

SECTION – III

GENERAL TECHNICAL SPECIFICATIONS

3.1 INTRODUCTION

The Contractor shall strictly observe these General Technical Specifications in conjunction with the Particular Technical Specifications. He shall carry out all work in a skilled and workman like manner in compliance with modern methods of engineering. All design, calculations, materials, works; manufacture and testing shall conform to the latest applicable standards.

In addition, the Contractor shall conform to all applicable regulations regarding the execution of supply and installation work, and shall follow all instructions issued by the competent Authorities, and the Engineer.

3.2 SCOPE OF WORK

The scope of work include necessary Engineering designs and drawings of the E&M equipments including machine foundations, supply, repair, renovation and overhauling of E&M equipments as per schedule, erection thereof and successful commissioning of the E&M components complete to generate 2000 KW of power (4 X 500 KW). All the repairs / renovation and overhauling works of E & M components shall be carried out at manufacturers authorized service workshops or workshops having vast experience in doing such jobs.

The scope of work in this Contract is established in the Particular Technical Specifications, wherever necessary and in the schedule of work / quantity. The Contractor shall design, manufacture, supply, repair, renovate and overhaul, erect, test & commission, and hand-over to Owner and guarantee after commissioning and all works complete in every respect with all necessary accessories in conformity with civil contractor for reliable continuous operation as per the relevant technical specifications.

These Specifications include the performance of all works and the provision of all labours, materials, permanent and temporary equipment, tools, accessories for transport to the site, including loading, unloading, if necessary reloading in the port of arrival, complete installation, painting, testing and commissioning of all works and accessories of the works.

The Contractor shall make competent and experienced staff available for the training and assistance of the operating staff during commissioning and trial operation and, if required by the Purchaser, for a period after completion of the trial operation which shall be agreed separately.

3.3 PROJECT DETAILS AND SALIENT FEATURES

3.3.1 SALIENT FEATURES

I. GENERAL

- | | | |
|-------------------------------------|----------|--|
| 1. (a) Name of the Project | : | R & M of Mai Phase-I Mini Hydel Power Station |
| (b) Year of commissioning | : | 1978 |
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 | | |
| 2. Location | | |
| i) State | : | Arunachal Pradesh |
| ii) District | : | Lower Subansiri |
| iii) Town/Village | : | Mai |
| iv) Access | : | 157 km from Itanagar |
| Nearest Rail Head | : | North Lakhimpur 50 (app.) km from site |
| Nearest Airport | : | Tezpur – 350 km from the site
Naharlagun heliport – 157 from site |
|
 | | |
| 3. Geographical co-ordinates | | |
| (a) Latitude | : | 27° 30' N |
| (b) Longitude | : | 93° 50' E |
|
 | | |
| 4. Details of Site | | |
| (a) Name of stream | : | Kale |
| (b) Catchments Area | : | 124 sq. km |
| (c) Head (Gross) | : | 211.00 m |
|
 | | |
| 5. Hydrology | | |
| (a) Minimum discharge | : | 0.975 cumecs |

I. PROJECT FEATURE

- | | |
|-----------------------------|-----------------|
| 1. Diversion | Existing |
| (a) Type | : Trench Weir |
| (b) Length of weir | : 15 m |
| 2. Head Race Channel | : |
| (a) Shape | : Rectangular |

- (b) Size : Bed width 1.5 m
Water depth 1.2 m
- (c) Material of lining : PCC lining
- (d) Design discharge : 1.15 m³/s
- (e) Free Board : 0.30 m
- (f) Longitudinal Bed Slope : 1:750
- (g) Length : 1706 m
- 3. Desilting Tank (New proposed) :**
- (a) Size of Tank : Length 21 m
: Width 5 m
: Dpth 2 m
- (b) Material : RCC
- (c) Particle size elimination : 0.2 mm
- 4. Forebay Tank (Existing) :**
- (a) Size : 50 m x 6.75 m
- (b) Free Board : 0.30 m
- 5. Penstock :**
- (a) Material : Steel
- (b) Diameter : 450 mm
- (c) Nos. : 3
- (d) Length : 466 m each
- 6. Power House (Existing, only part replacement needed) :**
- (a) Type : Surface power house
- (b) Head (Gross) : 211 m
- (c) Size of Power House : Length –39.80 m
Width – 8.0 m
- (d) Installed Capacity : 4 x 500 kW

- 7. Turbine** :
- (a) Type : Turgo impulse
- (b) Nos. : 4 Nos.
- (c) Capacity : 500 kW
- (d) Make : Jyoti
- (e) Speed : 1000 rpm
- (f) Design Discharge/Unit : 0.365cumecs
- 8. Generator** :
- (a) Type : Synchronous
- (b) Nos. : 4 Nos.
- (c) Speed : 750 rpm 1875 kVA
- (d) Generator Voltage : 415 V
- 9. Governor** :
- (a) Type : Jyoti make B type
- (b) Year of manufacturing : 1975
- 10. Switchyard** : Outdoor type 0.415/33
kV
- (a) Transformer : 3 x 800 kVA.

II. BASIC DATA

LOCATION

Mai Mini Hydel Power Station is located on the Kale River in Mai village of Lower Subansiri district of Arunachal Pradesh. The site is connected by road to all major towns of Arunachal Pradesh.

TOPOGRAPHY

Mai Mini Hydel Power Station is located in the foothills of Himalayas. The topography of the area is very rugged with steep slopes.

ACCESS

The site is connected to and other parts of the state by road/rail/air as detailed below.

Road

Route	Distance	Terrain
Tezpur-Itanagar	200 km	Plain & Hilly
Itanagar Yazali	145 km	Plain & Hilly (on Kimin-Zero State Highway)
Yazali-site	12 km	Hilly

Rail

North Lakhimpur Railway station is 50 km (approx) from project site.

Air

Tezpur airport is 350 km from site.

Naharlagun/Itanagar heliport is 157 km from site

CLIMATE

The weather is an average as other towns in the area. The maximum and minimum temperature is of the order of 38 deg. C and 2 deg. C during summer and winter respectively. The construction season is 6 months a year except during monsoon months of April to August.

SEISMICITY

Mai Mini Hydel Power Station is seismic zone V as recommended by Indian Standard code of practice. Accordingly the basic seismic coefficient for the site is 0.08.

GEOLOGY

The Mai Mini Hydel Power Station is located along the foothills of the Himalayas, in Mai village of Lower Subansiri distt. of Arunachal Pradesh State. The topography of the area is very tough with steep slopes and occupied by dense mixed jungle. The existing diversion weir site is the most suitable site throughout nallah course. Both banks are observed to be equally stable. The exposed nallah bed is composed of boulders ranging from 0.75 m to 3.0 m size.

POPULATION

The scheme falls in the fairly populated area as the scheme is located in Lower Subansiri valley. The area is surrounded by a large number of small towns and villages.

METEOROLOGY

Rain gauge and discharge measuring station had already been established in the nearby area. The annual rainfall of area is 600 cm.

ELECTRO MECHANICAL WORKS

Technical details of the equipment installed in Mai Phase –I, Small Hydro Power Station

In this power station there are 4 units of 500 kW each. All three turbines are connected to separate synchronous generators. Each machine is equipped with B type mechanical governor. The power generation from this station is being fed to Ziro, township, which is headquarter for Lower Subansiri District. Apart from Ziro, the station feeds power to Papumpare which is the capital town of state. The general data as available from the site is given below.

Turbine

i.	No. of turbine	4 Nos.
ii.	Specification of turbine	
	Make	Jayoti make
	Inlet size	300 mm
	Type	16.5 T – 500 – E Turgo Impulse Turbine
	Year of installation	1977 - 78
	Whether working or not	Set No. –2 working, others out of order.

Generator/ Alternator

i.	No. of generator	4 Nos.
	Make	Syn. Generator (Jyoti Ltd., Baroda,

Type	India) TMG -91 -6-B 3 style -1 m 852 - 085 -1
Voltage	415V, Current-870
Speed	Amp 1000 rpm
Excitation	47 V, 146 Amp
Serial No.	1144/3001538
Whether working or not	1 (one) No. working, other out or order.

Governor

i.	No. of governor	4 Nos.
	Type	Jyoti Make oil pressure governor, B- type
	Capacity	125 kg/m ²
	Pendulam Pulley speed	750 rpm
	Pendulam Speed	500 rpm
	Normal Oil Pump Speed	400 rpm
	Minimum Closing time	2 Sec.
	Oil Capacity	28 ltrs.
	Dia of Pendulam Drive Pulley	228 mm
	Dia of oil pump dirve pulley	415 mm
	Serial No.	153 B/210
	Style No.	IT 429 - 008A
	Year of Mfg.	1975
	Whether working or not	2 (two) Nos. working, other out of order

Excitation unit (SEU)

Type	SSV/03010/SR No. - 006
Voltage range	415V+5%
Voltage Regulation Accuracy	+ 1.5% of set value
Maximum output volts	65 Volts.
Maximum output current	150 Amps.

Incoming panels

4 Nos.
1(One)
incoming
panel for each
set. Each panel
is provided
with 1 (one)
1250 Amps.
Jyoti Make
ACB including
metering units
(like kWh
meters, kW
meters etc.)

2.13.6 Outgoing panels

3 (Nos.) one for each transformer of 800 kVA, 0.415/33 kV. Each panel provided with one mechanical type 1250 Amp, Jyoti make ACB including metering Units.

Switchyard

I	Oil circuit breaker (OCB) type Rated short circuit capacity	2 (Two) Nos. 13.1 kA at 33 kV in 1 sec.
II	Step up transformer Make Transformer Ref. IS Voltage ratio Capacity Impedance % Ampere Rating Phase Oil Capacity	3 (Three) Nos. Volt Amps. Transformer (P) Ltd., Baroda, India 2026 - 1982 0.415/33 kV 800 kVA 4.8205 HV = 14.00 LV = 1112.90 3 855 liters

Conservator Weight	1445 kg
Weight of oil	743 kg
Total Weight	3320 kg
Guaranteed Max. Temperature	45 ⁰
Year of Manufacturing	1977
Phase displacement	30 ⁰
Group No.	4
Vector Symbol	YDII
Insulation Level	
Kilo Volts Peak	170 kV
RMS	70 kV

Power Evacuation Arrangement

The generator output of each machine is at 415 V. The switchyard has 3 Nos. of 800 kVA, 0.415/33 kV transformers. There are two nos. of bulk oil circuit breakers on H.T. side. In control panel. i.e. on L.T. side, the 7 Nos. Air Circuit Breaker are installed. These breakers are manually operated and need lot of maintenance.

The Mai Hydro Power station is connected to a power transmission system in which two other power stations viz Mai Phase-II and Tago are operating in parallel. All these power stations are connected through 33 kV lines. The single line Diagram of 33 kV system is given in Figure 2.8. The single line diagram for power house control panel is given in Figure 2.9.

