7.2 PRIVATE AUTOMATIC BRANCH EXCHANGER (PABX)

7.2.1 APPLICABLE STANDAARDS AND CODES

7.2.2 SCOPE OF SUPPLY

The following automatic telephone exchanger, telephone sets, power source equipment and their accessories shall be provided, but not be limited to the followings.

One (1) set	Private automatic branch exchanger (PABX) and attendant console with chair
One (1) set	Terminal board
One (1) set	Power source equipment
Eighty (80) sets	Telephone set

7.2.3 TECHNICAL INFORMATION

The PABX shall be provided in order to enable mutual connection among public telephones and subscribers of West Wharf Thermal Power Station.

The PABX shall be installed in the communication room in the administration building.

The power source equipment for PABX with battery and battery charger shall be provided and installed in the battery room in the main powerhouse.

The telephone set (receiver) with eighty (80) sets shall be provided.

7.2.3.1 TYPE

(1) PABX

Crossbar switch system, locker type construction.

(2) Attendant console

Stationary, push buttom type

(3) Telephone set

Dial type, stand type, black color

7.2.3.2 CAPACITY OF PABX

The circuit capacity of PABX shall be Ten (10) for public telephones and one-hundred (100) for station telephones and the items shall be as follows.

(1)	Subscriber	:	One-hundred (100) circuits
(2)	Public telephone trunk	:	Ten (10) circuits
(3)	Extension trunk	:	-
(4)	Number group	:	Two-hundred (200)

7.2.3.3 TRUNKING SYSTEM

The trunking system of PABX shall be as follows.

(1) Connection among subscribers shall be performed through station telephone trunk by nine (9) digits dialing.

(2) Connection to public telephone shall be made possible by dialing zero (0).

(3) Connection to subscribers from public telephone call shall be made possible through attendant console.

(4) Connection to subscribers to exchange from attendant console shall be possible during night time or operator's absence.

(5) Reset call system shall be provided.

4-904

7.2.3.4 TONE SIGNAL

The tone signal shall have the following rating.

(1) Dial tone : 400 Hz continuous

(2) Busy tone : 400 Hz intermittent of 0.5 sec.

(3) Ring back tone : 400 Hz modulated by 16 Hz, intermittent of 1 sec.; 2 sec.

(4) Ringing tone : 16 Hz, intermittent of 1 sec.; 2 sec.

(5) Howler tone : 400 Hz, 10 sec. to 60 sec.

(6) Output : *

7.2.3.5 MONITORING ALARM

The monitoring alrm of PABX shall be provided with the following alarm and lamps.

(1) Main fuse failure

(2) Branch line fuse fialure

(3) Trunk equipmetn failure

(4) Power supply failure

(5) When temporarily leaving receiver off the hook

(6) Indication of telephone connection of other circuit failure

7.2.3.6 CONDITION OF USE

The PABX conditions of use shall be as follows.

(1) Input voltage

DC 48V ± 5%

(2) Line condition

a. Loop resistance of line * ohm

b. Leakage resistance * ohm

4-96

(3) Characteristics of impulse

a. Impulse type	:	10 PPS (Pulse per second)
b. Impulse speed	:	10 PPS ± 0.8 PPS
c. Impulse make-ratio	:	33 ± 3%
d. Minimum pulse	:	more than 600 msec

7.2.3.7 TERMINAL BOX AND BRANCHING BOX

The terminal box and the branching box shall be provided for branching and cutting off the cables for the MDF circuit.

Indoor type terminal box shall be of drip-proof, steel material wall hanging type, and the indoor type terminal box shall be of drip-proof, dust-proof steel material and wall hanging type.

The terminal box shall have at its front a hinged door with a key.

The quantity of spare terminals to be provided shall be about 20% of the required terminals.

7.2.4 SHOP TEST

The shop tests shall be as follows, but shall not be limited to the items below. The tests shall be carried out in the presence of the Engineer.

(1) PABX and attendant console

Construction

Operation test

Withstnad voltage test

Meggering

Operation test between exchanger and trunk board

Receiving impulse measurement

Function test

Impulse distortion test

Speech attenuation measurement

Alarm and annunciator test

Combined test of toll dialing all stations.

7.2.5 ACCESSORY

7.2.5.1 TEST EQUIPMENT

Measurement and test instruments of standard set for line resistance, insulation resistance, voltage, impulse speed, impulse mark ratio, telephone call, etc., shall be provided.

7.2.5.2 ACCESSORY

(1) PABX

Code	:	One (1) set
Paper	:	One (1) roll for each kind
Test transceiver	:	One (1) set
Maintenance tool	:	One (1) set
Wrapping tool	:	Two (2) sets
(hand operation)		
Un-wrapping tool	:	Two (2) sets
(hand operation)		

7.3 CLOCK SYSTEM

7.3.1 APPLICABLE STANDARDS AND CODES

The applicable standards and codes shall be in accordance with "Panels and Boards" in Clause 2.1 in Section II of Part I.

7.3.2 SCOPE OF SUPPLY

The following clock equipment and accessories shall be provided, but not be limited to the followings.

One (1) set	Master clock equipment
Thirty (30) sets	Slave clock

7.3.3 TECHNICAL INFORMATION

7.3.3.1 GENERAL

The clock equipment shall be of the crystal oscillation electric clock type, and shall be used to display the standard time and to control the slave clock groups. The driving oscillating section shall be a combination of solid state circuits which oscillate constant frequency.

Power source of master clock shall be DC 48 V.

Master clock shall have one (1) second pulse which is branched to the outside line through the control panel to drive the slave clock groups in the Unit No. 1 and Unit No. 2.

7.3.3.2 COMPONENT

(1) Master clock equipment

Type	Self standing metal clad, drip-proof
Oscillating frequency	*
Time error	1×10^{-7}/day
Slave clock output	1 (1) channel

Signal	One (1) second polarized pulse
Input power source	DC 48 V
Number of signals	30 more

(2) Slave clock

Slave clocks shall be provided and shall be operated by receiving and counting the clock pulse.

In accordance with the location of the two (2) types of slave clocks, a single face about 30 cm diameter and a double face about 60 cm diameter analog type clock shall be provided.

The slave clock shall have hour, minute and second hands.

7.3.3.3 LOCATION

(1) Main Powerhouse

Single face : On BTG board
No.1 instrument, elecrtical repair room
No.1 control equipment room
Shift room
Computer room

Double face : Ground floor (Unit No. 1 and Unit No. 2)
Mezzanine floor (Ditto)
Operating floor

(2) Substation

Single face : Control room

(3) Water treatment

Single face : Control room

(4) Administration building

Single face : Fifteen (15) rooms

8. LIGHTING

8.1 APPLICABLE STANDARDS AND CODES

The following applicable standards and codes of latest edition shall be applied, but not be limited to the followings.

International Electrotechnical Commission (IEC)

IEC 309 "Plugs, Socket-outlets and Couplers for Industrial Purpose"

Other pertinent International Electrotechnical Commission (IEC) standards and/or equivalent shall be applied generally for electrical apparatuses, and more detailed specifications for panels shall be in accordance with "Panels and Boards" in Clause 2.1 Section II of Part I.

8.2 SCOPE OF SUPPLY

The lighting fixtures, lighting distribution panels and accessories shall be supplied and installed in the following locations.

One (1) set	For Unit No. 1 and No. 2 power house
One (1) set	For Unit No. 1 and No. 2 boiler
One (1) set	For H_2 gas generator room
One (1) set	For plant water equipment control room
One (1) set	For administration building
One (1) set	For ware house
One (1) set	For screen control room
One (1) set	For screen area
One (1) set	For guard house
One (1) set	For FDF area
One (1) set	For waste water treatment area

One (1) set	For plant water treatment
One (1) set	For heavy oil tank and transfer pump station
One (1) set	For main and auxiliary transformer area
One (1) set	For heavy oil service tank/heater/pump area
One (1) set	For unit neutralization area
One (1) set	For house boiler tank
One (1) set	For make up water tank, and service water storage tank area
One (1) set	Other outdoor equipment
One (1) set	Parking area
One (1) set	Road

8.3 TECHNICAL INFORMATION

The lighting shall consist of normal lighting, normal emergency lighting, and emergency lighting and shall be used for lighting for the indoor and outdoor equipment, the offices and roads.

The power source shall be supplied from the No.1 or No.2 380V 3 ϕ 4 W lighting distribution panel.

The normal emergency lighting shall be capable of automatically providing lighting for safety at the time of a power source failure in the normal lighting system. The places to be installed shall be areas around the main power house and boiler.

The power source for the normal emergency lighting shall be supplied from the No.1 220V 3 ϕ 4 W normal emergency lighting distribution panel.

The emergency lighting shall be capable of automatically providing lighting for safety at the time of a power source failure in the normal lighting system. The emergency lighting shall be installed in the same locations as those for the above mentioned normal emergency lighting.

The power source shall normally be supplied from the AC V in the No.1 or No.2 380V 3 ϕ 4 W lighting distribution panel, but the lighting system shall be designed so as to changeover source to DC 220V power source, in case of emergency.

All lamps and power receptacles must be readily available from suppliers in Pakistan.

8.4 DESIGN

8.4.1 ILLUMINATION LEVEL

The normal and emergency illumination level shall be in accordance with the following. However, the Contractor shall submit the layout, quantities, etc. of the fixtures to the Engineer for approval.

Illumination level (minimum)	(lx)
Normal lighting	
Central control room	500
Office	300
Shift room	200
Instrument and electrical repair room	"
Metal clad switchgear area	"
Power center, control center and distribution panel	"
Turbine-generator room	100
Emergency diesel engine generator area	"
Control equipment room	"
H_2 gas generator room	"
Plant water equipment control room	"
Pre water and waste water equipment control room	"
Bridge for intake water pump station	"
Fuel oil unloading area	"
Battery room	70
Other room and stairs	"
Generator seal oil equipment area	"
Fuel equipment, screen area, evaporator area	50
Air compressor, BFP and condenser area	"

Plant water equipment and waste water equipment	"
Main, auxiliary and starting transormer area	20
Main roads	20
Branch road	5
Emergency lighting	
Central control room	5
Others	5

8.4.2 LIGHTING CIRCUIT

8.4.2.1 LIGHTING DISTRIBUTION PANEL

The lighting distribution panel shall be installed on each floor of the main power house, the central control room, the plant water equipment control room.

The panel shall be made of steel plate having a thickness of 1.6 mm to 2.3 mm, and shall be of the wall mounting or wall embedded type. The panel shall have a three-phase 380V bus for the normal lighting and a single-phase 220V bus for the normal emergency lighting. The panel shall serve to supply power to each fixture through the molded type air circuit breaker.

The panel shall have an automatic timer for outdoor lighting.

8.4.2.2 AC-DC CHANGEOVER PANEL

The AC-DC changeover panel shall be provided to feed power to the emergency lighting fixtures.

Under normal conditions, the power source shall be from the No.1 or No.2 AC 380V lighting distribution panel. However, should the above power source fail, the power source shall be automatically changed over to DC 220V.

8.4.2.3 INDOOR LIGHTING

The indoor lighting shall be designed to be manually switched on and off by means of the lighting distribution panel.

8.4.2.4 OUTDOOR LIGHTING

The outdoor lighting shall be designed to enable automatic switching on and off by means of an automatic timer built in the lighting distribution panel, as well as to enable manual switching on and off by means of a changeover switch.

8.4.3 LIGHTING FIXTURE

The typical types of the lighting fixtures shall be, in principle, as shown in the attached drawing.

8.4.3.1 FLUORESCENT LAMP

The fluorescent lamp shall be of a rapid-start type, and the stabilizer shall be of a high power factor constant voltage type. The fluorescent lamps shall be used for the main power house, auxiliary buildings, the boiler area, etc.

8.4.3.2 INCANDESCENT LAMP

The incandescent lamp shall be used for local lighting and emergency lighting.

8.4.3.3 MERCURY VAPOR LAMP

The mercury vapor lamp shall be used for the road lighting, the operating floor in the main power house and outdoors. For the stabilizer, the high power factor constant voltage type shall be supplied.

