

Input over range/open sensor	:	All digits to flash
Mounting	:	Panel mounting
Zero and Span	:	Adjustable by digital calibration
Serial communication communication	:	Isolated RS232/485 for modbus-RTU
Memory Capacity	:	5MB Flash
Alarm output	:	Required
Contact rating	:	2A at 220 V AC
Power supply	:	240 V AC/24 V DC
Properties	:	i. Any channel shall be configured for Data Logging ii. Channel to Channel online Isolation shall be provided iii. Real Time RTC Interface for Printer shall be provided
Operation Modes	:	Auto/manual mode, Run mode, Verify mode, Calibration Mode, Program mode.

3.03.48 AMMETERS (AMM)

Input	:	4-20 mA DC
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Face Dimensions	:	96 x 96 mm
Scale/Type	:	Moving coil, circular, FSD 240 deg. With six times suppression scale
Zero adjustment	:	Screw on meter face
Accuracy	:	± 1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating ≥ 30 KW and other critical application motors/drives.

3.03.49 VOLTMETER:

Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96x96 mm
Range	:	As per requirement
Accuracy	:	$\pm < 0.5$ %
Indication	:	Digital type 4 1/2 digit
Magnetic Shield	:	Shielded Case
Connection	:	Plug in type
Quantities	:	For 230 V AC input power supply, UPS power supply, 24 V DC interrogation voltage & 220 V DC.

3.03.50 FREQUENCY METER/MW METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting On mosaic grid panel
Number of digits	:	4 1/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	± 0.2 Hz
Display	:	Red LED display.
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

3.03.51 AC CURRENT TRANSDUCERS

Input	:	0 - 1 A CT current
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.52 DC CURRENT TRANSDUCERS

Input	:	0 - 75 mV
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.53 AC VOLTAGE TRANSDUCERS

Input	:	0 - 110 V PT, Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.54 DC VOLT TRANSDUCERS

Input	:	System Voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.55 TRANSDUCERS FOR POWER

Input	:	CT and PT (1A) (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.56 TRANSDUCERS FOR FREQUENCY

Input	:	110 V PT Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.57 TRANSDUCERS FOR POWER FACTOR

Input	:	PT (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.58 TRANSDUCERS FOR MVAR

Input	:	CT & PT (110V/1A)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.59 DIFFERENTIAL FREQUENCY TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	110 V PT
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.60 DIFFERENTIAL VOLT TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	System voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.61 PUSH BUTTONS (PB)/ ILPBs FOR ON/OFF, OPEN/CLOSE, START/STOP

Type	:	Momentary/Miniaturised Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
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Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy
Contact Rating	:	500V / 10 A
Insulation Voltage terminals and earth	:	2 KV for 1 minute between

Lamp Rating :-

a) Voltage	:	240 V AC
b) Watt	:	2 Watt (approx.)

Colour

Red	– ON/Start/Open ILPB
Green	– OFF/Stop/Close ILPB
Red	- energized, running, Start, valve open LED/Lamp
Green	- de-energized, stopped, valve closed LED/Lamp
Light yellow	- abnormal, discrepancy LED/Lamp
Red	– OFF/Stop/Close PB
Green	– ON/Start/Open PB
Red	- Emergency trip push buttons with red flap / hinged Transperent arylc cover.

3.03.62 PUSH BUTTON FOR Control DESK: **Momentary mosaic grid mounted**
24x48 mm size, single PB 18x40 mm
Colours for DESK RELEASE - Yellow,
Desk Lamp test - Blue, Desk Ack - Green

3.03.63 PUSH BUTTON FOR SEQUENCE START/RELEASE : Momentary (Miniaturised) suitable
for mosaic grid 24x48 mm
3 PB + 5 LED

3.03.64 PUSH BUTTON FOR ANNUNCIATION

Contacts

- Number & Type	:	As per requirement
- Breaking capacity	:	1 Amp, 220V DC 10 Amp, 600V AC Different colours for Accept/Ack - Green, reset Grey, Lamp test – Blue, System Test – Yellow & Audio Ack - Black.

3.03.65	<u>BELT WEIGHING SYSTEM</u>
3.03.65.1	General
	The mechanical design and constructional features for belt weigher has been described under mechanical section, hence not repeated here, Similarly motor specifications for the same has been covered under electrical specification, hence not repeated here.
	The belt weighing system shall have its own local control panel to be located in electrical equipment room. The local panel shall include: (a) Local flow rate indication (b) Integrated flow rate indications (c) System alarm annunciation (d) Local Calibration facility (e) Power on/off All these above display shall be backlit LCD type with 12mm character height. NI Cd Battery back up (60 minutes backup) shall be provided for the measurement system. (a)Application : Bulk material, Powder material (b)Drive Protection : Reverse Polarity, Communication failure

3.03.65.2	Load Sensing Cell	
	(a)Type	Strain Gauge/Compression type
	(b)Enclosure Protection	NEMA 4X (IP 66)
	(c)Load	
	(i)Nominal Load	Bidder to specify in tabular form.
	(ii)Rated Load	Bidder to specify in tabular form.
	(iii)Destructive Load	Bidder to specify in tabular form.
	(d)Supply Voltage	24V DC
	(e)Sensing	Resistance bridge
	(f)Temp. Effect on Zero & span	+/- 0.015%/10K
	(g)Basic Resistance	Manufacture's Standard
	(h)No. Of Load Sensors	Single
	(i)Mounting Type	Four idler
	(j)Accessories	Mounting plate kit, cable etc.
	(k)Accuracy	+/- 0.015% FSD
	(l)Speed Sensor	Tacho/encoder
	(m)Speed Output	Pulse train to be distributed tp
		(i)Local control panel for own use
		(ii)4-20 mA DC signal to PLC
	(n)Load Sensor Output	4-20 mA DC isolated signal for PLC along with provision for serial communication link standard protocol
	(o)Computed Flow rate	
	(i)Hardware	4-20 mA DC isolated 2 numbers
	(ii)Serial Link	In Compliance with standard protocol
	(p)Protection class for measuring cell	NEMA 4X (IP 66)
	(q)Accessories	Special cables, electronics, cabinets etc. As required to make the system complete, with bar/chain.
	(r)Range	Application dependent
	(s)Range increment	0.1% of this selected range
	(t)Operating Temperature	0-70 degC
	(u)Accuracy	+/-0.25 % FS range
3.03.66	Hydrogen Gas System Instruments/Analysers	
3.03.66.01	Hydrogen Gas Hygrometer	

A	Performance	
1	Measuring Range	-80 C to 20 C
2	Response Time for 63% Step Change	<5 sec.
3	Output Resolution	0.01 mA
4	Storage Temp: Max	70°C
5	Operating Ambient Relative Humidity	<95%
6	Sensitivity	< 5 se conds for 63% s tep ch ange i n moisture content
B	Construction	
7	Measuring Principal	Thin Film Alum Oxide
8	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
9	Display	3-1/2" Digit LCD
10	Mounting	In Explosion Proof Box
11	Location (Hazardous)	Hydrogen delivery after compressors.
12	Service	Measures Moisture co ntent i n t he Hydrogen Delivery
13	Code & Standard	EMC di rective 89/ 336/EEC and P ED 97/23/EC f or DN<25 - FM Standard 6320
14	Analog Output	4-20 mA, HART.
15	Type of Transmitter	4 to 20 mA loop powered 24 VDC
16	Certification	CE
17	Calibration	Required ev ery 12 m onths, C alibrator shall be supplied by bidder.
3.03.66.02	TRACE OXYGEN (O2) in Hydrogen gas Analyser	
A	Performance	
1	Nature of Fluid	Oxygen in Hydrogen
2	Response Time for 90% step change	< 10 sec.
3	Relative Humidity	0-99 %
4	Measuring Range	0-100 ppm
5	Accuracy	+ 2%
6	Repeatability	+ 0.1 ppm
7	Sensitivity	0 - 10 ppm < 45 seconds
B.	Construction	
8	Measuring Principle	Electrochemical Fuel Cell
9	Display	3-1/2" Digit LCD
10	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
11	Mounting	On Panel with Sample System
12	Service	Measure t race oxy gen i n t he pr oduct hydrogen
13	Location (Hazardous)	Hydrogen delivery after compressors.
14	Code & Standard	ATEX Approved. II 1/2 G Ex ia II c T4
15	Output Current	4-20 mA, HART
16	Type of Transmitter	4 to 20 mA Loop powered 24 VDC
17	Calibration	Every 12 m onths with c alibration gas,

