

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

## **VOLUME II:**

### **Section-I: ANNEXURES**

### **General Technical Specifications**

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

## TABLE OF CONTENTS

<b>1</b>	<b>PAINTING SHEDULES</b>	<b>3</b>
<b>2</b>	<b>SYMBOLS AND ABBREVIATIONS</b>	<b>11</b>
2.1	LENGTH, AREA AND VOLUME	11
2.2	TIME AND TIME DERIVED UNITS	11
2.3	MASS, FORCE AND DERIVED UNITS	11
2.4	ELECTRICAL UNITS	12
2.5	OTHER SYMBOLS AND ABBREVIATIONS	12
<b>3</b>	<b>SPECIFIC PROJECT CHARACTERISTICS</b>	<b>14</b>
3.1	SITE OPERATING CONDITIONS	14
3.2	MOTOR VOLTAGES AND POWER RATINGS	14
3.3	COLOUR CODING FOR ELECTRICAL CONNECTIONS	15
3.4	COLOUR CODING FOR MIMIC DIAGRAMS	15
<b>4</b>	<b>REQUIRED DOCUMENTS FOR ELEC. &amp; MECH. PLANT/INSTALLATIONS</b>	<b>16</b>
4.1	GENERAL	16
4.2	PRINCIPAL REQUIREMENTS	16
4.2.1	LOADING DRAWINGS	16
4.2.2	FOUNDATION DRAWINGS	16
4.2.3	GENERAL ARRANGEMENT DRAWINGS	16
4.2.4	SHORT-CIRCUIT CALCULATIONS	17
4.2.5	LOAD EVALUATIONS	17
4.2.6	LIST OF PLANT IDENTIFICATION NUMBERS	17
4.2.7	BASIC DOCUMENTATION	17
4.2.8	OVERALL DIAGRAMS	17
4.3	SPECIFIC DOCUMENTS FOR ELECTRICAL PLANT AND INSTALLATIONS	18
4.3.1	GENERATOR AND ACCESSORIES	18
4.3.2	MOTORS	19
4.3.3	MEDIUM VOLTAGE INSTALLATIONS	19
4.3.4	LOW VOLTAGE INSTALLATIONS	20
4.3.5	BATTERIES	20
4.3.6	BATTERY CHARGES	20
4.3.7	ELECTRICAL CONTROL AND PROTECTION SYSTEMS	20
4.3.8	I & C AND COMMUNICATION SYSTEMS	21
4.3.9	CABLING	21
4.4	SPECIFIC DOCUMENTS FOR MECHANICAL PLANT AND INSTALLATIONS	22
4.4.1	DOCUMENTS FOR ALL MECHANICAL PLANTS AS APPLICABLE	22
4.4.2	TURBINES AND ACCESSORIES	23
4.4.3	GOVERNORS AND ACCESSORIES	23

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

4.4.4	MAIN INLET BUTTERFLY VALVES AND ACCESSORIES	24
4.4.5	PENSTOCK PROTECTION VALVES AND ACCESSORIES	25
4.4.6	PUMPS AND FILTERS	26
4.4.7	COMPRESSORS	27
4.4.8	OIL PURIFICATION EQUIPMENT	27
4.4.9	PIPING AND VALVES	27
4.4.10	MECHANICAL WORKSHOP EQUIPMENT	28
4.4.11	VENTILATION SYSTEM	28
4.4.12	CRANES AND ACCESSORIES	28
4.4.13	ELEVATOR	29

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

## 1 PAINTING SHEDULES

### PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in $\mu\text{m}$	Remarks
A.					—
	— Internal surfaces of steel linings, penstock, turbine spiral casing, valves and other wetted internal ferrous surfaces		<u>Intermediate Coat :</u> 2 x micaceous iron oxide paint, 2-component Base: epoxy resin	2 x 100	— This paint system is for temperatures up to 120°C
			<u>Finish Coat :</u> 1 x topcoat, 2-component Base : epoxy resin	1 x 100	— The colours of intermediate and finish coats shall be black - brown - black
			Total	300	
				=====	