Details of Construction Materials of Spares

Sl. No.	Part Name	Material
1.	Suction Bend	Fab Steel
2.	G3/ Stud Nipple	Stainless Steel
3.	Pressure Gauge Cock	3/8/BSP
4.	Vacuum Gauge	0 to 760 Hg
5.	Runner Cap	Stainless Steel
6.	Runner	Stainless Steel
7.	Facing Ring	Tin Bronze
8.	Bush	Leaded Bronze

Sl. No.	Part Name	Material
9.	Bottom Casing	Cast Iron
10.	Casing	Fab Steel
11.	Bracket	Cast Iron
12.	Copper Tube	Copper
13.	G3/8 Nut	Stainless steel
14.	Bend 90	Galv. IS 1239
15.	Pressure Gauge	0 to 10 kgf/cm ²
16.	M.S. Tee	Galv. IS 1239
17.	Hand Hole Cover	Cast Iron
18.	Bush	Leaded Bronze
19.	Gland Packing No. -2	Asbectors
20.	Guide Vane Gland	Leaded Bronze
21.	Guide Vane	Tin Bronze
22.	Guide Vane Level	S.G. Iron
23.	Gland Packing No. -1	Telfon Coated Asbestos
24.	Lentem Ring	Tin Bronze
25.	Spacer Ring	Leaded Bronze
26.	Locator Plate	M.S.
27.	Spilt Gland	Leaded Bronze
28.	Thrust stay	M.S.
29.	Shaft Sleeve	Stainless Steel
30.	Water deflector	Natural Rubber
31.	Cover No. - 3	Steel Sheet
32.	Oil Seal	150 x 180 x 15
33.	Top Brg. House No. -1	Cast Iron
34.	Cylindrical Roller Brg.	SKP MU 230
35.	Air Vent Assy	Bright Bar C 40
36.	Oil Seal	160 x 190 x15
37.	Cover No. -2	Steel Sheet
38.	Pulley	Cast Iron

Sl. No.	Part Name	Material
39.	Fly Wheel Hub	Cast Iron
40.	Fly Wheel	Fab Steel
41.	Cover No. -3	Cast Iron Steel Sheet
42.	Top Brg. House	Cast Iron
43.	Spherical Roller Brg.	SKF 22328 Ce - H 2328
44.	Disc.	Cast Iron
45.	Shaft	Forged Steel C-40
46.	Love Joy Flexible Coupling	-
47.	Facing Ring	Tin Bronze
48.	Rex. Screw for leveling	M 24 x 90 IS : 1363
49.	Foundation Bolt	AM 30 x 630
50.	Guide Vane House	Cast Iron
51.	Operating Ring	Cast Iron
52.	Circlip	A 150 x 4
53.	Brg. Pedestal No. -1	M. S.
54.	Bottom Brg. House No. -1	Cast Iron
55.	Base Plate	M.S.
56.	Brg. Pedestal No. -2	M.S.
57.	Bracket	M.S.
58.	Bottom Brg. House	Cast Iron
59.	Trigger auxiliary Switch Assy	Cast Iron
60.	Fly Pin	Stainless steel
61.	Spring Retainer	Leaded Bronze
62.	Hex Lock Nut M-6	IS: 1363
63.	Crub Screw AM 6 x 20	IS: 1363
64.	Spring	Spring steel Wire
65.	Cylindrical Pin	IS : 2393
66.	Collar	Black Bar C 40
67.	Seating Washer	Copper Sheet
68.	Adaptor	Stainless Sheet

Sl. No.	Part Name	Material
69.	Lock Nut	Black Bar C 40
70.	'O' Ring	724.3 x 5.7
71.	Lock Nut	Black Bar C 40
72.	Distance Piece	M.S.

Component Reference List

Sl. No.	Ref. No.	Description	Specification	Supplier
1.	3, 3A, 12, 5	Terminal Station	CT –2.5/CT – 10	M/s Tosha
2.	4, 4A	Multipin and receptacle	16 pin	M/s Jyoti Ltd.
3.	51/64	Over current and earth fault relay O/C-2.4 to 9.6 A, E/F – 0.3 to 1.2 A with timer range 0.1 to 2 sec Aux. Supply 24 V DC	APAK – 412	M/s Jyoti Ltd.
4.	50	Instantaneous over current relay range 24- 96 A, Aux. Supply 24 V DC	PA – 21 A	M/s Jyoti Ltd.
5.	52 CS	Trip Neutral close Breaker control switch	JSL 425 – 017	M/s JSL.
6.	A	Ammeter 967 0 – 50 A	SIP – 96	M/s JSL
7.	AS	Ammeter Selector Switch	SRP – 136 – NA – 60	M/s Kayee
8.	B	Blocking Magnet	24 V DC	M/s Jyoti

Sl. No.	Ref. No.	Description	Specification	Supplier
				Ltd.
9.	CT	Current Transformer Ratio – 50/5A 10 VA, Class 1/10P15	BCT –33	M/s JSL
10.	C	Closing Coil	34 V DC	M/s Jyoti Ltd.
11.	F1, F2	Main DC & AC Control	10/24 A	M/s Bharat Linde
12.	F5, F6	Circuit Fuse/fuse base		
13.	F3, F4	Control circuit fuse/fuse base for closing circuit	6/25 A	-Do-
14.	F7	Control circuit fuse/fuse base for spring charging motor circuit	6/25 A	-Do-
15.	F8	Control circuit fuse/fuse base for IL lamp circuit	6/25 A	-Do-
16.	F9	Control circuit fuse/fuse base for closing circuit for heat circuit	6/25 A	M/s Bharat Linde
17.	II	Pndl Illuminating lamp	15 W 240 V AC	M/s Bharat Linde
18.	M	Spring charging motor	240 V AC 1 Phase	M/s Bharat Linde

Sl. No.	Ref. No.	Description	Specification	Supplier
19.	K	Resistor	2.2 k 15 W	I.E.
20.	HE	Heater	2-250W, 240W, AC	M/s Isotemp.
21.	SL1, SL2	On off indicating lamp	Bulb-5/7 W, 240 V AC Holder 3 SL 1020 – 21/BA 15 d	M/s Binay
22.	SW1	Toggle switch for heater	10A, 250 V AC TS – 1020/PL	M/s IFC
23.	SW2	Switch for lmap	5A, 240 V aC	M/s Sepro
24.	SW 3	Switch for socket	5A, 240 V aC	M/s Sepro
25.	ST	2 pin socket	5A, 240 V aC	M/s Sepro
26.	I, II	Auxiliary switches for spring charging mechanism	4 Pole 2 No. & 2 NC	M/s Jyoti Ltd.
27.	III, IV	Breaker Auxiliary switch	4 Pole 2 No. & 2 NC	M/s Jyoti Ltd.
28.	75S, 75T	Limit switches for service and test position	2 NC	M/s Jyoti Ltd.
29.	MS	Motor starter	MF	M/s L&T
30.	TP1	Test plug box for C.T. circuit	“C”	M/s Jyoti Ltd.
31.	94	Anti pumping relay	RE – 301	M/s Jyoti Ltd.
32.	V	Breaker Aux.	3 Nos. & 2	M/s Jyoti Ltd.

Sl. No.	Ref. No.	Description	Specification	Supplier
		Switch mounted on panel	Nos.	
33.	VII	Breaker Aux. Switch mounted on panel	2 Nos. & 3 Nos.	M/s Jyoti Ltd.
34.	VT 16 to 18	Plus Transformer	Voltage ratio 2/1/1/	M/s Jyoti Ltd.
35.	VT – 19	OVP transformer	415V/105, 107, 110, 112, 112V, 25 VA, Auto transformer	M/s Jyoti Ltd.
36.	VT 20	Power Transformer	415V/80V, 12 VA, Single Phase, 50 HZ	

III. PRESENT STATUS OF WORKS AND PROPOSALS FOR RENOVATION

CONCEPT OF WORKS

The project is situated in Mai village of Lower Subansiri distt. of Arunachal Pradesh. The site index map is shown in Drg. No. C-202-1. Mai Hydrel Project is the lifeline of this distt. but since the project has suffered due to weathering actions and absence of power maintenance etc. the valley has been affected for want of electricity. The project envisages utilization of water from river Kale by construction of diversion weir, intake structure, power channel, spill pipes, forebay tank, mild steel penstocks (3 nos.) each of 450 mm diameter, supported by anchor blocks and a surface power station to accommodate turbine –generators and allied switchgear.

PRESENT STATUS OF WORKS

The Civil works of the project have been designed for 2000 KW capacity. The project has a water conductor system which includes a Diversion Weir, Head Race Channel, Forebay Tank, Penstock (3 nos.) to join in a common header which feeds 4 units of 500 kW each in a

surface power house. No. desilting tank exists in the water conductor system. Though 4 units are existing but only 3 units run at a time. The fourth unit is kept as a standby unit. After the renovation works the 4th Unit is also proposed to run in parallel with other three Units.

E&M WORKS STATUS AND PROPOSAL FOR RENOVATION

General

The plant was commissioned in the year 1977-78 and is in operation for more than twenty years. The plant has already operated for almost sixty percent of its expected life. The stator coils of two units are out of order. The excitation system of one unit is completely damaged and for other two units need to be repaired. There is an alignment problem with the each unit of the plant.

The component wise status of Mai Station is given below:

(A) Turbines

All the four units have alignment problem. The thrust and journal bearing are required to be replaced. The balancing of runner is not OK. Which is to be set right. The economizer assembly is not in working conditions, which is to be refurbished.

(B) Synchronous Generators

The stator windings of two units are healthy. The windings of other two units are worn out due to short circuit. Complete replacement of winding of two generators is necessary. Replacement of two generators by new ones is necessary.

(C) Excitation System

The excitation of all the three units needs to be repaired. The excitation system of 4th unit is completely out of order and need to be replaced.

Two sets of generator bearing (driving and non-driving ends) are to be replaced.

(D) Governor

All the four nos of governors need maintenance. The mechanical protection system of all governor is non functional and machine gets over speed. The belt system of governor need to be repaired.

(E) Inlet Valve

The general condition of Powerhouse is not good, specially the governors are not operating smoothly and therefore need repairs.

(F) Protection system

Over current cum earth fault protection is provided for each unit at L.T. side. Reverse power relay is also provided on LT. Side on HT. Side two over current cum earth fault relays are provided differential relay for generator winding protection is also provided.

(i) Alarm

There is no annunciation or alarm in Powerhouse in working conditions

(ii) Temperature

No speed sensing device is available either on generator or turbine bearings

(iii) Speed

No speed sensing device is available for over speed protection.

(G) Crane

A HOT Crane of 10 tonne capacity is available in power house which is in working conditions.

