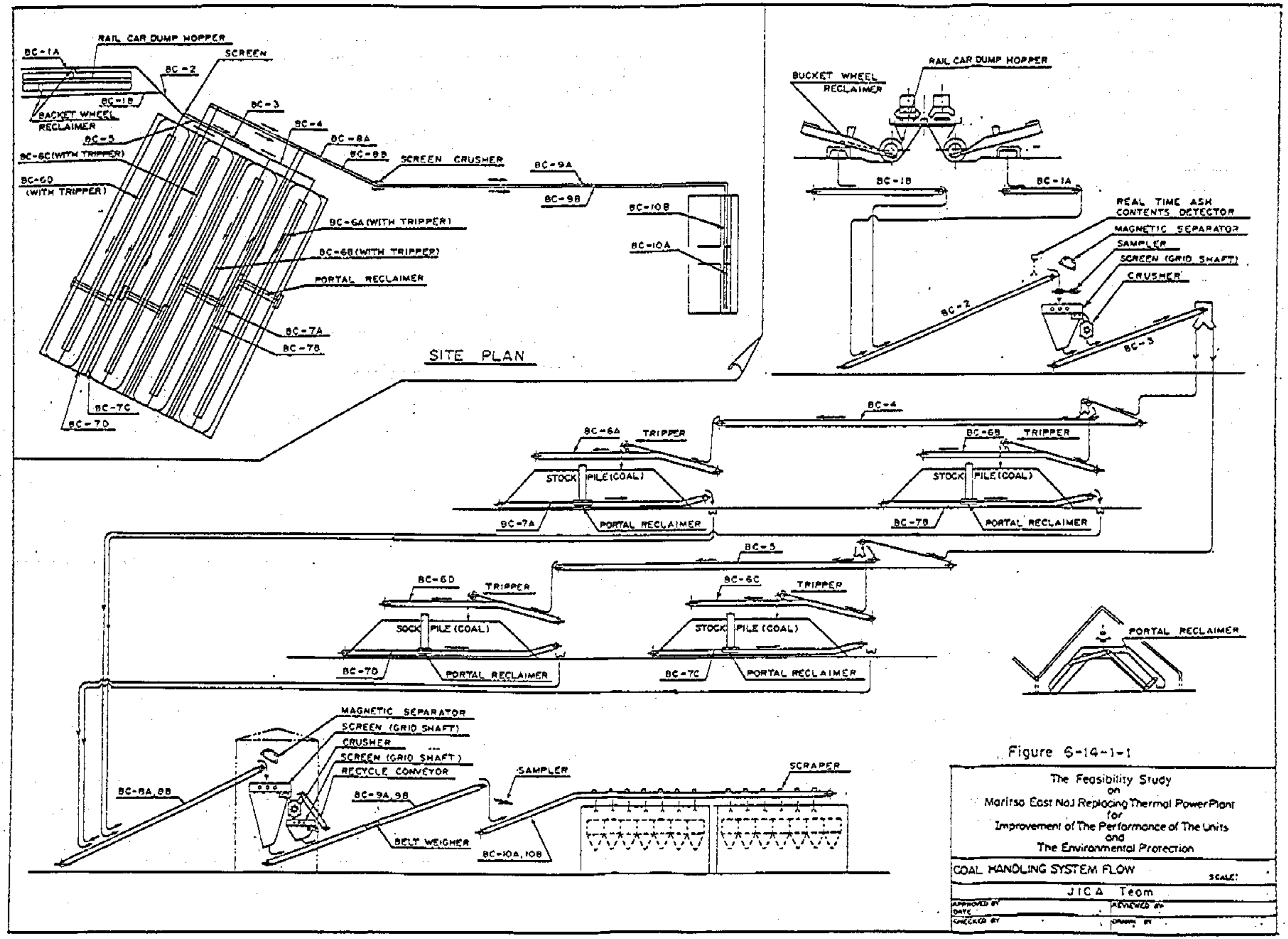


Figure 6-14-1-1

The Feasibility Study
on
Maritsa East No.3 Replacing Thermal Power Plant
for
Improvement of The Performance of The Units
and
The Environmental Protection

COAL HANDLING SYSTEM FLOW

SCALE:

JICA Team

APPROVED BY | REVIEWED BY
DATE
CHECKED BY | DRAWN BY

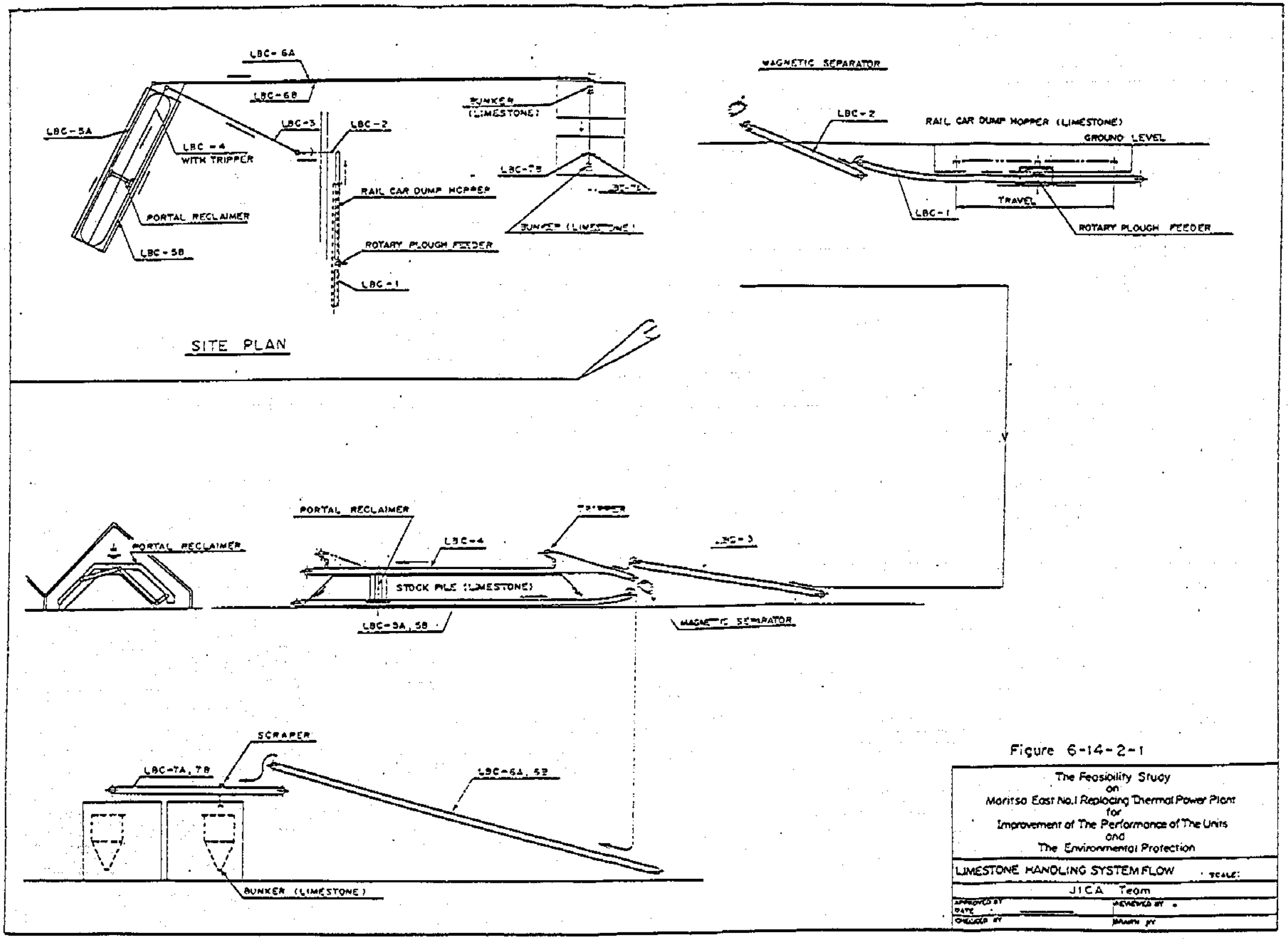


Figure 6-14-2-1

The Feasibility Study
on
Maritsa East No.1 Replacing Thermal Power Plant
for
Improvement of The Performance of The Units
and
The Environmental Protection

LIMESTONE HANDLING SYSTEM FLOW

SCALE:

JICA Team

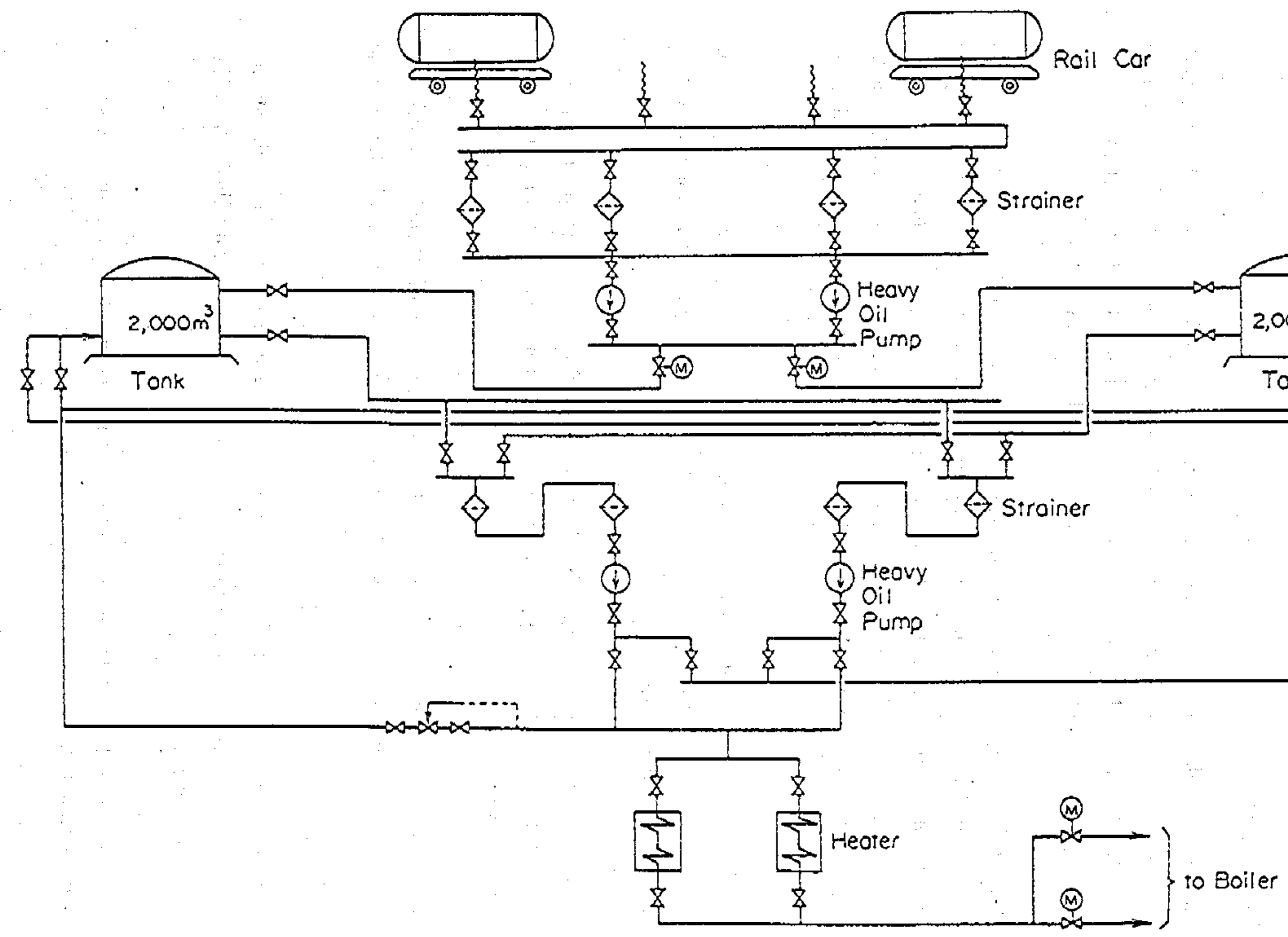


Figure 6-14-3-1 System of Heavy Oil Receiving and Discharging

6.15 Electrical & Control Equipment

6.15.1 Electrical Equipment

6.15.1.1 Power transformers

(1) Conditions for study

(a) In addition to the main transformer and station service transformer installed for each unit, one set of starting transformer (auxiliary transformer) is required as a transformer common to the power units. The starting transformer will be installed at the time of constructing unit R-1, and its appropriate capacity is considered to be roughly 40 MVA.

(b) The rated capacity of the main transformer should be equal to that of the generators. In case the station service transformer is faulty, the station service power should be supplied from the starting transformer to enable the generator output to be transmitted.
The rated capacity of the station service transformer should be determined according to the required station service load capacity, power factor, station service ratio and utilisation factor.

(c) A starting transformer will be shared by power units R-1 and R-2 to step down the voltage from the switchyard bus and supply power to the station service circuitry during the start-up and shutdown of the units.

During normal operation of the units, the starting transformer should supply power to the common loads in the power plant and be in standby for backup in case of trouble in the station service transformers.

Therefore, the maximum rated capacity of the starting transformer should be sufficient to supply power to the common loads in the power plant and station service load of a single power unit.

(d) Since the actual load is much smaller than the maximum rated capacity of the starting transformer, however, the rated capacity should be duplicated and the oil-filled self-cooling type be adopted for it.

The rated capacity of the starting transformer should be enough for time-differential start-up of two power units.

(e) Protective relay

In order that a trouble in transformer due to malfunction or operation failure of the protective relay does not progress to any serious trouble, it is recommended to duplicate the ratio (percentage) differential relays and its current transformers (CT) in the case of 220 kV or higher voltage transformers.

(2) Design of disaster preventive countermeasures of transformers

The basic requirements for design of countermeasures for protecting the oil-filled transformers of power plant (e.g. main, starting, station service, local and other transformers) against disaster are as described below:

(a) Basic policy of design

Any oil leak should be limited to as small a range as possible, and by no means such leak oil be flown out to any river or other areas outside the compound of power plant. Should any fire accident occur, the damage shall be limited to the relevant transformer, and spread of fire to any other adjacent transformer or building be avoided.

(b) Oil leak countermeasures

① To prevent dispersion of oil during operation of the pressure relief device of a transformer, an oil drain pipe shall be arranged up to roughly 30 cm above the surface gravel level and not above the transformer foundation.

② Around any transformer, gravel shall be laid with a depth of roughly 30 cm to absorb leak oil.

③ In the case of transformer containing a large amount of oil such as the main transformer, oil dike shall be provided around the transformer to prevent flow-out of oil to the surrounding area. At the same time, an underground tank for collecting leak oil shall be installed to collect oil inside the oil dike.

④ The height of oil dike shall be 0.5 m or over. However, a part of the dike, for example the front part shall be made a little lower so as to limit the position of overflow.
The oil dike shall be installed as apart as possible from the transformer body, and its capacity be not smaller than 50% of the amount of transformer oil.

⑤ One underground oil drain tank shall be used commonly for two or more transformers. In principle, the tank capacity shall be not smaller than 100% of the oil capacity of the largest-capacity transformer. A water discharge pump of manually operated type shall be provided for the underground tank.

⑥ The water from the water discharge pump shall be fed to an oil separator tank.

(c) Fire-protection wall

In case more than one transformer is arranged adjacent to each other, a concrete wall for fire protection shall be provided between the transformers.

The position and height of the fire-protection wall shall be determined as per the design criteria of ENG so as to prevent spread of fire to any adjacent transformer.

(d) Fire extinguishing equipment

① Around any 220 kV or higher voltage transformer, a water spray fire extinguisher and an auxiliary hydrant shall be provided.

The water spray fire extinguisher shall cover the upper surface of transformer including its cooler, and the water spraying flow be not smaller than 8 - 10 litres per square metres per minute.

The extinguisher shall be capable of both remote direct operation and local manual operation.

② Around any 110 kV or lower voltage transformer, a hydrant and a portable dry chemical fire extinguisher shall be provided.

(e) Manhole within oil dike

Any manhole and so forth shall not be arranged within any oil dike.
Should it be inevitable to arrange a manhole, a countermeasure shall be taken to prevent entry of any leak oil into the manhole.

(3) Results of study

(a) Main transformer specifications

Type	:	Outdoor service, 3-phase, forced oil air cooling type
Capacity	:	275 MVA
Primary voltage	:	14.7 kV

Secondary voltage	:	220 kV
Connection system	:	Delta-star

(b) Station service transformer specifications

Type	:	Outdoor service, 3-phase, oil-filled air cooling type
Capacity	:	35 MVA
Primary voltage	:	14.7 kV
Secondary voltage	:	6.9 kV
Connection system	:	Delta-Delta

(c) Starting transformer specifications

Type	:	Outdoor service, 3-phase, oil-filled air cooling or self-cooling type
Capacity	:	40 MVA
Primary voltage	:	220 kV
Secondary voltage	:	6.9 kV
Connection system	:	Delta-Delta

(d) Excitation power transformer specifications

Type	:	Outdoor service, 3-phase, oil-filled self-cooling type
Capacity	:	Approx. 1.8 MVA
Primary voltage	:	14.7 kV
Secondary voltage	:	770 V
Connection system	:	Delta-Delta, with

6.15.1.2 Plant power circuit configurations

(1) Station service circuitry

(a) The station service circuitry adopts a unit system configuration which has been proven to be high in reliability.

At the time of the unit start-up, this circuitry receives power from the starting transformer connected to the switchyard bus, and after the generator has been synchronised to power system, it supplies station service power from the station service transformer connected to the generator circuit.

(b) The values of the station service circuit voltage of the ME-1 Power Plant shall be as follows:

High voltage circuit	:	6 kV
Low voltage circuit	:	400 V, 220 V, 110 V, and 110V and 220 V DC

The short-circuit capacity of the station service circuitry will be determined after detailed design based on the impedance of the starting and station service transformers, taking into account voltage drop and contribution of generator.

The load distribution of the station service circuitry will be determined at the time of detailed design based on the load capacity.

(c) The station service power equipment includes the high-voltage metallic clad switching gear, which is the switching equipment for the high-voltage circuitry (6 kV, 4 kV and 3 kV) composed of two groups; the common group supplying the common power for the power plant buildings and power for the common auxiliaries for all of the power generating equipment, and the station service group supplying power for the required auxiliaries for operating the power generating equipment.

The loads are as listed in the following.

a) High-voltage motors with capacity of 200 kW or more.
b) Power transformer for low-voltage motors with capacity below 200 kW.

(d) Power from the high-voltage metallic clad switching gear is supplied through the power transformer to the low-voltage switch equipment. The low-voltage switch equipment is classified into the 440 V power centre which handles power for auxiliaries in the capacity class of 75 kW to 1200 kW and the 440 V control centre which handles lower-capacity power than the above.

(e) A low-voltage (200 V or 100 V class) power distributor board will be installed to supply power to other equipment than auxiliaries, such as the lighting equipment, control equipment and working equipment. This power distributor board incorporates non-fuse circuit breakers.

(f) To run the existing units 3 and 4, the 6 kV station service power bus should be provided with a power line which is connected to the starting transformer circuitry through a circuit-breaker.