		Calibrator shall be supplied by bidder.	
18	Calibration Gas	5ppm O2 in N2, shall be provided by bidder for one year after commissioning of plant.	
3.03.66.03	Combined Gas Sensor for Hydrogen Gas System		
A	Performance		
1	Nature of Fluid	Hydrogen /Air	
2	Measuring Range	0 to 100% LEL	
3	Response 50%	<10 sec.	
4	Recovery to 10%	<30 sec.	
5	Accuracy	0-50%LEL range	51-100% LEL range
		± 1%	± 2%
6	Repeatability	± 1%	
7	Calibration frequency	180 days	
8	Output Range: 0-100 LEL	4-20 mA, HART	
9	Humidity RH	<99%	
10	Sensitivity	<12 seconds to 60% full scale	
11	Measuring Range	0-100 ppm	
B.	Construction		
12	Measuring Principle	Catalytically bead	
13	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.	
14	Display	3-1/2" Digit LCD	
15	Mounting	4 mtrs above respective instruments supporting Conduit	
16	Service	Monitor combustible mixture in the atmosphere of each room where hydrogen may be present.	
17	Location (Hazardous) (one in each), Any other location as finalised by owner during detailed engineering.	Roof -H2 Generation room	
		Roof - Compressor Room	
		Roof - H2 Storage Room	
18	Code & Standard	FM Standard 6320 FM Standard 3600	
19	Type of Transmitter	4 to 20 mA Loop powered 24 VDC	
20	Calibration Gas	2% H2 in N2, shall be provided by bidder for one year after commissioning of plant.	
21	Calibration	Every 6 months with calibration gas , Calibrator shall be supplied by bidder.	
3.03.66.04	Hydrogen Gas purity measurement Analyser		
A	Performance		
1	Range	80% to 100 % H2 in air	
		0 to 100 % H2 in pure gas *	
		0 to 100 % air in pure gas *	
2	Accuracy/Linearity	± 1 % of FSD	
3	Resolution/Repeatability	± 0.5 %	
4	Response Time for 90% step change	< 5 sec.	

5	Stability/Drift	< ± 1 % of FSD/month
B.	Construction	
6	Measuring Principle	Thermal Conductivity or Multi mode Oscillation type
7	Enclosure Protection class	Intrinsically safe and explosion proof as per N E C article 500, class 1, Division 1 area I.
8	Display	3-1/2" Digit LCD
9	Safety & EMC Standards	Safety Standards EN 61010-1 EMC Standard EN 61326
10	Output	2 nos. 4 – 20 mA DC, isolated from input
11	H2 Purity	99.99%
12	Calibration Gas	shall be provided by bidder for one year after commissioning of plant.
13	Calibration	Every 6 months with calibration gas , Calibrator shall be supplied by bidder.
14	Note: * Pure Gas options: CO ₂ , N ₂ , Argon	

CHAPTER-6

SUPERVISORY CONTROL PANELS, SUPERVISORY CONTROL DESKS, EQUIPMENT PANELS

6.00.00 PANEL AND DESKS

6.01.00 GENERAL REQUIREMENTS

All DDCMIS/PLC/any other control system's electronic modules, power supply components, other control devices (except field mounted sensors/transmitters) and required for completeness of the system shall be housed in cabinets furnished by the Bidder. All equipment and dedicated cabinets required for termination, marshalling and proper interface within Bidder's system and also with other systems shall also be provided by the Bidder.

The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings in the manufacturing works of a qualified manufacturer prior to shipment to the project site. The Bidder shall ensure that the cabinets are complete and ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets should only involve connections through multi pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to UCD/UCP/BUP.

The Control cabinets shall house all types of modules / hardware to achieve all functions of Control System including signal conditioning modules, controller modules, I/O modules, communication controller modules, and all other requisite hardware for a complete system.

6.02.00 SUPERVISORY CONTROL PANELS AND DESKS

6.02.01 Control Desks & Other Furnitures

Supervisory control desks for DDCMIS and other systems shall be supplied for mounting the required operating station as specified elsewhere in the specification. Also control desk will be provided for balance work stations – located in computer room, supervisor room etc. All furniture including chairs and tables for printers etc. shall also be provided by the bidder.

Also control desk & complete furniture will be provided for work stations & printers – located in respective control room for BOP packages.

Industry standard Cushioned revolving, wheel, independently, adjustable seat and back chairs with provision for adjustment of height shall be provided for the operator & unit in charge & other personnel in central control room area & BOP's control rooms, simulator rooms, Conference room, meeting room, documentation room, staff room, CAAQMS shelters, CAAQMS room etc. These shall be designed for sitting for long duration such that these are comfortable for the back. The exact details shall be finalised & approved by Owner during detailed engg.

The actual nos., placement and profile of the main plant control room desk shall be decided during the detailed Engineering.

The tentative layout of central control desk, LVS & consoles are shown in the Drg. No. 114-05-0108, 0105 & 0111.

Control Desk for programmer's, Maintenance Engineer's, EWS, Serves, P C & diagnostic OWSs: -

Required numbers of control desks for accommodating programmer's/main-tenance engineer's/diagnostic etc shall be supplied. These shall preferably have the same dimension as that of supervisory control desks. Also required nos. of control desk will be provided for work stations & printers – located in respective control room for BOP packages.

Desks for accommodating printer:

Adequate number of table/desks/stands for accommodating printers in bidder's scope shall be supplied. Each printer shall be on a separate table / stand.

Care shall be taken to ensure ergonomically aspects so as to create ergonomically ideal work place considering physical aspects such as an average Indian person's size and reach, physiological aspects such as line of sight and field of vision and cognitive factors such as concentration and perceptivity. Extreme care shall be taken to design the desks with correct angles and dimensions.

Glass topped oak wood office table with lockable drawers shall be provided for Chief Engineer room and all other executive rooms.

6.02.02

Supervisory Panel Unit Control Panel

In addition to the LVS and OWS, a limited operation from backup unit control panel is envisaged for emergency operation and to provide safe shut down of plant. The Unit control panel shall house Conventional Push-button (ILPB) stations, Console inserts (for SG, TG & Generator like FSSS, HPBP, SADC, APRDS, ATRS, ATT, DEHC, LPBP etc), Trip Push Buttons, EWLI, Ammeters, chartless recorders, & min. 15 nos. programmable digital display units for Boiler, Turbine & Generator's parameters. The mosaic grid shall be heat resistant, flame retardant, self extinguishing, and shrinkage free, non reflecting type. Finish of mosaic grid shall be mat type without flaring. Hard wired emergency trip pushbuttons shall be arranged on operator station desk & in parallel on UCP.

Unit control Panel (UCP), shall be located suitably in the CCR.