(H) Switch yards**(I) Circuit Breakers**

Seven. Nos. of air circuit breakers of 1250 Amps are installed in power station on L.T. side. All the breakers are manually operated (For closing). Two nos. of Bulk oil circuit breakers are provided on HT. Side.

(J) Power Evacuation system

The power is generated at 415 V and transmitted at 33 kV. This transmission system is extended upto Lower Subansiri, Upper Subansiri and Papumpare districts.

The proposed single line diagram for evacuation of power is given in Drg. No. E-202-1

The bearings of some units have worn out. The economizer assembly for each unit is non-functional and need to be replaced. The governors of each unit are not working smoothly and need overhauling. The mechanical protection system of governor does not work at all.

Proposal for E&M Works

The E&M equipment have lived more than 60% of their expected life. The generation data show that either one or two unit operated at a time due to spares/maintenance problem of E&M equipment. As per the status of each unit every machine has one or other problem related to maintenance and repair. The governor of each unit is non functional. The excitation system of each unit is to be repaired/replaced the stator windings of two generators are to be

rewound to put all the generating units in operation. The bearings of generator and turbines are to be replaced.

The air circuit breakers used in the LT and HT side are bulky and obsolete. The replacement of such obsolete components is necessary.

Though protection relays like over current cum earth fault, earth fault on HT side and differential relay for generator winding are provided, but they are seldom functional. Speed and temperature sensing devices are not available and should be installed for safety and performance monitoring of a hydro unit.

3.4 CONSTRUCTION PROGRAMME

The project is envisaged to be completed within 150 days from the date of awarding contract.

The contractor has to take into account the factors necessary to be considered for design, drawing, layout construction/execution, repair, renovation and overhauling of electrical/mechanical equipment, erection and commissioning of E&M equipment complete system for generating specified power and evacuate the same to grid.

3.4.1 STANDARDS

When the Standards are referred to, the Edition shall be the current at the time of signing the agreement, together with any Amendments issued to that date.

If requested by the Engineer, the Contractor shall supply at his own expense two copies in English of any national standards, which are applicable to the Contract.

Standard publications issued by the different organisations of standardisation are considered being approved standards for the works and are listed in Table A of this section:

3.5 TECHNICAL SPECIFICATIONS

3.5.1 General

This Chapter specifies the general scope of the works which, together with those listed in the Particular Specifications, shall be delivered by the Contractor to the Engineer within the periods, and in a number and quality as specified in the General Contract Conditions.

The Engineer reserves the right to request the Contractor for additional documents as may be required for proper understanding and definition of constructional, operational, co-ordination or other matters.

All documents to be supplied shall be submitted in accordance with the agreed programme so that any comment and change requested by the Engineer can be taken into account before starting of the manufacture repair / overhauling works in the workshop and / or erection at the site. The Contractor shall not be released of his responsibility and guarantee after drawings and computations have been approved by the Engineer.

3.5.2 Drawings

Preparation of all designs and drawings in respect of the project shall be the entire responsibility of the contractor.

All the drawings shall be worked out on computers using latest version of AutoCAD on maximum A1 size. All electrical drawings including schematic drawings, block diagrams, flow diagrams, terminal details, panel outline drawings, circuit diagrams etc. shall be worked out on A3 size. All drawings shall have a uniform title-block as approved by the Engineer. Beginning with the very first submittal to the Engineer, the Contractor's drawings shall bear a serial number corresponding to a drawing classification plan to be agreed upon by the Contractor and the Engineer. The drawings of bought out items shall also be preferred in AutoCAD version, however, their scanned version will be allowed. Catalogue sheets, illustrations, printed specifications, etc., shall be checked and prepared by the Contractor in such a way that the figures, statements and data valid for the delivered sizes and types of the works concerned are clearly marked. These documents also shall be scanned and stored on CD.

Five sets of hard copies of the drawings shall be submitted to the Engineer for comments / approval by the consultant to be engaged by the purchaser prior to executing the work. The comments shall be marked on one set of hard copy and returned to Contractor for necessary correction in original drawings. Corrected drawings replacing previously submitted drawings should be marked accordingly. The final approved drawings shall be submitted on CD with eight sets of hard copies in product wise folders.

If the Engineer feels it necessary to give any comment on a drawing submitted "For Information Only", the same shall be entertained by the Contractor as " Drawing for Approval".

If any revision is required in the approved drawings by Contractor or the engineer, the same shall be got approved again and revised drawing shall bear revision number.

Drawings in respect of the following shall be supplied:

i) Foundation Drawings

If a piece of Works requires its own foundation or needs a special area for installation, the Contractor shall submit drawings indicating all pertinent dimensions, static and dynamic loads, etc. They shall include all essential details required for proper design and construction of the foundations. The drawings shall clearly indicate the embedments and 1st, 2nd, 3rd stage C.C. lines.

In addition, they shall include openings, sleeves, and details of conduits, drainage and dewatering system slopes and the arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purposes.

ii) Schematic Diagrams

Schematic diagrams of new and existing turbine control and auxiliary systems like oil pressure unit, compressed air system, drainage / dewatering system, cooling water system, inlet valve etc. shall be supplied. These drawings shall show all instruments and control devices. Standard abbreviations and component numbers shall be used as per relevant standards.

iii) Single-Line Diagrams

Each electrical works and their circuits shall be represented by a single line diagram. It shall contain all required technical information of the Works represented, e.g. voltage, current, capacity, short-circuit level, ratios, voltage variations, measuring transformer and protection relay indices, interlocking, kind of switch drive, code designation, etc. as applicable.

Single-line diagrams of individual main components and switchboards shall additionally show the control, indicating, measuring, metering, protection, automatic, and other auxiliary electric devices separated for each individual installations item and location as applicable:

Furthermore, the applied recommended setting of adjustable devices (protection and control elements, time relays, etc.) shall be indicated.

iv) Circuit Diagrams

The Circuit Diagrams shall show the power circuits in all phases with the main apparatus as well as the pilot circuits (measuring and control circuits). It shall show in full the functioning of part or all installations, Works or circuits with all required technical information.

The control part shall be subdivided into separately drawn "current paths", each showing all its components regardless of their actual physical location. The individual circuits are to be drawn in a straight-line sequence, avoiding line crossings. The current paths (to be designated by numbers) shall be drawn starting from two horizontal lines, which represent the control voltage source. All devices belonging to the Works or forming part of the Works or control devices shall appear between these two lines.

Contact developments of the installed switches, contactors, relays and other apparatus which appear in the diagram shall be shown below the respective contactor coil, indicating by means of numbers and, if not on the same, also the page No., the current path in which the corresponding contact has been used.

Circuit diagrams shall also contain all terminals and their correct designations. Terminals grouped together to terminal blocks of switchboards, distributors, etc.

The representation of electrical works and control circuits shall not be terminated at the limits of the scope of supply, but has to be extended beyond this limit by all switchgear, protective, measuring and monitoring equipment required for full comprehension of the whole circuit. All terminals and functions of Works to be supplied by others shall be taken over as well.

v) Block Diagrams for existing and new Equipment / System

The Block Diagrams shall be used to show in a simplified manner the main inter-relationships between the elements of a system by means of symbols, block symbols and pictures without necessarily showing all the connections. The symbols used for the individual kinds of components, e.g. servomotors, computing modules, etc., shall clearly be explained on the diagram or on an attached legend.

vi) Terminal Diagrams

Such diagrams shall be prepared for any type of terminal box, marshalling rack, control cubicle, switchboard, etc., and shall show the terminals (properly numbered) and the internal and/or external conductors (wires or cables) connected to them.

The terminal diagram of each individual switchboard, terminal box, panel, etc., shall contain, but not be limited to the following information:

Terminal number of terminal board with targets (terminal number and current path) of incoming and outgoing cables and wires

- Cable designation
- Type of cable
- Number and cross-section of conductors

3.5.3 Calculations

In addition to the drawings or whenever the contractual documents do so require, the Contractor shall submit to the Engineer for checking, the appropriate calculations for determining the main sizes, stress levels, dimensions and operational characteristics, safety factors, clearly indicating the principles on which the calculations were based. The calculations shall include the formulae, standards, test results, basic assumptions, etc. Submission of computer calculations without baseline information such as derivation of the calculation method, applied formulas, definition of variables and constants, explanation of abbreviations etc., will not be accepted.

Short-Circuit Calculations

The short-circuit calculations shall be performed in accordance with VDE Standard 0102, part I / IEEE 242 and 399.

3.5.4 Operation and Maintenance Manuals

The Operation and Maintenance Manuals shall be prepared in latest version of MS Word with enclosures in the form of computerised drawings and scanned figures. They shall be supplied on CD along with Ten (10) hard copies in properly bound form. The O & M manuals shall contain the following information in sufficient detail to enable the Purchaser to maintain, dismantle, reassemble, adjust and operate the Works with all its items of Works and installations:

- (a) Table of Contents
- (b) List of Illustrations
- (c) Introduction
- d) Detailed Description

Detailed description shall contain a complete and accurate description of the Works, all components and ancillaries, their assembling and dismantling. An accurate list stating clearances, tolerances, temperatures, fits, etc. shall be included.

- * (e) Operating Principles and Characteristics

A brief summary of the technical operating principles of the Works, including diagrams, circuit diagrams, sequence diagrams, piping, etc.

- * Operating Instructions

The instructions shall contain the sequence of individual manipulations required for operation. Tables, lists and graphic presentations should be used whenever possible for making the description readily understandable. An appropriate trouble-shooting list shall be included in this chapter.

- * Testing and Adjustment

The entire testing and adjustment procedure required for the Works after overhauls and during operation shall be described.

- h) Maintenance Instructions

This section is divided into five paragraphs:

- h1) Preventive maintenance, indicating the inspections required at regular intervals, the routine cleaning and lubricating operations, the regular safety checks and similar steps.

The maintenance instructions shall include a tabular summary of the required activities sorted according to

- * Daily
- * Weekly
- * Monthly

* Quarterly

* Yearly

(Or other) cycles as applicable.

- h2) Repair and adjustment procedures including fault tracing
- h3) Spare part lists, containing all the necessary data for ordering spare parts. These lists shall include all spare parts, those to be supplied and those not to be supplied under the present Contract. *Detailed drawing for each item of spare parts shall be supplied.* The above list should include minimum and maximum quantities of spares to be maintained by the project.
- h4) Tool lists, containing all necessary data for identification of tools to be delivered under the present Contract.
- h5) List of Contractors of bought out items and their addresses.
- H6) As-built drawings

3.5.5 Installation and Commissioning Manuals

The Manuals of Installation and Commissioning Procedures shall be prepared in latest version of MS Word with enclosures in the form of computerised drawings and scanned figures. They shall be supplied on CD along with 10 (Ten) hard copies in properly bound form. These manuals shall contain the following information in detail:

Installation Procedures

The installations procedures shall describe in sequential steps the erection of major equipment and shall contain sufficient details such as equipment preparation on erection bay, handling of large and heavy pieces, levelling, anchoring, site welding, site painting, erection checks, site pressure tests, site flushing and cleaning of hydraulic systems, alignment and run out checks to allow the Engineer / Purchaser to plan and supervise the Works at site, if required. The manuals shall contain the Log Sheets for taking measurements during installation.