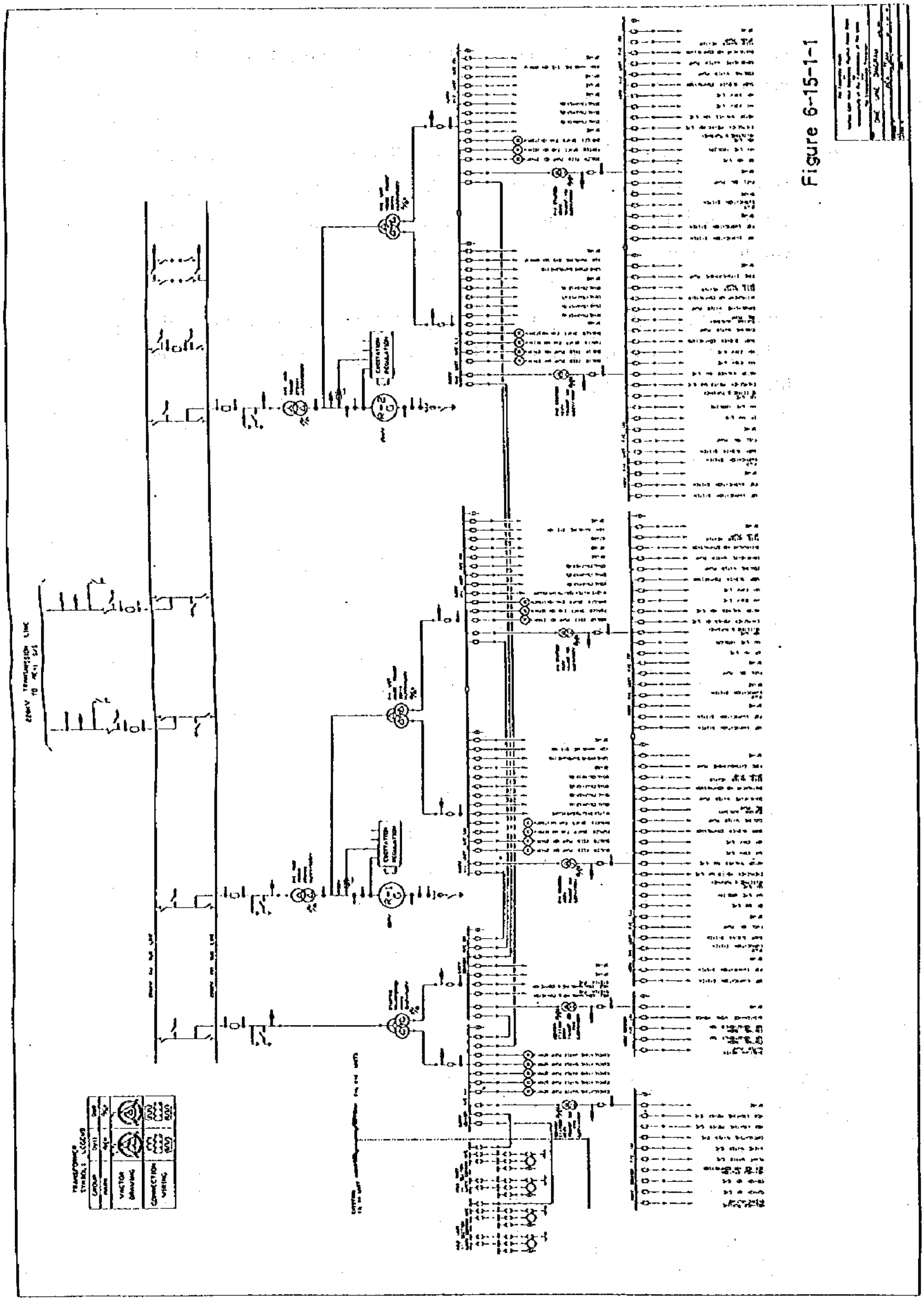


Figure 6-15-1-1

6.15.2 Control Equipment

The use of a distributed control system (DCS) is effective for solving the tasks as described in the following.

(1) Necessity of DCS

(a) Reflecting a world-wide trend to reduce the dependence of thermal power plant upon oil, most of the newly installed thermal power units have been designed for coal or LNG (Liquefied Natural Gas) burning.

(b) To make effective utilisation of limited fuel resources, it has been demanded increasingly to realise high efficiency operation of thermal power plant, particularly in countries where the fuel costs are high.

(c) As thermal power plants are the most important power source for the electric power industry of Bulgaria, it is essential for the industry to make utmost efforts not only for assuring the reliability of electric power supply but also for promoting rational arrangement of operation staff, measures for preservation of environment, rationalisation of power plant operation and so forth.

(d) One of the most important tasks in managing the service life of thermal power plant for a stable operation over a long period of time is to reduce the thermal stress in boilers and turbines. Therefore, monitoring of stress is one of the important items.

(e) Since the delay in the response of the fuel system including the coal feeders and crushers is one of important problems of coal-fuelled thermal power plants, the boilers and turbines are required to follow up quickly and stably the load demands with less thermal stress and less consumption of service life.

(f) High reliability required for the plant can be achieved by improving the reliability of control equipment, the ease of plant maintenance, the reliability inherent to the digital technology and the reliability of the control system by means of redundancy as well as by improving the plant operability by diagnosis of performance monitoring.

(g) Easy monitoring and operation of plant can been made possible as a result of expansion in the automated control range, realisation of sophisticated control, improvement of man/machine interface, high speed processing of a large volume of data and graphic display of operating conditions.

(h) When such situations surrounding thermal power plants are taken into consideration, the technical tasks required for plant control system are diversified and highly sophisticated.

(2) Functions of DCS

The trend of sophistication and diversification of digital technology is presented in Figure 6-15-2-1. Backed up by the rapid progress of computer-related technology, the functions for tabulation of daily report, supervision on CRT and automated, direct computer control, which correspond to the conventional functions for recording, monitoring and control, have been expanded in response to the needs for further sophistication of plant operations. Particularly, the following three items are new functions which have not been available with the conventional power-unit-based DCS systems:

① Operation control through CRT (CRT operation)
② Operations support through application of intelligent engineering technology
③ Long term storage, retrieval and effective utilisation of plant operation data

DCS shall be provided with higher technical performance pertaining to response speed, control accuracy, availability (not less than 99.9%) and MTBF (mean time between failure))not less than 30,000 hours), and able to function properly under the adverse and harsh conditions.

The capacity of processor's CPU (Central Processing Unit) shall be decided so that its load rate may be not more than 40%.

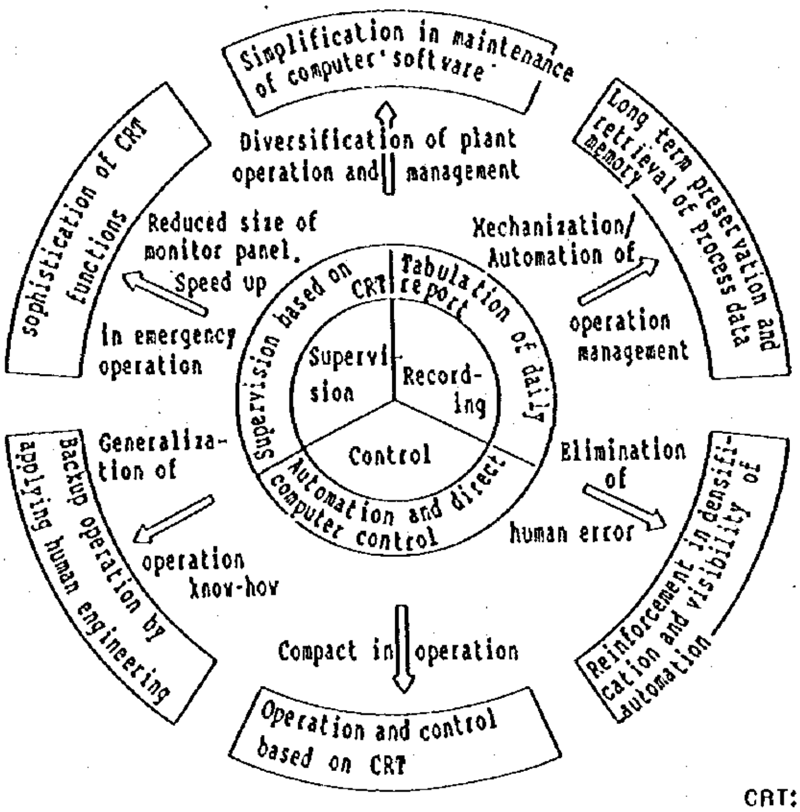
Frequency of information given to modulating processors and sequential processors shall be upgraded at least up to four (4) times per second and ten 810) times per second, respectively.

Maximum allowable duty cycle of processor module shall not exceed 250 milli-second (ms) at maximum loading to perform all assigned functions.

Modulating and sequence control loops demanding fast processing shall be capable of executing during the loop time of not more than 125 ms and 50 ms, respectively.

(3) Configuration of plant control system

Along with the progress of digital control technology, the reliability of plant and that of control system have been improved substantially at the same time. The digital technology has made it possible to realise a DCS (Distributed Control System) which controls the entire system by integrating the control functions distributed on a per-subsystem basis. The distributed control subsystems are connected through a network communication circuit and controlled as a single system. The system network (data highway) is duplicated, and the modules which are composed of microprocessors are also provided as duplicated systems.



CRT: Cathode Ray Tube

Figure 6-15-2-1 SOPHISTICATION OF THE ROLES AND EXPANSION IN APPLLCATION OF COMPUTER FOR THERMAL POWER PLANT

6.16 Switchyard and Substation

(1) Maritsa East No. 1 Thermal Power Plant, Switchyard

New equipment for the outdoor switchyard will be installed at the former outdoor equipment site of the Nos. 5 and 6 units.

The single line diagram plan is shown in Figure 6-16-1. The layout plan is shown in Figures 6-16-2 and 6-16-3.

(a) Regarding the circuit, considering the importance of this plan on the power system, a double bus circuit with high supply reliability will be used.

(b) The main transformer and starter transformer will be connected with a circuit breaker by connecting overhead lines.

(c) The bus will be of aluminum wire.

(d) As a result of discussion with NEK, gas circuit breaker will be used. There will be 3 breaker sets for the generator side, 2 sets for the line side and 1 set for the bus tie.
The ratings will be based on IEC standards. The rated voltage will be 245 kV, the rated current 1,250 A and the rated interrupting current 20 kA.

(e) Disconnecting switch will have earthing switch according to Bulgarian standard. The required amount is 6 sets for the generator side, 6 sets for the line side and 2 sets for the bus tie.

The ratings will be based on IEC standards. The rated voltage will be 245 kV and the rated current 1,250 A.

(f) In the case of the instrument transformers, 12 current transformers and 4 potential transformers will be used for measuring and to protect lines, buses and transformers. The specifications will be decided after the protection and control methods are studied.

(g) To protect the switchyard equipment, arresters will be installed in two places, at the line and the transformer.

(h) A pilot wire protection method will be used to protect the transmission line, with pilot wire newly installed between the power plant and substation.

(2) Maritsa East No. 1 Substation (Galabovo)

The existing outdoor equipment will be removed and outdoor equipment for R1 and R2 units will be newly installed at the site. Equipment between the line inlet and the 220 kV bus outlet will be removed.

The single line diagram plan is shown in Figure 6-16-4. Figure 6-16-5 shows the layout plan.

Principal specifications will be the same as Maritsa East No. 1 Thermal Power Plant, Switchyard

The required amount is 3 sets of circuit breakers, 11 sets of disconnecting switches, 6 current transformers, 2 potential transformers and 2 arresters on the line side.

(3) Transmission Line Facilities

(a) Outlines of Facilities

Figure 6-16-6 shows the power system diagram covering ME-1 TPP and its vicinities. Transmission lines route is indicated as Figure 6-16-7.

Until the shut-down of former Unit-5 and 6 , transmission lines comprised four routes with 6-circuit. All transmission lines are connected to the Galabovo Substation, situated approximately 5 km away from the power plant.

Of the four routes, three routes (transmission lines for former Unit-1 - 5) run directly from the power plant over Rozovkladentz Lake to the substation. The remaining route (transmission line for former Unit-6) passes along the right-hand side of the lake, as viewed from the power plant , to the substation.

The voltage of the transmission lines connecting Unit- 1 to 4 respectively is 110 kV, and the voltage of the transmission lines connecting to former Unit-5 and 6 respectively is 220 kV.

After the shut-down of former Unit-5 and 6 , a change was made at the outlet of the power plant and at the inlet of the Galabovo Substation to provide the current connections of the transmission lines as shown below:

* Unit-1 transmission line → Unit-1 transmission line is used.

* Unit-2 transmission line → Unit-3 transmission line is used.
* Unit-3 transmission line → Former Unit-5 transmission line is used.
* Unit-4 transmission line → Former Unit-6 transmission line is used.
* Unit-2 and Unit-4 transmission lines → Operation temporarily halted.

(b) Operation of Transmission Lines after Improvement

Transmission lines for former Unit-5 and Unit-6 will be reused. However, being about 35 years old and not at all well maintained, the operating conditions of transmission line facilities are unsatisfactory.

Concretely, there are some dirty insulators and ground wires are partially cut. Particularly, the foundations of several towers of the transmission lines for former Unit- 6 are very bad condition.

For this reason, detail survey of the foundations of towers and repair work as exchange of insulators and replacing of lines should be need.

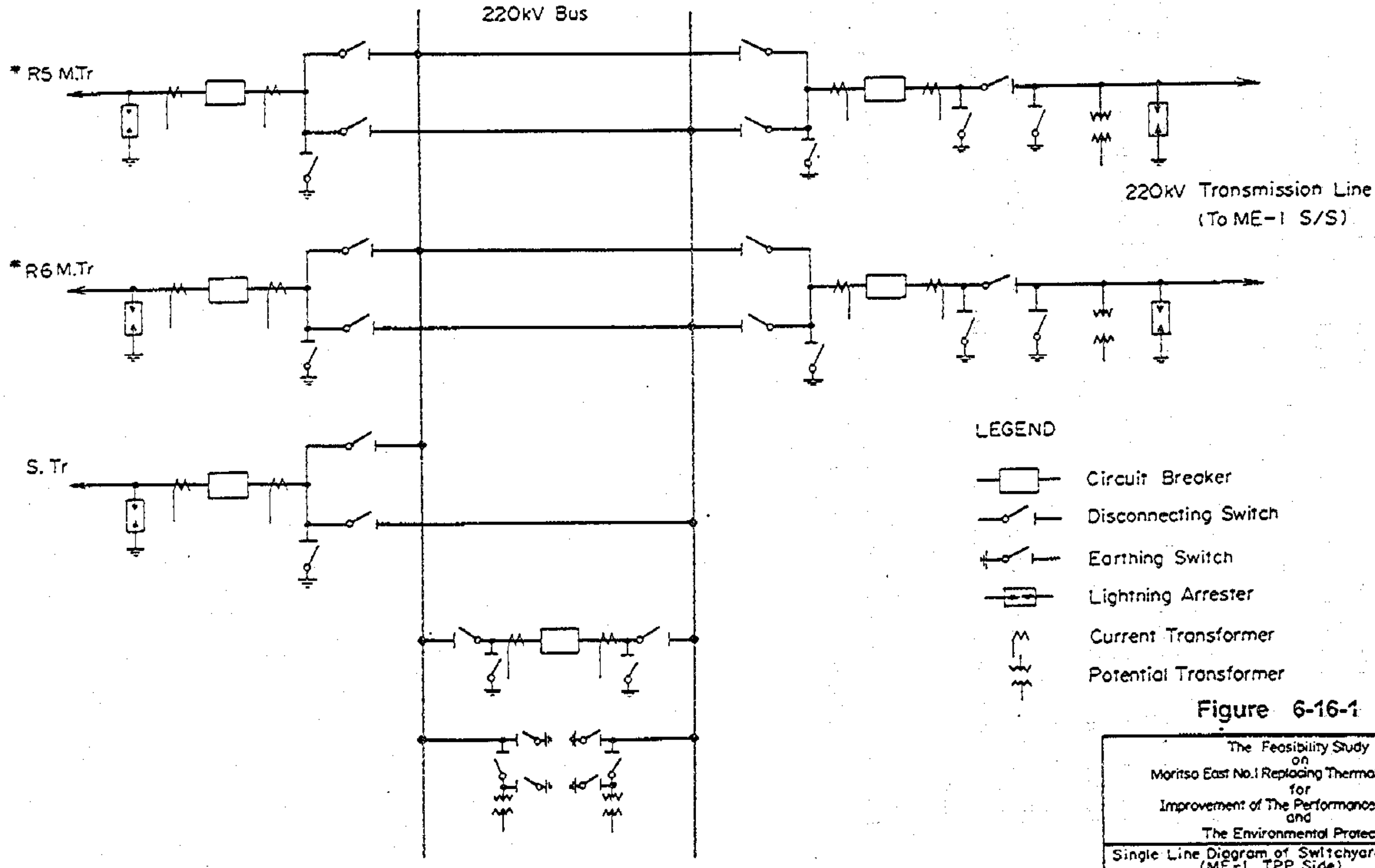


Figure 6-16-1

The Feasibility Study
on
Moritso East No.1 Replacing Thermal Power Plant
for
Improvement of The Performance of The Units
and
The Environmental Protection

Single Line Diagram of Switchyard
(ME-1 TPP Side)

SCALE:

JICA TEAM

APPROVED BY DATE	REVIEWED BY
CHECKED BY	DRAWN BY

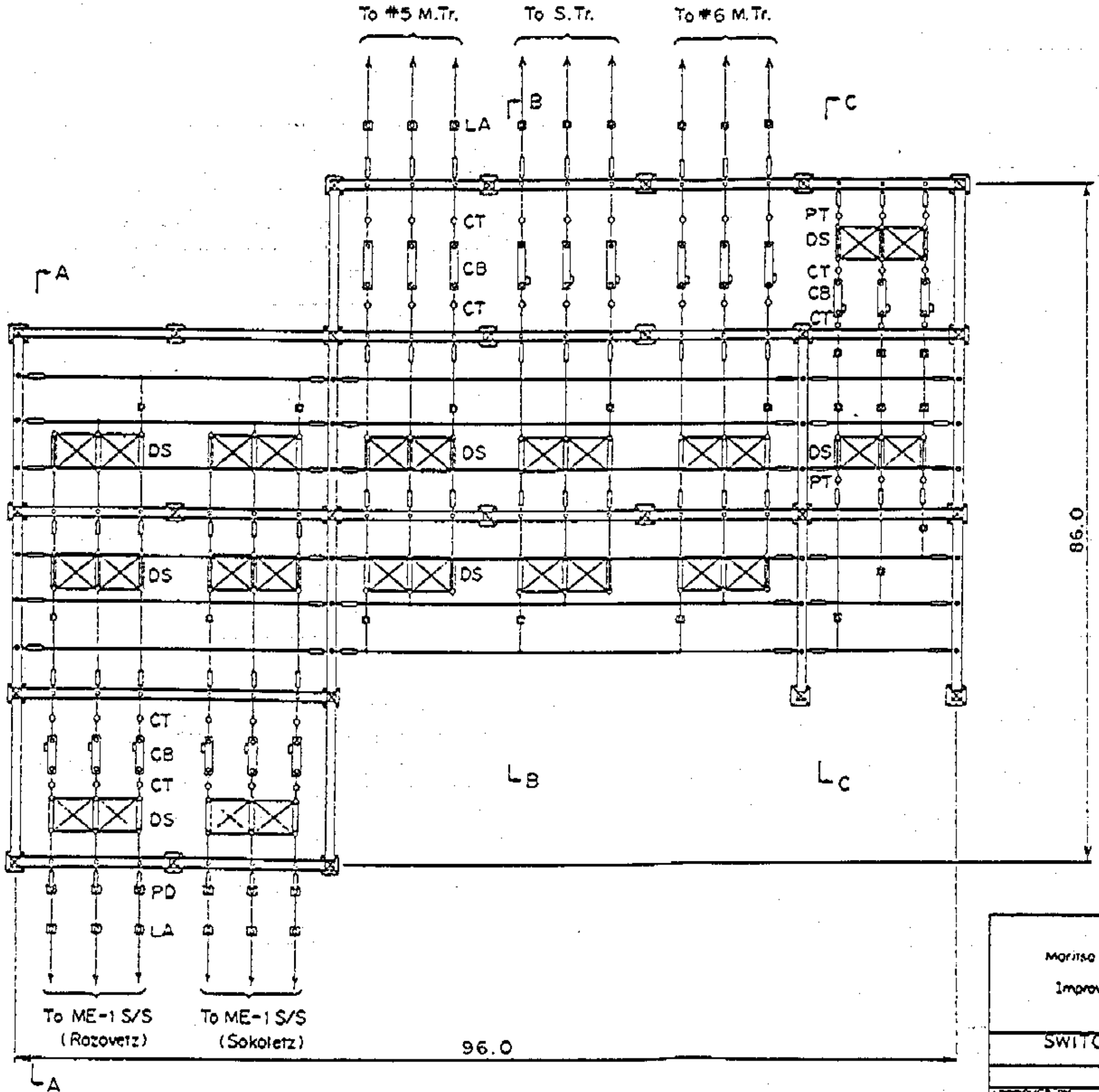


Figure 6-16-2

The Feasibility Study on Moritsa East No.1 Replacing Thermal Power Plant for Improvement of The Performance of The Units and The Environmental Protection	
SWITCHYARD PLAN (ME-1 TPP Side)	SCALE:
JICA TEAM	
APPROVED BY / DATE	REVIEWED BY
CHECKED BY	DRAWN BY