In addition to above, 21 nos. Programmable digital display units common for both units showing total MW shall be provided by bidder at different locations of plant. The data to this DDU will be fed from DDCMIS through MOD BUS/PROFI BUS /RS 485 protocol and not hard wired. The **digit size** of the display unit will be **300 mm for 6 Nos.** and **200 mm for 15 Nos.** The placements/locations shall be decided during detailed Engineering.

Control panel cum desk with HW annunciation windows, ILPBs, Ammeters, Annunciation & desk PBs, mimic, lamps, Indicators, recorders, etc. shall be provided as per Annexure A – Control System Philosophy for BOP packages.

(Exact service & quantities will be worked out & approved during detailed engineering by owner).

- 6.02.03 Two (2) nos. vertical Steel Almirahs shall be provided for keeping documents in each BOP package's control room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed engg.

Suitable lockers (min. 24 nos. per unit) shall be provided in the room adjacent to the each central unit control room for storing of personal articles of control room personnel. Similarly suitable lockers (min. 8 nos. in each control room) shall be provided in BOP package control rooms for storing of personal articles of control room personnel. Also, vertical steel almirahs (min. 4 nos. per unit) shall be provided in Documentation Room for storing of documents.

Vertical Steel Almirahs shall also be provided for the following rooms, wherein final quantity may be decided by owner during detailed engineering

- a. Maintenance room – 6 nos. min. (per Unit)
- b. ERP room – 2 nos. min (Common for both unit).
- c. PADO Room – One (1) no. min.(per unit)
- d. Station In charge room – One (1) no. min (common for both unit).
- e. Simulator room – 4 nos. min. (per Unit)

Thickness of steel almirah sheet shall be 18 gauges.

In addition to above, All industry grade furniture including chairs, control tables, tables for printers etc. & Almirahs for storage of consumables/catalogues/manuals shall also be provided by the bidder as on required basis and finalized by owner any where in power plant. Details shall be finalised and approved by Owner during detailed engineering.

- 6.02.04 Control panels for service system like C.W. Pumps etc. will be located in the respective control room. In addition, some local panels will be provided near respective system/equipment such as Boiler Feed Pump, Hydrogen seal oil system, Electrostatic precipitator etc.

6.03.00 TERMINATION/Marshalling CABINETS & Interposing Relay Panel

Marshalling/Termination cabinets for the control system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source of signal and for distributing the signals to different functional panels, MCC/SWGR and control cubicles.

Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.

Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.

Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives, breakers, isolators & bus couplers etc from DDCMIS/DCS/PLC or any control system.

Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.

General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted Terminal blocks (Screw less cage clamp type) with markers.

6.04.00

CONSTRUCTIONAL FEATURES OF PANELS, CONSOLES, CONTROL DESK, CUBICLES & ENCLOSURES

All panels, cubicles, consoles, SOV panels and enclosures furnished as per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates. The panel sheet thickness shall be not less than 2 mm unless otherwise specified herein.

The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three-point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise

above ambient to 10° C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.

In each panel /cabinet, a 24 VDC Voltmeter digital type shall be provided to check the Field Interrogation voltage.

Exhaust Fans with louvers & filters shall be provided on door's (front & Rear) upper side to remove hot air in all consoles, control desk and panels.

Fire/Smoke detectors shall be provided inside the Control room mounted system/control cabinets.

UPS, 24 V DC & non UPS's Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/ PLC/annunciation & suitably grouped.

All the panels shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.

Doors shall be provided with neoprene/polyurethane gasket only.

All the cable entries shall be at the bottom of electronic cubicles/control panels.

Protection class of panels shall be as specified at Vol. V, chapter 2.

6.04.01 Operator Control Desk

6.04.01.1 In CCR, Operator work station consoles/desk shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

Unit In charge desk/consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

Station In charge desk/consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

6.04.01.2 Engineer work station and all other consoles/desk shall be ergonomically designed industrial grade type with swivel chairs for use at the various Programming stations and all other plant locations. All the equipment like Programmers stations, P C's, various peripherals & similar devices shall be complete with desks and they shall be of industrial grade stands and other mounting accessories and the same shall be completely erected & commissioned by the bidder. Details for other operating and engineering stations shall be as below:

- i. Operator Control desk shall be free standing table top type with doors at the back and shall be constructed of 3 mm thick CRCA steel plates. It shall have concealed cable & wire way management system. The top surface of control

desk shall be 30mm thick with the top 12mm of acrylic solid surface and the remaining 18mm of laminated medium density fibre board. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, Mouse pads, Monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal & vertical directions.

- ii. To achieve durable & water resistant finish, a sheet of "plastic PVC membrane" on the surface of control desks shall be provided. Final paint finish with proper smoothening is to be ensured. Final finish of CD should be in line with relevant International standards. For more durability, the membrane sheet of the Control desk should extend 200 mm more into the underside of the desk. The cabling / wiring between OWS & CPU's, power supply cables etc. shall be aesthetically routed and concealed from view.
- iii. All the control desk shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.
- iv. Doors shall be provided with neoprene/polyurethane gasket only.

6.05.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The finish colours for exterior and interior surfaces shall conform to the following shades:

- a) Exterior - RAL 7032/RAL 7035.
- b) Interior - Glossy white two coats/RAL 7035 with fire resistant paint

One uniform colour shade as finalized shall be applicable for complete plant.

Paint films, which show saggs, checks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.06.00 PANEL WIRING

Interconnecting wiring shall be provided between all electrical devices mounted in the panels, and between the devices and terminal blocks if the devices are to be connected

to equipment outside the panels by cabling and through pre-fabricated plug in cables. All alarm contacts located within a panel shall be wired to terminal blocks. Thermocouple and other special circuits shall be field wires direct to instrument terminal blocks without the use of panel wiring.

All control and instrument wiring used within the panels shall conform to NEC and NEMA standards and shall be factory installed and tested at the works of a qualified manufacturer. All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrumentation leads, and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.

All panel wiring shall have appropriate ferruling for clear identification. Interior wiring shall be so arranged that the external connections can be made with only one wire per terminal point. Any common connections shall be made internal side of the terminal blocks. Common connections shall be limited to two wires per terminal. Instrumentation cable shield wires shall be connected to separate terminal at the terminal block. Signal circuit shields shall be grounded separately.

All internal wiring (except low level instrument wiring) shall be National Electric Code Type SIS, Polymeric/Elastomeric insulated, tinned copper stranded conductor, switchboard wire, or owner approved equal.

Panel wiring shall have a flame resistant insulation with adequately sized 650/1100 V grade tinned copper stranded conductor based on current carrying capacities as set forth by the National Electric Code.

Wire sizes shall be as specified herein and suitable for intended applications.

Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue breaking of the conductor.

Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.

Panel wires shall be identified with wire number and each termination by means of Action craft products split sleeve or Borden Chemical Co. indelible tubing markers or owner approved equal. Corrections and modifications of all panel wiring shall be Bidder's sole responsibility. Any corrections/modifications required at site for successful commissioning shall be done by the Bidder without any additional costs. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

Wires shall not be tapped or spliced between terminal points.

Panels, cabinets, consoles/desks will be provided with removable, gasketed cable gland plates and cable glands, for all floor slots used for cable entrance. Split type grommets shall be used for prefab cables.

Internal wiring in factory prewired electronic systems cabinets may be installed according to the Bidder's standard as to wire size, insulation, and method of termination on internal equipment except that insulation for all wiring power supply wiring, and interconnecting cables between devices shall pass the following tests.

- a) Flammability test IEEE 383/1974
- b) When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
- c) When tested under IEC 754 -1 maximum acid gas generation shall be 2% by weight
- d) Oxygen index not less than 30 as per ASTM D 2863.

All terminations for intra panel wiring inter panel cabling and connecting the Bidders panels, PB stations, control stations etc. shall be with cage clamp Screwed less connections. Soldered connections are not acceptable. All field side or external input connections shall also preferably of Cage clamp/Spring Clamp/ Screwed less connection.