Pre-Commissioning Tests and Procedures

Pre-commissioning tests and procedures shall be described in sequential steps for the pre-commissioning of all electrical and mechanical equipments and shall also contain sufficient details viz. checking of installations, ratings, cable terminal checking and operation test of all auxiliary equipments etc. necessary Log Sheets shall be annexed to facilitate proper recording of test results.

Commissioning Procedures

The commissioning procedures shall sequentially and in sufficient detail describe activities and tests for all systems covered by the Contract Document.

3.5.6 Progress Reports during Design; Manufacturing, Repair and Renovation

During design and manufacturing / renovation / repairing works, the Contractor shall fortnightly submit four (4) copies of the progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding period. The report shall contain (but not be limited to) the following information:

- A general description of the Works performed during the reporting period on each main activity, and include any notable problems, which were encountered.
- The total overall percentages of design and manufacturing repairing and renovation works completed, with reference to the CPM programme. Appropriate comments shall explain any differences.
- The percentages of each main work activity completed during the reported fortnight with reference versus the scheduled programme. Appropriate comments shall explain any differences.
- A list of activities scheduled to be started within the next period of one (1) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the CPM programme, an explanation shall be given.

3.5.7 Progress Reports during Installation at Site

During erection the Contractor shall, submit four (4) copies of the fortnightly progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding month. The report shall contain (but not be limited to) the following information:

- A general description of the Works performed during the reporting period on each main activity, and include any notable problems, which were encountered.
- The total overall percentages of erection works completed, with reference to the CPM programme. Appropriate comments shall explain any differences.
- The percentages of each main work activity completed during the reported fortnight with reference versus the scheduled programme. Appropriate comments shall explain any differences.
- A list of activities scheduled to be started within the next period of one week, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the CPM programme, an explanation shall be given.
- A list of the Contractor's Equipment and materials presently located at the Site.
- Progress photographs of significant events. The Engineer may direct the inclusion of specific photographs if deemed necessary.
- A statement detailing the status of progress on the overall programme and how to regain any lost time or setbacks which may have occurred.
- A statement concerning potential problems and recommendations on how they could be resolved.

*** Quality Assurance Plan For Manufacturing Works**

Four copies of Quality Assurance Plan giving details of inspection, tests and customer witness / hold points shall be submitted with the bids. The quality plan shall contain the details of inspection and tests to be carried out for each major component of each functional assembly as recommended by the manufacturer as per their standard practice. The tests will include material composition and its properties, NDT, X-ray, hydraulic tests, leakage tests, insulation, high voltage tests and functional tests etc. along with the applicable standards and acceptance criteria.

The Contractor shall get the quality plans finalised and approved after the award of the Contract. The approved quality plan shall form the basis for inspection and acceptance of the equipment. The Engineer shall have the right to ask for more relevant tests if the same could not be included in the quality assurance plan at the time of their approval due to non availability of final design drawings.

*** Quality Assurance Plan for Site Installation & Commissioning**

Four copies of Quality Assurance Plan giving details of stage inspection during installation, pre-commissioning and commissioning tests and customer witness / hold points shall be submitted with the bids. The quality plan shall contain the details of inspection and tests to be carried out for each major component of each functional assembly as recommended by the manufacturer as per their standard practice. Test Procedure shall be specified giving for each test item (kind of test) a description, test method / standards, used instruments, sample/routine test, test judgement.

The tests will necessarily include NDT, X-ray, hydraulic tests, leakage tests, insulation, high voltage tests and functional tests etc. along with the applicable standards and acceptance criteria.

The Contractor shall get the quality plans finalised and approved after the award of the Contract. The approved quality plan shall form the basis for inspection and acceptance of the equipment at site. The Engineer shall have the right to ask for more relevant tests if the same could not be included in the quality assurance plan at the time of their approval due to oversight and/or non availability of final design drawings.

3.6 SPARE PARTS, TOOLS AND SITE CONSUMABLES

3.6.1 Spare Parts

All spare parts to be supplied shall be interchangeable with the corresponding parts of all the Works supplied under these Specifications and shall be of the same material and workmanship. They shall be replaceable without cutting or destruction of adjacent components.

All spare parts shall be protected against corrosion and shall be marked with identification labels. The identification scheme for spares shall be sent for Purchaser's approval before dispatch of any spare.

All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage.

Spare parts supplied under this contract shall not be given to the Contractor for use during erection and commissioning for replacing the defective or damaged original components of his supplies of works. The Contractor will arrange the spares required during the erection and guarantee period at his own.

The required list of spare parts has been given in Technical Specifications of respective equipment/works. The Bidders will give a separate list of spares recommend by them in addition to the list given in particular specifications and offer the price of the same separately in schedule of prices for spares. Wherever the quantity of spares is given as set/sets, it will be taken as quantity for both generating units. Sufficient quantity of spares will be included for parts which are more prone to frequent wear and tear and can be replaced easily without involving long shutdown.

The Contractor shall provide 5%, but at least two pieces of all types of bolts, screws, nuts, washers, spanner rings and cotters. The quantity may be taken from the surplus handed over to the Purchaser after completion of the installation as described under the chapter "Bolts, Screws, Nuts, etc." of this Section.

Orders for recommended spare parts shall be optional to purchase by the Purchaser for a period of one (1) year after the date of the completion of the project.

3.7 TOOLS AND SITE CONSUMABLES

3.7.1 Tools and Appliances

The scope of work shall include all customary and special tools, as well as auxiliary devices including lifting devices, ropes, etc. necessary for total assembly and disassembly of all parts of the supplied Works. Furthermore, all accessories for maintenance shall be supplied and included in the Tender. The total price for tools and devices as required by this article shall be included in the Total Tender Price. The special lifting devices and tools designed and supplied for the project, can be used by the Contractor during erection and will be handed over to Purchaser in good working condition without any wear and tear. However, ropes, slings, small hoists and winches etc. shall be handed over in new condition.

All lifting devices and wire ropes slings to be used at site shall be tested at works and test certificate shall be supplied to the Engineer.

Suitable toolboxes shall also be included in the delivery. An itemised list and description of all provided tools, auxiliary devices, etc. shall be included in the Tender. The Purchaser shall be entitled to take over from the Contractor the entire erection tools, appliances, instruments at mutually agreed conditions.

The Scope of work shall include 2 (Two) number Pentium – IV, branded Computer Sets each with CD Drive and multi-media facility, 19” Colour Monitor, suitable UPS and A3 size Laser Printer.

3.7.2 Site Consumables, Lubricating Oil and Grease for First Filling

Scope of work shall include all site consumables like welding electrodes, brazing materials, insulating materials, sealants, cleaning agents, paints and varnishes, grinding wheels/discs, fasteners and raw materials etc. in fairly sufficient quantity so that erection and commissioning activity is not held up for want of these items.

For all items under this Contract, the Contractor shall deliver 5 % of the quantity of painting material, but at least one litre, in new sealed containers, for later repair works other than the Contractor's.

Lubricating oils, insulating oils and greases etc. required for first filling in the plant and equipment supplied by the Contractor under this Contract shall be supplied in quantity 20 % (twenty percent) higher than the actual capacity for first filling. These items shall be supplied as per site requirement and shall not be stocked with main equipment.

3.8 DESIGN REQUIREMENTS

3.8.1 GENERAL

The equipment shall be designed, manufactured, repaired, renovated and overhauled (as the case may be) to provide most optimum functional value and neat appearance. All major assemblies or equipment shall be designed to facilitate easy and quick surveillance, maintenance and optimum operation. All control sequences shall be simple and rational.

All live, moving and rotating parts shall be adequately secured in order to avoid danger to the operating staff. All electrical components shall be electrically earthed.

Suitable lifting eyes and forcing off bolts shall be provided where required or where they will be useful for erection and dismantling.

Any changes of the design of any part of the equipment, which may become necessary after signing the Contract have to be submitted in writing to the Engineer for approval, being sufficiently substantiated and justified.

3.8.2 Design Responsibility

The contractor shall assume full responsibility for a coordinated and adequate design of all equipment specified and shall ensure that such equipment conforms to the best engineering practice for the operating conditions specified. When requested by the Engineer, the Contractor shall furnish complete information as to the maximum stress and other criteria used in the design.

Working Stress

Conservative factors of safety shall be used throughout the design and especially in the designs of all parts subject-alternating stresses of shock. For the rotating parts of the generator and exciters, the maximum units stresses due to runaway speed of turbine shall not exceed two-thirds of the yield point.

3.8.3 Steel Casting

Except otherwise specified herein, all steel castings shall conform to 'standard specification for Mild to Medium strength carbon steel casting' (A.S.T.M. Designation A27-46-T, grade

63-35, of the American Society for Testing Materials). Before proceeding with foundry work.

3.8.4 Standardisation of Works

Every effort shall be made to standardise parts, instruments and devices to minimise costs of the Works and facilitate keeping stocks, maintenance, replacement, interchange ability, etc.

3.8.5 Surface Finish

Surfaces to be machine-finished shall be indicated on the shop drawings by symbols. Compliance with the specified surface shall be determined by the sense of feel and by visual inspection of the work compared to applicable "Standard Roughness Specimens", or with roughness feeler gauge instruments.

Where the finish is not indicated or specified, the type of finish shall be that type which is most suitable for the surface to which it applies and shall be consistent with the class of fit required.

3.8.6 Fits and Tolerances

Fits and tolerances shall be given in accordance with ISO Standard. Tolerances on matching components shall be suitable for intended service and will ensure interchangeability. Fits shall be selected for the smooth functioning of the components for fairly long life.

3.8.7 Materials

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which equipment is to work. Tropical grade material should be used wherever possible. Material specifications, including grade or class shall be shown on drawings submitted to the Purchaser.

3.9 CORROSION PROTECTION

All ferrous metal work shall be provided with an effective painted or galvanised finish, applied in accordance with the best trade practice to protect from corrosion.

The Contractor's services shall cover the procurement of all materials, and the preparation and application of the painting and other protective coats as specified. All costs of painting or galvanising shall be included in the Tender Price.

The Contractor shall submit for the Engineer's approval full details of the preparation, type of materials, methods and sequences he proposes to use to comply with the requirements for the protection works. Parts which are to be embedded in concrete shall be painted with cement base paints.