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

## PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in $\mu\text{m}$	Remarks
B.	External surfaces of penstocks, Gantries, Cranes, Lifting Beams, Fixed Hoist supports and other Drive Supports	Sa 2 1/2 - 3	<u>Prime Coat :</u> 1 x zinc dust primer, 2-component Base : epoxy resin  <u>Intermediate Coat :</u> 2 x micaceous iron oxide paint, 2-component Base : epoxy resin  <u>Finish Coat :</u> 1 x micaceous iron oxide paint, coloured, 2-component Base : epoxy resin	1 x 50          2 x 80          1 x 80                    290  =====	– The pure metallic zinc shall be at least 92% of the polymerized film          – This paint system is for temperatures up to 60°C

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

## PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in $\mu\text{m}$	Remarks
C.	External surfaces of indoor ferrous parts such as valves, connection pipes, oil carrying tanks and pipes, supporting structures, gantries, etc.	Sa 2 1/2 - 3	<u>Prime coat :</u> 1 x zinc dust primer, 2-component Base :epoxy resin	1 x 50	– The pure metallic zinc shall be at least 92% of the polymerized film
			<u>Intermediate Coat :</u> 2 x micaceous iron oxide paint, 2-component Base : epoxy resin	2 x 80	– This paint system is for temperatures up to 120°C
			<u>Finish Coat :</u> 1 x topcoat, 2-component Base : epoxy resin	1 x 50	

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Total

260

=====

## PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in $\mu\text{m}$	Remarks
D.	– Control cabinets, panels, cubicles, electric motors	Sa 3 and de-grease before painting	<u>Prime Coat:</u> 2 x zinc chromate primer, 2-component Base : epoxy resin  <u>Finish Coat :</u> 2 x topcoat, 2-component Base : epoxy resin  Total	2 x 40     2 x 50   _____  180 =====	

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification



EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh



Particular Technical Specifications

Volume II Section-I

Annexures: General Tech. Specification

## PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in $\mu\text{m}$	Remarks
E.	– Interior surfaces of oil tanks	Sa 2 1/2 - 3	2 x thixotrop consistent paint Base : epoxy resin	2 x 220	
			Total	440	



## PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in $\mu\text{m}$	Remarks
F.	– Frames, cover plates, pipes and tubes, and miscellaneous steel parts not especially mentioned	Hot-dip-galvanized as specified in Section 2.10.6.3 and de-grease before painting	<u>Intermediate Coat :</u> 1 x micaceous iron oxide paint, 2-components Base : epoxy resin  <u>Finish Coat :</u> 1 x topcoat, 2-component Base: epoxy resin  Total, incl. zinc	1 x 80      1 x 50  _____  200 =====	– All the parts inaccessible for painting shall be only hot-dip galvanized

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

## 2 SYMBOLS AND ABBREVIATIONS

### 2.1 Length, area and volume

$\mu\text{m}$	micron = $\text{m} \cdot 10^{-6}$
mm	millimetre
cm	centimeter
m	meter
km	kilometer
$\text{mm}^2$	square millimetre
$\text{cm}^2$	square centimetre
$\text{m}^2$	square meter
$\text{km}^2$	square metre
ha	hectare
$\text{m}^3$	cubic meter
l	litre
rad	radian

### 2.2 Time and time derived units

s	second
min	minute
h	hour
d	day
mm/s	millimetres per second
m/s	meters per second
km/h	kilometres per hour
$\text{m/s}^2$	meters per second squared (acceleration)
$\text{m}^3/\text{s}$	cubic meters per second
Hz	hertz (periods per second)

### 2.3 Mass, force and derived units

kg	kilogram
g	gram = $\text{kg} \cdot 10^{-3}$
mg	milligram = $\text{kg} \cdot 10^{-6}$
mg/l	milligrams per litre
t	ton = $\text{kg} \cdot 10^3$
$\text{kg/m}^3$	kilograms per cubic meter
$\text{t/m}^3$	ton per cubic meter
N	newton
$\text{N/m}^2$	newton per square meter