SECTION A-A

SECTION B-B

SECTION C-C

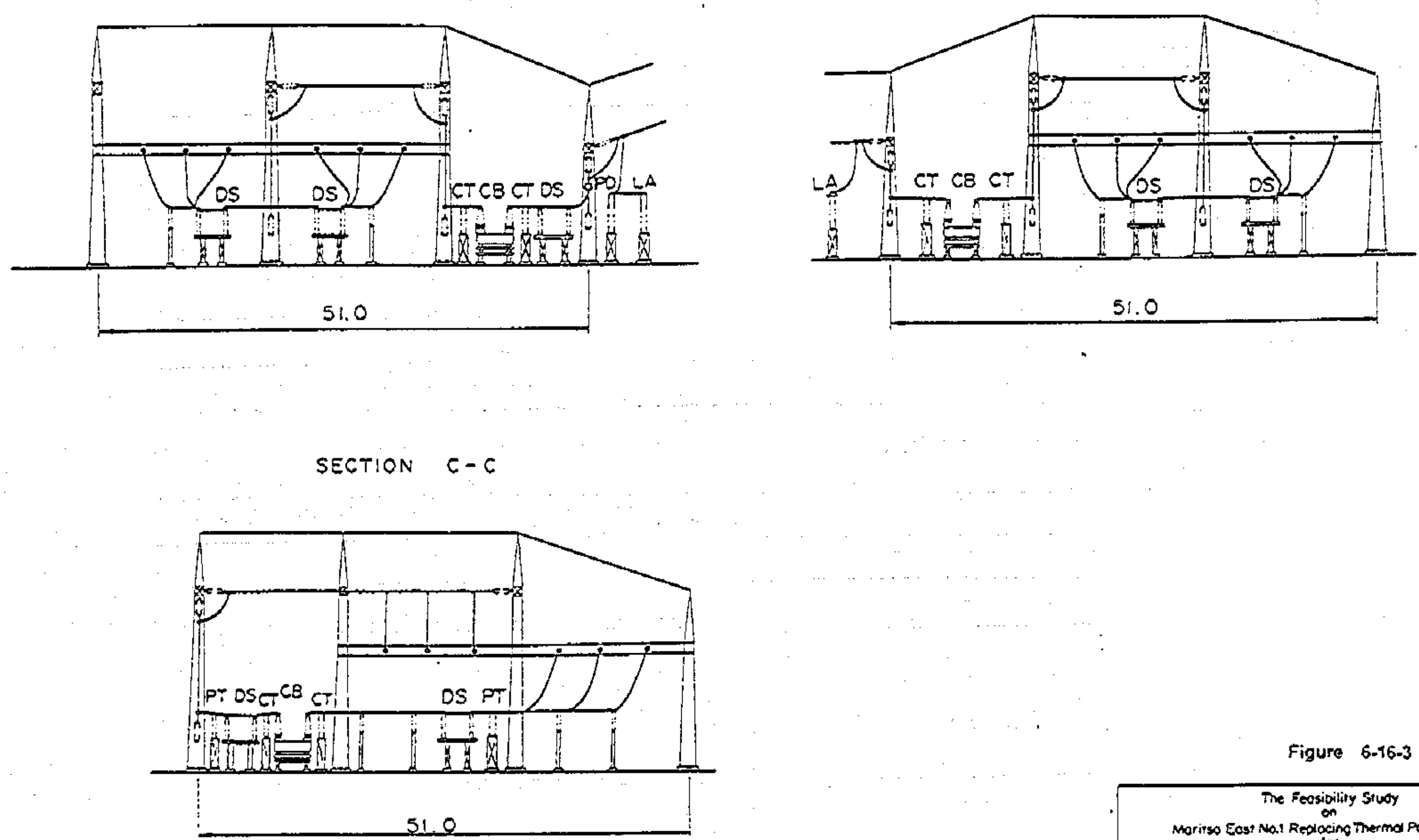


Figure 6-16-3

The Feasibility Study on Maritso East No.1 Replacing Thermal Power Plant for Improvement of The Performance of The Units and The Environmental Protection
SWITCHYARD SECTION (ME-1 TPP Side) SCALE:
JICA TEAM
APPROVED BY / DATE / CHECKED BY / REVIEWED BY / DRAWN BY

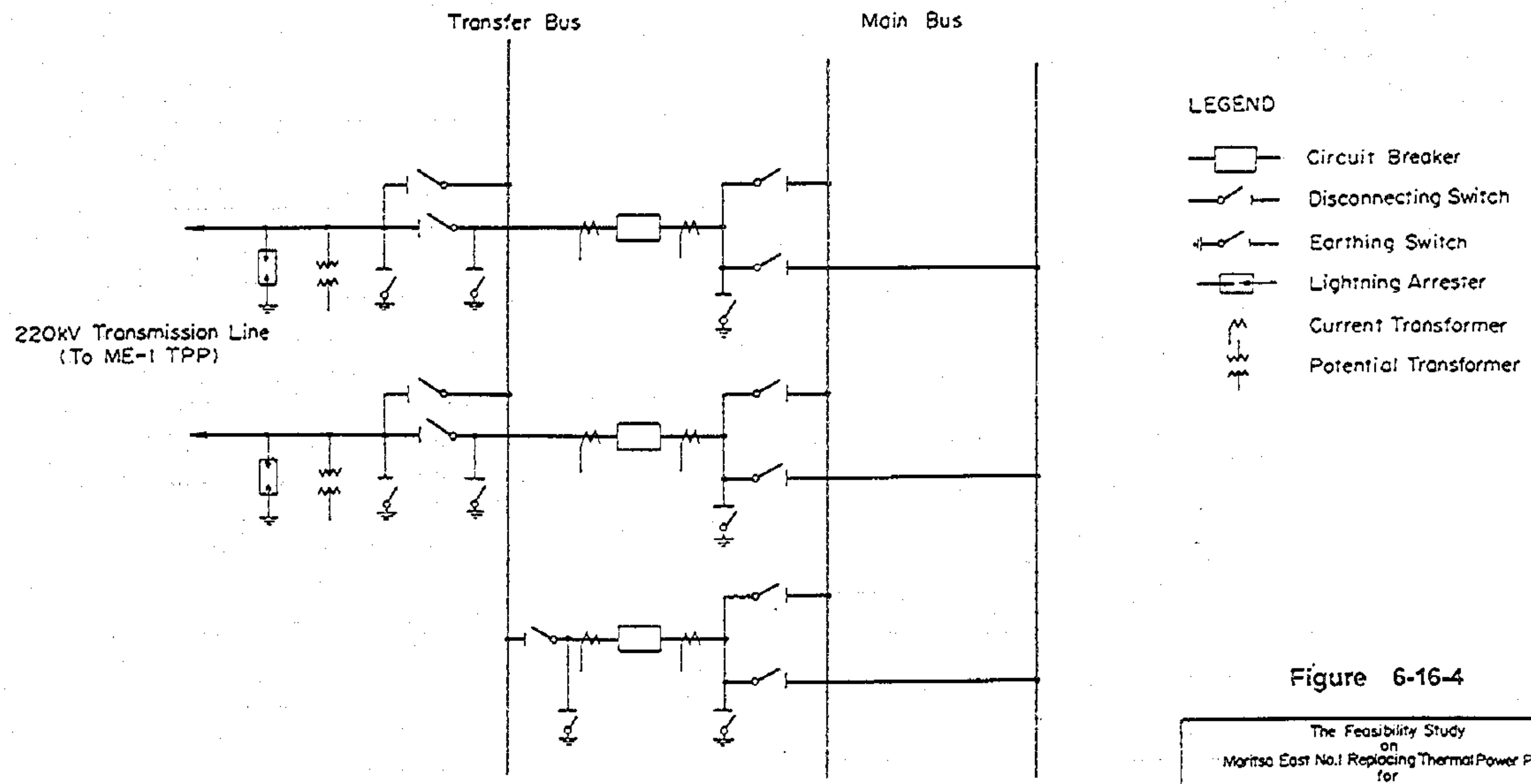


Figure 6-16-4

The Feasibility Study
on
Maritsa East No.1 Replacing Thermal Power Plant
for
Improvement of The Performance of The Units
and
The Environmental Protection

Single Line Diagram of Switchyard (ME-1 S/S Side)	SCALE:
JICA TEAM	
APPROVED BY / DATE	REVIEWED BY
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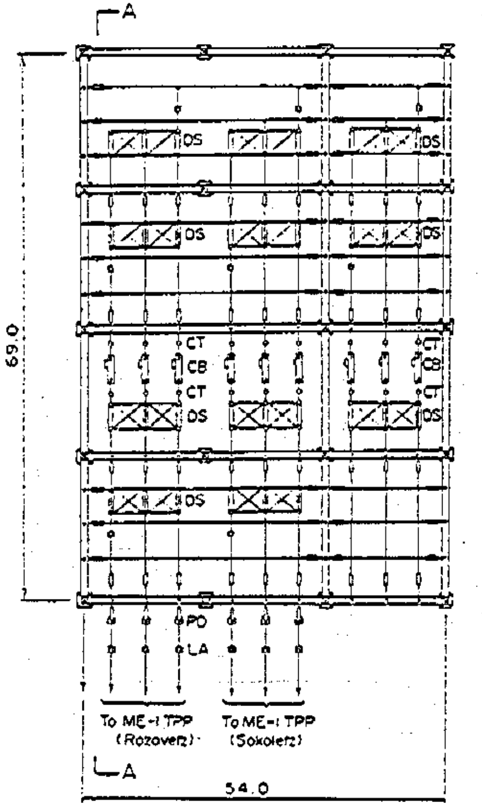


SECTION A-A

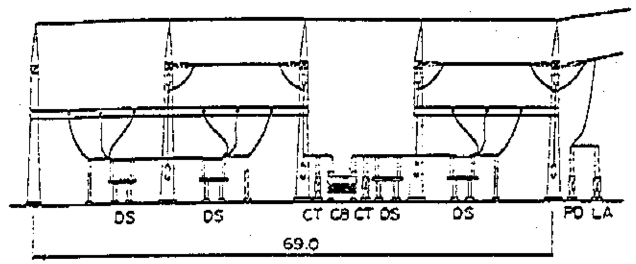


Figure 6-16-5

The Feasibility Study
on
Maritsa East No.1 Replacing Thermal Power Plant
for
Improvement of The Performance of the Units
and
The Environmental Protection

PLAN OF SWITCHYARD
(ME-1 S/S Side)

SCALE:

JICA TEAM

APPROVED BY
DATE
CHECKED BY
REVIEWED BY
DRAWN BY

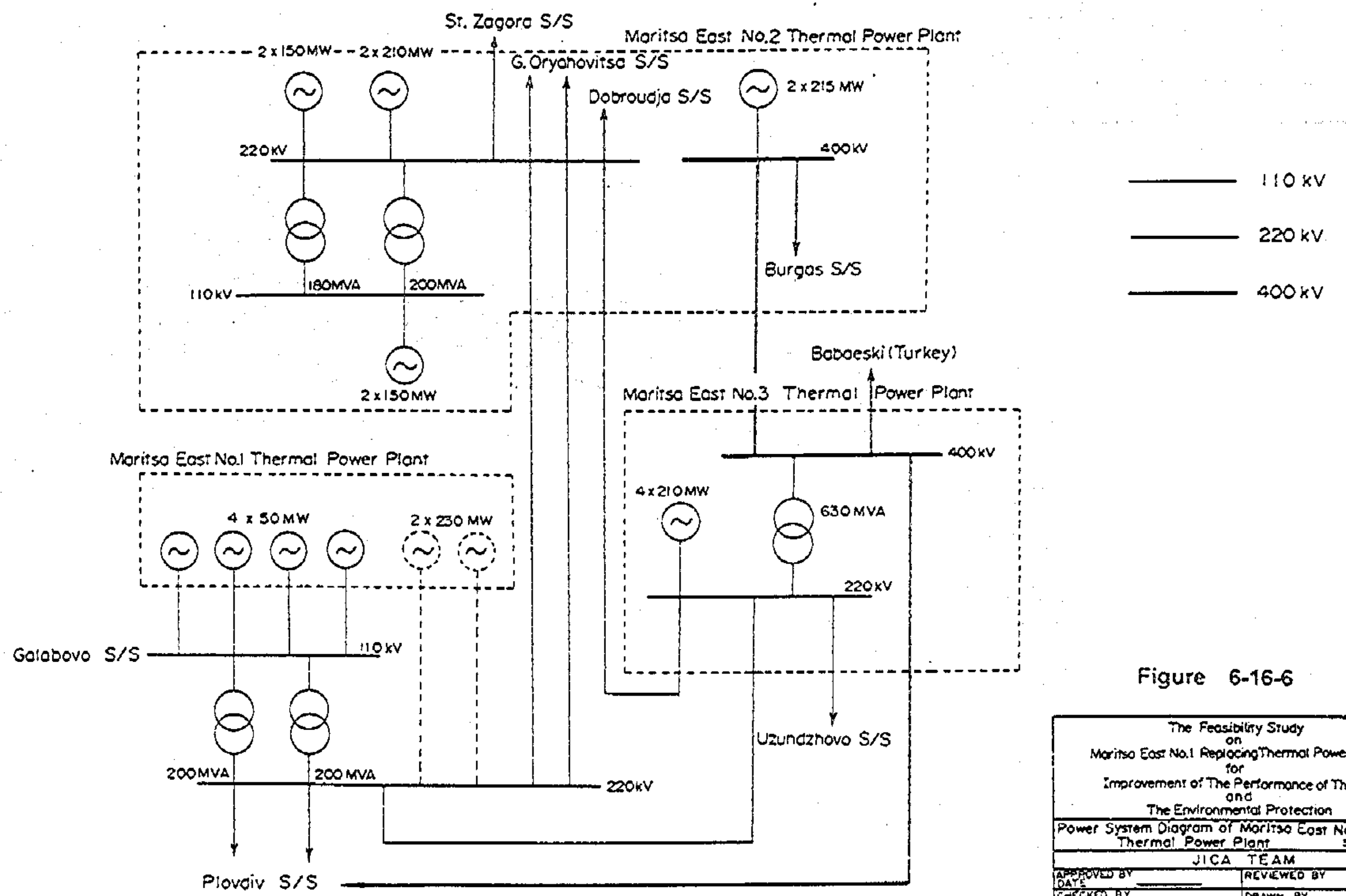


Figure 6-16-6

The Feasibility Study on Maritsa East No.1 Replacing Thermal Power Plant for Improvement of The Performance of The Units and The Environmental Protection	
Power System Diagram of Maritsa East No.1 Thermal Power Plant	SCALE:
JICA TEAM	
APPROVED BY DATE	REVIEWED BY
CHECKED BY	DRAWN BY

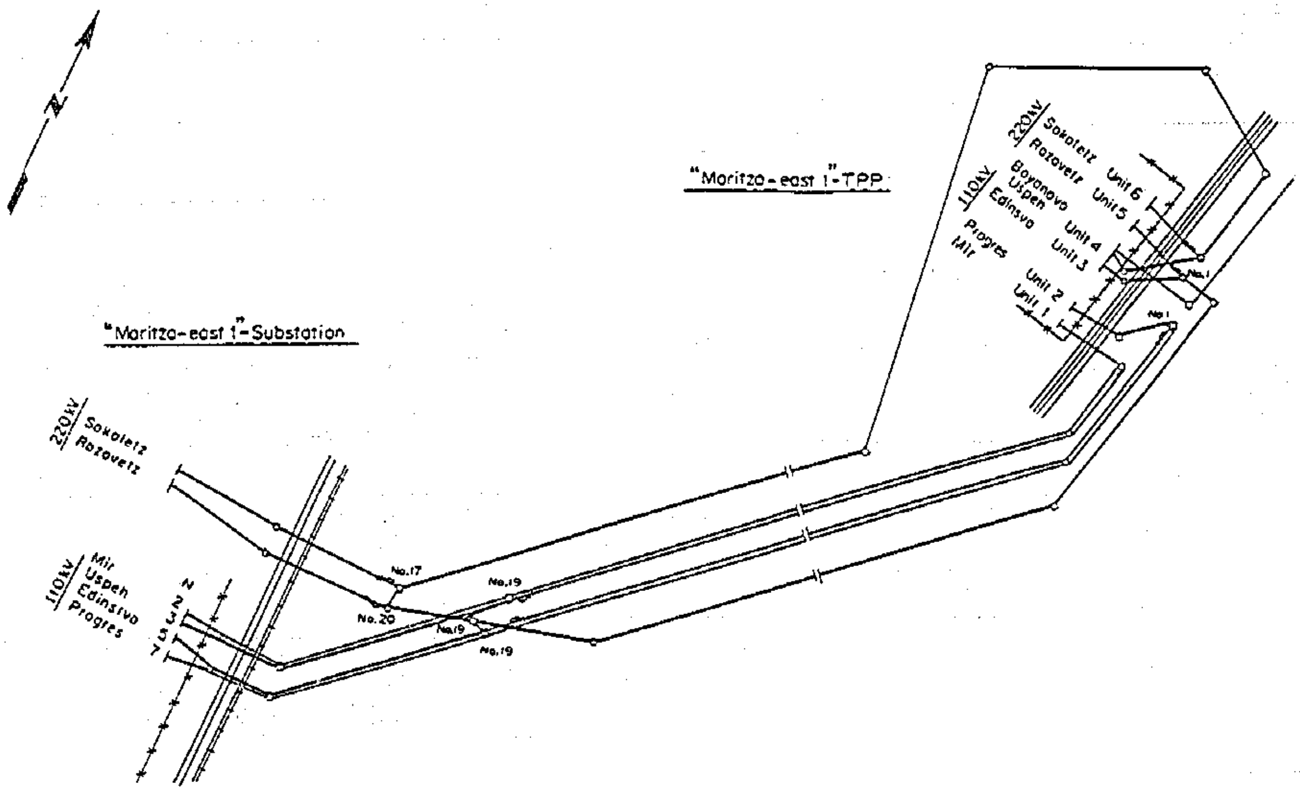


Figure 6-16-7

The Feasibility Study
on
Maritsa East No.1 Replacing Thermal Power Plant
for
Improvement of The Performance of the Units
and
The Environmental Protection

TRANSMISSION LINES ROUTE OF ME-1 TPP — SCALE:
JICA TEAM.
APPROVED BY — REVIEWED BY
DATE
CHECKED BY — DRAWN BY

6.17 Buildings and Stack

6.17.1 Buildings

(1) Check Conditions

The conditions of equipment arrangement plan and so on were checked in order that the volume, shape and structure of the buildings could be determined.

(2) Results of Check

- The scale and the structure of all buildings are shown in Table 6-17-1.
- The drawings of the turbine hall and boiler house are shown in Figure 6-17-1 to 6-17-4.
- The substructure of heavy load buildings is planned to have a direct supporting system on hard silt layer located at a 10m depth below ground level. The substructure of light load buildings is planned to have a direct supporting system on the upper sand layer of which the N value is about 15.
- The seismic load Q is calculated from the following equation.
  Q = (0.081 to 0.142) x W (W : Weight of building)

6.17.2 Stack

(1) Check Conditions

The exhaust gas conditions were checked in order to determine the shape of the stack.

(2) Results of Check

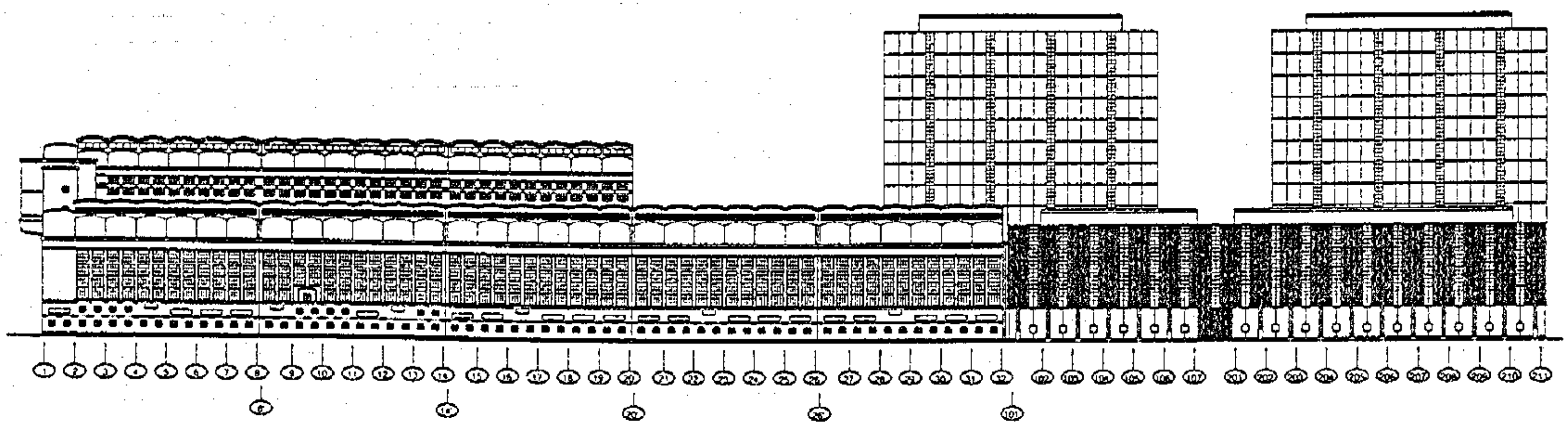
- The shape of the stack for C-FBC boiler type is the most economical one.
- Two inner flues are provided, and the outer shell of reinforced concrete bears the outer force.
- The substructure is a direct supporting system on hard silt located at a 10m depth below ground level as seen from the results of soil investigation.
- Typical drawings of the stack are shown in Figure 6-17-5.