Conductor Clamping shall also confirm to Standard IEC – 60947-1 & IEC-60947-7-1.

Identification of conductors may be done by insulation colour coding identified on drawings or by printed wiring lists. Terminal blocks for connection of external circuits in to factory prewired electronic system cabinets shall meet all the requirements as described elsewhere in the specification. For all multicore cables, the outer sheath shall satisfy the properties identified above. However, for panel wiring, the wiring insulation shall also satisfy the properties identified above. The internal wiring shall be done in coloured wiring.

6.06.01

Following Wire size shall be utilized for internal wiring:

- a. Current (4-20 mA) : 0.75 sq.mm
Low voltage signals :
(AI/AO & DI signals)
- b. DO signals, Ammeter/ : 1.5 sq.mm
voltmeter circuit, control
switches, indicator, recorder
- c. Internal Illumination : 2.5 sq.mm
- d. Size of Power supply cables shall be as below:-
 - i. 1 to 16 Amp. - 2.5 sq. mm
 - ii. 17 to 20 Amp. – 4 sq. mm
 - iii. 21 to 32 Amp. - 6 sq. mm
 - iv. 33 to 40 Amp. - 10 sq. mm.
 - v. 41 to 60 Amp. - 16 sq. mm
 - vi. Power earth - 4 sq. mm

6.07.00

INSTRUMENTS MOUNTING

6.07.01 Instruments and relays mounted on the panels shall be easily accessible for repair and replacement without disturbing other equipment their connected wiring. No special tools shall be needed for the purpose.

6.08.00 PANEL ILLUMINATION

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 6/ 16A, 240V A C uni versal t ype po wer so ckets with sw itch f or m aintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED l amps shall be p rovided with each panel , t hese a re i n addi tional t o mandatory spares.

6.09.00 FUSE BLOCKS

Where fuse blocks rated 30 amp. 250 Volts are required by the specifications or the manufacturer's design, t hey sh all be m odular t ype w ith bakelite frame and reinforced retaining clips. B locks shall be class H.2 pole, screw terminal fuse blocks. B locks for other current and voltage ratings shall be similar in construction.

6.10.00 FUSES & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS f uses. For al l D C P owered dev ices, si milarly t he f uses shall be f ast ac ting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermomagnetic type MCB. Make of Fuses shall be GE or Siemens. For all the DC power supply circuits, electronic type DC MCB shall be use d only. Make of DC MCB shall be S iemens, P hoenix contacts, Murr, Weidmuller, or Lutze.

50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.11.00 MOULDED CASE CIRCUIT BREAKERS

Moulded ca se ci rcuit br eakers used i n e quipment co vered under t hese sp ecifications shall have not less than 5000 amp. Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.

6.12.00 GROUNDING

All panels and cabinets shall be provided with a continuous bare copper ground bus of minimum 6 mm x 25/50 mm cross section. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. Each Ground bus shall have provision at each end for co nnection o f ground l eaks (6 m m x 50 mm GI Fl ats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be < 0.5 ohms.

Each circuit requiring grounding shall be i ndividually and directly connected to the panel ground bus by ring tongue type compression lugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately

connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

The Bidder shall furnish his recommendations regarding grounding requirements for all equipment/systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

6.13.00 TERMINAL BLOCKS

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

6.13.01 All outputs going to MCC/SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be screw less cage clamps type. Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be 6.6 polyimide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

6.13.02 Terminal blocks shall be provided with white marking strips and re permitted by the safety codes and standards shall be without covers.

6.13.03 Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable.

6.13.04 At least 20 per cent spare unused fully wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, SOV Boxes etc.

6.14.00 NAME PLATES AND LABELS

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.

6.00.02 **LOCAL CONTROL PANEL**

The local control panel for control and monitoring of the fuel Oil shall be located in the Fuel oil pressurizing pump area and shall house all necessary start/stop push buttons, auxiliary relays, control switches, meters, indicators, status indication lamps etc. to achieve the control philosophy described above. This panel shall also include all the annunciation described below.

For safe and reliable operation control of the Fuel Oil System, Following minimum instruments / control function shall be carried out in addition to process requirement

- a) Remote and Local differential pressure across each strainer in HSD (LDO), HFO line at pressurizing pump suction and at heater outlet.
- b) Remote and Local differential pressure across strainer at pressurizing pump suction in HSD (LDO) line.
- c) Remote and Local pressure at discharge of each HFO pressurizing pump
- d) Remote and Local pressure at discharge of each HSD (LDO) pressurizing pump
- e) Remote and Local pressure at suction and discharge header of HFO heaters

- f) Remote and Local pressure at discharge header of HSD (LDO) pressuring pumps
- g) Remote and Local temperature of steam & HFO at inlet/outlet of each HFO heater
- h) Remote and Local temperature in the connected fuel oil tanks
- i) Remote and Local pump suction temperature (for HFO only).
- j) Redundant radar type Level Transmitters for each fuel oil tank.

CHAPTER-9

ERECTION HARDWARE

9.00.00 PROCESS CONNECTION AND PIPING

9.00.01 General Requirements

This section covers the material requirement for instrument connection to process, instrument process, piping, tubing, supports, Instrumentation cables, control cables and power cables for connecting UPS, 24/48 V DC, unregulated power supply for cubicle illumination, compensating cables/Extension cables, transmitter racks and main accessories to be furnished under this specification and the requirements of installation and routing. Impulse lines, fittings and other accessories required for the erection of complete Instrumentation and Control System supplied under various packages of this specification shall be supplied on "as required" basis. Bidder shall offer all necessary items for this section based on his experience on similar plants, plant layout diagrams, installation drawings and other applicable sections of this specification. Based on the good engineering practices Bidder shall furnish installation drawings during the engineering of the system for Owner's review and approval. The installation of the drawings shall be suitable for his installation of his range of instrumentation.

The Bidder shall furnish and test all required erection hardware, which is necessary for proper installation and interconnection of the equipment/systems furnished by the Bidder and their integration with main equipment/systems as per the enclosed installation drawings and other applicable clause. The Bidder shall furnish all hardware and accessories to ensure that the equipment/systems furnished form a complete and operational system meeting the intent and requirement of this specification.

All materials, furnished shall conform to the latest editions of American National Standard Code for Pressure piping, Power piping, ANSI B31.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall conform to ANSI B.36.10 and of stainless steel pipe shall conform to ANSI B 36.19 unless otherwise specified.

All materials supplied under this section shall be suitable for intended service; process operating conditions and type of instruments used and shall fully conform to the requirements of this specification.

The Bidder is responsible for the performance of the equipment furnished on system basis any shortfall in erection material observed during erection stage shall be compensated by the Bidder at no extra cost. (Installation drawings # 114-04-0000, 0100 to 0113 shall also be referred by bidder).