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

N/mm <sup>2</sup>	newton per square millimetre
bar	bar = N/m <sup>2</sup> · 10 <sup>5</sup>
Pa	Pascal = 1N/m <sup>2</sup>
MPa	mega Pascal = Pa · 10 <sup>6</sup>
atm	standard atmosphere = 101325 Pa
J	Joule = 1 Nm (newton-metre)
kJ	kilojoule = J · 10 <sup>3</sup>

## 2.4 Electrical units

A	ampere
V	volt
kVA	kilovolt ampere
kWh	kilowatt hour
W	watt = 1 J/s
kW	kilowatt = W · 10 <sup>3</sup>
MW	megawatt = W · 10 <sup>6</sup>
A.C.	alternating current
D.C.	direct current
HV	high voltage (cables)
LV	low voltage

## 2.5 Other symbols and abbreviations

approx.	approximately
bhp	brake horse power
CIF	cost, insurance and freight
dia. or diam.	diameter
fig.	figure
FOB	free on board
hp	horsepower
horiz.	horizontal
HT	high tensile (steel)
max.	maximum
min.	minimum
no.	number (units) as in 6 no.
No.	number (order)as in No. 6
temp.	temperature
°C	degrees Celsius
vert.	vertical
vol.	volume

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

wt

weight

%

per cent

M.F.L

maximum flood level

H.W.L

high water level

M.O.L.

minimum operation level

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

### 3 SPECIFIC PROJECT CHARACTERISTICS

#### 3.1 Site Operating Conditions

Maximum outdoor ambient shade temperature for design purposes	°C	40 °C
Maximum outdoor ambient temperatures	°C	40 °C
Seismic loads shall be considered in accordance with relevant BIS for earthquake.		

The following values of Design Basic Earthquake (DBE) shall be taken into account:

- horizontal DBE : 0.24 g
- vertical DBE : 0.16 g

All the plant included in the supply shall be able to operate during a DBE or resume operation after a DBE without requiring any inspection or adjustment.

A DBE shall not trigger off a shut down of the generating units. All components or sensors whose function is to control load rejections or emergency shutdowns, shall be insensitive to the DBE or shall be provided with mountings or supports to protect them from the effect of the DBE.

In a more specific way the IEEE recommendations shall be applied to electrical plant.

#### 3.2 Motor Voltages and Power Ratings

The service voltages and corresponding power ratings for electric motors to be used in the Project shall be as follows:

<b>Motors up to 50 kW and above</b>	
Service voltage:	3-phase, AC, 415/240 V
Mode of starting:	direct-on-line (2.5 x IN MAX) or Star Delta Starter
<b>Motors up to 0.75 kW</b>	
Service voltage:	single-phase, AC, 240 V
Mode of starting:	condenser
<b>Motors intended to work on the DC system</b>	
Service voltage:	220 V DC
Mode of starting:	resistor

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

### 3.3 Colour Coding for Electrical Connections

Live parts of electrical connections shall be colour coded as follows:

Conductor Designation	Coding Alphanumeric	Symbol	Colour
AC network	phase 1	L1	red
	phase 2	L2	yellow
	phase 3	L3	blue
	neutral	N	black
DC network	positive	L+	white
	negative	L-	black
	neutral	M	blue
Protective earthed	neutral	PE/N	green
Earth		E	Gray

### 3.4 Colour Coding for Mimic Diagrams

Mimic diagrams to be arranged on switchgear cubicles, control panels / desks etc., shall be colour coded as per relevant practice and shall be finally agreed upon during detailed design.



EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

## 4 REQUIRED DOCUMENTS FOR ELEC. & MECH. PLANT/INSTALLATIONS

### 4.1 General

In compliance with Section 1 the following documents for the electrical and mechanical plant shall be supplied to the Engineer for approval (marked A) or for information (marked I).

For identical items being supplied several times such documents shall be submitted once only.

### 4.2 Principal Requirements

The following documents shall be supplied individually or as a whole for equipment / installations wherever applicable.