(3) Recommendations and Caution Items

- Substructure should be determined by execution of soil investigation directly under the stack.

Table 6-17-1 List of Buildings (including the list of foundations)

	Names	No.	St.*)	Width	Length	Height	Remarks
I. List of Buildings							*):Structure
1	Turbine hall	1	S	50.2	154.2	26.8	Including deacrator
2	Boiler house	2	S	66.0	57.0	70.0	Including bunker and heater
3	Central control building	1	S	24.5	43.9	17.5	Two stories
4	Coal storage house	1	S	260.0	355.0	38.0	
5	Limestone storage house	1	S	53.0	355.0	32.0	
6	Tripper house	1	S	5.0	280.0	13.0	
7	Ash treatment control house	1	RC	21.0	26.0	12.0	Two stories
8	Coal and ash handling control house	1	RC	20.0	20.0	12.0	Two stories
9	Water treatment house	1	S	29.0	39.0	13.0	Two stories
10	Waste water treatment house	1	RC	20.0	30.0	13.0	Two stories
11	Hydrogen generation house	1	RC	4.0	6.0	5.0	Roof is of steel structure
II. List of Foundations							
1	EP foundation	2		34.0	23.0	t=1.2	
2	Transformer found.(R1)	1		10.0	30.0	t=2.0	Main, auxiliary and starting
	Transformer found.(R2)	1		10.0	20.0	t=2.0	Main and auxiliary
3	Exhaust gas duct found.	18		5.0	1.6	t=1.0	L=90m @5m
4	FDF foundation	4		5.5	10.0	t=1.5	
5	IDF foundation	4		5.5	10.0	t=1.5	
6	Ash Storage Silo foundation	1		19.0	37.0	35.3	RC frame (2 stories)
7	Ash Transit Tank foundation	1		19.0	37.0	29.3	RC frame (2 stories)
8	Ash Loading Silo foundation	1		19.0	37.0	32.3	RC frame (2 stories)
9	Conveyer found. (Coal)	125		4.8	1.8	t=1.0	L=1250m @10m
	Conveyer found. (Limestone)	30		4.8	1.8	t=1.0	L=300m @10m (240m is the existing underground tunnel)
10	Pipe Rack foundation (Ash)	120		4.8	1.8	t=1.0	L=1200m @10m
11	Water treatment found.	1					LS
12	Waste water treatment found.	1					LS



ELEVATION WITH THE EXISTING HALL 1:500

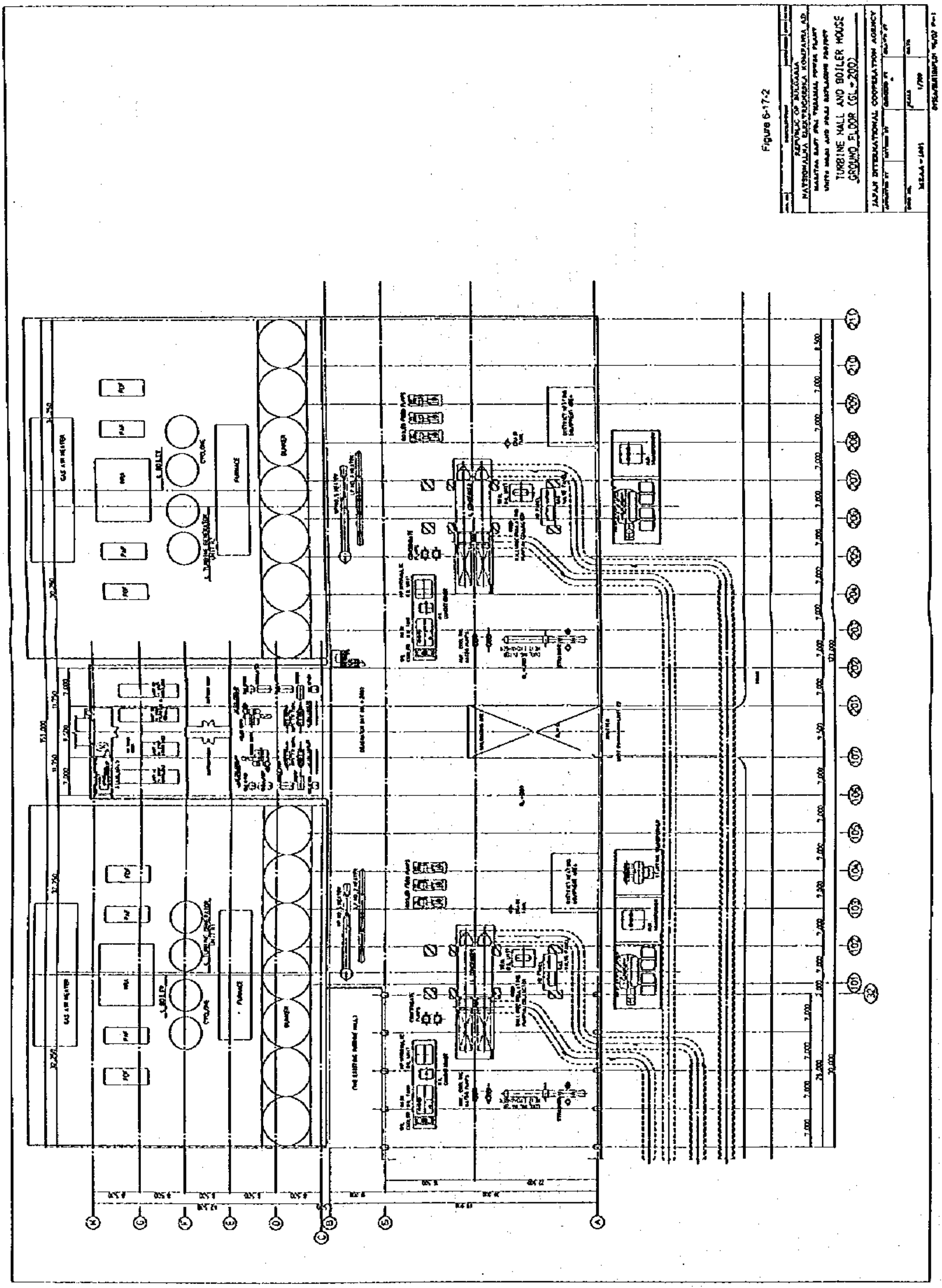
Figure 6-17-1

REPUBLIC OF BULGARIA
NATSIONALNA ELEKTRICHESKA KOMPANIA AD

MARITSA EAST NO.1 THERMAL POWER PLANT

ELEVATION WITH THE EXISTING HALL

JAPAN INTERNATIONAL COOPERATION AGENCY



REPUBLIC OF BULGARIA
TURBINE HALL AND BOILER HOUSE
GROUND FLOOR (GL+200)
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 6-17-2

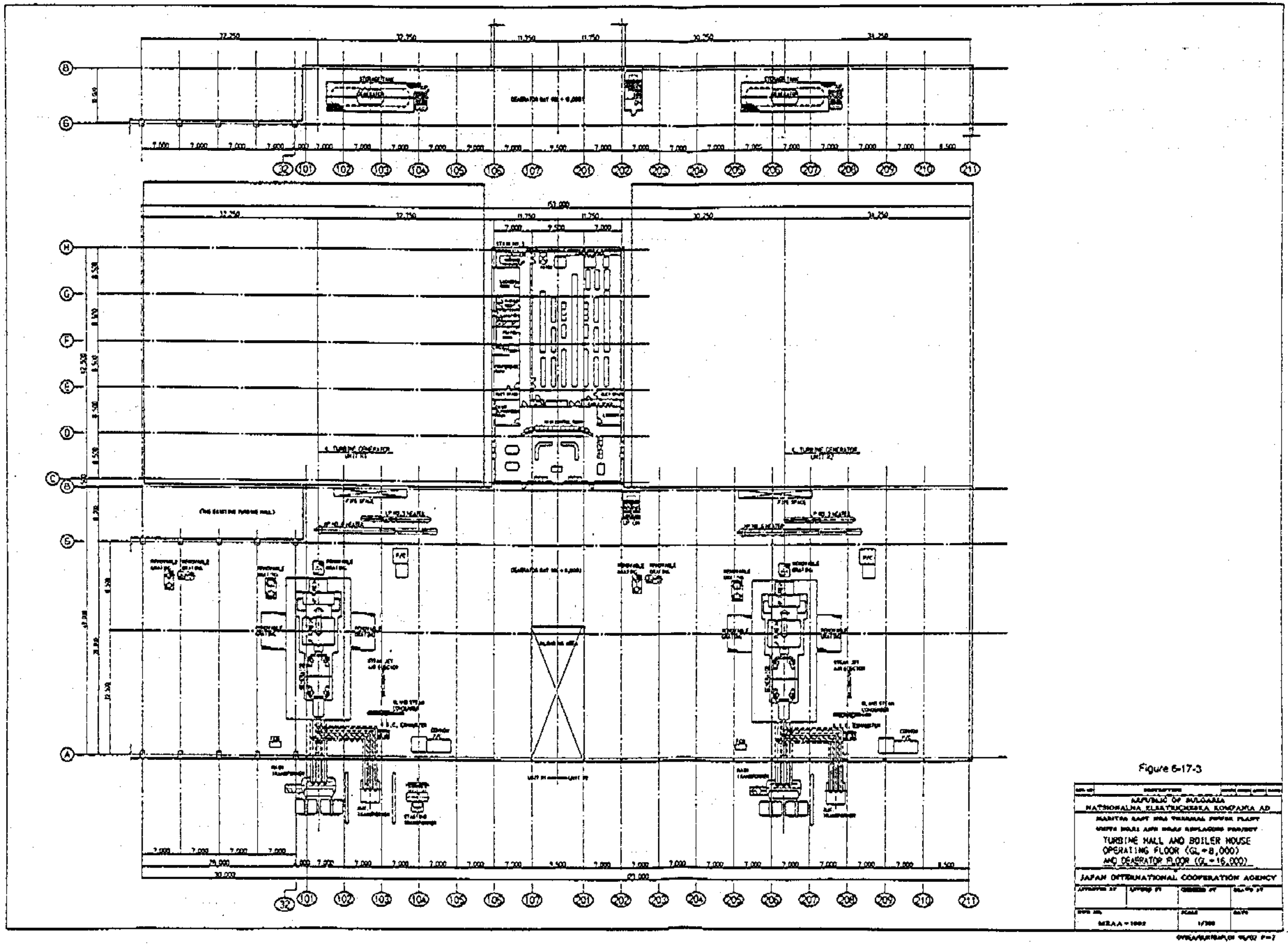
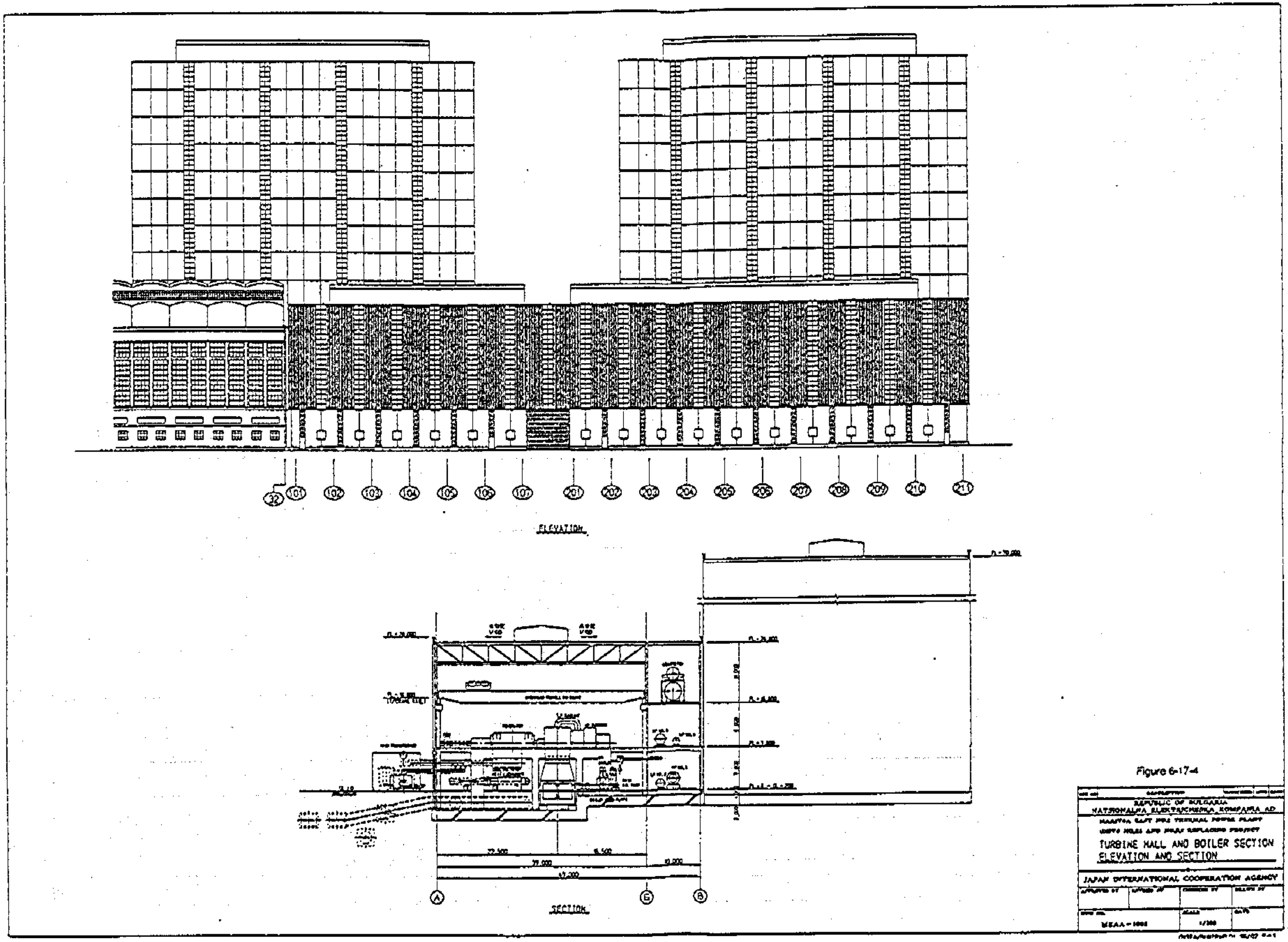

REPUBLIC OF BULGARIA
NATSIONALNA ELEKTRICHESKA KOMPANIA AD
JAPAN INTERNATIONAL COOPERATION AGENCY
TURBINE HALL AND BOILER HOUSE
OPERATING FLOOR (GL +8,000)
AND DEAERATOR FLOOR (GL +16,000)

Figure 6-17-3


ELEVATION
SECTION
REPUBLIC OF BULGARIA
TURBINE HALL AND BOILER SECTION
ELEVATION AND SECTION
JAPAN INTERNATIONAL COOPERATION AGENCY
Figure 6-17-4

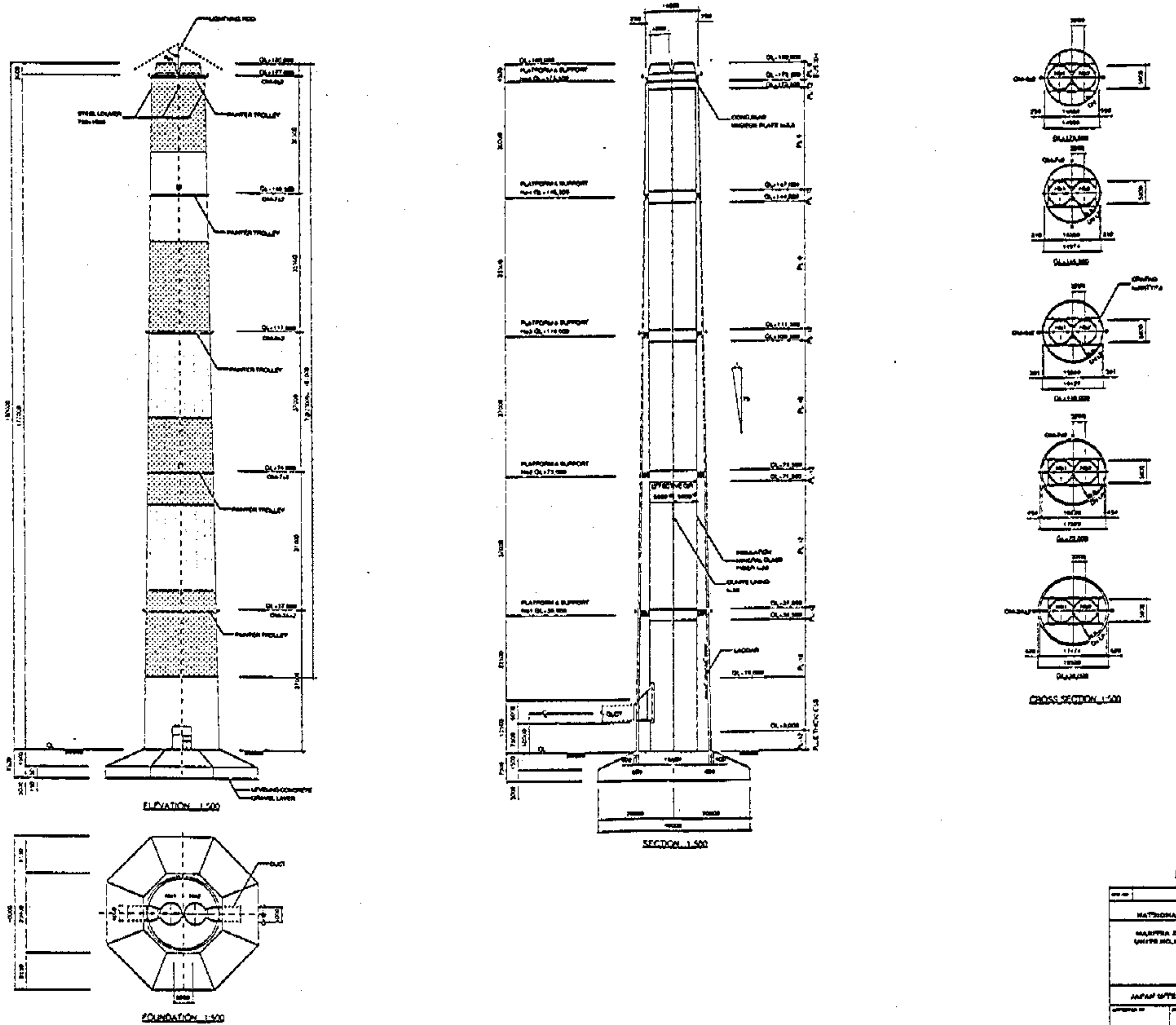


Figure 6-17-5

REPUBLIC OF BULGARIA

NEW STACK H=180

CHAPTER 7. PLANNING OF PROJECT IMPLEMENTATION

CHAPTER 7 PLANNING OF PROJECT IMPLEMENTATION

7.1 Contract Formation

7.1.1 Principle Concept of Contract Formation

It is of vital importance to establish its contract formation and organization in project implementation in advance clearly, and clear policy of a project formation and understanding of it at the stage of project planning enables subsequent planning to proceed smoothly.

In project implementation, there will be two parties; one is a owner, the other is a contractor who supplys equipment, devices, materials or systems to satisfy functions or performance required by the owner, within the required time period and then receives payment for them.
A contract will be settled between the above two parties, in other words they are in a position to confront with each other through (a) contract document(s).

Accordingly, it is not allowed for a party who is in a position of a contractor to play a role of a owner or to be replaced to a owner's position, even though partly.

However, in case a owner is lacking in sufficient number of personnel within his organization or does not have sufficient experiences in the fields of the associated technology or financing etc., he can employ a consultant from outside to make up for these deficiencies.

In most of cases, when NEK implements a large scale project, a PIU (Project Implementation Unit), a kind of task force, is established within NEK and executes a function of project management on behalf of NEK.

7.1.2 Contract Dividing

(1) There are two typical kinds of contract dividing; one is to assign a complete power plant contract to a single organization (a single enterprise or joint venture) as a whole, which is called a full turn key contract and the other is to divide a complete power plant into plural contracts, which is called a separate contract.

(2) In the former contract, since all responsibilities consist in a single organization, it is only one contractor that a owner has to control and expedite. This formation is ,therefore, very convenient to the owner.

However, there is no single organization in the world who can make every necessary equipment which is of the first class and cheap.

Accordingly, it is not necessarily expected to obtain excellent and cheap equipment or to introduce newly developed technology and a contract price also is marked up.

(3) In the latter contract, there are involved many organizations which have to assume responsibilities, therefore, a owner has to control every contractor efficiently and to spend a lot of energy for technical interfacing and job coordination among contractors concerned.

Naturally, a owner have to hold managerial and technical capability required for these tasks.