3.10 MANUFACTURING REQUIREMENTS

3.10.1 Workmanship

All works shall be performed and completed in highly professional manner and shall follow the best modern practices in the design, manufacturing repair, renovation and overhauling of the equipment. All parts shall be made accurately and shall not deviate from drawing and quality requirements. Wherever, in process inspection is required, due notice shall be given to inspection agency and the inspection shall not be bypassed. The Contractor shall arrange all measuring instruments, gauges, templates, fixtures and devices required for the purpose. All special gauges, instruments and devices deemed necessary for the maintenance of the equipment, shall be offered and included in scope of supply under this contract.

3.10.2 Materials

All materials used, shall be new and of first class quality free from rust, defects and imperfections. Inspection documents of all materials shall be reviewed and compiled before actual use. The Engineer shall review the inspection records of materials of major components. Materials of limited shelf life shall not be used after their expiry date.

3.11 MANUFACTURER'S NAMEPLATES

Each important part to be delivered under this Contract shall be equipped with permanent nameplate in readily visible locations. The nameplates shall be protected during erection and especially during painting.

The following data shall be shown in accordance with the relevant standards:

- Manufacturer's name
- Work's serial number and year of manufacture
- Main design data.

3.12 Oils and Lubricants

Efficient means of lubrication, suitable for use under Site conditions, shall be provided for all moving parts.

All different types of oils, lubricants, etc., shall be subject to the written approval of the Engineer.

Unless otherwise stated in the Particular Technical Specifications, the first oil or grease filling for bearings, pressure oil systems, transformers, etc., including the necessary quantity for flushing and for the first oil change shall be included in the Tender price.

3.13 ELECTRICAL WORKS

3.13.1 General

The electrical items of Works of any electrical or mechanical installation to be provided under this Contract according to the Particular Technical Specifications shall - if not stated otherwise therein-fulfil the requirements of this Section.

All components shall be of an approved and reliable design. The highest extent of uniformity and interchangeability shall be reached. The design shall facilitate maintenance and repair of the components.

The Works shall be pre-assembled to the highest possible extent in the Contractor or Sub-Contractor's workshop, complete with all devices and wired up to common terminal blocks.

The power supply and control cables shall be laid up to these common terminal blocks. The required control and protection devices, instruments, etc., within the different scopes of work shall be supplied and connected by the relevant Contractor.

Unless otherwise agreed, ratings of main electrical Works (in feeds, bus-ties) as selected or proposed by the Contractor, whether originally specified or not, shall generally include a safety margin of 10% under consideration of the worst case to be met in service. Prior to approval of such basic characteristics, the Contractor shall submit all relevant information such as consumer lists, short circuit calculations, de-rating factors, etc.

Short-circuit calculations shall be evaluated giving full evidence that every electrical component can withstand the maximum stresses under fault conditions, for fault levels and durations obtained under the worst conditions, e.g., upon failure of the corresponding main protection device and time delayed fault clearing by the back-up protection device.

All Works shall be suitable for the prevailing climatic conditions.

The Contractor shall ensure that all the supplied Works is insensitive to any signals emitted by wireless communication equipment.

3.13.2 Clearances

The layout of the Equipment on the site shall provide for ready access for operation and maintenance whilst the remaining sections of Equipment are alive. Working clearance provided between isolated Equipment and nearest live metal work shall be as per Indian Electricity rules & Standards.

3.13.3 Electrical Supplies For Auxiliary Equipment

The electricity supplies available for Auxiliary Equipment will be :

- (i) 415 V, 3-phase 50Hz, 4-wire for power
- (ii) 220 V, single phase, 50 Hz for lighting, indication, and anti-condensation heaters.
- (iii) 24 V D.C. for essential indication, controls, protection, alarms and circuit breaker closing and tripping supplies.

3.13.4 Alternating Current Supply Practice

All mains supplies shall be switched and fuse in accordance with the requirements stated in the appropriate Section. Double-pole switches shall be used to break single-phase A.C. mains supplies.

For multi-phase supplies, each phase shall be switched simultaneously and the neutral should preferably not be switched. If it is switched, it shall be opened after and closed before the phase-lines.

All mains circuits shall be protected only in the phase-lines by fuses of suitable rating or by other suitably protective devices. The neutral shall be connected by a removable link located near the protective devices.

All mains transformers shall have an electrostatic screen which shall be earthed.

Except where the prior approval of the Engineer is obtained, wires external to the equipment shall be coloured in accordance with the current IEC or relevant IS recommendation.

3.13.5 Moulded Case Circuit Breakers

All moulded case circuit breakers shall be of 2 or 3-pole type as required, having thermal time delay and instantaneous trips with "On-Trip-Off", indicating/operating mechanism. Circuit breakers used in combination type motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the circuit breaker is open. The breakers shall comply with applicable section of IEC 157/1 or equivalent standards.

3.13.6 Terminal Blocks

All terminal blocks shall be mounted in an accessible position with the spacing between adjacent blocks not less than 100 mm and space between the bottom blocks and the cable gland plate being a minimum of 200 mm. Sufficient terminals shall be

provided to allow for the connection of all incoming and outgoing cables, including spare conductors and drain wires. In addition, 20 percent spare terminals shall be provided. In enclosed cubicles, the terminal blocks shall be inclined toward the door for facilitating terminations.

Terminals shall be of the channel mounting type and shall comprise a system of individual terminals so that terminal blocks can be formed for easy and convenient cabling consistent with the high reliability required of the circuits.

Terminal blocks shall be provided with shorting links and paralleling links where applicable and mounting identification numbers and/or letters.

Terminal blocks shall conform to the applicable standards. The smallest size to be used shall be designated for 2.5-sq. mm wire and not more than two conductors shall be connected under one terminal clamp.

Terminal identification shall be provided corresponding to wire number of connected leads.

Circuit terminals for 415 V AC shall be segregated from other terminals and shall be equipped with non inflammable, transparent covers to prevent contact with live parts. Warning labels with red lettering shall be mounted thereon in a conspicuous position.

3.13.7 Equipment Wiring

All wiring connections shall be readily accessible and removable for test or other purposes. Wiring between terminals of the various devices shall be point to point.

Multi-conductor cables shall be connected to the terminal blocks in such a manner as to minimise crossovers. Approved claw washers of crimp type connector shall be used to terminate all small wiring. Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilising slip-on ferrules approved by the Engineer.

Markers may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.

Markers must withstand a tropical environment and high humidity and only fungus proof materials will be accepted. Ferrules of adhesive type are not acceptable.

All trip circuits shall employ markers having a red background.

3.13.8 Earthing

Provision shall be made for earthing all equipment intended for connection in an A.C. mains supply. All structural metal work and metal chassis shall be connected to earth. Connection between circuits and metal work shall only be made for reasons of safety and/or reduction of interference. Where such connections are made, they shall not be used as normal current-carrying earth returns.

Earthing conductors shall be at least equal in cross-sectional area to the supply conductors and shall be capable of carrying the fault current.

3.13.9 Labels And Plates

Labels and data plates shall be provided in accordance with applicable standards and as detailed hereunder.

The proposed material of the labels, size, exact label lettering and proposals for the arrangement of the labels shall be submitted to the Engineer for approval.

Labels written in the Contract language shall be provided for all instruments, relays, control switches, push buttons, indication lights, breakers, etc. In case of instruments, instrument switches and control switches, where the function is indicated on the device, no label is required. The label shall be fixed close to the devices in such a way that easy identification is possible.

Each separate construction unit (cubicle, panel, desk, box, etc.) shall be identified. Cubicles and similar units shall also bear this identification number on the rear side if rear access is possible. The overall designation of each unit shall be given in the Contract language and - if required - also in a selected local language. These labels shall be made of anodised aluminium with black engraved inscriptions, arranged at the top section of the units. Manufacturer's trade labels shall - if desired - appear in the bottom section of the units.

All Works inside cubicles, panels, boxes, etc., shall be properly labelled with their item number. This number shall be the same as indicated in the pertaining documents (wiring diagrams, Works list, etc.).

Instruction plates in the Contract and selected local language, the sequence diagrams or instructions for maintenance shall be fitted on the inside of the front door of the electrical switchboards.

3.13.10 Warning Labels

Warning labels shall be made of synthetic resin with letters engraved in the Contract and selected local language, where required in particular cases.

For indoor circuit breakers, starters, etc., transparent plastic material with suitably contrasting colours and engraved lettering would be acceptable.

3.13.11 Labels For Cables

Each cable when completely installed shall have permanently attached to each end and at intermediate positions as may be considered necessary by the Engineer, non-corrosive labels detailing identification number of the cable, voltage, and conductor size.

The cable identification numbers shall comply with those of the cable list.

All cables in cable pits and at the entry to buildings shall be labelled utilising the aforementioned type of label.

3.14 Single-Line Diagram

Each switchgear room shall be furnished with a copy of the final as-built single-line diagram detailing all electrical data and denominations, separate for each individual switchgear / distribution board / MCCB, placed under glass and frame / wall mounted at an approved location.

The same applies to the Station Single-Line Diagram one copy of which shall be arranged in the control room (s).

3.15 INSTRUMENTATION AND CONTROL EQUIPMENT

DESIGN CRITERIA

All components shall be of an approved and reliable design. The highest extent of uniformity and interchangeability shall be reached. The design shall facilitate maintenance and repair of the components.

The Works shall be pre-assembled to the highest extent in the Contractor's or Sub-Contractor's workshop, e.g., shop welding of thermometer wells and other connections, wiring of boards, desks, etc., including internal wiring and installation of devices shall be carried out. Fragile instruments shall be removed for transportation to site.

All components shall be suitable for continuous operation under site conditions.

Materials for instrumentation and control equipment, including piping material, which are exposed to the measured media, shall be selected accordingly.

All components shall be compatible with other electrical, electronic and mechanical Works.

All instrumentation and control functions shall be shown on the piping and instrumentation diagrams. The symbols to be used shall be in accordance with ISO standard. The identification system (tag numbers) shall be in accordance with the Works identification system and is subject to approval by the Engineer. All measurements and alarms shall be listed in a measuring list of a standard form subject to Approval by the Engineer. For remote controls, a schedule of interlocks shall be provided. The features of automatic controls shall be shown in block diagrams.

Shielded cables shall be provided for the control and supervisory equipment where required.

Sizes of Indicators, Recorders, Etc.

The meters, instruments and recorders shall be of standard size, to be selected to guarantee unique appearance of switchgears, control panels, control desks, etc. The front glasses shall be of the anti-glare type. The scales shall be 90 degrees type for local control panels but must be 240 degrees type for control room instrumentation.

Tests

The single components and pre-erected assemblies shall undergo functional and routine tests in the Contractor or Sub-Contractor's workshop. The ready mounted control and supervisory system shall undergo functional tests on Site prior to commissioning of the power Works.

Calibration tests shall be made on all-important pressure gauges and other instruments as required by the Engineer.