The mercury vapor lamp to be used for the operating floor shall be of the rapid-start type, and the outdoor-use lighting shall be of the water-proof type.

For the poles to be used for road lighting, the hot-dipped galvalized pipes shall be used. The pipes shall have a built-in stabilizer with a cut-out switch, and shall have a construction easy for inspection.

8.4.3.4 EXIT SIGN LIGHT

The exit sign light shall be mounted above the access ways, stairs, exits, etc., of the main building.

The light shall have a battery with a rectifier with a capacity of more than thirty (30) minutes.

8.4.3.5 POWER RECEPTACLE

The AC 220V, 15 A, single phase power receptacle with an adapter and a grounding terminal shall be provided in each room and each floor of the main power house, auxiliary buildings and the boiler area.

The power receptacle to be used for the boiler area shall be of the water-proof type.

All power receptacles shall be three (3) pin type,

9. 220 KV AND 132 KV CV CABLE

9.1 220 KV AND 132 KV CV CABLE (XLPE)

(CROSS LINKED POLYETHYLENE INSULATED VINYL SHEATH)

9.1.1 APPLICABLE STANDARD AND CODES

The following codes of newest edition shall be applied.

International Electrotechnical Commission (IEC)

IEC-287 "Calculation of the continuous current rating of cable"

Also, other pertinent International Electrotechnical Commission (IEC) standards and/or equivalent shall be applied generally for Electrical Apparatuses, and more detailed specifications shall be in accordance with "Panel and Board" in Clause 2.1 in Section II of Part I.

9.1.2 SCOPE OF SUPPLY

The following CV cable shall be provided:

One (1) set	220 kV CV cable, with accessories for No. 1 Main Transformers
One (1) set	132 kV CV cable, with accessories for starting transformer
One (1) set	220 kV CV cable, with accessories for No. 2 Main Transformers

9.1.3 TECHNICAL INFORMATION

The main CV cable shall be provided for transmitting the generated power (200 MW) from the No. 1 generator to the 220 kV switchyard through the main transformer.

The starting transformer CV cable shall be applied to connect the starting transformer (* MVA) with the 132 kV

9.1.3.1 TYPE

220 kV cross linked polyethylene insulated vinyl sheath cable

9.1.3.2 RATING

Rated voltage

Main cable	220 kV
Starting transformer cable	132 kV
Main cable	One (1) core x 800 mm^2 x 3
Starting transformer cable	One (1) core x 200 mm^2 x 3
Temperature rise	90°C

9.1.3.3 MANUFACTORY TEST

The items of manufactory test shall be as follows, but not be limited and the tests shall be in the presence of the Owner and/or the Engineer.

Measurement of conductor resistance

Meggering

Measurement of capacitance

Measurement of tan

Withstand voltage test

Bending test

9.1.4 CONSTRUCTION

9.1.4.1 CV CABLE

(1) Conductor

The conductor shall be the round compact stranded wires or the segmental compact stranded wire consisting of annealed copper wires.

4-9-17

(a) Round compact stranded wires

The round compact stranded wires shall comprise wires which are stranded into a concentric round form and compression-molded.

(b) Connection of conductors

The conductor shall have no connected portions nor shall it have two or more connected portions over the length of 30 cm at any optional portion of the outermost layer. Moreover, all annealed copper wire shall be carefully connected so as not to deteriorate its electrical and mechanical characteristics.

(c) Others

The external surface of the conductor shall be smooth and free from any cracks, protrusions, etc.

(2) Internal semiconductor layers

The internal semiconductor layer shall be formed uniformly over the conductor by similtaneous extrusion molding of the insulator. The internal semiconductor layer shall have a smooth surface and be free from any void deemed hazardous to use.

A separator may be provided on the portion of the internal semiconductor layer that comes into contact with the conductor by using fabric type.

(3) Insulators

The insulator shall be formed by coating crosslinked polyethylene or its mixture into a concentric round form over the internal semiconductor layer.

The surfaces of the insulator that comes into contract with internal and external semiconductor layers shall be smooth and free from any separation of the layers. Moreover, no foreign matter or void deemed hazardous to use shall be allowed.

(4) External semiconductor layers

The external semiconductor layer shall be formed uniformly over the insulator by simultaneous extrusion molding of the insulator. The surface of the external semiconductor insulator that comes into contact with the insulator shall be smooth and free from any void deemed hazardous to use.

Fabric tapes shall be wound over the extrusion-molded external semiconductor layer, and the thickness of the tapes shall be included in the thickness of the external semiconductor layer.

(5) Shielding layers

Annealed copper wires shall be wound over the external semiconductor layers at a pitch of eight times or less the layer diameter, and copper tape shall be wound flatly over the annealed copper wires at an appropriate pitch. The annealed copper wires and the copper tape shall be wound in opposite direction, and holding tapes shall be applied on the copper.

(6) Sheaths

Red polyvinyl chloride tape shall be applied in a concentric round form over the shielding layer.

(7) Indication

The nominal voltage, symbols, nominal sectional area of conductor, date of manufacture and manufacturer's name (or its abbreviation) shall be indicated by continuous printing at appropriate positions of the sheath so that these indications can be identified clearly for a long period.

(8) Connection

The cable shall be one through (no connection).

9.1.4.2 CABLE HEADS

The cable head at the transformer side shall be connected with the bushing in the oil and the cable head at the substation side shall be connected with the bushing in the SF6 gas. The bushings shall be able to withstand the voltage rising of sounding phases after one phase grounding under a salt contamination condition of 0.03 mg/cm^2 when the humidity of the air around bushings is 100 percent.

(1) Mounting structures

The mounting structure with anchor bolts shall be of hot dipped galvanized material

(2) Grounding lugs

The 250 mm^2 compression type grounding lug shall be attached to the structure.

9.1.4.3 TEMPERATURE RECORDER

The temperature recorder of CV cable shall be provided, which is mounted on the substation panel inside the building for the switchyard, shall be used to measure the sheath temperature of the cable.

Measurement of the sheath temperature shall be carried out at four points, two for the main transformer cable and two for the starting transformer cable.

9.1.4.4 CABLE FOR TEMPERATURE MEASUREMENT

Since the cable for temperature measurement is applied to connect the heat element attached on the surface of the CV cable with the temperature recorder, the cable shall be of a construction giving consideration to prevent of static and electromagnetic induction interference.

For further details, refer to "Standard of Cable and Wire" in Clause 9.8 Section I.

9.1.4.5 ARRESTERS FOR CABLE SHEATHS

The arrester for cable sheath shall be mounted on the sheath on the cable head on the side of the switchyard on order to restrain the abnormal voltage in the sheath produced on the occasion of abnormality in the circuit.

Moreover, cable sheath on the side of the transformer shall be grounded.

10. ERECTION

10.1 ERECTION

10.1.1 GENERAL

This specification shall be applied for the erection of all electrical equipment to be installed.

10.1.2 APPLICABLE STANDARDS AND CODES

The International Electrotechnical Commission (IEC) standard *of latest edition or equivalent standards shall be applied* generally for electrical apparatuses.

10.1.3 SCOPE OF SUPPLY

The following equipment shall be provided and installed, but not be limited to the followings.

One (1) set ..... Cables

One (1) set ..... Conduits

One (1) set ..... Cable trays and cable hangars

One (1) set ..... Grounding wires

One (1) set ..... Distribution panel for maintenance

10.1.4 ERECTION

10.1.4.1 INSTALLATION OF EQUIPMENT

(1) Items for general attention

In erecting and adjusting the equipment, detailed study on the content of the equipment to be erected shall be carried out in accordance with the drawings and instruction manuals, and erection shall carried out after obtaining approval from the Owner and the Engineer.

(a) Installation

The said drawings and the equipment shall, without fail, be varified and checked by the Contractor.

For transporting and lifting up of heavy equipment and materials, steel structures or beams shall not, in principle, be used. In case it is unavoidable to use such a structure, the Contractor shall obtain prior approval from the Engineer.

Sufficient attention shall be given so that no shock or damage is given to the machinery, equipment, instruments (gauges, meters, relays), etc.

Mortar filling of foundation bolts and channel bases shall be carried out after receiving approval from the Owner and the Engineer.

(b) Adjustment

The adjustment shall be carried out after receiving approval from the Engineer.

Any work adjustment shall be carefully carried out after the mortar for foundation bolts is sufficiently hardened.

10.1.4.2 INSTALLATION OF CABLE TRAY

Cable trays manufactured in accordance with Clause 9.9 in Section I "Standard of Cable Tray" in Design Standard shall be applied.

(1) Route for installation of cable tray

The route for the installation of cable trays shall be determined by sufficiently investigating the location of piping including water pipes, oil pipes and steam pipes

as well as machinery and equipment subject to high temperatures, and the cable trays shall be installed as far away from the piping and machinery as possible.

(2) Installation method

(a) The installation work of the cable tray is closely related to other construction work.
Therefore, the work shall be carried out after sufficiently grasping the work schedule.

(b) In case of providing machinery and equipment in this installation work, the Contractor shall receive approval from the Engineer.

(c) All welded parts and surfaces of the cable trays shall be satisfactorily finished to obtain smooth surfaces so that no damage is given to the cables.

(d) In case beams, floors, walls of buildings, machinery, equipment or painting are damaged or stained on the occasion of the cable tray installation, the Contractor shall repair the said damage or stain.

(e) For penetrating parts through walls, an accessory plate shall be used, and the plate shall be machine finished.

(f) For connecting parts of indoor and outdoor cable trays, a connecting box shall be used in order to shield the indoor cable trays from the outdoor cable trays, and the outdoor cable trays shall be coated for water-proof protection.

4-926

(g) Drawing out cables inside the cable trays shall be carried out according to the conduits work method or the flexible conduits work method.

(h) A blind plate shall be mounted on each end of cable far away from the piping and machinery as possible.

(i) Cable trays supporters shall be placed at an interval of less than 2.0 m.

10.1.4.3 INSTALLATION OF PIPING

(1) Piping method

(a) The Contractor shall receive approval from the Engineer in regard to the kind of conduits to be used.

The bending radius shall, in principle, be six (6) times larger than that of the conduits.

(b) In case there are bending spots of more than three (3) along the piping, a box or manhole shall be set up. The box or manhole shall be placed at a position causing no difficulty in laying the cables or wire inside the conduits.

However, the each offset bend shall be counted as two (2) bending perts.

(c) For places where the length of piping exceeds twenty (20) meters and where it is considered difficult to provide laying of the cables or wire inside the conduit, a box or manhole shall be provided.

(d) The end of the conduits shall be finished so as not to cause any damage to the cable or wire.

(e) The conduits shall be installed as far away as possible from other pipings, machinery and equipment (the pipings including oil and steam pipes, machinery and equipment subject to high temperatures) so as not to cause any harmful effect to the conduits.

(f) The conduits shall not, in principle, be used commonly for circuits of different electrical systems (circuits of different voltage, power circuits and control circuits, circuits of different grounding system, instrument circuits and power circuits, etc.)

(g) In selecting the size of conduits unless specified otherwise, the ratio of the sum total of the cross section of the wire or cable and the cross section of the conduits shall be in accordance with the following.

Standard Space Factor Value (%)

Number of wires in one conduit (pcs.) / Number of bends	1	2	3	4	More than 5 pieces
0 - 1	53	30	43	40	37
2	40	23	32	30	28

(h) The conduits and the accessories shall be completely connected mechanically and fastened properly by means of the most suitable method.

(2) Steel Conduit

The steel conduits shall have a thickness of more than 1.2 mm as specified in JIS C8305 or equivalent. The accessories for the steel conduits shall be JIS C8330-8347, or equivalent.

(a) Piping work for exposed part

Three-phase and single-phase power circuits shall not be piped phase by phase. No rust-proof coated contacts having peeled coating or rust shall be used. The conduits at a connecting part with the box or cabinet shall be installed at a right angle against the bottom or the side wall.

The conduits shall have a bushing or a lock nut at the connecting part with the box or the cabinet.