In turn, a owner can select and purchase excellent equipment with cheaper price from around the world.

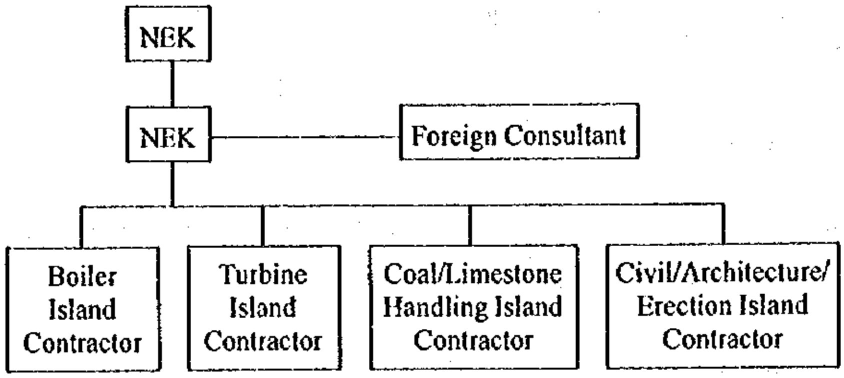
(4) Taking organically and integrally into consideration the nature of a project, required conditions, situation of the country, a owner's capability and experience, project budget, construction period and so forth, it is recommended that a total project job to be divided into the following four (4) islands.

(a) Boiler island
(b) Turbine island
(c) Coal/limestone handling island
(d) Civil/architecture/erection island

Islands (a) through (c) covers supply of the relevant equipment and dispatch of erection commissioning supervisor(s), and island (d) includes for all civil, architectural and erection works required for islands (a) through (c).

As for scope of consultancy services, in principle it covers engineering services and managerial/commercial services (assistance) in finance arrangement, tendering, evaluation, contract negotiation, project implementation and so forth.

The above contract formation can be shown illustratively as follows.



7.1.3 An Outline of Duty and Scope of Supply of Each Island

An outline of duty and scope of supply of each island is as follows.

(1) Boiler island

Boiler and the associated auxiliary, instrumentation and control equipment, boiler steel structure, ash handling equipment up to ash disposal yard, and technical interfacing/job coordination with other islands regarding instrumentation and control.

(2) Turbine island

Turbine/generator and the associated auxiliary, district heating facility, instrumentation and control equipment, district heating facility, electrical equipment, emergency diesel generator, water treatment equipment, waste water treatment equipment, substations, transmission line (limited)

(3) Coal/limestone handling island

Railway siding, coal wagon unloading facility, stacker, reclaimer, crusher, belt conveyor, and other handling facility

(4) Civil/architecture/erection island

All civil, architectural and erection works related to the above three islands and other civil, architectural and erection works and not directly related to the above three islands but directly related to the replacing project within the premises of the power station, if any.

Unloading of equipment and materials (delivered to the site) from transportation vehicles.

Demolishing works of the existing facility and subsequent land levelling works to be excluded.

7.2 Project Schedule

The following matters are taken into consideration as critical points in planning the construction schedule.

(1) Procurement of funds
(2) Selection of a consultant
(3) Basic/definite design and preparation of tender documents
(4) Time period required from tendering to contract award
(5) Civil design based upon loading data from mechanical design
(6) Check and approval procedure of drawings submitted by Contractors
(7) Construction and safety management
(8) Time period required for unit trial operation, and adjustment of system/equipment

The above mentioned items (1) and (2) are largely dependent upon NEK's effective promotion. To implement items (3)-(8), a competent and well-experienced consultant should be employed.

The construction schedule is prepared as shown in Figure 7-2-1, referring to the construction experiences gained on coal-fired power plant projects of a similar scale constructed in foreign countries. (See Figures 7-2-2 and 7-2-3.)

(1)	Completion of F/S	End of August, 1996
(2)	Fixing up of financial source (about 6 months - 1 year)	End of June, 1997
(3)	Selection of consultant	Beginning of January, 1997
(4)	Completion of basic/definite design and tender-documents	End of August, 1997
(5)	Completion of tender evaluation and contract award	
	· Civil/Architecture/Erection Island	Beginning of April, 1998
	· Boiler, Turbine and C/H Islands	Beginning of June, 1998
(6)	Commencement of civil work	Beginning of April, 1998
(7)	Boiler steel erection	Beginning of August, 1999
(8)	Boiler hydro-static test	Beginning of September, 2000
(9)	Power receiving and commencement of trial operation	Beginning of December, 2000
(10)	Initial firing	Beginning of April, 2001
(11)	Synchronizing	Beginning of July, 2001
(12)	Commencement of commercial operation (unit R1)	Beginning of October, 2001

A schedule for unit R2 will follow unit R1 6 months behind.

Construction schedule is shown in Fig. 2. This schedule has been prepared taking into consideration such conditions as shown below.

(1) In view of the balance of electricity demand/supply in Bulgaria, commercial operation shall be scheduled to commence as early as possible, say, in the beginning of 2000s.

(2) From the technical and economical point of view, unit R-2 will be schedule to operate 6 months after unit R-1. This will enable the highest work loads and number of workers to be minimized.

(3) Boiler hydrostatic test shall not be conducted during very cold winter season taking the boiler material embrittlement into consideration.

(4) Load restraint and shut-down period of existing power plant units of ME-1 to be caused by replacing works of circulating water pumps and common intake water channels shall be minimized as much as possible.

(5) The construction work in winter is expected to be carried out at the same rate as in summer. If there is seen a difficulty in construct work during very could period, time period and manner of construction work shall be reviewed.

Figure 7-2-1 MARITSA EAST NO.1 REPLACING POWER PLAN [Unit R-1 & R-2] IMPLEMENTATION SCHEDULE

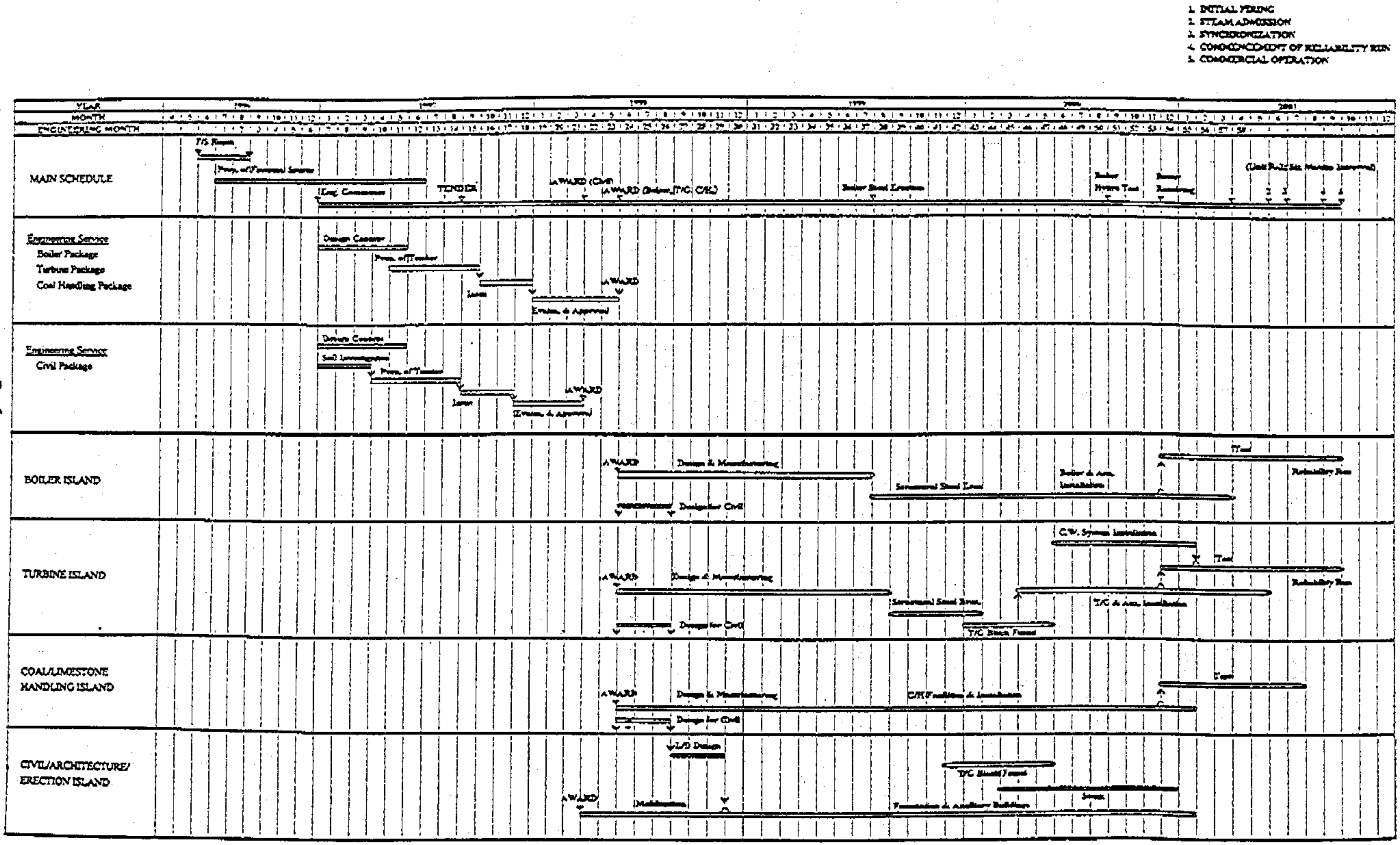
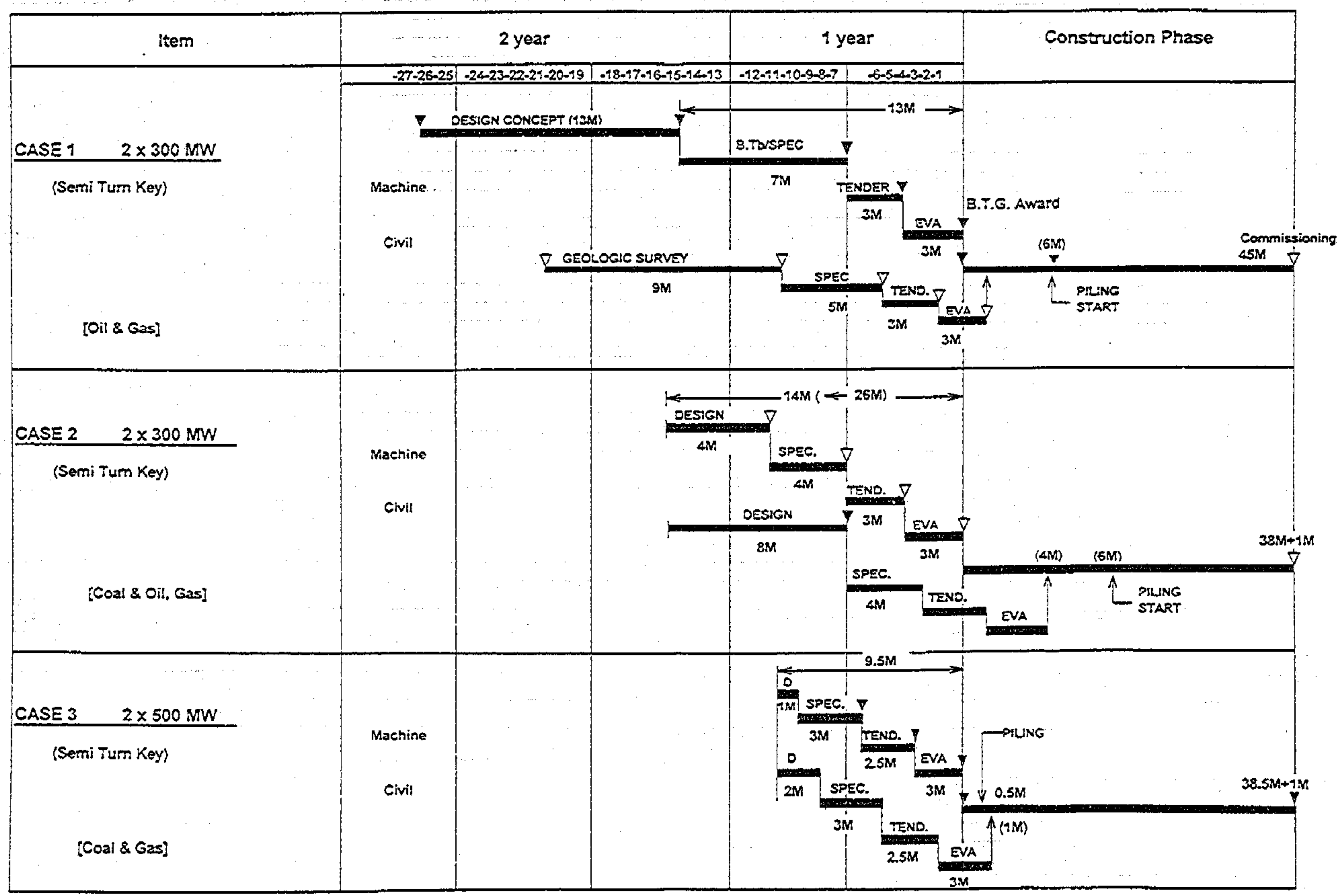
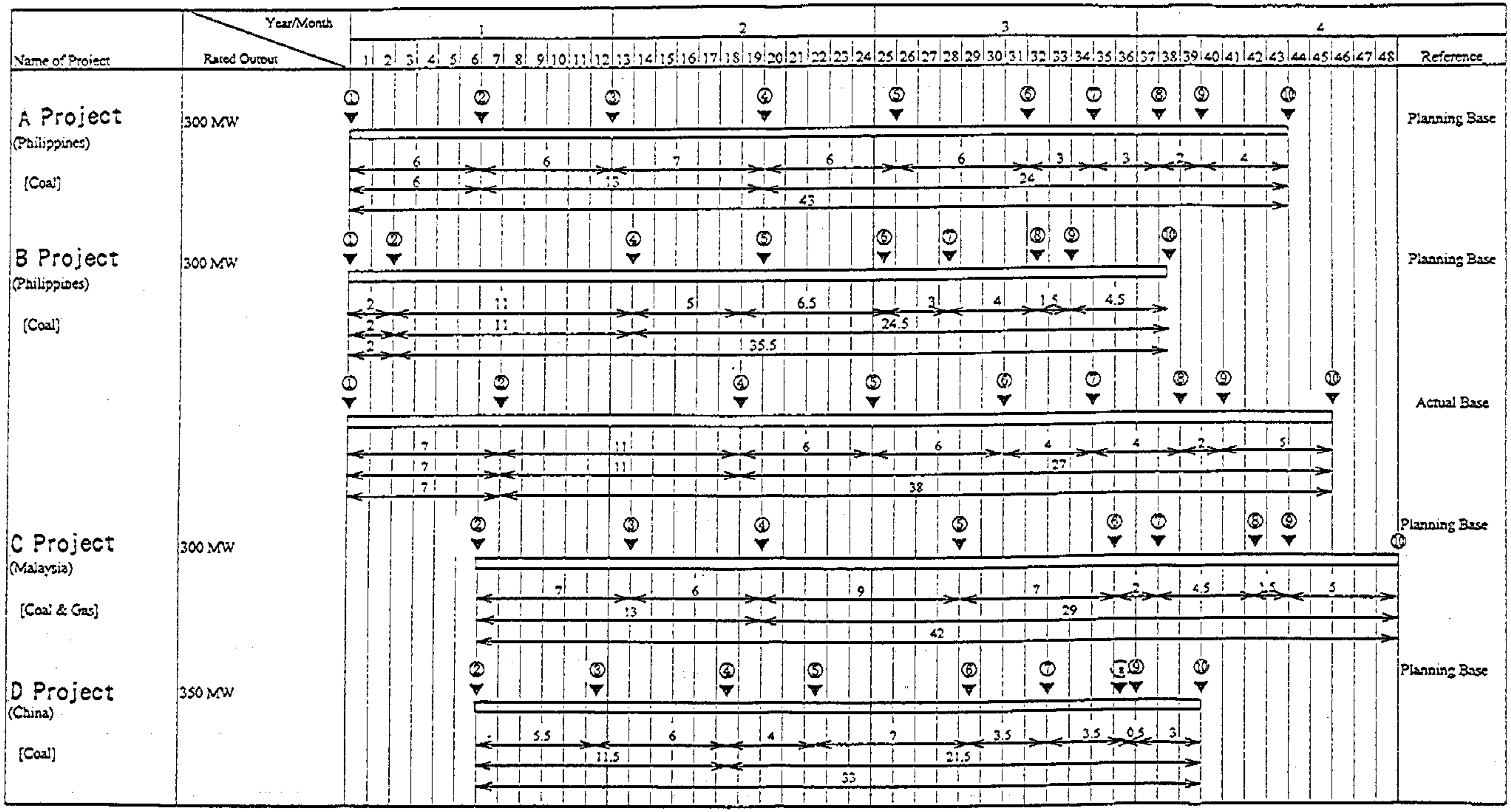


Figure 7-2-2 DESIGN STAGE (For Example)



① Award of Contract
② Civil Mobilization
③ Commencement of Civil
④ Boiler Steel Erection
⑤ Boiler Drum Lift
⑥ Boiler Hydro Test
⑦ Power Receiving
⑧ Initial Firing
⑨ Steam Admission
⑩ Commercial Operation

Figure 7-2-3 CONSTRUCTION SCHEDULE (For Example)



CHAPTER 8. CONSTRUCTION COST

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CHAPTER 8 CONSTRUCTION COST

8.1 Principle Concept of Cost Estimation

8.1.1 Premises for Estimation of Project Cost

(1) Of jobs related to project implementation, what (a) contractor(s) has (have) to do for supply, erection and commissioning of equipment is divided into the following four (4) islands, as recommended in " Chapter 7 Planning of Implementation, 7.1 Contract Formation"

(a) Boiler island
(b) Turbine island
(c) Coal/limestone island
(d) Civil/architecture/erection island

A island (d) covers for civil, architectural and erection works for islands (a) through (c) and those related to replacement project.

In turn, islands (a) through (c) have to supply to a island (d) all information, data and (as the case may be) design which a island (d) requires and further to despatch competent supervisors for erection and commissioning works.

(2) Contractors for islands (a) through (c) shall be decided through a process of international competition tender, and a contractor for a island (d) through a process of domestic competition tender among Bulgarian companies.

(3) Costs of islands (a) through (c) are estimated in principle on a import basis, taking a little account of a cost reduction to be attributed to local procurement.

As a means to give positive incentive to local procurement which is contributory to project cost reduction and activation of Bulgarian industry, it is recommended to stipulate a "local preferential clause" in the tender specification.

(4) Equipment and materials to be supplied in each island shall be delivered to the site on a free-on truck basis with the relevant insurance lodged, and their unloading from transportation vehicles shall be undertaken by a island (d).

(5) The existing facilities not to be re-used in replacement project shall be demolished completely by the owner before contractors have access to the site.

In other words, the relevant demolishing cost is not included in the project cost.

(6) All taxation applicable in Bulgaria e.g. customs duty to be levied on imported goods, income tax on contractor's income shall be totally exempted.

Taxation cost is not included in project cost.

(7) Such utility as electric power and water to be required for each contractor to execute its plant construction works at the site should be prepared and supplied to him by the owner free of charge.

(8) (A) consultancy company(ies) shall be employed from (a) foreign country(ies) and subject to approval of (a) financing source(s).

(9) The project costs estimated are firm as of January 1st, 1996, not subject to adjustment and further expected to be valid for one (1) year thenceforth.

8.1.2 Project Cost Estimation Base

(1) A total project cost was estimated lump sum-wise based upon data mentioned in a technical book published in U.S.A. as for lignite fired power plant, and based upon cost levels currently prevailing in Japan and overseas as for cost adjustment of key components.

Finally, compared with the market cost trend during the past fifteen (15) years, it was reviewed whether each cost is reasonable or not.

(2) A consultant fee will vary with a range of services to be covered, their contents, service duration and etc.

In view that in general a consultant fee is budgeted for with around 3 to 5 % of a project cost, a lump sum of 20 MM US$ was allocated for it in this feasibility study.

(3) Contingency was estimated to a lump sum of 20 MM US$.

(4) In principle, a cost to be required on a PIU side should be estimated and borne by PIU himself, and its estimation was not eliminated in this clause.

8.2 Project Cost

8.2.1 Scope of Supply of Each Island

Refer to " Chapter 7 Planning of Project Implementation, 7.1.3 An Outline of Duty and Scope of Supply of Each Island ".