9.01.00 GUIDELINE FOR INSTALLATION AND ROUTING OF INSTRUMENT PIPING

9.01.01 General Requirements

The following general erection guidelines have been enumerated here to enable the Bidder to estimate the requirement of instrument piping in plant:-

- i) All instrument piping shall be in accordance with good engineering practice. It shall be finalized during engineering stage. Instrument piping shall be complete with fittings, valves and other required accessories.
- ii) Instrument piping shall not be routed:-
 - a) Across equipment removal areas
 - b) Below mono-rails and cranes
 - c) Above or below removable gratings
 - d) Above or below cable trays.
- iii) Primary Impulse Piping System:
 - a) The primary impulse piping system shall include the instrument piping and all required accessories from process tap off point (root valves onwards) up to the respective instruments. From the same source, Tee off for instruments are not allowed. Separate tapping shall be provided for each instrument. The Bidder shall provide the necessary fittings and accessories along with impulse pipes for completeness and arrangements as per the finalized Instrument Installation Diagrams. Special accessories such as reservoirs and other devices shall be installed as required for flow primary element connection as required by the design of instruments, in accordance with the instructions of the instrument manufacturer.
 - b) The Bidder shall prepare impulse pipe routing drawings.
 - c) Impulse piping shall include a blow-down line and shut-off valve adequate for the duty requirements and for withstanding continuous design pressure and temperature of process medium. For process pressure above 40 Kg/Cm²g, double valves shall be used before connecting to the blow-down header (This arrangement shall be provided for installation for the new transmitter if the existing transmitter has the same arrangement.)
 - d) To assure a constant static head the connections from low pressure steam and low pressure liquid filled lines should preferably slope downward continuously towards the instrument as the instrument is mounted below the source point. If downward slope is not feasible or the instrument is mounted above the source point, the line should slope upward continuously and a "pigtail" installed at the instrument to assure a water seal for temperature protection. Upward sloping liquid lines should be used only if the process pressure is sufficient to assure a head of liquid at the instrument. Horizontal runs should have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope. Vacuum connections to the condenser should always slope upward to the instrument.
 - e) Primary process piping for steam flow, liquid flow and manometric level measurement systems should preferably slope downward from the primary element connections to the instrument. Primary piping for flue gas and air flow measurement systems should preferably slope upward from

the primary element connections to the instrument. If these requirements cannot be met, special venting or drain provisions will be required. Horizontal runs must have a slope of not less than 40 millimeters per meter and must be adequately supported to maintain a constant slope.

- f) Primary process piping from the field which enters the instrument enclosure from the bottom shall extend into the enclosure approximately 150 millimeters and be equipped with a socket weld to flare less tubing coupling of stainless steel. This coupling shall be used to connect the field primary process line to the enclosure process line. The field primary process line shall be anchored to the enclosure angle with U-bolts. Holes for supporting U-bolts shall be field or drilled.
- g) All impulse piping shall be supported rigidly at an interval not exceeding 1.5 meters so as to prevent excessive sag in piping. Process piping shall not be used for supporting impulse piping.
- h) Impulse lines subject to severe sonic pulsations such as boiler feed pump discharge, shall be of sufficient length and of suitable configuration to scatter harmful sonic wave energy before it reaches the instrument.
- i) Impulse piping shall be installed to permit thermal expansion without placing excessive stress on the piping and without affecting the gradient of slope. Long continuous straight runs of piping shall always be avoided. If required, expansion loops shall be provided at least every 2.5 meters to break the continuity.
- j) All welded and screwed fittings shall conform to ANSI B16.11. Threads of piping components shall be taper pipe thread in accordance with ANSI B2.1. All threads shall be clean machine cut with all burrs and chips removed. Lubricants shall be of dry film type. Any one of the following compounds may be used as a pipe thread sealer. Bidder shall supply adequate amount of his preferred sealer for erection purpose.
 - a) Permatex
 - b) Molycote
 - c) Neolube(Teflon tape shall not be used as a pipe thread sealer).

9.01.02 Impulse Piping System

Impulse piping system consists of primary impulse pipes/tubes, valves, fittings, valve manifolds and other accessories between the source connection point (source shut-off valve onwards) and all instruments/devices. Impulse pipe span for supporting clamp shall be 1.5 mtr. This will also include all piping and valves etc. required for instrument drain and vent connections. The Bidder shall furnish and test all items required for completeness of this specification.

9.01.03 AIR SUPPLY PIPING

The piping for air supply shall be as specified below (However the Bidder shall supply the materials as required basis to complete the system in all respect)

i) Individual Supply Lines and Control Signal Lines:-

Air lines shall be ¼ inch size, connected by brass/SS316 flare less tubing fittings. Copper/SS316 tubing shall be light drawn tampered tubing conforming to ATM B75 except copper tubing in tubing cables shall be annealed soft temper tubing conforming to ASTM B68 or B75. Fittings on the branch line to facilitate connections to the individual supply line shall be cast brass screwed type.

ii) Flexible Hoses:-

Flexible hoses shall be ¼ inch SS flexible hose pipe and with Buna-N liner steel wire braid reinforcement complete with ¼ inch brass/SS316 fittings and shall have swivel male pipe threads. Each hose shall be done meter in length.

iii) Pipe Material Specification:-

The piping material shall be carbon steel hot-dipped galvanized inside and outside as per IS-1239 or the equivalent of these standard heavy quality with screwed ends. The piping threads shall be as per ASA B.2.1.

iv) Isolating Valves:-

Gate valves as per ASTM B62 inside screw rising stem screwed female ends as per ASA B.2.1 valve bonnet shall be union type and trim shall be stainless steel body rating 150 pounds ASA. Valves sizes shall be ½ inch to 2 inch.

v) Fittings:-

Forged cast steel A234 Gr. WPM galvanized inside and outside; screwed as per ASA B2.1 dimensions as per ASA B16.11, rating 2000 pounds, elbows and soft seats. The size of the fittings shall be ½ inch through 2 inch.

vi) Air Filter Regulator Set:-

An instrument Air Filter Regulator Set with mounting assemblies shall be provided for each pneumatic device requiring air supply.

vii) Instrument Air Piping System:-

a) Instrument Air shall be made available by the bidder at 3.5 to 7.0 Kg/cm² pressure. The instrument air may be arranged as under:-

11. For the control valves and power cylinders in owner's scope but controlled by bidder's control system, the instrument air requirement for E/P converter shall be tapped from the nearby instrument air header laid by bidder / already laid existing piping with accessories available near the control valves or damper.

Complete hardware required for interfacing with Owner system shall be in bidder scope.

- b) Air supply piping shall be installed at site always with a slope of over 1/100 to prevent accumulation of condensed water within the pipe.
- c) All joints in the instrument air sub-header shall be of screwed type.
- d) Instrument air line shall be separate for each individual instrument, equipment & drive with own isolation valve and other required hardware. Tee off of instrument line for two or more same/similar services instrument, equipment & drive are not acceptable.
- e) Instrument air flushing/purging lines shall be provided for Bowl Mill DP, secondary air flow measurement instrument and other all flue gas services instruments etc.

viii) Signal / Control Air Tubing System:-

Necessary tubes with fittings and accessories for output signal from pneumatic instruments mounted in the field and control signals to final control elements shall be covered under this tubing system.

9.02.00 **SPECIFICATION FOR ERECTION HARDWARE**

The erection hardware shall meet the following specifications:-

	<u>Item</u>	<u>Specification</u>
9.02.01	Impulse Piping	
i)	High pressure and high temperature services (Medium: Steam & Water and furnace region)	Seamless Alloy Steel piping to ASTM A335 GR.P91/22 (schedule XXS/160 for high pressure & high temperature)
ii)	Low pressure and low temperature services (Medium: Steam & Water)	Seamless carbon steel piping to STM A106, Gr.C
iii)	Low pressure and low temperature services (Air, Flue gas)	ERW carbon steel piping to IS 1239:1973 Heavy class System)
iv)	Steam and water analysis system	Seamless stainless steel piping to ASTM A312 GR. TP-321
v)	Seamless copper tubing	ASTM B-75

9.02.02 Fittings Double compression type

- | | | |
|------|--|---|
| i) | Material for socket weld fittings | ASTM A105
ASTM A182,
Gr. F22
6000/3000 lbs |
| ii) | Dimensions of fittings | ANSI B16.11 |
| iii) | Fittings for steam and water analysis. | Gr. F-321 |