A coupling, feed coupling or a union coupling shall be applied at the mutually connecting part of the conduits.

The conduits shall be supported at an interval of less than two (2) m.

(b) Piping work at closed conduit

No conduit shall be buried directly in the ground but shall be enclosed in concrete. The thickness of concrete enclosure shall not be less than the outside diameter of the conduits.

In case several lines of conduits are installed in one lot, a sufficient distance between the mutual conduits shall be provided so that the concrete can be placed uniformly and easily.

The conduit shall be supported firmly so that it will not move during concrete placing.

Matters other than the above shall be in accordance with (a) (Piping work for exposed part).

Any load (lighting devices, etc.) directly from outside shall not work on the conduits or its accessories.

For conduits at a place with high moisture content or water content, the following shall be observed.

Sufficient moisture-proof treatment shall be provided for the coupling and other accessories. Piping which may cause water puddles (such as U-shaped piping) shall be avoided.

For conduits subject to exposure to concrete, sand, dust, etc., sufficient treatment (bush caps, wood cork) shall be provided.

(3) Installation work of flexible steel conduit

The flexible steel conduits shall have a thickness of more than 0.8 mm as specified in JIS C8309, or equivalent and shall have a rubber cover.

(a) Installation method

Both ends of the flexible steel conduits shall be fixed precisely and supported at its center at an interval of less than 0.6 m.

For connection with a box or a cabinet, a box connector shall be used.

For most suitable connector shall be used for the

connection of the flexible conduits with the electrical conduits.

Other matters shall be in accordance with 10.1.4.3 (1) Installation of piping.

(4) Installation work of rigid PVC conduits

For the rigid PVC conduits and accessories, material specified in JIS C8430 - 8437 or equivalent be used at places specified by the Engineer.

(a) Installation method

Mutual connection of the rigid PVC conduits shall be carried out by using a coupling, or by softening one side by heating and then inserting the connecting pipe. No connection shall be made by thread cutting.

The inserting depth shall be more than 1.2 times the external diameter of the conduits.

In case the conduit is installed at a place with high moisture or water content, adhesive shall be applied for mutual connecting parts.

On the occasion of bending, sufficient attention shall be paid to the following points.

After heating and softening carefully so as not to scorch the pipe, bending work shall be carried out. Wiring work shall be carried out after the conduit is sufficiently cooled.

Care shall be taken so that the wire is not crushed.

The conduits shall be supported at an interval of less than 1.5 m, and the supporting point shall be established at the connecting point with the conduits and the box, and at the spot near the respective connecting points of the mutual conduits. The conduits shall be supported by means of a rigid PVC saddle.

The maximum applicable temperature shall be 60°C.

For cutting the conduits, a saw shall be used.

After cutting, both inner and outer surface of both ends shall be slightly surface finished by means of a file.

(5) Installation work of outdoor cable duct

The outdoor cable duct with manhole shall be designed and shall consist of a power cable route and a control, instruments, computer and communication cabale route. The above cable ducts shall be separated in order to prevent static and magnetic induction from high voltage power line.

10.1.4.4 INSTALLATION OF WIRING

The cables and wires shall be in accordance with Clause 9.8 in Section I "Standard of Cable and Wire" in Design Standard.

The Contractor shall draw up a schedule describing kinds, purpose, size of cables, installation route, and installation method, and receive approval from the Engineer prior to carrying out wiring work of cables and wires.

(1) Wiring method of cable

Cables for circuits with different electrical systems (for example, circuits of different voltage, power circuits and control circuits, circuits of different grounding system, lighting circuits and other circuits, communication circuits and other circuits, etc.) shall not be, in principle, inserted in the same conduits.

The cables shall be inserted in the same conduit in such a manner so that no magnetic reaction is produced inside the conduit.

The cables shall be laid in such a way that they do not cross each other.

The cables shall not be supported directly by the wall of a building or other structures.

The cables standing vertically or hanging down vertically inside the shaft shall all be supported by means of the cleat anchoring method or other suitable methods. For the cleat, lauan or lumber having equivalent property shall be used.

For wiring, sufficient care shall be taken so that cables are not damaged, and no cables shall be drawn out forcefully. Messenger wires, lubricants and wire extension rollers shall be used. Lubricants which may cause harmful effects to cable sheath and conduits shall not be applied. The minimum bending radius of the cables shall be in accordance with the following standard dimensions:

Voltage	Single core	Multi core
600V	8 D	8 D
6,600V	10 D	8 D
6,600V Aluminium sheathed cable	15 D	---

However, D shall be based on the finished outside diameter of cable.

(2) Terminal treatment method

Immediately after cutting the cable, complete moisture-proof treatment shall be carried out.

For the terminal of the power cable, compressed or clamp terminal shall be used.

For the control cable terminal, clamp terminal with insulation cover shall be used.

After the power cable is connected to machinery or equipment, all charging part shall be taped with insulation materials used for the insulation covering for the cable.

Number plates indicating the circuits schedule shall be attached at easy to see places on both ends of each line of all cables.

For connection of cables with equipment, a compressed or crimp terminal shall be applied.

4-934

10.1.4.5 INSTALLATION OF GROUNDING WIRE

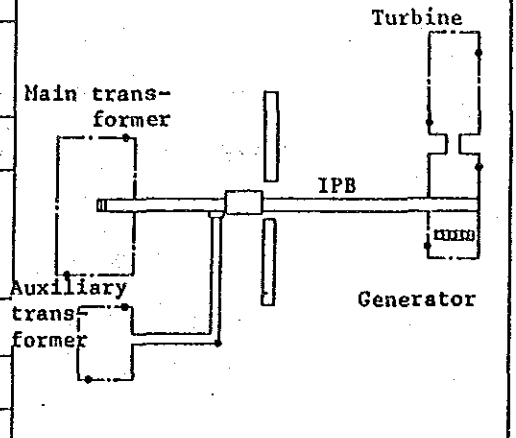
The grounding wire shall be applied in accordance with Clause 9.7 in Section I "Standard Design of Cable and Wire".

(1) List of grounding wire size selection

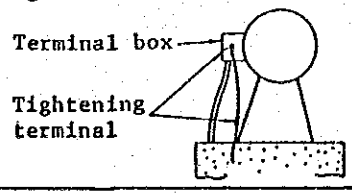
(a) Main grounding wire

	Type of Grounding	Size of Grounding Wire	Remarks
Main grounding Wire	Primary	250 mm^2	Mesh type
	Secondary	250 mm^2	"

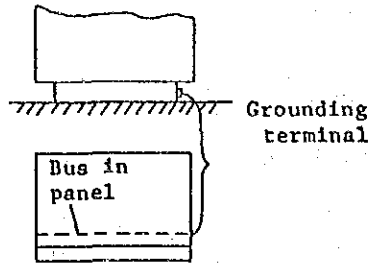
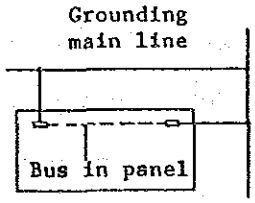
(b) Turbine, Generator and Transformer

Item		Wire Size (mm^2)	Number of Grounding	Remarks
Turbine		250x2	2	
Generator		250x2	2	
Isolated Phase Bus Duct	Main Body	250x2	2	
	Supporting Steel Structure	250x2	2	
Main Transformer	Main Body	250x2	2	
	Neutral (Direct Grounding)	250	1	
Auxiliary Transformer		250x2	2	
Starting Transformer		250	2	
Power Center Transformer	6,600V	150	2	
Power Potential Transformer		150	2	

(c) Motor

Voltage		Wire Size (mm^2)	Number of Grounding	Remarks
220V		38	1	o Terminal box of a 6.6kV motor shall be connected to the main body by grounding wire. o Terminal box of a motor of lower voltage need not be grounded.
380V	Less than 11kW	38	1	
	12-29kW	60	1	
	Larger than 30kW	100	1	
6.6kV		150	1	
DC Motor		38	1	
				

(d) Cubicles and Panels

Item	Wire Size (mm^2)	Number of Grounding	Remarks
Main Transformer Cooler Cubilce	50	1	
Generator PT and SA Cubicle	250x2	1	
Generator NGR Cubicle	150	1	
Instrument Panel Control Panel Distribution Panel	38	2	o Both ends of a grounding bus in a panel shall be grounded. o A grounding bus in a panel shall be electrically connected to the panel. 
BTG Board	38	2	
Exciter Panel (AVR, Field Rheostat and ACB)	250x2	2	
Metal Clad Switchgear 6.6kV	150	2	
Power Center	100	2	
Control Center, Diesel Engine Panel 230V	38	2	
Control Center, Diesel Engine Panel 380V	50	2	
DC Control Center	38	1	
Lighting Distribution Panel	50	1	
Battery Charger Panel	50	1	
Local Control Box	14	1	o Ordinary local control box mounted on steel structures by welding need not be grounded.

K-937

(e) Others

Item	Wire Size (mm2)	Number of Grounding	Remarks
Emergency Diesel Engine Generator	250	2	. Base plate shall be grounded.
Cable Tray	-	-	. To be welded to steel structures.
Overhead Grane	-	-	. Rails shall be grounded.
Fuel Oil Tank	50	2	. Tank wall and floating roof shall be grounded.
Water Tank	50	1 - 2	

(2) Main grounding wire

The main grounding wire shall consist of two (2) kinds, the primary main wire and the secondary main wire. It shall be of mesh construction and applied to maintain the grounding resistance value of less than ohm.

The seconday main grounding wire shall be connected with substation grounding wire.

(3) Wiring method

Connection of the main grounding wire shall be carried out by ground connector or welding. However, connection of spots which require mechanical strength shall be carried out by fastening, compression or crimp connecting.

For connecting to each machinery and equipment, mounting structures or hangers, the grounding wire shall be firmly fastened after grinding the contract surface of the terminal.

4-7-84

Cutting of the main grounding wire shall be carried out by using steel saw after providing taping beforehand so that the stranded wire does not become untied nor dust adhere to the wire.

10.1.4.6 DISTRIBUTION PANEL FOR CONSTRUCTION AND INSTALLATION WORK

This distribution panel shall be used for the power source for the site construction work and maintenance. The power source shall be supplied from the miscellaneous distribution panel, and at least fifteen (15) sets for unit No.1 and ten (10) sets for unit No.2 shall be provided.

(1) Construction

The distribution panel for the construction work shall be of an indoor or outdoor type, wall supporting and metal clad type, and it shall have at its front a hinged door with a stopper and a handle with a key.

The distribution panel for the construction work shall have a built-in molded type air circuit breaker, terminals and a cable supporter.

The terminals shall have a construction facilitating easy and precise connection with the outdoor temporary cables.

(2) Grounding plate

The grounding plates shall be attached at the bottom part of the distribution panel for the field work, and the plates shall be of a construction facilitating easy and precise connection of the outer grounding wire.

10.1.4.7 PAINTING

(1) Painting method

As the painting work may be carried out during operation of the machinery and equipment or during preparation for operation at the final stage of the construction work, the painting work shall be carried out in accordance with the following instructions so as not to cause any damage to the machinery and equipment.

Sufficient surface cleaning shall be provided prior to painting.

After surface cleaning, the color to be painting shall be confirmed.

One coat of paint shall be applied after completion of the installation of the equipment.

For exposed metal conduits, accessory supporters, boxes, and other parts specified in particular on the occasion of the installation work of the metal conduits, two coats of base metal rust-proof paint and two coats of finish painting shall be applied.

For equipment and materials which may be exposed to corrosion gas, rust and corrosion-proof painting shall be applied.

In case of galvanized materials, painting need not necessarily be carried out, unless specified otherwise.

Painting of supporting fixing and wall penetrating parts shall be carried out.

4-9K0

10.2 FIELD TEST

The field test shall be provided for all machinery, equipment and wiring to be supplied in this specification.

The field test shall be carried out attended by the Owner and the Engineer on the occasion of installation of the machinery and equipment and on trial operation in regard to the following items.