Measuring Systems

Electric measuring signals of 4-20 mA shall be transmitted to the control room for essential or regulating circuits. In this case the absence of live zero signal shall lead to a warning signal. Measuring signals for indicating purposes will be 4-20 mA.

The components shall quickly respond to any changes of the measured magnitudes. Measuring ranges of indicators, transducers, etc. shall be selected in such a way that the rated value of the measured magnitude covers approx. 75% of the range.

All local instruments shall, as far as practicable, be mounted vibration free to allow good reading. Wherever required, damping elements shall be used.

Corresponding systems shall be grouped together in local panels.

3.15.1 Temperature Measurement

Resistance thermometers and thermocouples shall be equipped with waterproof connection heads. The temperature sensors shall be selected in such a way to minimise the number of different spare inserts.

Resistance thermometers shall be used as far as possible and shall generally be of type Pt 100.

The use of dial-type contact thermometers shall be restricted to bearing metal and oil temperature measuring.

3.15.2 Pressure Measurements

Pressure gauges shall be shock and vibration-proof (preferably by filling with glycerine) and shall be equipped with toothed wheels and toothed segments of the machined type. They shall completely be made of stainless steel.

The error for pressure transmitters shall be limited to $\pm 0.5\%$.

Each gauge, pressure switch and transmitter for absolute or differential pressure shall be equipped with a pressure gauge isolating valve including a test connection of the screwed type M20 x 1.5 mm so that such device can be removed without any disturbance of the plant operation.

If the pressure is pulsating, the devices concerned shall be connected via flexible tubes or other pulse-absorbing means.

The adjustment of the pointer shall be possible by means of an adjustment device without removing the pointer from its axle.

All casings shall be dust and watertight and be made of stainless steel.

3.15.3 Electrical Measurements

All Electrical instruments shall be of flush mounted design, dust and moisture-proof. A.C. ammeters and voltmeters shall have not less than 1.5 accuracy class for connection to the secondary side of instrument transformers. D.C. measuring instruments shall be of the same accuracy. Wattmeters/energy meters shall have electro-dynamic measuring mechanisms if fed by transmitters. Wattmeters shall be suitable for unbalanced systems and accuracy of energy meters should be static Electronic ISI marked preferably of L & T make of 0.2 % accuracy class. Trivector meter shall be Digital of L & T make only.

All indicating instruments shall generally withstand without damage a continuous overload of 20% referred to the rated output value of the corresponding instrument transformers. Ammeters shall not be damaged by fault-currents within the rating and fault duration time of the associated switchgear via the primaries of their corresponding instrument transformers.

All instruments and apparatus shall be capable of carrying their full load currents without undue heating. All instruments and apparatus shall be rear connected, and the enclosures shall be earthed. Means shall be provided for zero adjustment of instruments without dismantling.

When more than one measured value is indicated on the same instrument, a measuring point selector switch shall be provided next to the instrument and shall be engraved with a legend specifying each selected measuring point.

Scales shall be arranged in such a way that the normal working indication is between 50-75% of full scale reading permitting an accurate reading. CT connected Ammeters provided for indication of motor currents shall be provided with suppressed overload scales of 2 times full scale. The dials of such ammeters shall include a red mark to indicate the full load current of the motor.

All instruments mounted on the same panel shall be of same style and appearance.

All metering circuits shall be terminated in marked terminal blocks for remote metering purposes.

3.15.4 Protection Systems

Electrical/Mechanical Protection and Interlocking Systems shall be provided for all works components and individual systems to ensure a safe and reliable operation and to limit harm and damage to personnel and works to an utmost extent.

The primary functions of these facilities shall be to disconnect selectively faulty sections of the systems prior to influence or damage to other works and to maintain operative systems as far as possible.

Moreover these devices shall facilitate the duty of the operation staff and prevent mal-operation.

3.16 INSPECTIONS AND TESTS

3.16.1 General

Approval of assemblies, tests, inspections, related procedures etc. and acceptance of pertinent test and inspection certificates, or waiving of inspections or tests, shall in no way relieve the Contractor of his contractual obligations for finishing the Works in accordance with the provisions of the Specifications.

Three (3) sets of all test records, test certificates, performance curves, tables etc. of all inspections and tests, whether or not attended by the Engineer shall be supplied after each inspection or test. After completion of all testing two (2) sets of the above mentioned documents shall be supplied properly bound in books.

All test certificates shall be endorsed with sufficient information for identification of the equipment and material to which the certificates refer.

In addition, the following references shall be entered in the top right-hand corner:

Purchaser's name
 Project title
 Plant's (stage's) name
 Number of Contractor's drawing
 Date

3.16.2 Workshop Inspections And Tests

As far as practicable, quality of materials, workmanship and performance of all items of the Works to be furnished under this Contract shall be inspected at the places of manufacture / repair and overhauling as the case may be.

Where the Contractor desires to use stock material, not manufactured specifically for the Works, satisfactory evidence that such material conforms to the requirements of the Contract shall be submitted.

Free and unrestricted access to the Contractor's factory and shops (including those of his Subcontractors) shall be granted to the Engineer also and upon reasonable notice by the Engineer if deemed necessary by the same for additional witnessing of assembly work or inspections and tests.

3.16.3 Material Tests

Unless otherwise specified, the quality of materials shall be verified generally by:

- Chemical analysis
- Mechanical tests (yield point, tensile strength, elongation, and notch impact.)
- Welding tests (welding procedure, welding material, welding tensile strength, welding bend test, welding reversed bend test, etc.)
- Non-destructive x-rays, ultrasonic, magnetic particle, liquid tests, penetration inspection, etc.).
- Electrical tests (voltage, losses, tan delta, insulation, magnetic properties etc.)

Certified mill test reports of plates will be acceptable when these comply with the requirement of specifications. Test specimen and samples for analysis shall be plainly marked to indicate the materials they represent.

Castings and forgings shall be tested in the rough state in order to detect flaws in good time thus avoiding delays. Magnetic particle inspection of important castings shall cover the whole surface of the casting. After partial machining further tests can be conducted.

Load tests on crane hooks, steel wire ropes, chains and other lifting devices, etc. shall be considered as material tests.

3.16.4 Checking of Dimensions

The dimensions, especially clearances and fits, (ISO 286) which are essential for operation and efficiency shall be carefully checked in an approved manner, as for example:

- run out and roundness tolerances of shafts, pistons, etc., to be measured on single parts,
- fits and clearances of bearings, servomotor pistons, valves, guiding, distributing and actual actuating elements, etc.,
- Accuracy, surface roughness and shape of sliding and guiding surfaces of seals, bearings, water passages in hydraulic machinery, valves, etc.,
- Dimensions of couplings or connections for assembly with other deliveries from the Contractor, Sub-contractors or other contractors.

3.16.5 Workshop Assembly

In addition to the quality and production control tests, the following shop assembly work and tests shall be made to check measurements, fitting and functioning.

Works to be furnished shall be shop assembled to a status sufficient to prove that the design and workmanship have been executed in accordance with the Specifications, that the delivery is complete, and that no work remains to be done at Site, which reasonably can or should be done in the shop.

Where applicable, each item of the Works shall be assembled completely prior to painting.

Field joints shall be temporarily connected. All parts shall be properly matched marked, identified and doweled where practicable, to facilitate correct and quick field assembly and alignment. Where necessary, suitable dowels shall be provided for insertion after field assembly and drilling. The holes for any fitted bolt shall be accurately reamed.

During workshop assembly all instruments, control devices and piping shall be fitted. If the assembly shows defects in the design or manufacture or unforeseen difficulties in assembling and dismantling, these shall be eliminated. If required, design alterations or corrective measures can be executed provided that reliability of operation or inter changeability are not reduced and provided that the agreement of the Engineer has been obtained.

If the corrections cannot be carried out in accordance with the terms mentioned above, the components concerned will be rejected. The decision on possible subsequent corrections is reserved exclusively to the Engineer. Faulty parts or Works shall by no means be delivered. The assembled parts shall subsequently be subject to tests as per applicable standards or required by the Engineer.

3.16.6 Pressure And Leakage Tests

All parts subject to internal or external pressure or containing any liquids or gases temporarily or permanently during operation shall be tested prior to painting.

In addition to the Specifications, the applicable and approved standards and official regulations shall be observed. If any liquid is used for the test that may cause corrosion, all Works and piping shall be thoroughly cleaned immediately after the test.

Leaks and defects can be repaired if permitted by the applicable standards and approved by the Engineer. If defects are found, the Engineer may reject the defective parts, or permit welding repairs with stress relieving, radiographic examination and additional pressure tests.

3.16.7 Parts Exposed To Hydraulic Pressure

Unless otherwise specified or required, the following shall apply: the hydraulic pressure tests shall be carried out using the liquid to be used during operation or a liquid with less viscosity.

The hydraulic test pressure shall be 1.5 times the maximum operating pressure and shall be maintained for a period of 30 minutes. Afterwards the test pressure shall be reduced to the operating pressure.

3.16.8 Functional Tests

Functional tests shall be defined as tests of the function of assemblies, sub-assemblies or parts of the Works under no load conditions. Functional tests shall be performed on all Works prior to the execution of operational tests.

3.16.9 Operational Tests

As far as practicable operational test shall be carried out on all Works, simulating operating conditions.

Parts to be delivered by sub-Contractors shall be tested either at the premises of the sub-Contractor or of the Contractor, as agreed by the Engineer.

Testing of the electrical Works shall be performed in accordance with applicable Standards; they shall include but not be limited to tests of heating, loading, overloading, and losses.

Operational tests of lifting equipment and other machinery shall include tests under nominal load and 125 % of nominal load unless otherwise specified.

3.16.10 Electric Tests

Electrical Works shall be tested in accordance with applicable Standards and agreed test programs and procedures.

3.16.11 Type Tests

Type tests for certain parts of the work or Works shall be carried out as specified or agreed between Contractor and Engineer.

3.17 ERECTION AND COMMISSIONING

3.17.1 Preparation And Installation

Prior to commencement of installation, the Contractor shall closely inspect the site and all the foundations and other structures on which parts of the plant supplied under this Contract will be installed; he shall check that the foundations conform to the installation drawings.

3.17.2 Reference Points

The Contractor shall employ a competent surveyor for setting-out of all datum lines including the constant checking and maintenance of the setting-out until the completion of his works.

The Contractor shall provide all necessary pegs and centre lines and shall establish all such permanent markings and recovery marks as may be required by the Engineer for checking the Contractor's setting-out. The Contractor shall be responsible for rectifying, at his own cost, all work rejected by the Engineer due to errors in setting-out.

The Contractor shall be responsible for the true and proper staking-out of the works and levels of reference given by the Engineer in writing, for the correctness of the positions, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances and labour in connection with this.

The checking of any staking-out or of any line or level by the Engineer or the Engineer's Representative shall not in any way relieve the Contractor of his responsibility for its correctness.