8.2.2 Project Cost

A project cost is as shown below. (Unit : MM US$)

	Foreign Currency	Local Currency	Total
1. Boiler Island	192.1	33.9	226.0
2. Turbine Island	90.1	15.9	106.0
3. Coal/limestone Island	75.7	13.4	89.1
4. Civil/Architectural/ Erection Island	62.0	82.2	144.2
Subtotal	419.9	145.4	565.3
5. Consultancy Fee	20.0	—	20.0
6. Contingency	15.0	5.0	20.0
Total	454.9	150.4	605.3

8.3 Disbursement Schedule

The disbursement schedule is shown in Table 8-3-1. The interest of during construction is calculated with a rate of 8% per year as foreign portion and 10% per year as local portion and allocated in the disbursement schedule.

The required fund for each year is estimated based upon the normal payment terms for applicable to overseas thermal power plants, as follows.

(1) Mechanical and electrical equipment

(a) Boiler and Turbine Island

0% in the 1st year, 40% in the 2nd year
50% in the 3rd year, 10% in the last year

(b) Coal/limestone island

0% in the 1st year, 25% in the 2nd year
55% in the 3rd year, 20% in the last year

(2) Civil and architecture works

90% of progress payment, 10% at the time of completion.

The interest during construction (I.D.C.) is estimated as 91.9M$, which is around 15% of the project cost.

ME - 1 TPP

Table 8-3-1 Disbursement Schedule

Unit : Million US $

	1998			1999			2000			2001			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
I. Direct Cost															
1. Civil / Erection Island	18.6	24.7	43.3	13.0	17.3	30.3	15.5	20.5	36.0	14.9	19.7	34.6	62.0	82.2	144.2
2. Boiler Island	0.0	0.0	0.0	76.8	13.6	90.4	96.1	17.0	113.1	19.2	3.3	22.5	192.1	33.9	226.0
3. Turbine Island	0.0	0.0	0.0	36.0	6.4	42.4	45.1	7.9	53.0	9.0	1.6	10.6	90.1	15.9	106.0
4. Coal / Limestone Handling Island	0.0	0.0	0.0	18.9	3.3	22.2	41.7	7.4	49.1	15.1	2.7	17.8	75.7	13.4	89.1
Total of Construction Cost (1-10)	18.6	24.7	43.3	144.7	40.6	185.3	198.4	52.8	251.2	58.2	27.3	85.5	419.9	145.4	565.3
II. Indirect Cost															
1. Contingency	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0	3.0	20.0	17.0	3.0	20.0
2. Engineering fee	2.0	0.0	2.0	6.0	0.0	6.0	6.0	0.0	6.0	6.0	0.0	6.0	20.0	0.0	20.0
Total of Indirect Cost	2.0	0.0	2.0	6.0	0.0	6.0	6.0	0.0	6.0	23.0	3.0	26.0	37.0	3.0	40.0
Sub - Total (I + II)	20.6	24.7	45.3	150.7	40.6	191.3	204.4	52.8	257.2	81.2	30.3	111.5	456.9	148.4	605.3
III. Interest During Construction	0.8	1.2	2.0	7.7	4.5	12.2	21.9	9.2	31.1	33.3	13.3	46.6	63.7	28.2	91.9
Grand Total (I+II+III)	21.4	25.9	47.3	158.4	45.1	203.5	226.3	62.0	288.3	114.5	43.6	158.1	520.6	176.6	697.2

Final: Adm. cost not included.
Contin. 20 mil.$
Eng. Fee. 20 mil.$
IDC: F/P 8%, L/P 10%

8.4 Generation Cost

8.4.1 Estimation of Operation and Maintenance Cost

Estimated annual operation and maintenance cost for the replacing units (C-FBC, 230MW x 2) is shown in Table 8-4-1. Conditions adopted for this cost estimation are as follows.

(1) Utility consumption of coal and limestone, etc. is based on the plant design conditions.

(2) Utility unit price is estimated on the data of NEK.

(3) Labor cost and number of personnel are as per the planning data of NEK.

(4) 3% of the construction costs is allocated for the maintenance cost.

Annual fuel cost is estimated 30,312 x 10^3\$, which is equivalent to 1.1 cent per kWh. The sum of costs for utilities (such as limestone), labor and, maintenance is estimated 25,052 x 10^3\$, which is equivalent to1.0 cent per kWh.

8.4.2 Estimation of Generation Cost

An estimated generation cost is shown in Table 8-4-2. The capital cost is 2.8 cent/kWh and the operation and maintenance cost including fuel cost is 2.1 cent/kWh. A generation cost (at sending end) is estimated 4.9 cent/kWh.

Table 8-4-1 Operation and Maintenance Cost (for 2 units)

Item	Quantity (year)	Unit Price ($)	Cost ($)	Note
1. Fuel cost				
Coal	$2 \times 2{,}526 \times 10^3$ton	6	$30{,}312 \times 10^3$	• Unit price includes 1$ as development/transportation fee.
2. Utility cost				
1) Limestone	$2 \times 521 \times 10^3$ ton	7	$7{,}294 \times 10^3$	• Unit price includes 1$ as development/transportation fee.
2) Heavy oil	660 ton	97	64×10^3	• Unit price is based on NEK data.
3) LPG	80ℓ x14		307	• 20,600 Leva/year
4) Water	$2 \times 448 \times 10^3$ ton	0.0003	269	• Unit price is based on NEK data.
3. Labor cost	300 persons	2,450	735×10^3	• Unit price and personnel are based on NEK data. • 164×10^3Leva/person≒2,450 $/person
4. Maintenance cost	565.3x3%		$16{,}959 \times 10^3$	• Construction cost: 565.3[MS]
Total of 2-4			$25{,}052 \times 10^3$	O/M Cost
Grand Total			$55{,}362 \times 10^3$	

Note) Annual electricity generation (at sending end): 2 x 230,000kW x 24 x 365 x (1-0.07) x 0.7
= $2{,}623 \times 10^6$ kWh

Table 8-4-2 Trial Calculation of Generation Cost

Item	Unit	Cost	Note
1. Total Construction Cost	M$	697.2	Project cost 605.3M$ I.D.C. 91.9M$
2. Life Time	Years	30	
3. Discount Rate	%	10	
4. Capital Recovery Factor	%	10.6	
5. Annual Capital Cost	M$	74	
6. Annual Generation kWh	kWh	$2{,}623 \times 10^6$	Sending End
7. Capital Cost per kWh	C/kWh	2.8	
8. O/M Cost per kWh	C/kWh	1.0	$25{,}052 \times 10^3$ $/year
9. Coal Price	$/ton	6.0	
10. Coal Calorie	kcal/kg	1,686	(wet, H.H.V.)
11. Thermal Efficiency	%	28.5	(wet, H.H.V.)
12. Heat Rate	kcal/kWh	3,018	
13. Coal Consumption for kWh	kg/kWh	1.79	
14. Fuel Cost per kWh	C/kWh	1.1	
15. Generation Cost	C/kWh	4.9	Sending End

CHAPTER 9. ENVIRONMENT IMPACT ASSESSMENT

CHAPTER 9 ENVIRONMENTAL IMPACT ASSESSMENT

9.1 Environmental Regulations

(1) In Bulgaria, the environmental regulations have been set in accordance with to the Environmental Protection Act, a principal law pertaining to protection of environment. The act makes clear the basic principles for management of environment, and provides basic guidelines for other regulations pertaining to environment.

(2) The emission control standards in Bulgaria are enacted to regulate separately the existing and new thermal power plants. Should only the existing power plant exceed any standard value, then the power plant is allowed to continue its operation by paying a penalty.

(3) While the Maritsa East No.1 Thermal Power Plant is imposed penalties due to emissions of both SO_2 and dust, the No.2 and No.3 Thermal Power Plants are imposed a penalty due to emission of only SO_2.

(4) In preparation for joining the European Union (EU), the Government of Bulgaria expressed its intention to comply with the Guideline of the EU. The environmental protection policy of EU is presented in the form of "directive" in many cases, and the same form is presented also to Bulgaria. According to the directive, the Member Countries are forced to be responsible for establishing a legal system in their domestic laws.

(5) In the case of this replacing project, the amount of SO_2 emission should satisfy either the Bulgarian standards (650 mg/Nm^3) or the EU Standards (the desulfurization efficiency should be not lower than 90% in the case where the fuel with a high sulfur content is to be used). The amounts of NOx, dust and CO should also satisfy the Bulgarian Standards (not greater than 600 mg/Nm^3, 100 mg/Nm^3 and 250 mg/Nm^3, respectively).

(6) No standard for regulating the quality of waste water directly at its discharge outlet has yet been established in Bulgaria. In other words, the public service water areas are classified into three categories (I: Tap water; II: Irrigation and fish farming water; III: Other than the above two categories of water), and enterprises are regulated by measuring the water quality downstream of the enterprises and comparing the quality with standard values stipulated in the above categories. The river around the proposed project site are set to belong to the standard values of categories III. Therefore, the standard values of Category III have been determined to be adopted for preservation of environment in the case of this reconstruction project. These standard values are roughly equivalent to those prevailing in the other

countries which experienced execution of countermeasures for protection of environment, and deemed to be sufficient for preservation of environment in the proposed replacing project site area.

(7) Noise

Bulgarian Standards No. 14478-82 stipulate the restriction of noise in the workplace not at the boundary of premises. Further, Ministry of Health Hygienic Norms No. 0-64 (Official Gazette, Issue No. 87/1972) set up highest admissible noise levels in different residential areas and zones.

9.2 Present Situations of Environment

(1) Conditions in the Surrounding Area

The proposed replacing project site is located on a plain at a sea level of 100 m, and the surrounding area is used as a farmland area. The site is located in the Garabovo District where there are residences, schools, hospitals and other facilities.

There is the Rozovkladenetz Lake on the south side of the Maritsa East No.1 Thermal Power Plant, and the Sazliika River runs on its north side.

(2) Meteorology

The climate in Bulgaria is comparatively warm, and divided clearly into four seasons. The area around the Maritsa East No.1 Thermal Power Plant belongs to the warm and humid Mediterranean climate. According to the data observed during 1983 through to 1992 at the meteorological observation station installed around the Rozovkladenetz Lake 1 km southwest of the power plant, the meteorological conditions are as follows:

The yearly mean ambient temperature	:	12.5°C
The yearly mean atmospheric pressure	:	1,003.5 hPa
The number of days with precipitation	:	42 days/year
The number of days with snowfall	:	14 days/year
The annual average humidity	:	73%
The prevailing wind direction	:	Northeast
The yearly mean wind velocity	:	2.5 m/sec.

(3) Atmospheric Environment

The amount of SO_2 emitted from the boiler of Maritsa East No.1 Thermal Power Plant substantially exceeds the emission standard since the flue gas is not desulfurized. As only the cyclone type dust collector has been installed for coal drying facilities, the amount of dust emission also substantially exceeds the emission standard.

The environmental protection policy in Bulgaria is administered by the Ministry of Environment. According to the observation data of the atmospheric environment concentrations obtained from the stationary environmental observation stations (Garabovo, Polskigradetz and Medinicarbo) installed by the Ministry of Environment around the proposed project site, the concentrations of SO_2 and dust are observed to be high and sometimes exceed the environmental standards.

(4) Water Quality

At the Maritsa East No.1 Thermal Power Plant, no waste water treatment equipment has been installed. All of waste water from the thermal power plant is disposed of by discharging it into the ash disposal yard. According to the observation data of water quality in the lake around the power plant, the nitrogen, phosphorus and other nutrient contents tend to be high. This is deemed presumably due to discharge of waste water from households in the surrounding area. However, harmful substances are rarely detected.

(5) Noise

There is not the noise standard at the site boundary in Bulgaria. Comparing measured noise levels at the site boundary with the highest admissible noise levels in industrial district - 70 dB(A) in the daytime, 60 dB(A) at night (Hygienic Norms No.0-64) - as reference, measured levels at several boundary points are exceed the reference admissible one due to existing transformers, neiboring briquette factory and much traffic.

It is judged that noise levels at residential areas are lower than those of reference admissible owing to reduction effect of distance.

9.3 Prediction and Assessment of the Environmental Impact

(1) Air Pollution

As a matter of fact, the impact of air pollutants emitted from the Maritsa East No.2 and No.3 Thermal Power Plants on the environment in the Maritsa East area also is quite serious, but considered to be studied separately. As far as the Maritsa East No.1 Thermal Power Plant is concerned, in consideration that appropriate countermeasures are scheduled to be taken for removing pollutants in flue gas under this reconstruction project, it is predicted that the maximum aboveground concentration of air pollutants satisfies the environmental standards of Bulgaria in terms of either sulfur oxides, nitrogen oxides or dust. Therefore, the environmental impact of this project is deemed to be negligibly small.

Rather, the total amount of sulfur dioxide (SO_2) and dust emissions from the Maritsa East No.1 Thermal Power Plant is expected to be reduced substantially from the present level after completion of this reconstruction project, because the existing units are to be demolished in the course of project execution. Therefore, the degree of contribution of this reconstruction project for improvement of the environment is evaluated to be significantly large.

(2) Noise

As there is not the noise standard at the site boundary in Bulgaria, evaluation is done by comparing forecasted noise levels at the site boundary with the highest admissible noise levels in industrial district - 70 dB(A) in the daytime, 60 dB(A) at night (Hygienic Norms No.0-64) - as reference.

As a result, it is judged that noise level at the site boundary is not considered a problematic level.

9.4 Study of the Lake Water Temperature

The Rozovkladenetz lake adjacent to the Maritsa East No.1 Thermal Power Plant is used for intake of condenser cooling water for the power plant. To study whether this lake would satisfactorily function as a cooling water intake source or not, the warm waste water diffusion analysis and so forth have been carried out. As a result of analysis and study, there has been concluded to be no problem in any cases. Therefore, the lake water temperature is not considered to be raised by diffusion of warm waste water. In the case where further extension of equipment is to be carried out after implementation of this reconstruction project, however, it is recommended to install a cooling towers as in the case of the Maritsa East No.2 and No.3 Power Plants.

9.5 Environment Preservation Plan

To prevent or mitigate the environment impact resulting from implementation of this project, countermeasures should be taken to preserve the environment.

In this project, the amount of pollutants emitted from thermal power plant is to reduced by taking various countermeasures e.g. against sulfur oxides by desulfurization in the furnace of circulating type fluidized bed boiler, against dust by adoption of electrostatic precipitator and other means. To prevent water pollution caused by discharge of waste water, moreover, general waste water should be treated appropriately by adopting waste water treatment and other equipment. The countermeasures for reducing the noise and vibration levels from any equipment constituting such noise and vibration sources should be taken by indoor installation of equipment, adoption of low noise equipment, adoption of substantial foundations and so forth.

9.6 Environmental Monitoring Plan

(1) Smoke and Dust

On the basis of a basic policy for smoke and dust emission monitoring, the concentrations of SO_2, NO_x dust and CO should be measured periodically installing measurement seats in the boiler flue.

(2) General Waste Water

As a means of monitoring the quality of general waste water causing water pollution, the concentration of hydrogen ion (pH value) and turbidity should be measured periodically to check the water quality at the outlet of waste water treatment equipment to be installed in the power plant.

9.7 Overall Evaluation

The Maritsa East No.1 Thermal Power Plant Replacing Project is intended to bear a part of the burdens of future electric power supply in Bulgaria and make effective utilization of lignite, a main domestic energy sources available in the country.

The reconstruction project should be implemented to ensure thorough preservation of the natural and social environment in the surrounding area. Thereby, it is considered possible to reduce the impact of the Maritsa East No.1 Thermal Power Plant Replacing Project upon the surrounding environment.

After completion of the reconstruction project, the total amount of dust and sulfur oxide emissions will be reduced to much smaller than the present levels. In parallel with promotion of home electrification and regional heat supply, it is predicted possible to reduce environmental pollution resulting from burning briquette (made of lignite) used as a domestic heat source. Therefore, this reconstruction project is concluded to contribute significantly for improving the environmental quality in the surrounding area.

Table 9-1-1 Air Quality Standard in Bulgaria

(Unit:mg/m³N)

Pollutant	30 Minutes Average	24 Hours Average	Annual Average
SO_2	0.50	0.15	0.05
NO_2	0.60	0.10	0.10
NO_x	0.60	0.06	—
Dust	0.50	0.25	0.15
H_2S	0.008	0.008	0.008

Table 9-1-2 Emission Standard in Bulgaria

(Unit:mg/m³N)

Fuel type	The existing Power Plants commissioned up to 1992				New Power Plants			
	Dust	SO_2	NO_x	CO	Dust	SO_2	NOx	CO
Domestic coal	200	3,500	1,000	250	100	650	600	250
Imported coal	150	2,500	1,300	250	80	650	600	250
Liquid fuel	50	2,500	700	170	50	650	450	170
Gaseous fuel	10	—	500	100	10	—	300	100

Table 9-1-3 SO_2 Emission Level and Its Reduction Percentages in Bulgaria

	SO_2 Emission Level per year	SO_2 Target Emission Level per year	Emission Reduction Percentage (base year 1980)
1980	2,050kt	—	—
2000	—	1,374kt	33%
2005	—	1,230kt	40%
2010	—	1,127kt	45%

Table 9-1-4 SO_2 Emission Limit from New Plant in the EU(Solid fuels)

MWth	Emission Limit Value (mg/m_3N)	Desulphurization rate(%)
50~100	[2,000]	—
100~500	2,000~400 (liner decrease)	40%:100~167MWth 40-90%:liner increase 167~500MWth
>500	400	90

Note:Should the emission limit not be met with high sulphur coal/solid fuels fire, the percentage reduction rates or maximum limit of 650mg/m_3N shall be applied.

Table 9-1-5 The Water Quality Standard of Bulgaria

Indicators and Standards for Assessment of the Admissible Pollution Rates of Various Categories of Running Surface Waters

Item No.	Indicators	Measure Unit	Category: I	II	III
1	2	3	4	5	6
	Group A. General Physics and Inorganic Chemistry Indicators				
1.	Temperature	°C	Not exceeding the average seasonal temperature by more than 3°C.		
2.	Colour		No visible additional colouring at 20°C.		
3.	Smell	Force	2	3	3
4.	Active reaction	pH	6,5-8,5	6,0-8,5	6-9
5.	Oxygen saturation	%	75	40	20
6.	Electric conductivity	mkC	700	1300	1600
7.	Dissolved oxygen	mg/dm^3	6	4	2
8.	Dissolved substance	"	700	1000	1500
9.	Suspended matter	"	30	50	100
10.	Total hardness	$mgekv/dm^3$	7	10	14
11.	Chlorine ion	mg/dm^3	200	300	400
12.	Sulphate ion	"	200	300	400
13.	Hydrogen sulphide (free)	"	n.a.		
14.	Iron (total)	"	0,5	1,5	5
15.	Manganese (total)	"	0,1	0,3	0,8
16.	Nitrogen (ammonia)	"	0,1	2	5
17.	Sodium nitrogen	"	0,002	0,04	0,06
18.	Nitrate nitrogen	"	5	10	20
19.	Phosphate (PO4)	"	0,2	1	2
20.	Phosphorus (total content as PO4)	"	0,4	2	3
21.	Selenium	"	0,01	0,01	0,01
22.	Beryllium	"	0,0002	0,0002	0,002
23.	Vanadium	"	0,1	0,01	1
24.	Molybdenum	"	0,5	0,5	3
25.	Barium	"	1	1	4
26.	Boron	"		n.a.	
27.	Silver	"	0,001	0,01	0,01
28.	Uranium	"	0,6	0,6	0,6
29.	Radium 226	mBk/dm^3	150	150	150

Group B. General Indicators of Organic Pollutants

30. Organic non-dissolved matter	mg/dm³	5	15	25
31. Oxdizability (permanganatic)	"	10	30	40
32. HPK (bichromate)	"	25	70	100
33. BPK5	"	5	15	25
34. Dissolved organic carbon	"	5	12	20
35. Extractable species (with tetrachloromethane)	"	0,5	3	5
36. Organic Nitrogen	"	1	5	10
Group C. Indicators of Inorganic Industrial Pollutants				
37. Mercury	mg/dm³	0,0002	0,001	0,003
38. Cadmium	"	0,005	0,01	0,02
39. Lead	"	0,02	0,05	0,2
40. Arsenic	"	0,02	0,05	0,2
41. Copper	"	0,05	0,1	0,5
42. Chromium (trivalent)	"	0,1	0,5	1
43. Chromium (hexavalent)	"	0,02	0,05	0,1
44. Cobalt	"	0,02	0,05	0,1
45. Nickel	"	0,02	0,05	0,1
46. Zinc	"	1	5	10
47. General beta-activity	mBk/ dm³	750	750	750
48. Cyanide (highly degradable)	mg/dm³	n.a.	0,05	0,1
49. Cyanide (total)	"	n.a.	0,5	1
50. Fluoride (total)	"	0,5	1,5	3
51. Free active Chlorine	"	n.a.	0,05	0,1
Group D. Indicators of Industrial Organic Pollutants				
52. Anionoactive detergent	mg/dm³	0,5	1	3
53. Phenoles (volatile)	"	0,01	0,05	0,1
54. Oil product	"	n.a.	0,3	0,5
55. Aldrine	"	0,0002	0,0002	0,0002
56. Pyridine	"	0,2	0,2	0,5
57. Xanthogenate	"	0,001	0,01	0,1
58. Saponine	"	0,2	0,2	1
59. Styrene	"	0,1	0,2	0,5
60. Benzene	"	0,5	0,5	1