Prior to the field test, the Contractor shall draw up test procedure documents and submit them to the Owner and the Engineer for approval.

All temporary equipment, testing devices, gauges and meters, recording sheets, etc. required to provided the field test shall be supplied by the Contractor.

10.2.1 TEST METHOD DOCUMENT

The test procedure documents shall include, but not be limited to, the following items.

Date

Tested machine

Test item

Test method

Test results

Number of testing operators

List of tested machines and instruments

Countermeasures for safety

10.2.2 TEST ITEM

The following tests shall be carried out, but shall not be limited to the items below.

(1) Generator

- Meggering
- Withstand voltage at commercial frequency
- Shaft voltage measurement
- No load operation
- Vibration measurement
- Air gap measurement
- RTD circuit check
- Exciter and AVR
  - Sequence
  - Static characteristic
  - Dynamic characteristics
- H_2 gas leakage
- Sense

(2) Isolated phase bus duct

- Meggering
- Welding check
- Withstand voltage
- Temperature

(3) Potential transformer

Meggering

Withstand voltage

Polarity test (including cable, terminal box, panel terminals)

Burden measurement (including cable)

(4) Current transformer

Meggering

Polarity (including cable, terminal box, panel terminals)

Burden measurement (including cable)

(5) Power transformer

Insulation oil withstand voltage test

Withstand voltage test at commercial frequency

Ratio

Polarity

Phase angular

Cooling pump and fan

Protective device

Noise measurement

(6) Metal clad switchgear, power center, control center, panel and board

Sequence

Withstand voltage(metal clad switchgear only)

(7) Battery and battery charger

Battery charger

Meggering

Sequence

Battery

Electrolyte specific gravity measurement

Voltage measurement

(8) CVCF

Meggering

Sequence

Operation

(9) Motor

Meggering

Withstand voltage (V motor and cable only)

No load operation

On load operation (V motor only)

(10) Disconnecting switch

Air piping leakage

Operation

Contact resistance measurement

Sequence

Withstand voltage test at commercial frequency

(11) Lightning arrester

Meggering

(12) kV Overhead line

Meggering

Withstand voltage test at commercial frequency

(13) CV Cable

Meggering

Withstand voltage

(14) Grounding

Measurement for grounding resistance (by voltage drop method)

(15) Emergency diesel engine generator

Sequence

Protective device

No load

On load

Temperature

Noise measurement

(16) Relay

Characteristic test on setting tap

System operation charactristic

(17) Watt hour meter

Characteristic and accuracy

(18) Meter

Accuracy

(19) PABX

Operation maggering

Operation test (exchanger trunk board)

Combination test of toll dialing for all stations

(20) Lighting

Meggering

Illumination level measurement

AC-DC automatic changeover

K-9/45

(21) Telecontrol equipment

Sequence

10.2.3 OVERALL TEST

Overall interlock

Sense

Parallel operation

Starting transformer and auxiliary transformer changeover

On load

Dump

Generator and transformer heat running

4-946

11. SPARE PARTS FOR GENERATOR AND ELECTRICAL EQUIPMENT

The following minimum required spare parts shall be provided. In addition, the Tenderer shall propose the recommended spare parts for the generator and electrical equipment as stated in Clause PA.14 of "Spare Parts" in Section II of Volume 1.

(1) Common Parts	Numbers of spare
(a) Panel and board	
Indicating lamp (including announciator lamp)	each type 200%
Lamp lens and globe	each type 100%
Lamp socket with resistance or transformer	each type 50 sets
Main protective relay (except over current relay)	each type 1 set
Over current relay	each type 3 sets
Auxiliary relay (including time relay)	each type 20 sets
Control switches and changeover switches	each type 5 sets
Push button with indication lamp (series II)	each type 20 sets
Push buttons	each type 10 sets
Recording charts, pens and ink	each type for 5 years
Closing and tripping coil for VCB and ACB	each type 5 sets
Enclosed fuses	each type 200%
Molded type ACB	each type 10 sets
Magnetic contractor	each type 10 sets
Thermal relay	each type 10 sets
Control transformer in control center	each type 3 sets

(b)	Motor	
	Bearing	200% all of motors
	Brush of DC motor	each type 200%
(c)	Current transformer	each class ratio 2 sets
(d)	Potential transformer	each class ratio 1 set
(2)	Special Parts	
(a)	Generator	
	Generator bushing	1 piece
	Vibration detector	1 piece
	Packing, gasket, packing compound	400%
	Bearing and assemble	1 set
	Oil seal rings and O-rings	2 sets
	Brush	1,000%
	Brush holder	10 sets
	Cooling air filter for	200%
(b)	Exciter and AVR	
	Control device	100%
	Module	2 of each type
(c)	H_2 gas control cubicle	
	Silica gel	200%
	H_2 gas reducing valve	1 set
(d)	Seal oil unit	
	Packing and gasket	400%
	Differential pressure control valve	1 set
(e)	Isolated phase bus duct	
	Insulator	4 sets

(f) Potential transformer

Secondary fuse	200%
Current limiting fuse for primary	200%

(g) Main transformer

High tension side bushing	1 set
Low tension side bushing	1 set
Bursting plate	2 sets
Packing and gasket	200%
Removal type unit radiator (including fan and motor)	1 set
Thermo element of temperature detector	2 pieces
Silica gel	200%
Insulation oil	600 litres

(h) Auxiliary transformer

High tension side bushing	1 piece
Low tension side bushing	1 piece
Bursting plate	2 sets
Packing and gasket	200%
Removal type unit radiator	1 set
Thermo element of temperature detector	2 pieces
Silica gel	200%
Insulation oil	600 litres
Lightning arrester with condenser	1 set

(i) Starting transformer

Same as Item (h)

(j) 6,600 V M/C	
PT primary and secondary fuse	200% each
VCB assembly	
3000 A	1 set
600 A	3 sets
(k) 400 V power center	
PT primary and secondary fuses	200%
Movable and fixed contractors for ACB	
3000 A	3 sets
600 A	6 sets
Complete assembly of ACB	
3000 A	2 sets
600 A	4 sets
(l) 400 V Control center	
Unit assembly	6 sets each type
(m) Distribution panel	
Molded type circuit breaker	6 sets each type

(n) Emergency diesel engine generator	
Diesel engine	
Admission gear rods	1 set
Exhaust gear rods	1 set
Piston rings	each piston 1 set
Connecting rod bush	1 set each piston
Cylinder head and accessories	2 sets
Admission valves	each type 1 set
Exhaust valves	each type 1 set
Valve spring	each type 1 set
Injector	2 sets
Injector holder	2 sets
Oil cartridges	2 sets
Joints	100%
Generator	
Brushes	200%
Brush holder	2 set
Control device	100%
Module	2 sets of each type
(o) Battery and battery charger	
Battery cells	11 cells
Battery charger	
Module	each type 2 sets
Electronic part	100%

K-24/

(p)	Paging and clock	
	Paging handset	5 sets each type
	Speaker	
	Horn type	4 sets each type
	Cone type	2 sets
(q)	PABX	
	Fuses	200% each type
	Lamp	200% each type
	Condensor	200%
	Varistor	200%
	Discharge tube	200%
	Relay	50 sets each type
	Resistor of relay	200% each type
	Jumper wire	200%
	Oil	200%
	Expendables	each type for five (5) years
	Fuse for repair	200%
	Power source equipment	
	Battery cells	11 cells
	Battery charger	
	Module	each type 2 sets
	electronic part	200%
	Telephone set	25 sets
(r)	Clock	
	Stare clock	5 sets
(s)	Lighting	
	Lighting fixture except mercury vaper lamp	each type 5 sets

Lighting fixture for mercury vaper lamp	each type 10 sets
Mercury vaper lamp	each type 50 sets
Power receptacle	each type 10 sets

PART II

SECTION VI

PLANT COMPUTER SYSTEM

SECTION VI. PLANT COMPUTER SYSTEM

CONTENTS

These specifications are prepared for two (2) units, Unit 1 and Unit 2.

		PAGE
1.	PLANT COMPUTER SYSTEM	P10-1
	1.1 SCOPE OF SUPPLY	P10-1
	1.2 GENERAL OF INFORMATION	P12-1
	1.2.1 APPLICABLE STANDARDS AND CODES	P12-1
	1.2.2 OUTLINE	P12-1
	1.2.3 DESIGN DATA	P12-4
	1.2.4 PERFORMANCE AND GUARANTEE	P12-7
	1.2.5 TESTING	P12-16
	1.2.6 TRAINING	P12-16
	1.3 TECHNICAL INFORMATION	P13-1
	1.3.1 POWER DISTRIBUTION AND PROTECTION	P13-1
	1.3.2 CABINETS FOR COMPUTER SYSTEM	P13-1
	1.3.3 CABINET WIRING	P13-2
	1.3.4 CENTRAL PROCESSING UNIT	P13-2
	1.3.5 INPUT/OUTPUT SYSTEM	P13-3
	1.3.6 AUXILIARY MEMORY UNIT	P13-6
	1.3.7 PRINTERS	P13-6
	1.3.8 CATHODE RAY TUBE UNITS	P13-7
	1.3.9 TREND RECORDER	P13-7
	1.3.10 FLOPPY DISK DEVICE	P13-8
	1.3.11 HARD COPY UNIT	P13-8
	1.3.12 OPERATOR'S CONSOLE	P13-8
	1.3.13 PRINTER DESKS	P13-9

4-955

PAGE

1.3.14 OPERATOR'S DESK P13-10

1.3.15 ENGINEER'S DESK P13-11

1.3.16 PROGRAMMING P13-12

1.3.17 FUNCTIONAL REQUIREMENTS P13-13

1.3.18 DATA LOGGING P13-15

1.3.19 TURBINE STARTUP SEQUENCE CONTROL (TSC) P13-18

1.3.20 PERFORMANCE CALCULATION P13-19

1.3.21 GRAPHIC DISPLAY P13-20

1.3.22 SEQUENCE OF EVENTS LOG P13-21

1.3.23 EVENT RECALL P13-22

1.3.24 OPERATION GUIDE TRAINING SYSTEM BY CPU P13-22

2. SPARE PARTS FOR PLANT COMPUTER SYSTEM P20-1

4-946

1. PLANT COMPUTER SYSTEM

1.1 SCOPE OF SUPPLY (for two (2) units)

The on-line computer system shall include, but not be limited to, the following items.

(1)	Central processing unit (CPU) with main memory unit	Two (2) sets
(2)	Auxiliary memory unit	Two (2) sets
(3)	Process I/O unit	Two (2) sets
(4)	CPU and floppy disk device (FDD) unit cabinet	Two (2) sets
(5)	Auxiliary memory unit cabinet	Two (2) sets
(6)	CRT controller cabinet	Two (2) sets
(7)	I/O unit cabinet	Two (2) sets
(8)	Termination cabinet	Two (2) sets
(9)	Distribution cabinet	Two (2) sets
(10)	Color cathode ray tube (CRT)	Seven (7) sets
(11)	Printers	Six (6) sets
(12)	I/O printer	One (1) set
(13)	Trend recorders	Four (4) sets
(14)	Floppy disk devices	Two (2) sets
(15)	Hard copy unit	One (1) set
(16)	Operator's console	Two (2) sets
(17)	Operator's console	Two (2) sets
(18)	Printer desks	Six (6) sets
(19)	Engineer's desk	One (1) set
(20)	Computer software including program memorized floppy disk	One (1) set
(21)	Computer system diagnostic software including program memorized floppy disk	One (1) set

4-85)

(22)	Testing of computer hardware and software	One (1) set
(23)	Anchor bolts, nuts, anchor frames, templates, insulation sheets, etc. for equipment	One (1) set
(24)	Power cables, control cables and grounding wires	One (1) set
(25)	Conduits and ducts for electrical	One (1) set
(26)	Expendables for trial operation	One (1) set
(27)	Training	One (1) set
(28)	Special tool and standard tool sets	One (1) set
(29)	Operation guide training system by CPU	One (1) set

4-9-78

1.2 GENERAL INFORMATION

1.2.1 APPLICABLE STANDARDS AND CODES

The following standards and codes of the newest editions shall be applied.