3.17.3 General Notes On Installation Work

All transportation and handling of the plant from the place of storage to the place of installation shall be carried out by the Contractor. He shall provide all hoisting equipment, staging and scaffolding, winches and wire ropes, slings, tackles and all other appliances and temporary materials.

The Contractor shall comply with all applicable and approved safety regulations while carrying out the works on Site and with all reasonable requirements of the Engineer. This stipulation shall in no way release the Contractor from any obligation concerning his liability for accidents and damages. He shall be responsible for adequate protection of persons, plant and materials against injuries and damages resulting from his operations.

The Contractor shall be responsible that the installation of all plant is properly executed to the correct lines and levels and in accordance with the manufacturer's instructions and the Contract requirements.

The alignment of the plant shall be done exactly; the tolerances in specifications and indicated by the Manufacturers or in the drawings shall be kept.

Setting of parts to be aligned shall be performed by means of fine measuring instruments. All erection clearances and settings shall be recorded. Copies of these records shall be given to the Engineer. After alignment, the parts shall be held firmly in position by means of set pins, fitted bolts, etc. embedments.

All parts to be embedded in concrete shall be set accurately in position and shall be supported rigidly to prevent displacement during the placing of concrete. Adjusting screws and bolts shall be drawn tight and secured adequately. Steel wedges shall be secured by welding. Wooden wedges shall not be used. Fixing of 1st, 2nd and 3rd stage embedments (as the case may be) should be done so as to match the concreting schedule of civil contractor.

The Contractor shall verify carefully the position of all parts to be embedded before concrete is poured. All important measurements and dimensions shall be recorded. Copies of these records shall be given to the Engineer for checking and approval before items are built-in to the Works.

After concreting, the control measurements shall be verified again, indicated in the above-mentioned records and submitted to the Engineer.

The Contractor shall provide all necessary anchors and braces to ensure the alignment and stability of the parts to be installed. All temporary anchors and bracings shall take care of all dead load, wind load, seismic and erection stresses, e.g., during concreting, and shall remain in place until they can be removed without endangering the stability of the plant.

If for installation purposes auxiliary structures have been attached to the plant, they shall be removed after completion of work and the surface restored to proper condition by grinding and repainting.

Special care shall be taken not to damage surfaces of galvanised or specially treated plant during erection. Care shall be taken to prevent or remove any rust streaks or foreign matters deposited on galvanised or otherwise finished surfaces during storage or transport or after installation.

Glass parts or other parts, which can easily be damaged, shall be provided with suitable protective sheaths or coverings during installation.

Machined or bare metal surfaces, which are to receive no coat of paint, shall be protected during transportation, storage and erection by a suitable anti-corrosion film.

All power tools preferably are operated pneumatically. They are to be handed over at the end of the installation work in good condition in accordance with the Engineer's instructions.

After erection, the works shall be finally painted, in accordance with the painting specification, and any damaged paintwork shall be restored.

The Contractor shall keep the site in clean condition during erection and commissioning time. On instruction of the Engineer he shall remove waste from the place of installation to the defined deposit site at his own cost.

3.18 PAINTING OF WORKS AT SITE

Painting Materials

Coating materials shall be standard products of a paint manufacturer with proven experience in the field of corrosion protection of the type of Works to be supplied.

Paint material shall be delivered in unopened original containers bearing the manufacturer's brand name and colour designation, storage directions and handling instructions. The entire paint material for a particular specified paint system shall be supplied by one manufacturer only; who shall guarantee the compatibility and quality of the paint material. A complete list of the proposed paint material shall be submitted to the Engineer. For multicoated painting systems each coat shall have a different colour.

With regard to materials, the Contractor shall submit full details including the source of the basic raw materials, volatile matter content, nature of solvent, number of components, type of coat, coverage, time interval between coats and number of coats, compatibility of each coat with the previous coat, toxic properties, physical properties, shelf life, resistance against chemical attack, resistance against ozone and UV-radiation, compatibility with drinking water standards, etc.

He shall describe in detail the treatment he proposes to apply in order to give adequate protection during transport, site storage, building and concreting and subsequent erection.

The Contractor shall submit to the Engineer for approval an overall colour scheme in accordance with the Particular All final coats shall be in the colours approved by the Engineer. On request of the Engineer, painting samples for the different coats and colours shall be provided.

All pigment, paints and primers shall be delivered to Site in sealed containers packed by the manufacturer. The manufacturer's instructions for preparation and application of all painting and protective coats shall be strictly observed. .

Preparation of Paint Material

Paint shall be delivered ready mixed wherever possible. Adding of diluting agents and mixing of two or multi-component systems shall be done in the field in accordance with the directions of the manufacturer. After mixing, the paint shall be poured into a clean container to ensure that no settled pigments are at the bottom.

Application: The most commonly used methods of application are painting by brush, roller, pressure and airless spraying equipment. Selection of the application method depends on the surface to be painted. The quality of the paint shall in no way be negatively influenced. The manufacturer's directions shall govern the choice of application method. Inaccessible surfaces shall be painted prior to erection with prime and finish coats according the specification. Areas inaccessible to spraying equipment shall be painted by brush. Corners and edges shall be pre-coated. Bolts, screws, studs, rivets etc. shall be painted as a whole with the complete paint system after erection.

The primer shall be applied to an absolutely clean and dry surface only. Temperature and dry-out time shall be in accordance with the manufacturer's directions. Whenever possible the prime coat as well as one intermediate coat shall be applied in-doors at the Contractor's shop.

During painting the air temperature shall be at least +5°C and the temperature of the items being painted must be at least 3°C above the dew point. During drying of the paint, the temperature shall not be below 0°C. For all paints the surface temperature of the metal shall not be higher than +50°C during the painting. Concerning special paints, the requirements set by the paint manufacturer shall be followed.

Cleaning and painting work shall be interrupted outdoors and in non-conditioned rooms under the following conditions: rain, fog, dew, and polluting winds, sand and other dusts. Surface preparation and application of the first paint layer are parallel operations to be carried out within a maximum delay of 4 hours.

All painting shall be free of cracks and blisters and all runs shall be brushed out immediately. After application of the last coat the paint system shall be free of pores. After erection of the equipment all damages to painted surfaces shall be repaired. Welds, rusty spots, slags, beads, flux deposits etc. shall be repaired and repainted. For touching up, the same materials shall be used as for the main painting work. Repaired finish coats shall be of the same appearance as the original coating.

Remove electrical plates, surface hardware, fittings and fastenings before starting painting operations. Carefully store, clean, and reinstall after completion of work.

Repair of Primer and Finish Coats

For touching up, the same paint shall be used as for the original painting work. Repaired finish coats shall be of identical appearance with the original and no difference in the colour shall occur.

Galvanised and Painted Structures

Surface Preparation: Thorough cleaning of the damaged surface i.e. removal of oil, grease, dust, etc.

Repair of Coatings: Two coats of 2-component epoxy-resin micaceous iron oxide (mio) paint. Total film thickness min. 0.160 mm. The colour of the paint shall be the same as originally applied.

Painted Structures

Repairs on painted structures shall be carried out as follows:

Surface Preparation: Scraping, wire brushing or grinding to Grade ST 3 according to SIS 055 900-1967.

Prime Coat: One coat of 2-component epoxy resin zinc-chromate primer. Dry film thickness minimum 0.050 mm.

Parts, which are embedded in concrete, must not be protected against corrosion. However, transition zones of large steel pipes and of steel linings shall be painted over a length of 1 m within the concrete, all other concreted in steel surfaces over a length of 200 mm within the concrete.

Quality Control of Painting

The minimum dry-film thickness prescribed in these Specifications shall be observed. Of each 100 m², one area of 10 m² will be measured for dry-film thickness. No measured thickness shall be less than the specified thickness. Where the minimum thickness is not achieved, the coat shall be repaired to reach the specified minimum dry-film thickness.

The dry-film thickness shall be measured by approved gauges to be arranged by Contractor.

Upon completion of each coat, the painter shall make a detailed inspection of the painting finish and shall remove from adjoining work all spattering of paint material. He shall make good all damage that can be caused by such cleaning operations.

A detailed inspection of all painting work shall likewise be made, and all abraded, stained, or otherwise disfigured portions shall be touched up satisfactorily or refinished as required to produce a first-class job throughout and to leave the entire work in a clean and acceptable condition.

3.19 SITE INSPECTION AND TESTS

During erection, commissioning and trial operation, the Contractor shall perform at suitable intervals all inspections and tests in the presence of the Engineer in order to prove the orderly execution of the works in accordance with the Contract.

Unless otherwise specified, all costs for testing at site and of the works and charges associated with it shall be borne by the Contractor. This includes the measuring devices, properly calibrated, and any pertinent accessories, which shall be made available by the Contractor for the entire duration of the tests. The Contractor shall delegate his experts to perform the tests at site.

The Engineer reserves the right to have checked at his own expenses the Contractor's instruments to be used or having been used for any tests by an independent, officially acknowledged institution.

The Contractor's testing at Site shall be complete in every respect to prove the successful performance and operation of all the works and Works supplied and erected under the Contract.

In case of disagreement between the Engineer and Contractor(s) on the test results, an independent expert shall be appointed by Purchaser to whom both parties shall agree. If no amicable settlement can be reached, the Arbitration Clause shall be applied.

For the procedure of inspections and test at site, notice to the Engineer, reports, commissioning, trial runs and trial operation, and acceptance tests refer to General Conditions of Contract.

3.20 COMMISSIONING TEST

Commissioning acceptance tests shall be carried out, on all generating units to verify the rating characteristics of generating units and other equipment's in accordance to relevant standards. The complete field acceptance test reports shall be prepared by the Contractor and submitted to Purchaser for approval.

The test run on generating units shall be carried out as per relevant provisions of IEC standards.

Before issuing the "Taking-Over Certificate", the revised copies of the Operation and Maintenance Manual shall be submitted together with the specified number of complete sets of drawings of the Works as completed. The Works shall not be considered complete for purposes of taking over under the terms of the General Conditions of the Contract until the above documents have been supplied by the Contractor in proper desired shape.

3.21 TRIAL RUN

Immediately upon completion of commissioning, the plant shall be kept on trial operation during which period all necessary adjustments shall be made while operating over the full load-range enabling the plant to be made ready for performance and guarantee tests. The plant, i.e., complete equipment, shall be on Trial operation for a period of one month.

The trial operation shall be considered successful, provided that each item of the equipment can operate continuously at the specified operating characteristics, for the period of trial operation.

For the period of trial operation, the time of operation with any load shall be counted. Minor interruptions not exceeding 3 (three) hours, at a time, caused during the continuous operation shall not affect the total duration of trial operation. However, if in the opinion of the purchaser, the interruption is long, the trial operation shall be prolonged for the period of interruption.