#### 4.2.1 Loading Drawings

For all larger pieces requiring special means for transportation, as for example:

Generator stator	I
Generator rotor	I
Switchgear assemblies	I
Turbine runner	I
Turbine shaft	I
Turbine spiral case	I
Turbine draft tube liner	I
Main inlet butterfly valve	I
Penstock Protection Butterfly Valve	I

#### 4.2.2 Foundation Drawings

For any equipment requiring a foundation or other civil provisions	A
--	---

#### 4.2.3 General Arrangement Drawings

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

For the whole plant and for individual area / buildings / rooms / trenches	A
--	---

#### 4.2.4 Short-Circuit Calculations

For the following voltage levels:

HV network	
MV systems (generators system and MV general & unit distribution systems)	
LV unit and general auxiliary systems	
Unit and general DC systems	
All documents	A

#### 4.2.5 Load Evaluations

For all medium and low voltage levels (AC and DC)	A
---	---

#### 4.2.6 List of Plant Identification Numbers

List of Plant Identification Numbers	I
--------------------------------------	---

#### 4.2.7 Basic Documentation

For any equipment / installation the following basic documents shall be provided:

Specification for rating plates and labels; including list of inscriptions	A
Motor lists	I
Workshop test schedule	I
Site test schedule	
List of tools and appliances	I
List of spare parts	I

#### 4.2.8 Overall Diagrams

Single-line overall diagram	A
Three-phase overall diagram with phase sequence and vector groups	A
Unit control diagram	A
Unit control sequence diagram	A
Control sequence diagram	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Low voltage distribution diagrams: Compressed air systems drainage and dewatering systems cooling water system oil purification equipment ventilation system	A
P&I diagrams for the following systems: Oil systems of bearings, governor, main inlet spherical valve and draft tube flap gate Compressed air, cooling water, drainage, dewatering and oil purification equipment Cooling water system	A

### 4.3 Specific Documents for Electrical Plant and Installations

#### 4.3.1 Generator and Accessories

Specification(s)	A
Outline drawings	A
Design drawings:	
Stator frame with core and winding	I
Fixing of stator core to frame	I
Stator winding	I
Main terminals	A
Shaft (including calculation of deflection, critical speeds, max. oscillations with and without prime mover)	A
Rotor hub and spider	I
Rotor him	I
Pole core	I
Pole winding	I
Damper winding	I
Shaft mounted fans	I
Bearings (with permissible clearances at standstill, crawling, rated and overspeed)	I
Bearing insulation	A
Bearing lubrication and cooling	I
Rotor jacking device	I
Slip rings including mounting details	I
Supporting / guiding spider(s)	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

For generator cooling systems:	
Dimension drawing	A
Process diagram	A
Specification	A
For auxiliary systems such as bearing oil supply, sealing oil, CO <sub>2</sub> -equipment, stand-still heating, as applicable:	A
Arrangement drawing	A
Dimension drawings	A
Circuit drawing	A
Block diagram	A
Logic diagram	A
Specification	A
Process diagram	A
Terminal diagram	I
For excitation and de-excitation system:	
Arrangement drawing	A
Dimension drawing	A
Specification	A
Circuit diagram	A
Block diagram	A
Logic diagram	A
Terminal diagram	I
Motor list	I
List of measurements	A
Drawings for erection / handling facilities	I

#### 4.3.2 Motors

For large size motors (if not standard product) the items as mentioned above shall be valid as far as applicable.

For standard motors the following shall apply:

Specification(s)	A
Outline drawing	A
Motor list	I

#### 4.3.3 Medium Voltage Installations

Specifications	A
Dimension drawing for complete distribution boards & for each type of feeder	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Single-line diagrams	A
Standard circuit diagrams	I
Individual circuit diagrams	A
Arrangement drawings	A
Specification for protection relays	A
List of measurements	A

#### 4.3.4 Low Voltage Installations

Specifications	A
Dimension drawings for complete distribution boards and for each type of feeder	A
Single-line diagrams	A
Standard circuit diagrams	I
Individual circuit diagrams	A
Arrangement drawings	A
Specification for protection relays	A
List of measurements	A

#### 4.3.5 Batteries

Specifications including capacity calculation	A
Dimension drawing for individual cells & for complete batteries incl. rack	A