Japanese Industrial Standards (JIS)

Japanese Electrotechnical Committee (JEC)

Standards of the Japan Electrical

Manufacturer's Association (JEM)

Standards of the International Standard Organization (ISO)

or equivalent standard

1.2.2 OUTLINE

(1) The plant computer system shall have the functions for data logging, graphic display, sequence of event log, event recall, trend record, turbine startup sequence monitor (TSM), alarming, plant performance calculation, prewater treatment, water treatment and waste water treatment performance, etc. The above interface equipments shall be furnished to communicate with the computer System.

(2) One (1) set of the computer system shall cover monitoring of two (2) power plant unit.

(3) The computer system shall be installed in the computer room to be constructed adjacent to the central control room for Units No. 1 and 2.

(4) The peripherals for man-machine communication, data CRT display unit, alarm CRT display unit, operator's console, logging printer, alarm printer, trend recorder, hard copy unit, operator's desk and printer desks shall be installed in the

central control room.

(5) Two (2) sets CPU and Auxiliary memory unit shall be installed. One (1) set shall be for normal operation, the other for stand-by. The stand-by unit shall startup automatically by self-trouble diagnosis.

(6) The peripherals for the computer engineer's communication, CRT display unit, floppy disk, I/O printer and engineer's desk shall be installed in the computer room. For the operation training peripherals, operation console, CRT, key board, printer, hard copy, etc. shall be installed in the meeting room.

(7) The alarm CRT and two (2) trend recorders shall be mounted on the BTG board.

(8) The I/O printer and CRT unit with keyboard shall be provided on the engineer's desk.

(9) For the operator's communication, the CRT unit, operator's console, hard copy unit and data printer shall be provided on the operator's desk.

(10) The general arrangement for the computer system shall be as shown in the Drawings for tendering WAT-1103 "Operating Floor Plan" and WITS-1001 "Conceptual Diagram of Plant Control System".

(11) The unit computer main system (CPU unit and each memory) to be offered by the Contractor shall have sufficient reliability to ensure a mean time between failure (MTBF) of longer than six (6) months. Any and all such MTBF in connection with software/hardware failures shall be included in this

performance criteria.

The following definition for MTBF shall apply.

$$\text{MTBF} = \frac{\text{(Total time required for operation) - (Total outage time)}}{\text{Total number of failure}}$$

(12) The Contractor shall also submit a reliability prediction report providing details of the predicted and guaranteed MTBF figures.

The report shall include the following.

(a) The type of failure analysis performed on each system offered. The Contractor shall furnish all details of predicted failure rates obtained from this analysis. These rates will enable an estimate to be made of the manpower requirements and spare parts necessary to provide support to each system.

(b) The mathematical model shall be used to calculate the MTBF and all factors that have resulted in deviations from the model.

The report shall state whether or not actual temperature rise measurements were made to determine equipment operating temperature.

(c) A section stating the system failure rate, the operational failure rate and the emergency failure rate shall verify the predicted and calculated MTBF.

(d) The Contractor shall provide detailed availability data for each system. In addition, the Contractor shall provide all manufacturer's reliability and quality assurance information to enable a maximum MTBF and minimum

Mean Time to Repair (MTTR) to be achieved.

(13) Multi microprocessor and high speed data highway are preferred for data communication.

(14) The configuration and technical specification of the unit computer system shall be based on the process system, the operation requirement of the unit and all the descriptions stated hereinafter. The configuration diagram shall be included in the proposal.

1.2.3 DESIGN DATA

The specifications for the computer system shall include, but not be limited to, the following.

(1) Central processing unit (CPU)

Logic circuit element	LSI, MSI, SSI
Arithmetic operation unit	Binary parallel, fixed point, floating point
Register	16 general registers (minimum)
Number	Two (2) sets

(2) Main memory unit

Capacity	1 MB (minimum)
Element	IC 32 bits
Error check	Included
Cycle time	0.5 sec/2 Bytes (less than)

(3) Auxiliary memory unit

Fixed head disk or IC bulk memory	
Capacity	40 MB
Access time	Average, less than 10 msec.
Memory protection	Included

	Number	Two (2) sets
(4)	CRT unit	
	Number of characters	3,200 (80 characters x 40 lines) in minimum
	Number of colors	Eight (8)
	Display tube	20 inch diagonal
	Number	Seven (7) sets
(5)	Floppy desk	
	Storage capacity	256 kB
	Number of connected devices	Two (2) devices per controller
	Number	Two (2) sets
(6)	Trend recorder	
	Number of pens	Four (4) pens
	Input signal	4 - 20 mA
	Number	Four (4) sets
(7)	Operator's console	
	Type	Selective type with keyboard function
	Number	Two (2) sets
(8)	Printer	
	Printing speed	132 characters/sec (more than)
	Line length	132 characters/line (more than)
	Number	Six (6) sets
(9)	Engineer's printer	
	Printing speed	132 characters/sec (more than)
	Line length	132 characters/line (more than)
	Number	One (1) set

(10) Process I/O unit for one unit

Analog input unit	
Thermocouple	One (1) set
RTD (unit)	One (1) set
mA (unit)	One (1) set
Digital input unit	One (1) set
Pulse input unit	One (1) set
Analog output unit	One (1) set
Digital output unit	One (1) set

(11) Hard copy unit

Type	Multi colors
Number	One (1) set, selective use for No. 1 or No. 2 unit
Copy size	A4 (215.9 x 279.4 mm)

(12) Printer desk

	(W) (D) (H)
Dimension	800 mm x 700 mm x 700 mm (Tentative)
Number	Two (2) sets

(13) Operator's console desk

with CRT, keyboard, and hard copy unit

	(W) (D) (H)
Dimension	2,100 mm x 900 mm x 750 mm
Number	Two (2) sets

(14) Engineer's desk

with CRT, keyboard and printer

	(W) (D) (H)
Dimension	1,250 mm x 1,000 mm x 750 mm
Number	One (1) set

1.2.4 PERFORMANCE AND GUARANTEE

(1) Availability test

An availability test run shall precede take over of the computer system.

The availability of computer system shall not be less than 99.5% for a tested period of three (3) months, and shall apply to all equipment included in take over.

A guaranteed figure for availability shall be stated in Clause 1.2.4 (2) in this Section.

(2) Guaranteed capability of computer system

(a) The computer system shall be guaranteed with respect to the following items.

* Availability factor of computer system	99.5% or over
* MTBF of main computer equipment	2160 hours or over
* Test period	90 days

(3) In case the computer system is disqualified as a result of tests on MTBF or availability factor, the said tests shall be carried out successively for another three (3) month. Depending upon the actual circumstances, however, such matters shall be solved upon negotiation between the parties concerned. Any defective equipment found during the test shall be repaired, remodeled or replaced by and at the expense of the Contractor.

The availability factor is expressed in detail as follows:

$$\text{Availability factor} = \frac{T1 + T2 + (T3 - T'3)}{T1 + T2 + T3} \times 100\ (\%)$$

$$\text{MTBF} = \frac{T1 + T2 + (T3 - T'3)(\text{hour})}{F}$$

4-96

The degree of effect factor is expressed in detail as follow.

$$\text{Availability factor} = \frac{T_1 + T_2}{T_1 + T_2 + T_3} \times 100\ (\%)$$

$$\text{MTBF} = \frac{T_1 + T_2}{fi}\ (\text{hour})$$

where

T1 : On-line operation time

T2 : Available on-line operation time

T3 : Computer failure time

T3' : Computer failure time

F : Frequency of failures counted regarding the MTBF of pverall system

T4 : Time disregarded for counting

T3 = ti (hour)

T3' = witi (hour)

F = Ki fi (Frequency/Number of times)

wi : Weighted factor of overall computer system failure (in case two or more troubles have occurred at the same time, the respective weighted factors shall be added. However, the maximum value of wi shall be 1)
The weighting factor of the respective equipment for the computer system shall be as indicated in Table 1.

ti : Actual failure time of computer

ki = 1: In the case of failures counted for MTBF Calculation of the computer overall system

ki = 0: In the case of failures which are not counted for MTBF calculation of the computer overall system

4-966

fi : Actual frequency of computer failure (downtime)

On-line operation time: T1

Time (duration) when the computer system has been in operation while demonstrating its necessary functions without any trouble in both the hardware and software (program)

Available on-line operation time: T2

Time when on-line operation has not been executed, although the computer system is available/ready for on-line operation or when on-line operation has been impossible due to defects in the equipment or program other than those intended for the test. For example, T2 includes the following:

(1) Time when on-line operation has been suspended due to the convenience of the Owner.

(2) Time when the computer system has been kept off-line for education and training in response to the request from the Owner.

(3) Time when a failure in the equipment or program has made it impossible to continue on-line operation as a result of maloperation of the Owner's engineer who should have naturally complied with the instructions for operation of the computer system.

Meanwhile, it shall be a prerequisite that the computer system to be procured under this project should ensure easy operation and maintenance so that any plant operator who has no professional computer knowledge or skill will be able to operate the system without any error.

(4) Time when on-line operation has been suspended for maintenance of the equipment other than that not intended

for the test.

(5) Time when the ambient conditions have not met the designated conditions as a result of trouble in air-conditioning or other equipment.

Meanwhile, this time T2 shall be as short as possible and be applied after sufficient discussions between the Employer and Contractor.

Computer failure time (downtime): T3 and T3'

This time is the duration when on-line operation has become impossible or the function has been in trouble due to a failure in the computer hard-ware or software during the on-line operation time or available on-line operation time.

(1) Should any failure have occurred in a part of the functions, the failure time (down time) shall be corrected by multiplying a weighted factor (1.0 or less).

(2) In principle, the extent of trouble shall be evaluated (decided) based on the degree of the effect of the trouble upon the system according to the categories indicated in the table below. For further detail, refer to the weighted failure factors indicated in the Table-1 attached hereto.

(3) The failure time shall be measured (counted) on the basis of a unit of one (1) minute, and in case the failure time is shorter than one (1) minute, the time be counted up as one (1) minute.

(4) Meanwhile, the following time (durations) shall also be counted as the computer failure time (downtime):

(a) Time required for checking the computer system using

a test program after repair of the system.

(b) Time required to reload a program into the computer system after elimination of a failure

(c) Time required until completion of initializing the shutdown computer after elimination of a failure

(d) In case a failure has occurred due to the same cause within one (1) hour after restarting the computer, such failure shall be deemed as a continuous failure time (downtime).

(e) Time required until completion of initialization in case the computer has been initialized automatically based on its self-diagnosis function. In this case, however, the time (duration) shall not be included in the frequency of failure (F) for calculating the MTBF.

Concept of starting and ending points for calculating downtime as well as the time to be disregarded for calculation (continuing)

(1) The definition of "Downtime

Downtime is the duration when the system does not work normally.

Downtime will commence from the time of declaration of system failure which is announced by KESC Engineer to contractor, and cease to the time of declaration of system repair announced by contractor to KESC. After that, both engineer confirm that the failure is removed and the system is returned to normal or not.

Downtime will be calculated to the nearest one minute.

And minimum downtime is also one minute.

Downtime will not be calculated by the very tiny failure such as lamp damage of computer console, misprint which does not affect the plant operation etc.

Downtime is not calculated when the failed device/abnormal function is backed up by any other device/function.

Following is the example, but not limited to them:

(a) CPU failure of unit but automatically re-initialized and restarted again by itself.

(b) Peripheral device failure but backed up automatically by another peripheral without the loss of data.

(2) Time disregarded for counting: T4

In case the following troubles have occurred, the downtime shall be disregarded for counting even during the availability or MTBF test.

Meanwhile, this time T4 shall be as short as possible, and be applied after sufficient discussions between the Owner and Contractor.

(a) Time when it has not been allowed to start repair or start of repair has been delayed due to a reason on the part of the Owner after occurrence of a failure

(b) Time when it has been impossible to use the computer due to periodical inspection, extension of modification of the computer.