9.02.03 Valves

- | | | |
|------|----------------------------|--|
| i) | 3 – way valves | SS body/forged CS
body stellited internals and SW ends
as per requirement for 2500 lb/800 lb
ASA ratings. |
| ii) | 5- valve manifolds | FAS body/FCS body
316SS stellited internals with NPT(F)
SCRD ends for 3000/2500 lb/1500
lb/800 lb ASA ratings. Construction –
Single block (Bar stock) |
| iii) | 3-valve manifolds | FAS body/FCS body
316SS stellited internals with NPT(F)
SCRD ends for 3000/2500 lb/1500
lb/800 lb ASA ratings. Construction –
Single block (Bar stock) |
| iv) | 2-valve manifolds | FCS body, 316SS
stellited internals, NPT(F) SCRD
ends. Construction – Single block
(Bar stock) |
| v) | Isolation and drain valves | Globe valves with
FAS body/FCS body, 316SS stellited
internals SW ends for 3000/2500
lb/1500 lb/800 ASA ratings. |

9.02.04	Condensation vessels	FAS/FCS body with NPT (F) SCRD connection and vent plugs for 3000/2500/1500/800 lb ASA ratings.
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9.02.05	Racks and Associated Equipment	ANSI C83.9-1972
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9.02.06	Code for pressure piping, welding and Hydrostatic testing	ANSI B-31.1
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- 9.02.07** Flexible conduits with fittings Lead coated, paper insulated, heat resistant flexible metallic conduits with necessary fittings.
- 9.02.08 3 Valve manifold shall be used, wherever Diff Pressure transmitter/switch have been used for pressure measurement.
- 9.02.09 5 Valve manifold shall be used for Diff. Pressure & Flow measurement Transmitters/Switches.
- 9.02.10 In addition to above, table # 9.1 shall also be followed for selection of specific erection hard ware as per process requirements.

9.03.00 TRANSMITTER & SWITCHES ENCLOSURES

In general, BTG process transmitters & switches installed at outdoor location and in areas where they are subjected to splashing oil, water, steam etc., shall be mounted in closed type transmitter rack. For other areas (indoor), open type racks may be used for installation of transmitters and process switches. However the actual requirement shall be finalized during detailed Engineering considering following:-

- i) Transmitter/Switches enclosures shall be free standing, enclosed type offering protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in thermal power plants.
- ii) The enclosures shall comprise of Galvanized Sheet mounting plate internally. Also external-mounting brackets in Polyamide or Stainless Steel shall be available. Alternatively transmitter enclosures can be glass Fiber Reinforced Polyester (GRP) compression moulded and shall be weather proof.
- iii) Instrument piping inside the enclosure shall conform to the specification and in line with typical installation drawings enclosed with the specification.
- iv) Blow down header shall be provided inside the enclosure as called for.
- v) Bulk head connection shall be provided to receive and terminate the impulse pipes from root valves.
- vi) Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subject to hydrostatic tests at 1.5 times maximum system pressure.
- vii) Support angles shall be provided for valve manifolds, wiring trays etc. Enclosures shall be complete with necessary bulk head fittings, junction boxes, drain header and other accessories as needed on the basis of approved hook up drawings.
- viii) Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up

the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.

- x) A minimum of twenty (20) percent spare terminals shall be provided. Only one wire per terminal shall be used on the outgoing side of these blocks (for cable panel). Any common connections required shall be provided on the panel side of the block. All incoming power terminals are to be clearly identified in a manner distinctly different from all other terminals and grouped in a logical pattern.
- xi) Chapter no. 6 of this volume shall also be referred for designing of Transmitter/Switches enclosures.

9.04.00

LOCAL INSTRUMENTS, LOCAL BOARDS AND TAPPING POINTS

- i) All local gauges as well as sensors, Transmitters and switches any other instruments for parameters like pressure, temperature, level, flow etc for safe and efficient operation of equipment under the scope of specification, shall be provided by bidder as approved by Owner. Such equipment shall be listed by the Bidder detailing the items with the respective functions in service. All field mounted instruments shall be mounted in such a way as not to be affected by vibration & environmental conditions. Racks to mount these instruments shall be furnished by bidder complete with requisite erection hardware, tubings and junction boxes with all terminals of the instruments duly wired complete with cable glands. Groupings of instruments, actual number of racks for instruments and its construction shall be to Owners approval.
- ii) Transmitters & Switches provided shall be mounted in transmitter/Switches enclosures to owner's approval. The junction box for electrical connections shall be outside the transmitter enclosures.
- iii) All erection hardware required for complete installation/ implementation of entire instrumentation specified is included in bidders scope. Any change in size, type, rating or in quantity deemed necessary during engineering shall be supplied within package price with no additional financial implication to owner.
- iv) Bidders scope includes providing counter flanges on pipe lines/ vessels to suit owner arranged flanged devices. Counter flanges shall be complete with gaskets, nuts, bolts and other requisite accessories for proper installation.
- v) Separate and independent tapping on equipment/associated piping shall be provided to suit the philosophy of redundant primary sensors. Separate sensors for control and monitoring etc are as decided by Owner. This shall include application such as first stage pressure. Wherever the process value being measured needs to be compensated for temp, pressure variations, the tapping points for such compensating elements shall be provided in requisite number along with the tapping for the process value.
- vi) Whereever transmitters & switches are provided, in addition Local gauges shall also be provided by bidder for local field monitoring.

- vii) Local instruments and remote sensors & transmitters to be furnished with the equipment shall generally be as indicated herein and as per redundancy criteria indicated elsewhere but not be limited to the following: -

1. Pressure Measurement

i. Pressure Gauge for:

- a) Shell pressures of all Deaerator, HP and LP heaters and other vessels.
- b) Mercury manometers shall be provided during air outlet flows measurement.
- c) Bleed steam pressure at extraction point for all turbine extractions and for pressure on drain lines.
- d) Pressure gauges at inlets and outlets of condensate extraction pumps, main oil pump, each auxiliary oil pump, AC standby oil pump, DC Emergency oil pump, jacking oil pumps, DM makeup pumps, DMCW pumps, BFP, or any other pumps etc.
Pressure Gauge at outlet of each type of Fan.
- e) Lube oil pressure before and after oil coolers, HPT & IPT front seal chamber leak off pressure.
- f) MS pressure downstream of ESV, after HPT control valves and after HPT first stage, HRH steams pressure after IV, Gland steam header pressure, HPT exhaust etc.
- g) Condensate pressure in condensate pump discharge header, and feed water pressure at inlet and outlet of each LP & HP heaters.
- h) LP turbine exhaust pressure and condenser pressure
- i) Relay/Lube/Control oil pressure, Drain oil lines pressure.
- j) Pressure gauges for vacuum pumps and each pump discharge.
- k) Pressure gauge at Instrument and service air header in compressor room and in the field at the main location of instrument/service air header, the pressure gauges shall be provided.
- l) Pressure gauges at inlet and outlet of each heat exchanger and cooler.
- m) Frame mounted Pressure Gauges (FMG) shall be provided for Main steam Pressure, Feed water pressure to economizer, CRH Steam Pressure, HRH Steam Pressure etc.
- n) For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300 mm or bigger size** shall be provided.
- o) **U tube manometer with Hg filled for direct measurement of condenser vacuum** shall be provided in the fixed with isolation valve for local indications.
- p) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering by owner.
- q) Pressure gauge for all BoP packages as decided during detailed engineering by owner.

ii. Pressure Switches

- a) Pressure switches at condensate Extraction Pump Discharge header, Boiler feed pump, seal water line or any other pumps for alarm (high & low) and interlock purpose.