The trial operation report comprising of observations and recordings of various parameters to be measured in respect of the above trial operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during trial run, shall also

include the dates of start and finish of the trial operations and shall be signed by the representatives of both the parties. The report shall have sheet, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the trial operation. Based on the observations, necessary modifications, repairs to the plant shall be carried out by the Contractor to the full satisfaction of the purchaser to enable the latter to accord permission to carry out the performance and guarantee tests on the plant. However, minor defects, which do not endanger the safe operation of the equipment, shall not be considered as reasons for withholding the aforesaid permission.

During the trial run the Contractor shall make familiar the Purchaser's personnel with the equipment, the operation and maintenance of the Works and its auxiliaries to such extent that thereafter the duties can be assigned to the Purchaser's trained personnel.

If any defects or irregularities affecting the safety or reliability of the Works should arise during the trial run, the trial run shall be interrupted and started again after such defects or irregularities have been corrected by the Contractor at his own cost.

3.22 PERFORMANCE AND GUARANTEE TESTS

- (i) The final test as to the performance and guarantees shall be conducted at site, by the contractor in presence of the Department representative. Such tests will be commenced, within a period of 15 (fifteen) days after successful completion of Trial Operations. Any extension of time beyond the above 15 (fifteen) days shall be mutually agreed upon.
- (ii) These tests shall be binding on the Contract to determine compliance of the equipment with the performance guarantees.
- (iii) The available instrumentation and control equipment will be used during such tests and the contractor will calibrate, all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken in to account in a reasonable manner, for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable.
- (iv) Any special equipment, tools and tackles required for the successful completion of the performance and guarantee tests shall be provided by the contractor.
- (v) The guaranteed performance figures of the equipment, shall be proved by the contractor during these performance and guarantee tests. Should the results of the these tests show any decrease from the guaranteed values, the contractor shall modify the equipment as required to enable it to meet the guarantees. In such case, performance and guarantees tests shall be repeated within one month, from the date the equipment is ready for retest and all cost for modifications including labour, materials and the cost of additional testing to prove that the equipment meet the guarantees, shall be borne by the contractor.
- (vi) The contractor is to keep the project in operation successfully for a period of 3 (three) months after commissioning at the cost of the contractor.

All the costs for the pre-commissioning test, trial operation, performance and guarantee test including the consumables shall be borne by the contractor.

3.23 TRAINING OF GOVERNMENT PERSONNEL

The contractor shall impart training at least for a period of two months from the date of successful commissioning of the project on operation and maintenance of the plant. However, the engineer personnel/officers/staffs shall be associated for the purpose of training right from the stage of dismantling to installation of the equipments. Such training shall be imparted at free of cost to the engineer personnel / officers to enable them to make themselves conversant in the operation and maintenance of plants and equipments.

3.24 TAKING OVER OF THE PROJECT

After conclusion of the training period of Govt. Personal as specified in Clause 28 above, the contractor shall give due notice to the Department about successful operation of the plant and conclusion of the training period. Thereafter the Department shall take over the project formally subject to fulfillment of all relevant requirements in terms of this agreement.

3.25 ACCEPTANCE

The taking-over testing of any part or section of the Permanent Works, which can operate as an independent unit, shall be performed as per the test procedure agreed upon between Engineer and Contractor.

Immediately upon termination of any such testing of a part or section of the permanent Works a "Protocol of Acceptance" which shall be deemed to be the Test Certificate required by General Conditions of Contract shall be issued by the Engineer.

This document shall be signed by an authorised representative of the Purchaser, the Engineer and the Contractor and shall form an integral part of the later "Taking-Over Certificate".

This "Protocol of Acceptance" shall state:

- The date of testing
- The quantity and type of Works concerned
- Statement of all minor defects which have to be corrected by the Contractor
- Confirmation that the guaranteed data have been proven

If any test for the verification of the guaranteed data could not be performed for operational reasons beyond the Contractor's responsibility, this part of the acceptance shall be stated in the "Protocol of Acceptance" and be postponed for a mutually agreed period.

However, the tested part or section of permanent work shall continue to be operated by the Purchaser with the help of Contractor's personnel, till all Generating units have been tested and commissioned and trial run period of 10 day, has been completed in respect of last unit to be commissioned.

LIST OF APPLICABLE STANDARDS

A. STANDARDS FOR GENERAL APPLICATIONS

- AISI American Iron and Steel Institute
- ANSI American National Standards Institute
- ASME American Society of Mechanical Engineers
- ASTM American Society for Testing and Materials
- AWS American Welding Society
- BS British Standards
- CMAA Crane Manufacturers Association of America
- DIN Deutsche Institute für Normung
- IEC International Electro-technical Commission
- IEEE Institute of Electrical and Electronic Engineers
- IPCEA Insulated Power Cable Engineer's Association
- IS Indian Standards
- ISO International Standards Organisation
- JEC Standards of the Japanese Electrotechnical Committee
- JIS Japan Industrial Standards
- NEMA National Electrical Manufacturers Association
- VDE Verein Deutscher Elektroingenieure
- VDI Verein Deutscher Ingenieure

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

B. ELECTRICAL AND INSTRUMENTATION

S.No.	DESCRIPTION		INDIAN
1.	Rotating electrical machines	IEC 34	IS:4722-1968
2.	Direct action indicating electrical measuring instruments	IEC 51	
3.	Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV	IEC 55	
4.	High voltage alternating current circuit breakers IEC 56	IS:2516-1980	
5.	Basic environmental testing procedures	IEC 68	
6.	Insulation co-ordination	IEC 71	
7.	Dimensions and output ratings for rotating	IEC 72	

	electrical machines		
8.	Colours for indicator lights and push buttons	IEC 73	
9.	Power Transformers	IEC 76	IS:2026
10.	Classification of materials for the insulation of electrical machinery	IEC 85	
11.	Primary Batteries	IEC 86	
12.	Lead Acid Starter Batteries	IEC 95	
13.	Lightning Arrestors recommended graphic symbols	IEC 99	
14.	Alternating current disconnecters (isolator) and earthing switches	IEC 129	
15.	Bushings for alternating voltages above 1000 V.	IEC 137	
16.	Degrees of protection for low voltage switch gear and control gear	IEC 144	
17.	Low voltage switchgear and control gear	IEC 157	
18.	Low voltage control gear tests on indoor and outdoor post insulators for voltages greater than 1000 V.	IEC 168	
19.	Current transformers	IEC 185	IS:2705
20.	Voltage transformers	IEC 186	IS:3156
21.	Low frequency cables and wires with P.V.C. insulation and PVC sheath	IEC 189	
22.	On-load tap changers	IEC 214	
23.	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V.	IEC 227	
24.	Conductors for insulated cables	IEC 228	
25.	Impulse tests on cables and their accessories	IEC 230	
26.	Electrical relays	IEC 255	IS:3231-1965
27.	Low voltage fuses calculation of the continuous current rating of cables (100% load factor)	IEC 287	
28.	Low voltage motor starter	IEC 292	
29.	Specification for new insulating oil for transformers and switchgear	IEC 296	
30.	AC metal-enclosed switchgear and control gear for rated voltages above 1 kV up to and including 72.5 kV	IEC 298	

31.	Standard colours for insulation for low frequency cables and wires	IEC 304	
32.	Guide to the calculation of resistance of plain and coated copper conductors of low-frequency cables and wires.	IEC 344	
33.	Loading Guide for oil immersed transformers	IEC 354	
34.	Marking of insulated conductors	IEC 391	
35.	Report on synthetic testing of high voltage alternating current breakers.	IEC 427	
36.	Factory-build assemblies of low voltage switchgear and control gear	IEC 439	
37.	Identification of insulated and bare conductors by colours	IEC 446	
38.	Standard directions of movement for actuators which control the operation of electrical apparatus	IEC 447	
39.	Methods of measurement of radio equipment used in their mobile services	IEC 489	
40.	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto 30 kV	IEC 502	
41.	Class 0.5, 1 and 2 alternating current Watt-hour meter	IEC 521	
42.	Test methods for insulations and sheaths of electric cables and cords	IEC 540	

C. TURBINES, GENERATORS AND ANCILLARY PLANT

1. International Code for Field Acceptance Test of Hydraulic Turbines Publication 41 (IEC - 41)-1963.
2. The IEC publications 308 'International code for testing of speed governing systems for hydraulic turbines' shall be an integrated document of the governor specification.
3. Test code for Hydraulic Prime Movers, ASME Power Test Codes, ASME-New York 1949.
4. Electromechanical Equipment Guide for Small Hydroelectric Installations (IEC-1116-1992-10)
5. International Code for Model Acceptance Tests of Hydraulic Turbines 193-1965-193A-1972.

D. CODE AND STANDARDS

In complement to the standards specified in generator section, the particular following standards shall be applied ;

1. Bolt calculation : VSM 14 332;
2. Vibrations : VDI 2 056;
3. Shaft coupling : ANSI B 49.1;
4. Shaft alignments : NEMA;
5. Rotating electrical machines; IEEC 30.4 to 34.11;
6. Test Procedure for Synchronous Machine; IEE 115

E. INDIAN STANDARDS

S.No.	IS:CODE	DESCRIPTION
1.	IS:4722-1968	Rotating electrical machines
2.	IS:325-1978	Three phase induction motors
3.	IS:8789-1978	Values of performance for three-phase induction motors
4.	IS:3156	Voltage transformers
5.	IS:L3156(Pt.I)-1978	General requirements
6.	IS:3156(Pt.II)-1978	Measuring voltage transformers
7.	IS:3156(Pt.III)-1978	Protective voltage transformers
8.	IS:3156(Pt.IV)-1978	Capacitor voltage transformers
9.	IS:2705	Current transformers
10.	IS:2705(Pt.I)-1981	General requirements
11.	IS:2705(Pt.II)-1981	Measuring current transformers
12.	IS:2705(Pt.III)-1981	Protective current transformer
13.	IS:2704(Pt.IV)-1981	Protective current transformers for special purpose applications
14.	IS:2026	Power transformers
15.	IS:2026(Pt.I)-1977	General
16.	IS:2026(Pt.II)-1977	Temperature-rise
17.	IS:2026(Pt.III)-1981	Insulation levels and dielectric tests
18.	IS:2026(Pt.IV)-1977	Terminal markings, tappings and connection

19.	IS:335-1983	New insulating oils
20.	IS:3231-1965	Electrical relays for power system protections
21.	IS:3043-1966	Code of practice for earthing
22.	IS:1651-1979	Stationary cells and batteries lead-acid type (with tubular positive plates)
23.	IS:2516-1980	Circuit-breakers
24.	IS:2147-1980	Degree of protection provided by enclosures for low voltage switchgear and control gear
25.	IS:L1554(Pt.II)-1976	For working voltages upto and including 1100 V
26.	IS:5613(Pt.I/Sec.I) 1978	Lines upto and including 11 kV, section 1 Design.