4-97P

Table 1. Weighting factor of failures for availability and MTBF tests

Categories of the degrees of effects	Decision of failure relevant to MTBF, wi	Weighting factor of failure time, wi	Description of failures		
				Items	Conditions
I	1	1	Hardware	Computer main frame	o Failure in single system o Failure in two (2) sets in the case of multiple systems or cross-call system or in case any back-up from other system is not available at the time of failure in two (2) or one (1) CPU
				I/O control unit	o Failure in single system o In case any backup from other system is not available at the time of failure in two (2) or one (1) system in the case of multiple systems
				I/O connector	o No. of failure points > 1/3 of total No. of I/O points The above relation shall also decided according to the ratio to the overall system in the case of a failure in remote station.
			Software	Operating system o Analog input processing program o Contact input processing program o Annunciation and supervision program o Message control/management program o Message output program o Others	o Failure in single system o In case any backup is not available from the other CPU at the time of a trouble in one system out of multiple systems
II-1	0	1	Hardware	Computer main frame	Failure in data link module
				I/O connector	Failure in remote station (including failure in data transmission line)
			Software	Operator request function	Total or partial trouble > 2 points
				Plant supervision function (including CRT display function)	Total or partial trouble > 2 points

				Automatic control function (including schedule calculation)	Total or partial trouble > 2 points
				Performance calculation function	Total or partial trouble > 2 points
				Other functions (Calculation of equipment life consumed, monitor of overload and underload to starting transformer, etc.)	Total or partial trouble > 2 points
II-2	0	0.5	Hardware	I/O typewriter	Total or partial trouble > 2 points
				Teletypewriter and CRT for engineer	
				Operator console	Total or partial trouble > 2 points
				Engineer's console	
				Other console/s for plant supervision	
				Digital printer	Same as above
				CRT and audio annunciator	Same as above
				Periodical logging typewriter	Same as above
				Plant logging typewriter	
				Special logging typewriter	
				I/O typewriter (output)	
				Hard copy equipment	
				I/O connector	1/2 of total number of points > Number of failure points > 1/20 of total number of points (The above relation shall also be decided according to the ratio to the total system in the case of failure in remote station)
II-3	0	0.05	Hardware	I/O connector	1/20 of total number of points > Number of failure points ≥ 1 point (The above relation shall also be decided according to the ratio to the total system in the case of a failure in remote station)
				Operator console	Partial failure = 1 point
				Engineer's console	
				Other console for plant supervision	
				Digital printer	Partial failure = 1 point
				Trend recorder	Partial failure = 1 point
				CRT and audio annunciator	Partial failure = 1 point
				Periodical logging typewriter	Partial failure = 1 point
				Plant logging typewriter	
				Special logging typewriter	

			Hardware	I/O typewriter (output) Logging CMT Paper tape puncher Paper tape reader Floppy disc unit	Partial failure = 1 point
			Software	Operator request function	Partial trouble = 1 point
				Plant supervision function (including display of system on CRT unit)	Partial trouble = 1 point
				Performance calculation function	Partial trouble = 1 point
				Other functions	Partial trouble = 1 point
III	0	0		Minor failure or similar one causing no effect upon the system function by early detection of trouble in the equipment in standby	
IV	0	0		Failure detected during inspection for periodical maintenance, etc. and causing no effect upon the system functions	

Note: The peripheral equipment shall be deemed to be subjected to a failure (total or partial failure in case the equipment or devices in parenthesis of the respective column has failured to perform the respective backup functions.

1.2.5 TESTING

The Contractor shall execute the following tests and inspections during manufacturing and field construction.

The test and inspection reports shall be submitted to the Owner and the Engineer for approval.

The test items marked "*" below shall be carried out in the presence of the Owner and the Engineer.

(1) Shop test

Dimensional test

Peripheral running test

Power supply test

* Software test

Scanning and alarming

Process calculation

Data logging and data display

Operator communication

(2) Field test

Sensor test

Function test

Availability test

1.2.6 TRAINING

All training to be given in connection with the software and hardware for the computer system shall be provided in accordance with the provisions in Clause PA.29 of SECTION IV in Volume 1 "Conditions of Particular Applications".

(1) The training for the Owner's engineer regarding the computer system shall be carried out in two (2) group, one for software

and the other for hardware.

(2) The training shall be given at the training school and the factory of the manufacturer. Moreover, on the job training shall be provided by the manufacturer after the computer system has been installed at the West Wharf Thermal Power Station.

1.3 TECHNICAL INFORMATION

1.3.1 POWER DISTRIBUTION AND PROTECTION

The computer system cabinet power distribution and protection system shall comply with, but not be limited to, the following.

(1) The electric power source shall be AC 220 V, 50 Hz from CVCF. The incoming CVCF power supply to the computer shall terminate in a distribution cabinet. Breakers shall be provided in the panel for all power supply branch circuits to the equipment in the cabinet and to system peripherals.

(2) The low voltage AC and DC branch circuits supplying power to the system cabinets shall be fused. Fuses shall be used for both DC branch circuits, while one fuse shall be used for non-grounded wire. The power supply circuits for contact input sensing shall be fused for groups of not more than 16 inputs per fuse.

1.3.2 CABINETS FOR COMPUTER SYSTEM

The cabinet for the computer system shall consist of, but not limited to, the following.

(1) CPU and FDD unit cabinet

(2) Auxiliary memory unit cabinet

(3) CRT controller cabinet

(4) I/O device cabinet

(5) Termination cabinet

(6) Distribution cabinet

The design of the respective cabinets shall be in accordance with Clause 2.1 of "Panels and boards", Section II of Part I. All

cables for the respective panels shall, in principle, the drawn in from the bottom of the panels.

The cabinets shall be designed to be protected from dust.

The Contractor shall furnish the base frame, anchor bolts, nuts, templates, insulation sheets, etc., for the cabinets.

1.3.3 CABINET WIRING

The computer system cabinet wiring shall comply with the following.

(1) Terminals for incoming signal cables shall be screw connections for twisted pair shielded wire. Terminations shall be provided for all necessary shields.

(2) All terminals shall be located for ease of access in a group remote from the I/O logic cards. The terminals shall be suitably numbered for polarity and circuit identification.

(3) All internal wiring shall be number or color coded, and all connecting plugs shall have facilities for locking to prevent inadvertent disconnection.

(4) Interconnecting wiring shall be of a preterminated type having stranded copper conductors and non-flame propagating PVC insulation, and shall be provided with steel wire or tape armour and PVC sheath treated with a chemical additive to resist insect attack. The connectors shall be of Elco type with thread coupling, or equivalent.

1.3.4 CENTRAL PROCESSING UNIT

The central processing unit (CPU) shall be a digital, programmable computer for a real time and process interrupting environment. The CPU shall consist of, but not be limited to, the following.

(1) A programming and maintenance panel

(2) Minimum word length of 16 bits

(3) Memory cycle time not greater than 0.5 micro-seconds

(4) A hierarchical interrupting system for both wired and software interrupting

(5) Parity checking

(6) A real time clock having a stable crystal oscillator as a time base to facilitate periodic task execution as well as elapsed time measurements with an error of not more than one second per day.

(7) The facilities shall be provided so as to enable the operator to read the time and date and reset the clock after a power failure.

(8) Power failure auto-start

(9) Modular IC memory for system programs supplemented by disk memory.

(10) Watchdog timer

1.3.5 INPUT/OUTPUT SYSTEM

The I/O system for the computer system shall be housed in the system cabinets, and shall so constructed so as to enable modifications to the number and nature of input points.

The input terminal and the input devices shall be designed to enable a 10% increase of the respective capacity for future extension.

The minimum amount of I/O signals of the computer shall be as specified below, however, the Contractor shall consider actual necessary I/O to meet the computer functions.

	Point
(1) Analog inputs	200
(2) Thermocouple inputs	400
(3) RTD analog inputs	60
(4) Digital inputs	300
(5) Pulse inputs	16
(6) Analog outputs	10
(7) Digital outputs	15

The Contractor shall supply any/all additional equipment such as reference junctions for thermocouples, power supplies and bridge circuits for resistance temperature detectors (RTD's), power supply for energizing, field contacts, and input equipment for signal range changes and conversion curves.

All inputs shall be continually scanned and automatically updated without interrupting the scanning, storing, processing or readout of information. Periodic checks shall be made of the accuracy of measurement and conversion circuits.

Signal conditioning shall be provided at all input and output signal terminals for protection against voltage transients and to provide noise rejection.

Protection shall be furnished against open-circuited, short-circuited or grounded-analogue inputs. Inadvertent application of the power supply on any input shall not damage logic inputs or affect other inputs.

(a) Analog Inputs

The analog input systems shall be designed to accept the following signal ranges.

1V to 5V

4mA to 20mA

E(CRC) type thermocouple inputs

T(CUC) type thermocouple inputs

RTD (pt 100 ohm) supplies

Linearization and scale factor for each input shall be provided as required to give outputs in engineering units. Multiplexing shall operate at a speed that complies with the time requirements of the different functions.

Analog input logic shall have the following characteristics. Differential, floating and high impedance (greater than 1 megahom) input circuit, overall system accuracy $\pm$0.1% of full scale input, resolution of $\pm$one (1) digit (least significant digit of four (4) digit output).

(b) Digital Contact Inputs

The system shall accept contact inputs from both normally open and normally closed plant contacts. The nominal rating of these contacts shall be 300 volts AC or DC, 0.5A, and the Contractor shall provide a voltage greater than 40V DC and less than 130V DC for the sensing of these contacts.

(c) Pulse Inputs

The system shall accept pulse inputs in the form of repeated contact closures. The Contractor shall provide a voltage greater than 40V DC and less than 130V DC for the sensing of these contacts.

4-780.

1.3.6 AUXILIARY MEMORY UNIT

The bulk memory unit shall consist of the following.

Fixed head disk or IC bulk memory

Average access time: Less than 10 msec.

Memory protection

In no case shall any recorded data be affected by power loss, and the unit shall be restarted automatically on occasion of power interruption.

1.3.7 PRINTERS

The Contractor shall provide identical printers for the following controls.

(1) Data logging printer

(2) Alarm printer

(3) Operator's data printer

(4) Engineer's printer

The printers shall be of a dot matrix type using tractor-fed paper. The column width shall be adjustable, and the number of columns shall be more than 132. All printouts shall be on-lined fan-fold paper with no data printed on the paper folds.

The latest printed line of data shall be clearly visible to the operator when viewed directly from the front of the printer.

1.3.8 CATHODE RAY TUBE UNITS

The following cathode ray tube (CRT) units shall be provided. The CRT display shall facilitate operation guide, and acoustic announcer shall be furnished for calling the attention of the operation.

(1) Alarm CRT unit

(2) Engineer's CRT unit

(3) Data and communication CRT unit

All CRT monitors and operation devices for the associated controllers shall be capable of displaying alphanumeric and limited graphic character sets. Each character shall be displayed in any of the following colors: red, green, blue, yellow, white, magenta, cyan and black.

1.3.9 TREND RECORDER

The trend recorder shall be designed so that data of any range can be input as required by the operator by selecting an optional analog point from the operator's console.

The trend input points shall consist of more than five (5) groups, per unit, and the maximum number of trend input points shall be (8) points per group, per unit.

The number of pens shall be four (4) per units per one (1) trend recorder. Four (4) units of the trend recorders shall be attached to the BTG board.

1.3.10 FLOPPY DISK DEVICE

The floppy disk device (FDD) shall be used for the dump and compiler for data in the memory unit.

The number of floppy disk control devices shall be two (2), and the devices shall be mounted on and connected to the floppy disk controller in the CPU cabinet.

1.3.11 HARD COPY UNIT

The hard copy unit shall duplicate the graphic images, including lettering figures displayed on the CRT to the paper in the unit in accordance with the command from the operator's console.

The paper to be used for this purpose shall be A4 sized plain paper. The hard copy unit shall be capable of marking dot typed colored hard copy, and shall feature easy maintenance. And shall be possible to select either unit 1 or unit 2 by switching.