- b) Pressure switches for steam supply to LP/HP heaters.
- c) Pressure switches for initiation of turning gear.
- d) Pressure switches for control oil, jacking oil and lube oil pressure for all required alarms and interlocks.
- e) Steam pressure downstream of ESV, steam pressure after first stage of HPT, gland steam header pressure and suction line from turbine glands to Gland cooler.
- f) Pressure switches for condenser vacuum low, very low alarms & interlocks.
- g) Condenser water box pressure for alarm interlocks.
- h) Pressure switches (low & high) for individual pumps/blowers suction/discharge and discharge header – alarms, interlocks and protection
- i) At the main location of instrument air header the pressure low switches shall be provided for alarms in DDCMIS
- j) Pressure switches/any other process switch etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.
- k) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria by owner.
- l) Pressure switches for all BoP packages as decided during detailed engineering. by owner.

iii. Differential Pressure Transmitters, Diff Pressure Switches & Diff. Pressure Gauges

- a) Pressure across strainers and filters.
- b) Diff. Pressure Transmitters/switches/Gauges for all BoP packages as decided during detailed engineering by owner.
- c) Diff. Pressure Transmitter across condenser on CW lines, Air pre heaters on air & flue gas lines, on PA lines, CEP suction strainers, Feed control station etc.
- d) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria by owner.

iv. Pressure Transmitters

- a) For all services as mentioned for Pressure gauges & Pressure Switches.
- b) Pressure Transmitters at condensate Extraction Pump individual Discharge and discharge header, Boiler feed pump individual Discharge and discharge header, seal water line or any other pumps/fans/HT/LT unidirectional drive for alarm (high & low) and interlock purpose.
- c) Pressure transmitter for wind box (Left/Right) & pulverizer seal air fans discharge pressure.
- d) Pressure Transmitters as on required basis for monitoring, interlocks & controls as per redundancy criteria and approved by owner.
- e) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria and approved by owner.
- f) Pressure Transmitters for all BoP packages as decided during detailed engineering by owner.

2. Temperature Measurements:-

The Bidder shall furnish all temperature sensing elements to be installed in their piping. The scope of supply shall include, but not limited to the following: -

- i) Duplex RTDs for all bearing, drain oil from bearings, LPT exhaust steam, 3 no's of duplex RTDs each on left and right CW outlet of condenser etc.
- ii) 6 no. duplex or 12 no. simplex Embedded temperature detectors for various motor stator windings and duplex RTDs for Motor/Pump bearing temp.
- iii) Chromel-alumel surface/other thermocouples for turbine casings, ESV, IV bodies, superheated steam, hot reheat steam piping, steam of first stage HPT, inlet bowl of IPT, steam exhaust of HPT, down stream of ESV and IV, steam in ESVs and IVs, steam admission pipes metal temperatures, HPC, IPC flange metal temperature etc.
- iv) For all HP heaters remote monitoring with redundant independent sensors of inlet/outlet temperatures of feed water and extraction steam shall be provided in addition to local gauges.
- v) For all LP heaters remote monitoring with redundant independent sensors of inlet/outlet temperatures of feed water and extraction steam shall be provided in addition to local gauges.
- iv) Temperature sensors for HP-LP bypass system for measurement as well as for control.
- v) Adequate number of temperature Elements shall be furnished to provide initiating contacts for temperature interlocking and trip circuits. The temperature elements shall be provided, but not limited to the following: -

Steam temperature of HPT exhaust, steam temperature after ESV (L&R), IV (L&R), LPT exhaust hood steam, drain oil temperature of all journal bearings and thrust bearing & lube oil header temperatures, thrust bearing of each condensate extraction pump and vacuum pump protection, interlocks.

- vi) Metal Temp measurement and steam temp measurement at each super heater & Reheater location.
- vii) Temp. Element & Temp gauges at Feed water line to economizer inlet, economizer to steam separator, spray water lines to desuperheaters, Soot blower steam, Soot blower steam drain lines, steam drain lines, Flue gas & air lines etc
- viii) Temp. Measurements (Local & remote) for all BoP packages as decided during detailed engineering.
- ix) Thermocouples for Temp. above 200 deg C shall be provided by bidder.
- x) For plate heat exchangers, spare thermowell provision shall be made at inlet & outlet of ACW & DMCW lines in addition to local & remote temperature monitoring points.
- xi) Each ESP Hopper shall be provided with RTDs to control the temperature of ash through Hopper heater.

xii) Temperature gauges.

- a) For bearing temperatures AC and DC lube oil pumps, LPT exhaust hood etc.
- b) For condensate and feed water at inlet and outlet of HP heaters, Vacuum pumps, LP heaters etc.

- c) Steam & water inlet/outlet of LP and HP heaters, steam and air mixture inlet to vacuum pumps, and drain lines etc.
- d) Journal/thrust bearing drain oil, lube oil at inlet/outlet of oil coolers, cooling water at inlet and outlet of oil coolers etc.
- e) Thrust bearing of each condensate extraction pump.
- f) Temp. Gauges at inlet and outlet of each heat exchanger and cooler.
- g) Frame mounted Temperature Gauges (FMG) shall be provided for Main steam Temperature, Feed water Temperature to economizer, CRH Steam Temperature, HRH Steam Temperature etc
- xiii) Above are the min. requirements, actual quantities shall be as decided during detailed engineering by owner.

3. Level Measurement

- i) Level gauges - level gauges for boiler separator, HP heaters, LP heaters, deaerator, drain cooler, gland steam cooler, vacuum tanks, condenser hot well CBD tank, stator water tank, Stator water expansion tank and other pressure vessels, main oil tank and all oil tanks in BTG & BOP package. The level gauges shall be mica shielded steel armoured transparent glass type. Level gauges for condenser hot well shall be provided on both sides.
- ii) Level switches for HP/LP heaters, drain cooler, gland steam cooler, condenser hot well, deaerator, main oil tank and other pressure vessels, tanks, sumps etc. The separate switches for high, very high and low levels shall be provided as per interlocks and protection requirements.

External cage mounted magnetic level switches/ displacer type shall be employed for low pressure & low temp. services.

However conductivity type level switches shall be provided for high pressure & high temp services like HP heaters, CRH/HRH drain Pot, Turbine Drains etc.

- iii) Level Transmitters (Type as per Owner approval) for open sump/tank/bunker/vessel/heaters.
- iv) Level measurement for all BoP packages as decided during detailed engineering.
- v) Level switches for OLCS / Alarms / Interlocks / Protection. Level switches for sump/tank level high/normal/ low/very low interlocks.
- vi) Each ESP hopper must be provided with 3 nos. level switch (switches 2 nos. for high level and One no. for low level.)
- vii) Above are the min. requirements, actual quantities shall be as decided during detailed engineering by owner.

4. Flow Measurements:-

- a) Primary Elements: Flow nozzles shall be used for feed water flow and other critical measurements where weld-in construction is required. Flow nozzles shall be made of stainless steel, with three sets of pressure taps installed in the pipe wall where required. One no. spare set of pressure tap shall also be provided on flow nozzle,

wherever required. Installation of flow nozzles and pressure taps shall be made in the pipe fabricator's shop and shall be witnessed by a representative from the flow nozzle manufacturer.