61. Formaldehyde	mg/dm^3	0,5	0,5	1
62. Caprolactam	"	1	1	1
63. Phthalic acid	"	0,1	1	5
64. Phenitrotione (Agria 1050)	"	0,0001	0,0001	0,3
65. Zolone (Agria 1060)	"	0,0001	0,0001	0,002
66. Saturnine	"	0,1	0,1	1
67. Atrazine (Ceazine)	"	0,25	0,25	2,5
68. Lasso	"	0,3	0,3	0,5
69. 2,4 D	"	1	1	5
70. Sevine (Decarban)	"	0,002	0,002	0,1
71. Vinyl chloride	"	0,01	0,01	0,01
72. Dichloroethane	"	1,5	1,5	1,5
73. Aphalone	"	0,5	1	1
74. Pathorane	"	0,2	2	2
75. Dimyde	"	1	1	5
76. Ramrod	"	0,5	0,5	1
77. Treflane	"	1	1	5
78. Propanide	"	0,1	1	2
79. Diphenzoquate	"	0,2	1	5
Group E. Biological Indicators				
80. Saprobacity		olygo	beta-mezo	alfa-mezo
Pantle-Book Index		< 1,5	< 2,5	< 3,2
Zelenika-Marvan-Rotstein Index		> 60	> 40	> 25
81. Species variety of the macro-zoobentos (by Shannon)		> 3	> 2	> 1
82. Macrozoobentos equalization degree		> 0,7	> 0,6	> 0,5
83. Macrozoobentos domination degree		< 0,2	< 0,3	< 0,5
84. Micro-organism total (direct) count		6	6	6.
85. Total coli-titre	cm^3	< 0,1	< 0,1	< 0,001
86. Escherichia-coli-titre-thermoresistant	"	< 1,0	< 1,0	< 0,01
87. Patogenic micro-organisms			- Not admissible -	

Table 9-1-6 Permission Noise Level (BSS 14478-82)

Working place	Equivalent should level dB(A)	Level of sound pressure octave frequency lane - Hz							
		63	125	250	500	1000	2000	4000	8000
Production rooms at enterprise site	85	99	92	86	83	80	78	76	74
Penalize and cabins for survey and remote control: laboratories without phone extension	80	95	87	82	78	75	73	71	69
In control rooms, typist offices and direct telephone contact	65	83	74	68	63	60	57	55	54
Management office (administration)	60	79	70	63	58	55	52	50	49
Designer offices, programmers, theoretical work	50	71	61	54	49	45	42	40	38
Drivers and service personnel of agricultural transport and load vehicles	85	99	92	86	83	80	78	76	74

Table 9-1-7 Highest admissible noise levels in different residential areas and zones

Residential areas and zones	Noise level -dB(A)	
	Day-time	Night
1. Residential areas and zones		
a) existing urban districts	55	45
existing urban districts next to major communication facilities	60	50
b) new districts	50	40
new districts next to major communication facilities	55	45
2. Central urban regions	60	50
3. Industrial districts and zones	70	60
4. Public and individual recreation area	45	35
5. Hospital, sanatorium and other medical establishments' estate	45	35
6. R&D and educational zones	45	35

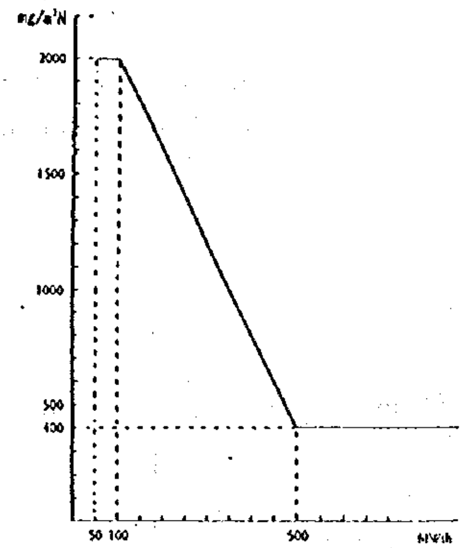


Figure 9-1-1 New Plant Emission Limit Values for SO_2 in the EU in mg/m3N(Solid fuels)

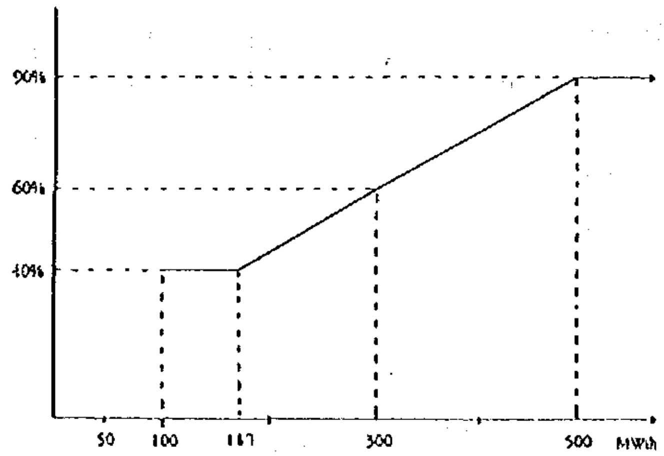


Figure 9-1-2 Rates of Desulfurization in the EU

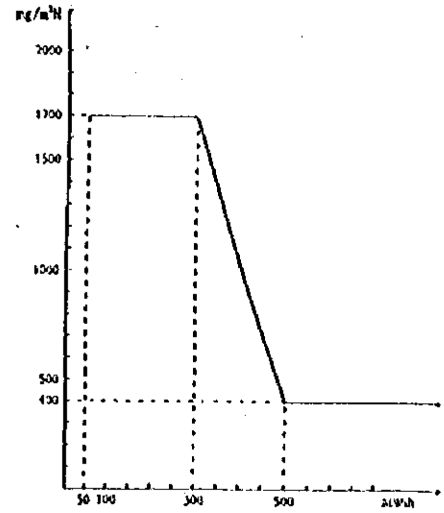
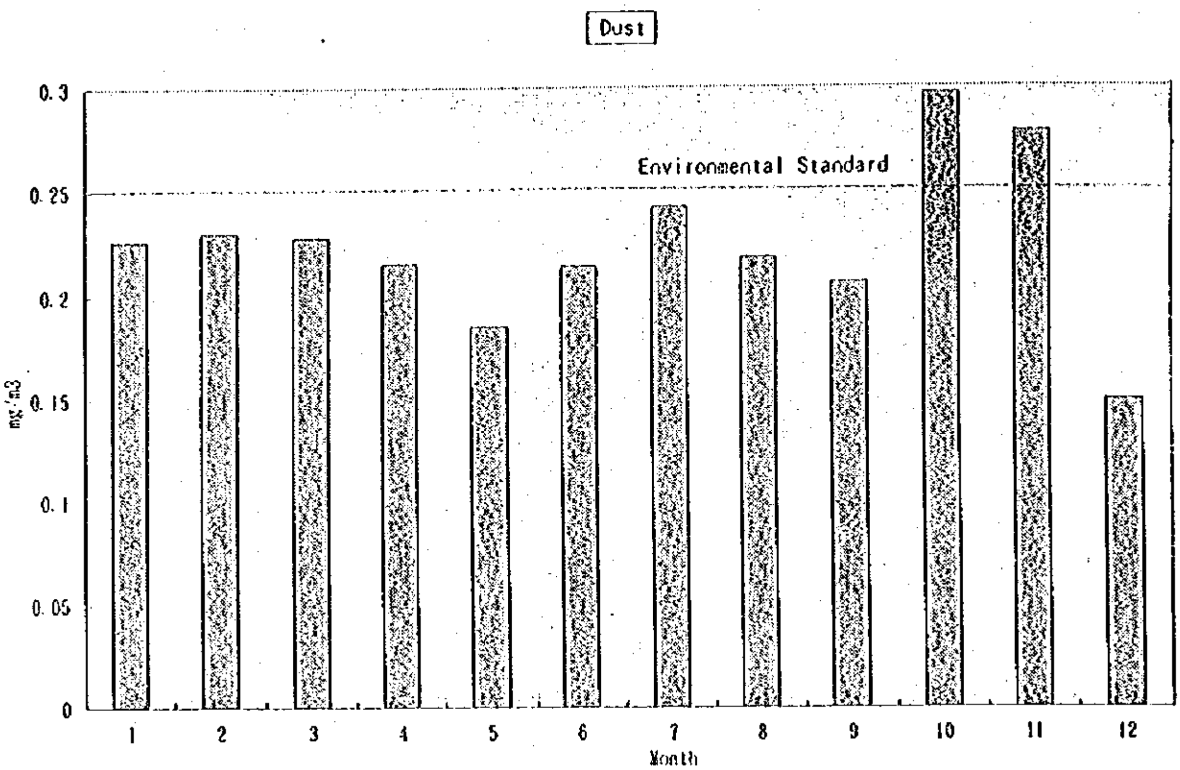


Figure 9-1-3 New Plant Emission Limit Values for SO_2 in the EU in mg/m3N(Liquid fuels)

Figure 9-1-4 Water Quality Sampling Sites at River Network in Bulgaria



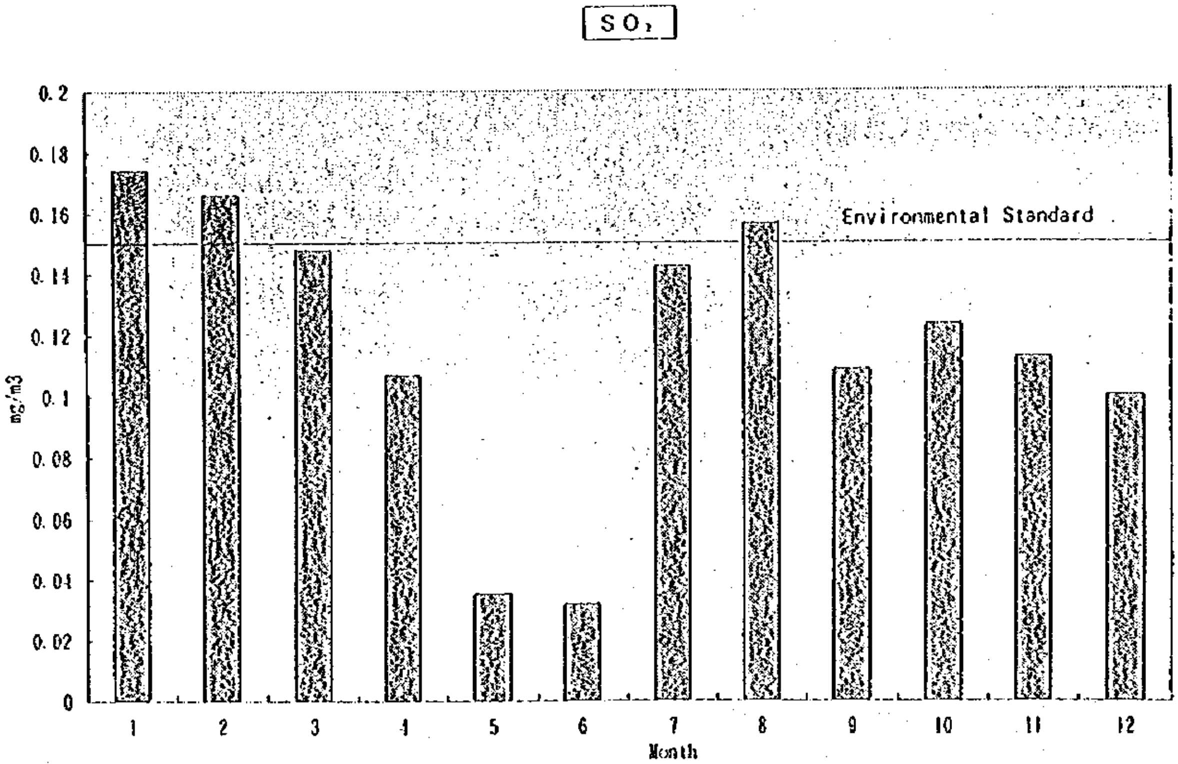


Figure 9-2-1 Monitoring Record (Galabovo, 1993)

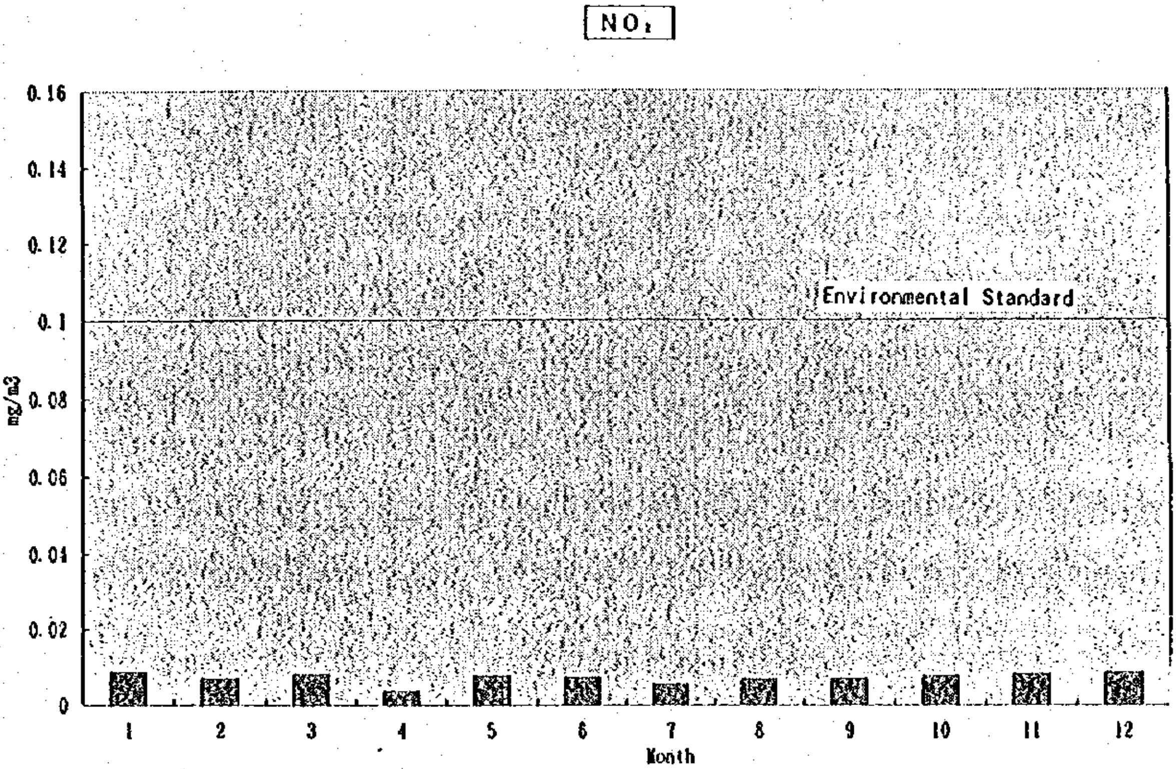


Figure 9-2-2 Monitoring Record (Galabovo, 1993)

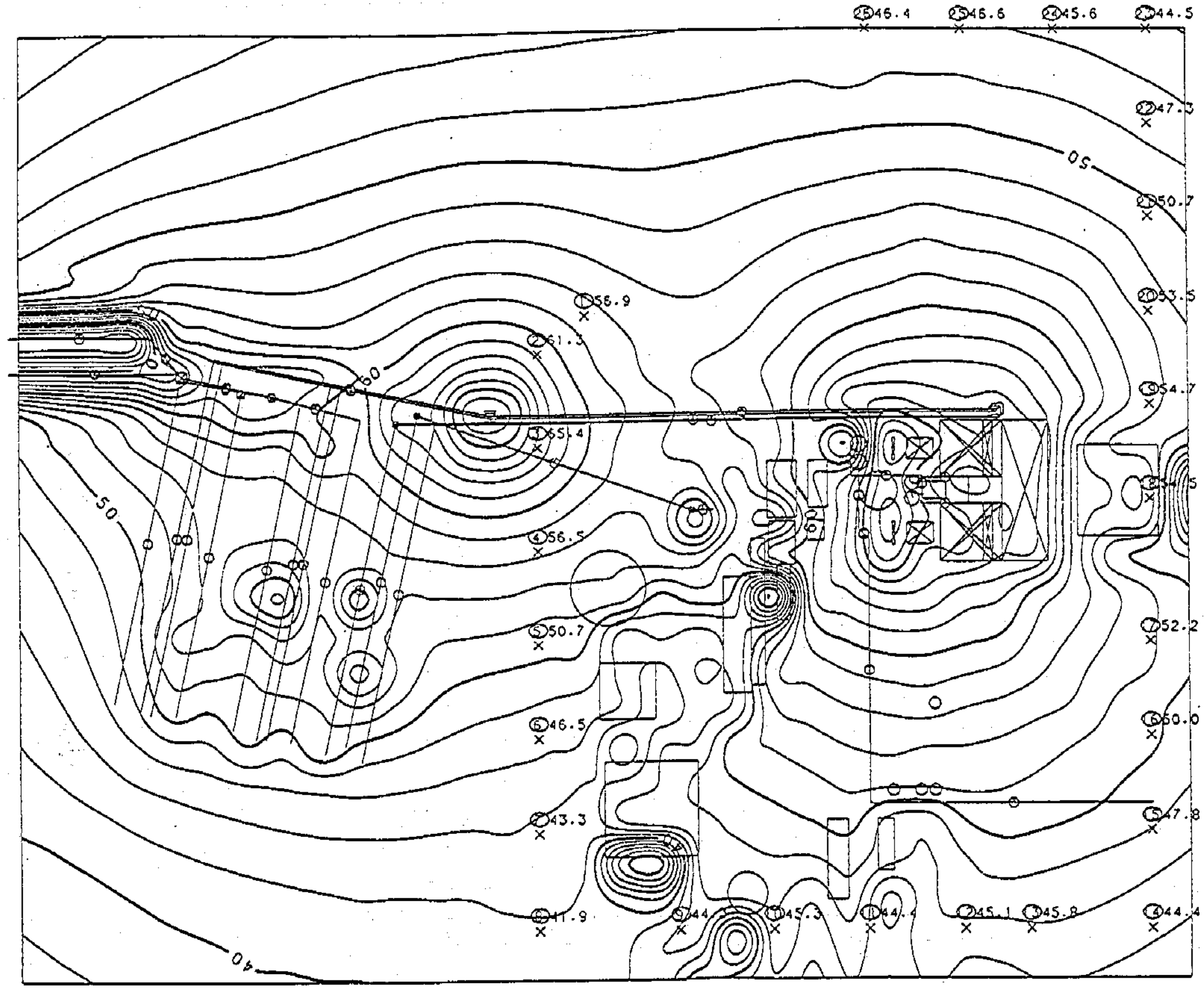


Figure 9-3-1 Contour Map based on replaced equipment (Daytime)