1.3.12 OPERATOR'S CONSOLE

The operator's console shall be designed so as to enable communication with the data CRT and conversationally execute demand of the respective functions.

Functional keyboard shall be used for calling CRT display in order to simplify the operating procedure.

All function keys or push buttons shall be provided on the operator's console, and the names of the respective functions shall be entered on the key or push button heads.

The design of the operator's console shall be provided by the Contractor.

1.3.13 PRINTER DESK

The size and number of the printer desk shall be in accordance with Clause 1.2.3 (12), and the desk shall be of a steel frame and plate construction with the surface being finished with acrylate resin board.

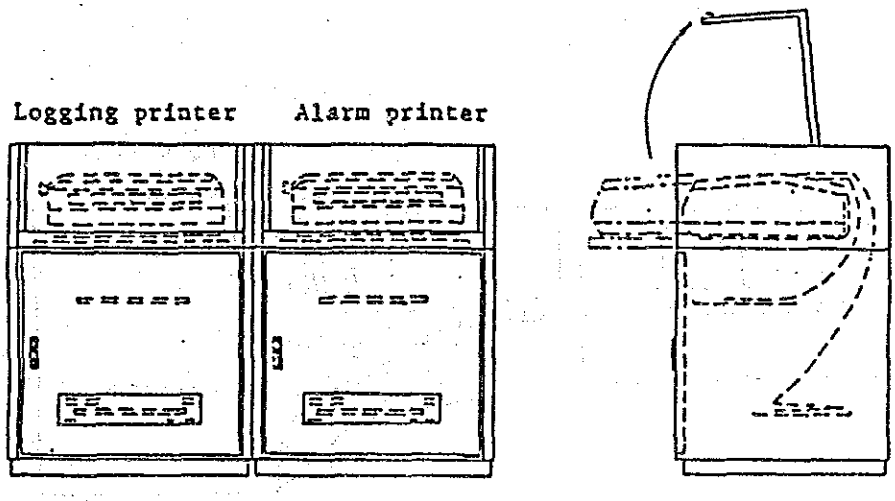
The paper shall be housed in the desk.

The printer shall be designed so as to be drawn out from the desk.

The cables shall be drawn up through the duct.

The data logging and alarm printers shall have a soundproof cover made of plastic, and the cover shall be attached so as to be opened and closed as outlined in the following diagram.

TYPICAL CONFIGURATION OF PRINTER DESK



Printer desk

Side view of printer desk

1.3.14 OPERATOR'S DESK

The size of the operator's desk shall be in accordance with Clause 1.2.3 (13), and the desk shall be of a steel frame and plate construction with the surface being finished with acrylate resin board.

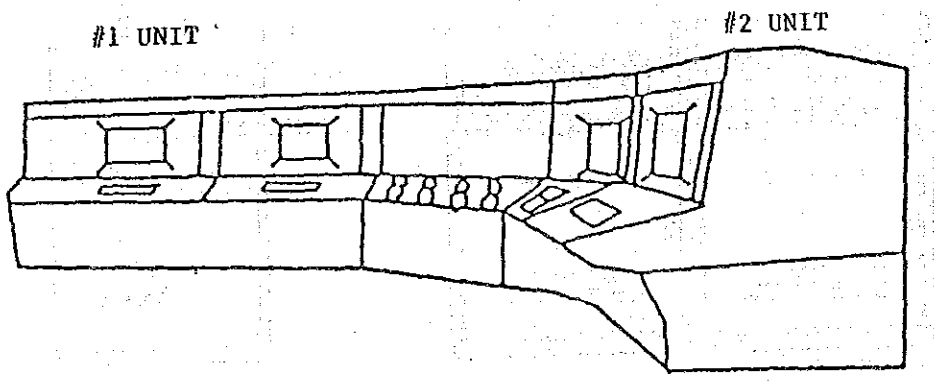
The data printer shall be housed in the desk, and doors for replacement of paper shall be provided at the front and rear parts of the desk as well as the upper part of the desk.

The data CRT units, hard copy unit and operator's console shall be provided in the operator's desk.

The cable shall be drawn up through the duct.

A conceptual drawing of the operator's desk is as indicated in the diagram below.

TYPICAL CONFIGURATION OF OPERATOR'S DESK



1.3.15 ENGINEER'S DESK

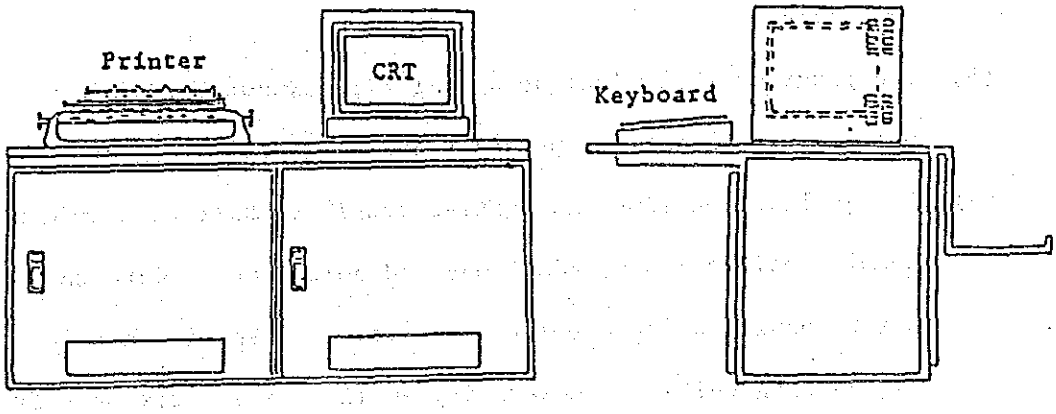
The size of the engineer's desk shall be in accordance with Clause 1.2.3 (14), and the desk shall be of a steel frame and plate construction with the surface being finished with acrylate resin board.

An I/O printer and CRT unit with keyboard shall be provided on the engineer's desk.

The cables shall be drawn up through the duct.

A conceptual drawing of the engineer's desk is as indicated below.

TYPICAL CONFIGURATION OF ENGINEER'S DESK



Engineer's desk

Side view of engineer's desk

1.3.16 PROGRAMMING

The Contractor shall provide a complete set of programs for the operation of the computer system. These programs shall be a standard product of the Contractor, and shall have a proven record of successful application in steam power plants.

(1) All programming shall be in modular form to permit easy modifications, additions and deletions, and shall be carefully and precisely documented so that the Owner can maintain, operate, and modify system programs without dependence on the Contractor's programmers.

(2) Specifically, 20% spare space in large, well located blocks shall be left in the programs to provide for a reasonable number of additional inputs, outputs, interrupts and interrupt priorities.

(3) The programs shall include a real time executive, system programs, applications programs and diagnostic programs.

(4) A high level on-line interactive compiler shall be provided to permit modifications, additions and deletions of data base point modules using a point description in English and in engineering units. The facility shall be available only from the programmer's terminal.

(5) The programmer's terminal for the computer system shall consist of a printer, a full alphanumeric keyboard and CRT, and shall provide complete programming communication with the computer.

(6) All programs shall be stored in floppy disks and used for program loading and compiling at the time of maintenance of the computer system and modifications to the programs.

1.3.17 FUNCTIONAL REQUIREMENTS

The computer system, its peripherals and the software system shall meet the following functional requirements.

(1) Scanning and alarming of all plant inputs, including analog and digital and pulse inputs.

(a) All alarm and status messages shall be reported on the alarm CRT on the BTG board.

(b) Alarming and return to normal shall be reported on the alarm printer.

(c) An alarm lockout device and return push button shall be provided on the operator's console.

(d) The Contractor shall offer his standard for CRT color and flashing alarm method.

(2) Open circuit thermocouple detection and analog input 'out-of-range' reporting.

(3) Operator adjustment of high, low and dead band limits for alarm reporting.

(4) Removal and addition of points to and from point scans.

(5) Removal and addition of points to and from limit checking.

(6) The status of values, limits, on/off scan, etc., of any input and/or computer internal reference point shall be displayed on the data CRT unit or printed out by the operator's data printer.

(7) Any pre-assigned groups of trend points or individual points shall be displayed on the data CRT unit or printed out by the operator's data printer.

4-788

(8) The above groups of points or individual points on a data CRT or the data printer shall be generated and modified as required by the operator.

(9) Display/update time and data.

(10) All dummy values shall be able to be entered into any points.

(11) All alarms including 'lockout of alarm', 'removal from scan', 'out-of-scan', etc., shall be reviewed on the data CRT unit or printer points.

(12) The data CRT shall be so designed as to be used as an alarm CRT.

(13) The data log printer shall be so designed as to be used as an alarm printer.

(14) All languages to be printed and displayed shall be in English.

(15) From the programmer's terminal, it shall be possible to modify data base module defining point description, conversion constants, group assignment for any point, etc. This operation shall be interactive with engineering units for point definition in the English language.

(16) Backup devices for peripheral equipment

The peripheral equipment shall be backed up mutually as follows.

(a) Mutually between the log printer, alarm printer, operator's data printer and I/O printer.

(b) Mutually between the alarm CRT, engineer's CRT unit and data & communication CRT unit.

(17) Point identification device (PID) number

(a) The PID number shall be provided for the analog point, pulse point, pseudo analog point, input point, constant point and calculation point.

(b) All PID shall be provided with the abbreviation symbols of PID.

(c) The Contractor shall propose his standard formats of PID, abbreviations of PID and indications of alarm.

(18) Alarming

Should any trouble arise in the main computer and peripherals, or should any plant input point reach an alarm point, all such alarms shall be output or indicated on the CRT and in the annunciator windows on the BTG board.

1.3.18 DATA LOGGING

The computer system shall be provided with the following three (3) types of data logs.

Group data log

Demand log

Daily log

Equipment status log

The contractor shall propose his standard formats of such log sheets.

The Contractor shall provide details on log selection techniques, and shall indicate the respective function keys employed for display selection.

(1) Group Data Log

The computer system shall have provisions for manual initiation of the operator's console and group data logging of plant status at the following intervals.

(a) Group data logging shall be selected for either 1, 5, 10, 30, minutes or one (1) hour intervals.

(b) Spot data logging (as requested by operator)

The data logs shall contain a summary of the information related to the boiler group, turbine group and electrical group.

At least ten (10) groups with minimum 20 points per group shall be provided.

Moreover, each group shall include the following information.

- o Correct time (hours and minutes)
- o Data (day, month and year)
- o Unit identification
- o "GROUP DATA LOG" message, group number

(2) Demand Log

The computer system shall allow, on demand by the operator, the following information to be printed out by the operator's data printer or displayed on the data CRT.

(a) Alarm summary

(b) Bad input summary

(c) Deleted input summary

(d) Alarm lockout summary

(e) Trend summary

(f) Turbine startup log

(g) Single and multipoint display

(h) Event recall

(3) Daily Log

The computer system shall have provision for automatic and manual indication of the operator's console.

(a) Data logging shall be carried out by printing out the data of maximum 80 points per hour. Each point shall be divided into four (4) groups with each group consisting of 20 points.

(b) Data from the times of 1:00 through 24:00 shall be recompiled, and four (4) sheets of daily report shall be prepared every twenty-four (24) hours.

(c) The integrated average values shall be printed out at the times of 08:00, 16:00 and 24:00.

(d) The historical operating time of the respective auxiliary equipment shall be printed out at the time of printing out daily reports every twenty-four (24) hours.

(e) The daily logging shall normally be performed every one (1) hour, but may be selected for 30 minutes. Each group shall include the following information.

- o Correct time (hours and minutes)
- o Data (day, month and year)
- o Unit identification
- o "DAILY LOG" message, group number

(4) Equipment status log

This log shall be printed each day as an addition to the daily logs. On the last day of the month, this printout shall be a monthly summary of equipment status and accumulated hours until outage for overhauling.

1.3.19 TURBINE STARTUP SEQUENCE CONTROL (TSC)

(1) The functions of TSC shall include monitoring of preparation of turbine startup through to turbine full arc startup, changeover of the MSV and/or initial load as well as instructions for operation guides to the operator.