#### 4.3.6 Battery Charges

Specification including capacity calculation	A
Arrangement drawing	A
Dimension drawing	A
Circuit diagram	I
Block diagram	I
Logic diagram	A

#### 4.3.7 Electrical Control and Protection Systems

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Specifications	A
Arrangement drawings	A
Dimension drawings	A
Circuit diagrams	A
Block diagrams	I
Logic diagrams including tripping scheme for protection	A
Single-line diagram (protection diagram)	A
Protection co-ordination diagrams	I
Specifications for protection relays including tripping curves, setting ranges etc.	I
Generator earthing system calculation	A

#### 4.3.8 I & C and Communication Systems

Specifications	A
Dimension drawings	A
Arrangement drawings	A
Execution drawings	I
Block diagrams	I
Logic diagrams	A
Process diagrams	A
Circuit diagrams	A
Terminal diagrams	I
List of measurements	A
Final list of control elements	A
Description of software	I
Installation drawings	A

#### 4.3.9 Cabling

For power, instrumentation and control installations:

Specifications including calculation for size selection	A
Cable list	I

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Connection diagrams	I
Arrangement drawings (cable routing plans) for buried cables	I
Cable tray arrangement drawings	I
Cable allocation drawing for trays at different locations / trench path, can be combined with above cable tray arrangement drawings	I

#### 4.4 Specific Documents for Mechanical Plant and Installations

##### 4.4.1 Documents for all Mechanical Plants as Applicable

Shop test programs	A
Material test certificates	I
Shop test reports	A
Weld production procedure	A
Welders' qualification procedure	A
Welder's qualification certificate	A
Paint schedules	A
Instrument lists	A
Wiring diagrams	I
Erection procedures	A
Site test procedures	A
Commissioning program	A
Operating & maintenance manuals	A
Specification(s)	A
Component list(s)	A
Critical speed calculation	I
Outline drawings	A
Neat line drawings	A
Foundation drawing	A
Foundation load calculations	A
Hydraulic transients analysis	A
Stress analysis for main components	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Design drawings: Turbine runner Turbine shaft Shaft seal Couplings Turbine guide bearing Head cover Spiral casing Distributor assembly Regulating ring Guide vanes Guide vane bushings Servomotors Bottom ring Draft tube lining Draft tube compressor Wearing rings, facing plates Turbine assembly Pipe routings	
Safety self-restoring device drawing	
Overspeed device drawing	
Outline drawing of failure (blockage) indicator cubicle	
Efficiency hill chart	
Hydraulic thrust calculation	
Maximum steady runaway speed calculation	
For turbine cooling system: Dimensional drawing Specification	
Drawings for erection / handling facilities	
Program for training of Employer's personnel	
Site test reports	A
Test service period operation program	A

#### 4.4.2 Turbines and Accessories

#### 4.4.3 Governors and Accessories



EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Specifications	A
Dimension drawings	A
Design drawings:	A
Electronic governor head	A
Pressure oil unit	A
Air/oil accumulator	A
Electro-hydraulic actuator	A
Hydraulic amplifier	A
Speed sensor arrangement	A
For turbine control:	A
Schematic diagram	A
Block diagram	A
Circuit diagram	A
Loading drawings	A
Drawings for erection / handling facilities	A
Foundation drawings	A

#### 4.4.4 Main Inlet Butterfly Valves and Accessories

Specification	A
Component list(s)	A
Outline drawings	A
Foundation drawings	A
Hydraulic transient analysis	A
Stress analysis for main components	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Design drawings:	
Valve body	A
Base plates and anchoring components	A
Valve rotor	A
Trunnions and bearings	A
Valve seals	A
Operating mechanism	A
Servomotors	A
Dismantling and expansion joint	A
Upstream connection pipe	A
Maintenance seal bypass line	A
Dewatering line	A
Manhole	A
Butterfly valve assembly	A
Oil pressure unit with air / oil accumulator	A
Air inlet / outlet valve	A
For main inlet butterfly valve control:	
Arrangement drawing	A
Schematic diagram	A
Circuit diagram	A
Sequence chart of control functions	A
Drawings for erection / handling facilities	A