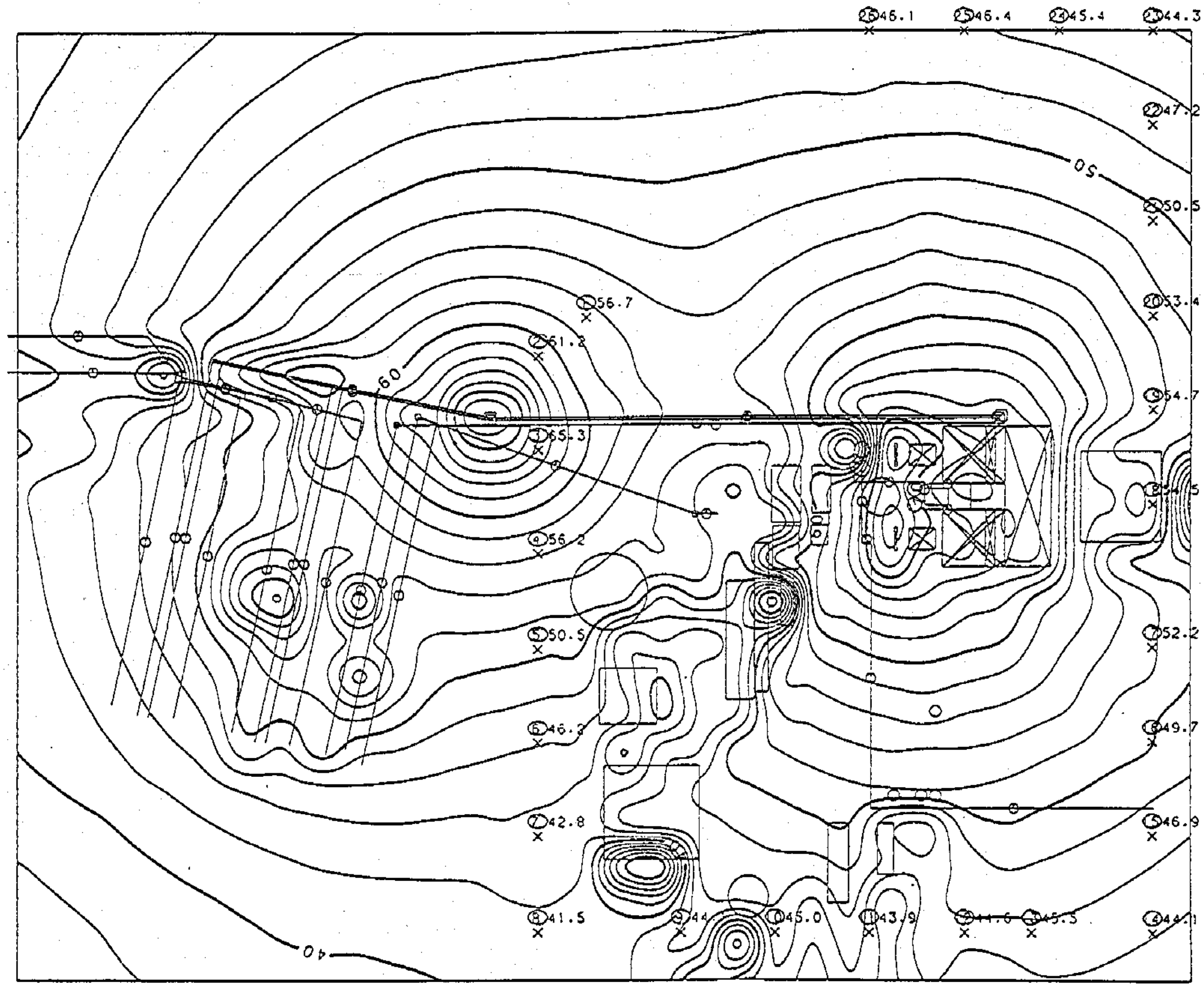


Figure 9-3-2 Contour Map based on replaced equipment (Night)

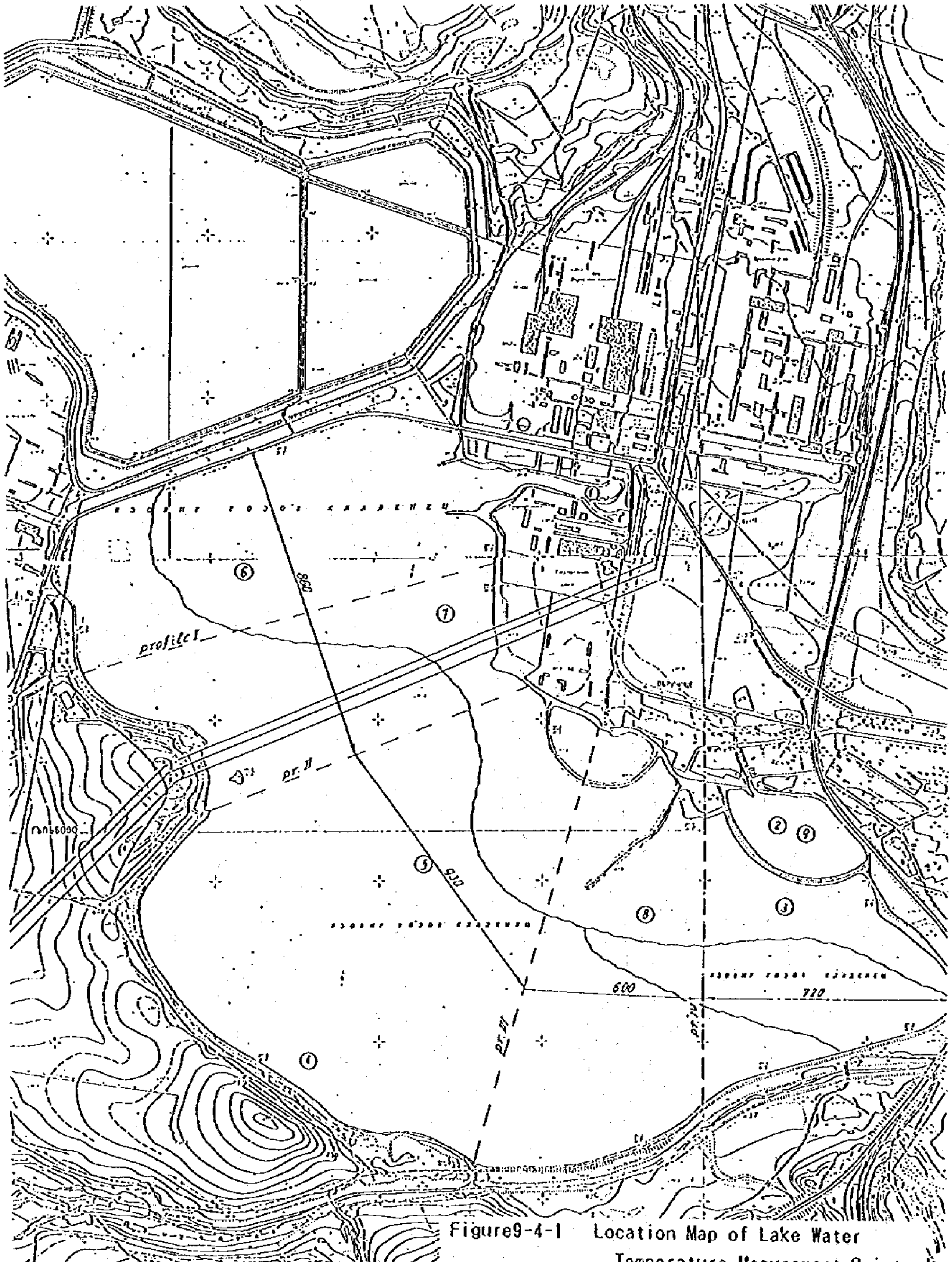


Figure9-4-1 Location Map of Lake Water Temperature Mesurement Points

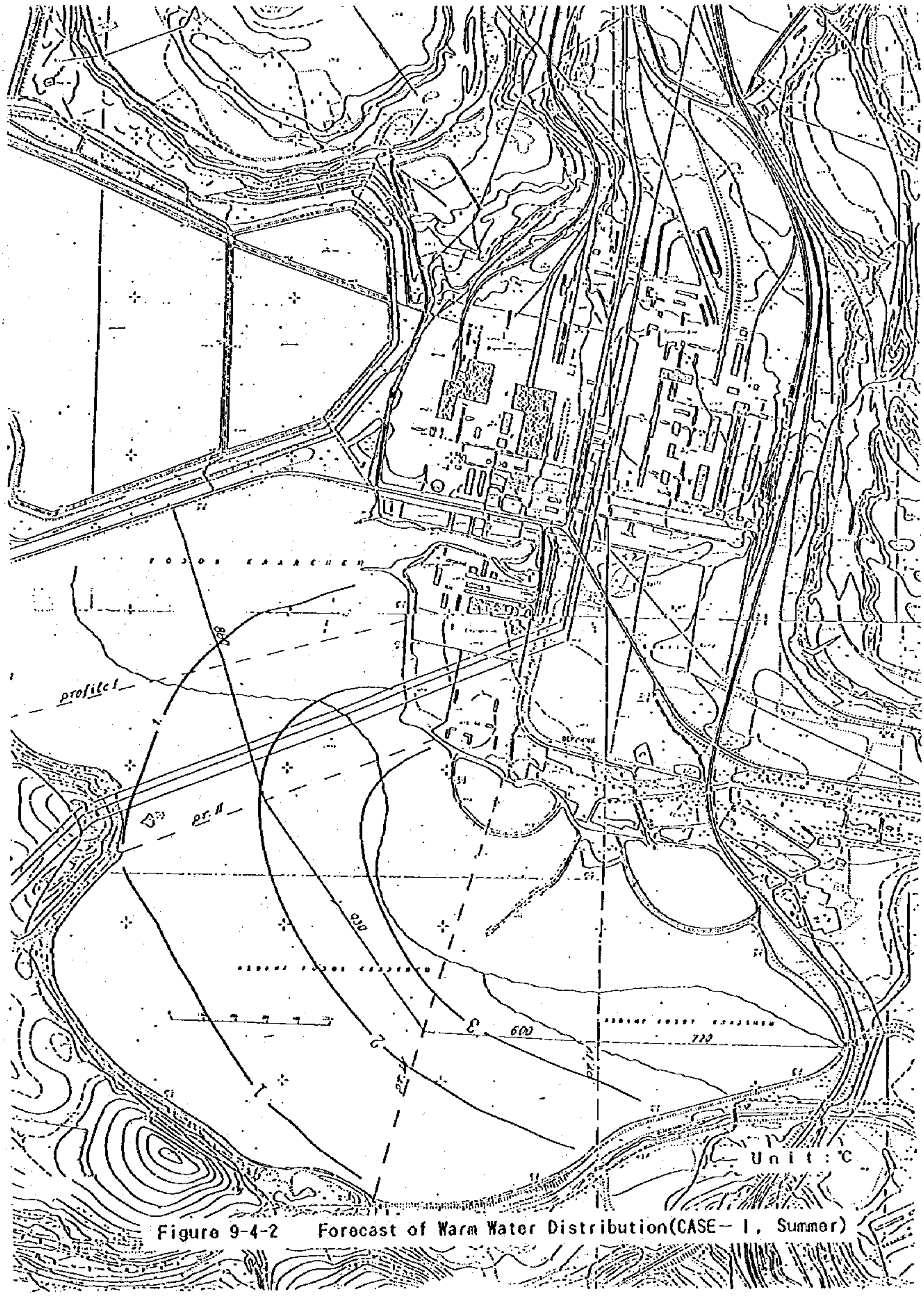


Figure 9-4-2 Forecast of Warm Water Distribution(CASE- I, Summer)

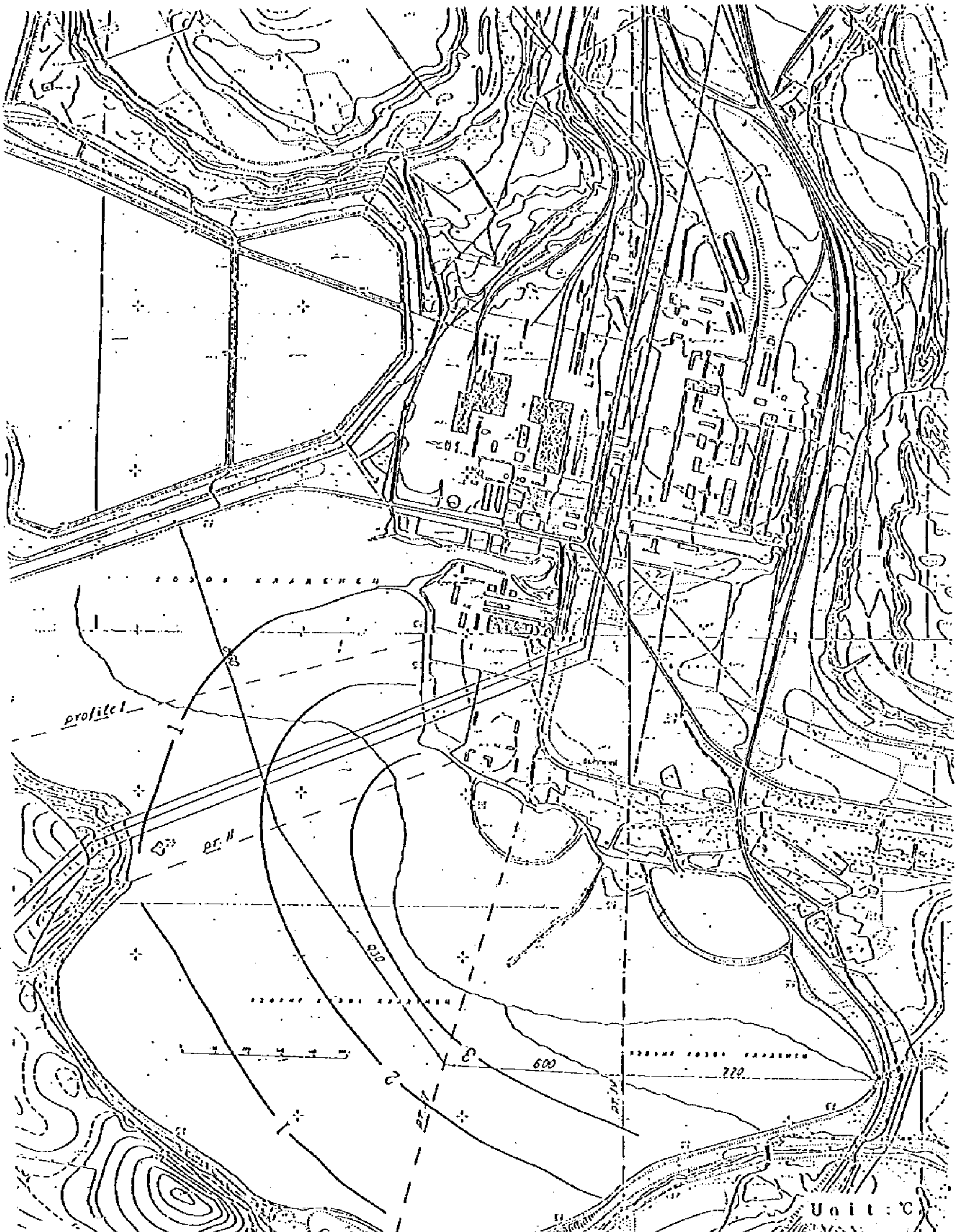


Figure 9-4-3 Forecast of Warm Water Distribution(CASE-II, Winter)

CHAPTER 10. ECONOMIC EVALUATION AND FINANCIAL EVALUATION

CHAPTER 10 ECONOMIC AND FINANCIAL EVALUATIONS

10.1 Economic Evaluation

(1) Method of economic evaluation

For this project "alternative project approach method" was adopted. Since the proposed project is considered to become a base load power plant, the alternative project is assumed to be a coal-fired thermal power plant using imported coal, which has a capacity to provide services and an ability to meet the given environmental emission and effluent standards equivalent to those of the proposed project. The proposed project was economically evaluated on condition that the construction cost and operation maintenance cost of the proposed project were given as a cost, while those of the alternative project were given as a benefit, and the net present value (B - C), benefit/cost ratio (B/C) and economic internal rate of return (EIRR) were calculated as the bases of the economic evaluation.

(2) Economic cost of proposed project

The initial investment, operation maintenance cost and fuel cost of the proposed project were totaled as the economic cost of the project. This economic cost was calculated at market prices without including the transfer cost items and applying the standard conversion coefficient.

(3) Economic benefit of proposed project

For the economic evaluation of the proposed project, the alternative project method was employed. In this method, an imaginary coal-fired thermal power plant using imported coal and capable of providing equivalent services to those of the proposed project was considered, and the initial investment, operation maintenance cost and fuel cost of such alternative project was totaled to be considered as the benefit.

(4) Economic evaluation of proposed project

The cost and benefit flow of the project and the alternative project is shown in Table 10-1-1. According to the result of the economic evaluation, the proposed project is, if executed and operated, much more advantageous costwise than the coal-fired thermal power plant using imported coal judging from B-C and B/C, and it can be said that such advantage can be maintained until the social discount rate reflecting the opportunity cost of the capital reaches 24.2%.

EIRR : 24.2%
B - C : $106{,}416 \times 10^3$ US$
B/C : 1.13

(5) Sensitivity analysis

Sensitivity of the project to an increase of construction cost and conditional changes of discounting rate as well as fluctuation of fuel prices was analyzed. The result of analysis is given in Fig.10-1-2, which indicates that the project will maintain its priority.

10.2 Financial Evaluation

(1) Method of financial evaluation

For the financial evaluation of the proposed project, the construction cost, operation maintenance cost and fuel cost which are necessary for executing the project were calculated as its cost, and the revenues from the sales of the electric power and the steam for district heating to be supplied by the project were calculated as the benefits. Then, the financial internal rate of return (FIRR) was determined by the discount cash flow (DCF) method as the basis for the evaluation.

In this financial analysis, the basic conditions were as follows.

- Financing conditions in;

foreign currencies: annual interest rate 8%, without considering commitment charges. 20-year equal installment repayment of principal and interest after the facilities became operative.

local currency: annual interest rate of 10%, without considering commitment charges. 15-year equal installment repayment of principal and interest after the facilities became operative.

(2) Financial cost and benefit of proposed project

The financial cost of the proposed project comprises the initial investment, operation maintenance cost and fuel cost calculated at market prices.

The financial benefit of the project is calculated based on the assumptions that the standard tariffs of electricity (4.5 cents/kWh) and steam (31.4$/Gcal) as of year 2001 will remain unchanged thereafter.

(3) Financial evaluation of project

As a result of financial evaluation, the financial internal rate of return is estimated to be 8.8% as shown in Table 10-2-1. Although we do not foresee any problems regarding repayment of the foreign currency portion from international financial institutions based on the assumptions made, the market discount rate of 10% will make the situation severer.

On the other hand, the cash flow sheet as prepared from the assumed debts repayment schedule of procurement funds and operation revenue balance of installation and spread indicate that the cost of investment will be recovered in the 6th year after the operation started. (See Tables 10-2-2 through 10-2-4)

10.3 Determination of New Electric Tariff System

(1) In Bulgaria, there is a double tariff system comprising the tariff system applicable to the private users and the other applicable to the industrial users. The electric tariffs for end users and regional heating are subject to the governmental approval through the Energy Committee. The electric tariffs were compelled to be raised in two years, 1994 through 1995, due to the progress of the domestic inflation and the fluctuations of exchange rate incidental to the shift of the economy system to the market economy system from 1989 and on. For instance, the electric tariff for the individual households was raised by 30%-50%, and the electric tariff for industrial users by approximately 30%-40%.

The average electric tariff for industrial users in 1995 was 3.01 cents/kWh (about 3 yen/kWh), and that for private users was 2.33 cents/kWh (about 2.3 yen/kWh). Table 10-3-1 shows the currently applied electric tariffs.

(2) The price of electricity for the end-users is determined and controlled based on the regional cost of electricity (e.g. regional electricity cost of Maritsa East No. 1 power plant) which was accumulated by each electric power plant. However, the electricity prices for the users, both the end-users and industrial users, are determined taking into account the government subsidies intended for reducing the burden to both private users and industrial users, so that the existing electric tariff system as the whole is not necessarily based on the pure market mechanism reflecting actual costs.

Thus, in the current tariff system of the country, the tariffs for the end users are determined with political consideration and there is a big departure from the cost-based tariff systems.

(3) After 1994, the government has reviewed the electric tariff in order to reflect on the tariff the effects of the fluctuating economic factors such as those of the inflation and exchange rate and raised the tariff frequently. However, the existing tariff system is not necessarily designed for assuring the balance between the revenue and expenditure, and so it is necessary to establish a tariff system for assuring each electricity supplier the revenues large enough for making large investment backed by long-term borrowing. Thus, the problem to be solved from now on concerning the structure of the existing tariff system is how the capital cost of appropriate investment (interest on borrowing and depreciation cost) should constantly be reflected on the electric tariff by controlling it by each power plant, not by regional basis.

(4) Cash flow of the proposed project was analyzed in view of the result of its financial evaluation and profitability, assuming two difference unit prices, 3.8 cents/kWh based on assumed average growth rate of 5% and 5.0 cents/kWh based on assumed average growth rate of 11% by 2001 as the standard selling unit price in 2001.

In this analysis, the tariff is assumed to be set for earning the revenue comprising one from the selling of electricity and the other from the selling of the heat for regional heating, which are large enough for recovering the investment cost and operating cost with profit.

The conditions for introducing necessary borrowing are considered on the same bases as those of the repayment schedule of the borrowing in the case of the financial analysis discussed in Section 10.2.

(5) The results of cash flow analyses of the individual cases are given in Table 10-3-2.
In the case where the selling unit price is 3.8 cents/kWh, as far as viewed based on the result of the financial analysis and cashflow statement, it is not desirable for the proposed project to determine its repayment schedule, assuming that the revenue and the expenditure can be profitably matched without revising the standard electricity tariff and steam tariff as in 2001, on the conditions such as the interest rate on the borrowing in foreign currency for 20 years being 8.0% and the interest rate on the borrowing in domestic currency for 15 years being 10%.

Thus, under the borrowing conditions similar to those discussed above, the case where the unit selling price is assumed to be 5.0 cents/kWh is most practical and feasible. It is also necessary for the project to study on more advantageous conditions for borrowing from the international financing institutions in order to reduce the financing cost as far as possible.