(2) The operation guides shall be provided by performing graphic display of messages on the alarm CRT unit and printout by the operator's printer at the following break points.

(a) Calculation of turbine startup schedule

(b) Preparation of turbine startup

(c) Rub check

(d) Acceleration

(e) Rotation speed hold and turbine acceleration

(f) Rated speed

(g) Synchronizing and initial load

(h) Turbine valve changeover

(3) The turbine startup schedule shall be calculated from the current plant status to completion of subsequent startup procedures in order to reduce turbine stress.

(4) Through selection of the TSC function from the operator console, the computer system shall be designed so as to enable checking of the turbine first stage inner surface temperature, performance of turbine startup schedule calculation and display on the alarm CRT unit and printout of such data by the data printer of the following items.

(a) First stage shall inner surface temperature

(b) Reheat bowl inner surface temperature

(c) Main steam pressure at turbine inlet

(d) Main steam temperature at turbine inlet

(e) Acceleration rate

(f) Rolling terminal speed for rub check

(g) Heat soak at certain speed

(h) Heat soak at rated speed

(i) Initial load

(j) Heat soak at initial load

1.3.20 PERFORMANCE CALCULATION

Performance calculations shall provide reliable information to the plant operators on the performance of the plant. These calculations shall assist in enabling attainment of optimum plant operation efficiency and performance.

For this purpose, the actual plant operating condition shall be compared with targets of the performance which shall be based upon the unit load and other variable parameters. The above target values of the performance shall be calculated based upon the boggie curve memorized in the computer.

The calculation formulas for the efficiency of boiler, turbine-generator and plant shall, in principle, be the same formulas as specified in "Guarantee and Performance" in Part II, Section I, which are using for the performance test. The formulas of Input/Output method shall be applied.

The efficiency and performance shall be calculated with the following items.

(1) Boiler efficiency

(2) Turbine-generator efficiency

(3) Plant efficiency at generator end/sending out end

(4) Condenser performance

(5) Terminal temperature difference of each feedwater heater

The cycle of calculation shall be within five (5) minutes, and scanning of the respective points required for calculation shall be made within 4 - 60 seconds.

The Contractor shall submit the detailed formulas and methods for each calculation to the Employer and the Engineer for approval.

1.3.21 GRAPHIC DISPLAY

(1) The computer system shall be provided with facilities for graphic displays such as flow diagram, bar chart curve, and group data as envisaged in the following. Therefore, the Contractor shall be responsible for providing the following fifty (50) programmed graphic displays.

(a) Turbine startup schedule and turbine startup trend curves

(b) Turbine metal temperature

(c) Supervising of turbine bearing vibration

(d) Supervision of boiler, turbine and generator

(e) Boiler/turbine steam line

(f) Boiler flue gas/air line

(g) Bearing temperature of auxiliary equipment

(h) Measurement of chemical values

(i) Measurement of vibration of turbine and bearing metal and oil temperature

(j) Condenser system monitoring

(k) LP feedwater heating system

(l) HP feedwater heating system

(m) Generator

(n) Unit electric single line diagram

(o) Boiler superheater metal temperature (secondary)

(p) Boiler superheater metal temperature (final)

(q) Boiler reheater metal temperature

(r) Chemical analysis

(s) Daily log display/correct menu

(t) Daily report display/correct menu

(u) Trend display menu

(v) Group data log menu

(w) Analog trend recorder menu

(x) Plant graphic display menu

(y) Others

(2) Measurement information for each displayed point shall include the following.

(a) Input identification code

(b) Actual updated value

1.3.22 SEQUENCE OF EVENTS LOG

The facility shall printout data in time sequence order from the date printer.

The time resolution shall be made in less than 1 millisecond. The maximum number of input points shall be 60, and the respective input points shall be submitted to the Engineer for approval.

1.3.23 EVENT RECALL

In the event any trouble should arise at 86G, MTS, MFT or other main equipment of the plant, the data at the predetermined 20 analog points shall be printed out at intervals of 10 seconds 5 minutes before occurrence of such trouble and 5 minutes after such trouble.

Such analog points shall be called optionally from the operator's console, printed out by the alarm printer, and reviewed or added from the operator's console.

1.3.24 OPERATION GUIDE TRAINING SYSTEM BY CPU

Training function are as follows.

* Over all plant start up & shut down flow chart
* B/T/G start up time chart (curve), load up/down
* Explanation of plant operation procedure & check points

  CCR

  LOCAL

* Annunciator list & counter measures
* Logic diagram

boiler, aux equipment	FDF, GRF, AH, damper ROP, ABC, ABS
turbine, aux equipment	BFP, CWP, CP, to Turbine Pass, AOP, EBP, EHC, Valve test
Local facility Plant interlock	W/T, PW/T, WW/T, C/T, intake

* Training mode

  Text mode

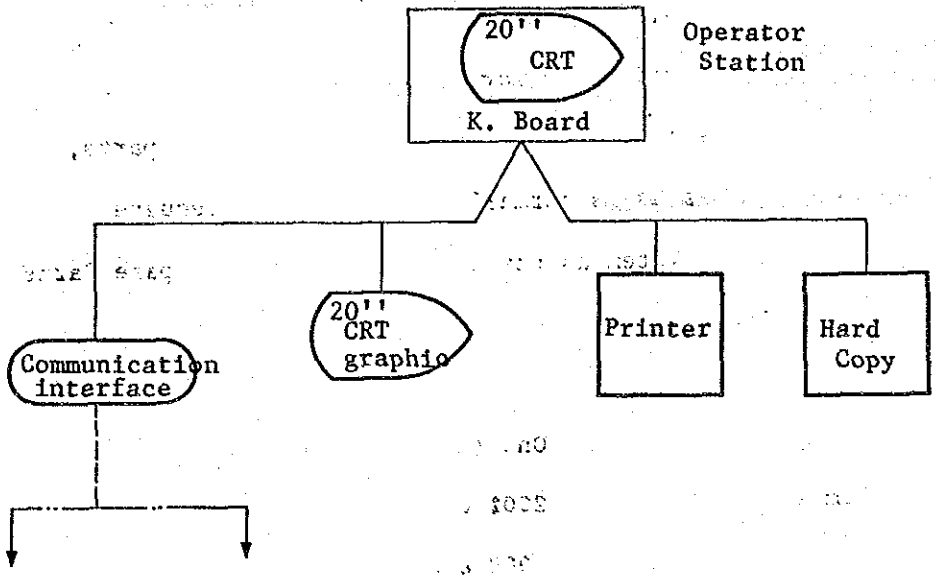
  Training mode

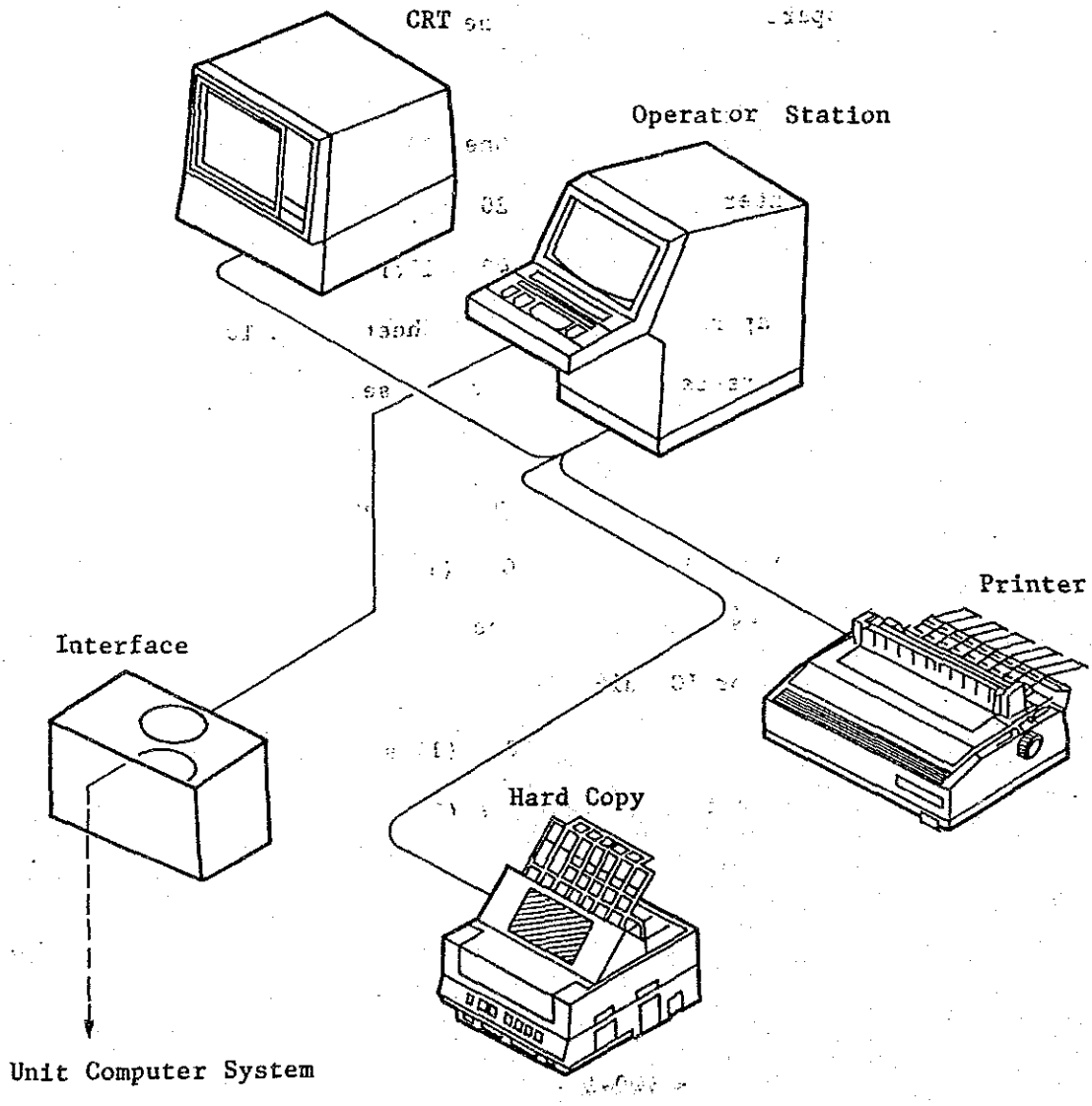
* CRT graphics — start, 1/4 4/4 Load, stop

#1 plant graphic
Aux equipment, — Valve Pump, Fan
Local "

#2 Operation Procedure Ann,

Training System Configuration





2. SPARE PARTS FOR COMPUTER SYSTEM

The following minimum required spare parts shall be provided. In addition, the Contractor shall propose the recommended spare parts, accessories and consumables as is normally required for adequate operation of the computer system as stated in Clause 6 of "Spare Parts" in SECTION 1 of PART II.

(1)	Computer system	
	Cards	One (1) set each
	Indicator lamps	200% each
	Fuses	200% each
	CPU power unit	One (1) set each
	Standard spare parts	One (1) set each
(2)	Printer	
	Cards	One (1) set each
	Paper for printer	20 boxes
	Ribbon	40 rollers
	Stock format paper	2000 sheet/box X 10 box
	Standard spare parts	One (1) set
(3)	CRT display	
	Cards	One (1) set each
	Standard spare parts	One (1) set
	Cathode ray tubes	One (1) set each
(4)	Fixed head disk or IC bulk	
	Cards	One (1) set each
	Standard spare parts	One (1) set
(5)	Floppy disk devices	
	Cards	One (1) set each

	Standard spare parts	One (1) set
	Floppy disk	Ten (10) sheets
(6)	Trend recorder	
	Cards	One (1) set each
	Pens	One (1) set each
	Inks	Two (2) sets each
	Chart	40 rolls
(7)	Hard copy	
	Cards	One (1) set
	Standard spare parts	One (1) set
	Ribbon	One (1) set
	Paper	2000 sheet/box X 10 box