#### 4.4.5 Penstock Protection Valves and Accessories

Specification	A
Component list(s)	A
Outline drawings	A
Foundation drawings	A
Hydraulic transient analysis	A
Stress analysis for main components	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Design drawings:	
Valve body	A
Base plates and anchoring components	A
Valve rotor	A
Trunnions and bearings	A
Valve seals	A
Operating mechanism	A
Servomotors	A
Dismantling and expansion joint	A
Upstream connection pipe	A
Maintenance seal bypass line	A
Dewatering line	A
Manhole	A
Butterfly valve assembly	A
Oil pressure unit with air / oil accumulator	A
Air inlet / outlet valve	A
For main inlet butterfly valve control:	
Arrangement drawing	A
Schematic diagram	A
Circuit diagram	A
Sequence chart of control functions	A
Drawings for erection / handling facilities	A

#### 4.4.6

#### Pumps and Filters

Specifications alongwith calculation for pump size selection	A
Outline drawings	A
Bill of materials	A
Design drawings:	
Pump impeller	A
Pump casing	A
Pump wearing rings	A
Pump shaft & coupling	A
Pump shaft seal filter casing	A
Pump shaft seal	A
Filter casing	A
Cross-section of pump & filter assemblies	A
Pump characteristics diagrams	A
Filter characteristics	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Control diagrams	A
Sequence chart of control functions for water systems	A
Drawings for erection / handling facilities	A
Foundation drawings	A

#### 4.4.7 Compressors

Specifications	A
Outline drawings	A
Bill of materials	A
Design drawings and cross-sections of compressor assemblies	A
Air receiver drawings	A
Safety valve drawings	A
Compressor characteristics diagrams	A
Control diagrams	A
Instrument list	A
Sequence chart of control functions	A
Drawings for erection / handling facilities	A
Foundation drawings	A

#### 4.4.8 Oil Purification Equipment

Specification	A
Component list(s)	A
Outline drawings:	A
Oil treatment unit including purifier, dehumidifier and degasser	A
Oil transfer pumps	A
Control diagram	A

#### 4.4.9 Piping and Valves

Specifications	A
Component lists with material specification	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Dimensional drawings	A
Arrangement and pipe routing drawings for:	
Cooling water system	A
Drainage and dewatering systems	A
Compressed air systems	A
Oil systems	A
Procedure for pressure testing at the Site	A
Procedure for touch-up painting at the Site	A
Drawings for erection / handling facilities	A
Foundations drawings	A
Evaluation of pressure transients and anchor points loads	

#### 4.4.10 Mechanical Workshop Equipment

Specifications	A
Component lists	A
Dimensional drawings	A
Arrangement drawings of 1 ton monorail chain hoists	A
Workshops layout drawing with pipe, cable and air duct routings	A

#### 4.4.11 Ventilation System

Heating and cooling load calculation	A
Arrangement drawings	A
Duct and pipe routing drawings	A
Calculation of air distribution and pressure drop	A

#### 4.4.12 Cranes and Accessories

Specifications alongwith calculation for motor / brake selection, girder design etc.	A
Outline drawings	A

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		Annexures: General Tech. Specification

Design drawings:	A
Runway	A
Crane bridge	A
Trolley with hoist	
Bridge drive	
Hook	A
Operator's cabin	A
For crane controls:	
Circuit diagrams	A
Instrument lists	A
Loading drawings	A
Drawings for erection / handling facilities	A
Foundation drawings	A
Calculations	A

#### 4.4.13 Elevator

Tech. dossier according to relevant BIS or Appendix C of EN 81, Part I (1985)	A
Outline drawings	A
Design drawings:	
Hoisting machine with safety brake in machine room	A
Elevator well and car with guides, counterweights, buffers, safety gears	A
Suspensions, overspeed governors and final limit switches	A
Elevator car	A
Landing doors and thresholds	A
For elevator controls:	
Circuit diagram	A
Instrument lists	A
Loading drawings	A
Drawings for erection / handling facilities	A
Foundation drawings	A
Calculations	A