- b) Paddle type orifice plates shall be used for other flow measurements where flanged construction and higher pressure loss are acceptable. Orifice plates shall be made of stainless steel. Orifice flanges shall be of the raised face weld neck type with dual sets of taps.
- c) Construction and installation of flow nozzles and orifices shall conform to the requirements of ASME Performance Test Code PTC-19.5, and discharge coefficients shall be predicted in accordance with data published in ASME Research Report on Fluid Meters.
- d) Airfoil or venturi flow sections, shall be used for measuring boiler combustion airflow.
- e) A special high accuracy flow nozzle pipe shall be provided to determine feed water flow to the economizer. This nozzle shall be hydraulically calibrated and utilized for feed water flow control and for turbine testing as described in ASME PTC 6 (latest revision).
- f) Orifice plates shall be supplied with carrier rings as per process requirement.
- g) Doppler effect type flow meters shall be used for sludge applications.
- h) For Raw water, water treatment plant and effluent treatment plant, ultrasonic type flow meters to be used.
- i) Secondary Elements: Secondary elements for differential type flow sensors shall be strain gauge or capacitance type differential pressure transmitters. Square root extraction required for the DP transmitters shall be performed electronically in the transmitter itself.
- j) HFO/LDO flow meters shall be based on coriolis mass flow technology. Fuel Oil meters shall be provided for fuel oil unloading system and near boiler after day oil tank (at main supply & return line).
- k) Flow nozzles shall be provided for following services in main plant:-
 - i) Steam flow measurement for BFP Turbines.
 - ii) Feed water flow measurement
 - iii) Auxiliary steam flow measurements
 - iv) HP bypass flow measurements
 - v) BFP suction flow.
 - vi) Deaerator water flow measurement
 - vii) HP heaters drain Flow measurements.

Orifices shall be provided for following services:-

- i) Spray water flow measurement

- ii) Condensate flow measurements
 - iii) DM/hotwell makeup to condenser.
 - iv.) Condensate dump flow to CST
 - v) Gland Steam Condensate flow measurements
- l) For DM water flow & Ash Slurry flows measurements online electromagnetic flow meter shall be used.
 - m) At CW & ACW pump discharge headers flow transmitters shall be provided (Non Contact ultrasonic Type are preferable). In addition flow measurement shall also be provided for CW water used anywhere except condenser service.
 - n) Instrument and Service Air - Vortex/Swirl type Flow meter
 - o) Flow transmitters for general applications shall be of the differential pressure type
 - p) Flow switches for OLCS / Alarms / Interlocks / Protection.
 - q) Lubricating oil Flow transmitter/meter with switch shall be provided for Bearing systems of APH, FD, PA, etc.,
 - r) Sight glasses flapper indication type shall be provided on lube oil cooling water piping as required to ensure indication of fluid flow.
 - s) On line Fuel flow & velocity measurement facility in each Pulverized Fuel (PF) pipe for each coal pulveriser shall be provided by bidder for accurate, absolute and simultaneous measurement of coal velocity, coal density, coal mass flow rate and air-to-fuel ratio. The equipments shall comprise of sensors working on micro wave technology.
 - t) In addition to the **conventional triple DP measurement techniques** involving venturi/Airfoil for secondary air flow measurement, One number **Flow measurement** system each on Left side and Right side shall be provided **as redundant/checking measurement for secondary air flow** which could be used in the optimization package.

On line secondary air flow & velocity measurement facility in each on left side & right side shall be provided by bidder for accurate, absolute and simultaneous measurement of air velocity & flow rate. The equipments shall comprise of sensors working on tribo-electric (Correlation technique) technology.
 - u) Any other flow element/meter required for system shall be finalised as per system requirement and as per approved drawings/documents by owner.

9.05.00

Process Connections

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.

Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	$\geq 40 \text{ bar(g)}$ OR 425°C
(ii)	1	15NB	$< 40 \text{ bar(g)}$ AND 425°C .
Level Measurement			
(a)	Level Gauge & Switch		
(i)	2	25NB	$\geq 40 \text{ bar(g)}$ OR 425°C
(ii)	1	25NB	$< 40 \text{ bar(g)}$ AND 425°C
(b)	Level transmitter (displacement type)		
(i)	2	40NB	$\geq 40 \text{ bar(g)}$ OR 425°C
(ii)	1	40NB	$< 40 \text{ bar(g)}$ AND 425°C
(c)	Stand pipe for level measuring instrument		
(i)	2	80 NB	$\geq 40 \text{ bar(g)}$ OR 425°C
(ii)	1	80 NB	$< 40 \text{ bar(g)}$ AND 425°C
<i>Flow Measurement</i>			
(i)	2	25NB	$\geq 40 \text{ bar(g)}$ OR 425°C
(ii)	1	25NB	$< 40 \text{ bar(g)}$ AND 425°C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	$\geq 40 \text{ bar(g)}$ OR 425°C
(ii)	1	25 NB	$< 40 \text{ bar(g)}$ AND 425°C

Technical Specifications for C&I Systems-Table-No. 9.1

S.No.	System/Line Description	Piping Class	Impulse Pipe material	Schedule (Size)	Materials for fitting/ valve body	Valve steam material	Rating of Piping Fitting	Pressure Class of valve
1	Main steam, Up steam & down stream of HP bypass and up stream of auxiliary steam pressure reducing valve.	A	ASTM-A335 Gr.P-91/22 (Note-2)	XXS (½ Inch)	Note-3	Note-3	9000lb	3000 SPL
2	BFP discharge/ superheater attemperator/spray to PRDS	B	ASTM-A106 Gr. C	160 (½ Inch)	Note-3	ASTM-A-182 Gr.F6a	6000lb	2500 SPL
3	Reheater attemperator	C	ASTM-A106 Gr. C	160 (½ Inch)	ASTM-A-105	ASTM-A-182 Gr.F6a	6000lb	1500 SPL
4	Hot. Reheat/Down stream of Aux.Steam pressure reducing valve upto desuperheater/flash tank drain manifold, HRH upstream & down stream of LP Bypass valve.	D	ASTM-A335 Gr.P-91/22 (Note-2)	160 (½ Inch)	ASTM-A182 Gr.F-22	Note-3	3000lb	2500 SPL
5	Cold reheat upto Tee-off for HP bypass.	E	ASTM-A335 Gr.P-22	80 (½ Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
6	Cold reheat down steam of Tee-off (HP Bypass)	F	ASTM-A106 Gr. C	80 (½ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800

7	BFP suction/condensate system/Extraction to LPH/HPH and Extractions to BFPT, Desecrator, auxiliary steam.	G	ASTM-A106 Gr. C, ASTM-A335 Gr.P-11/22	80 (½ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
8	Air/Flue gas outside furnace.	M	ASTM-A106 Gr.B/C	80 (¾ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
9	Air flue gas inside furnace	N	ASTM-A335 Gr.P-22	80 (¾ Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
10.	Purge Air	O	ASTM-A106 Gr.C	80 (¾ Inch)	ASTM-A105	SS316	3000lb	800
11.	DM Cooling water	P	ASTM-A312 TP 316	80/40 (1/2 Inch)	ASTM – A 182 F 316	SS316	3000lb	800
12.	CW & ACW	Q	ASTM-A106 Gr.C	80 (1/2 Inch)	ASTM-A105	SS316	3000lb	800

Note:-

- 1). Above requirements are minimum to be complied by bidder. Rating of piping / fittings / valves etc. is subjected to be approved by owner as per the final design pressure & temperature finalized during the detailed engineering, as per ANSI B 31.1.
- 2). In case temperature is more than 540 deg C, the material shall be P-91 only.
- 3). Material shall be compatible with that of the impulse pipe material and design parameter.
- 4). For DM Plant or DM water services, complete erection Hardware material shall be SS316 only.

9.06.00 INSTRUMENTATION AND CONTROL CABLES

9.06.01 General

Bidder's scope of supply, laying, erection & commissioning of instrumentation and control cables shall include the following:-

- a) Bidder shall supply, lay, erect, *terminate* all type of cables required for power plants i.e. the control, instrumentation, *interfacing (coaxial, fibre optic) cables etc.* irrespective of other end scope.
- b) All interconnecting cables and prefabs between bidder's supplied instruments, local JB, local instrument/transmitters, cabinets, panels and termination cabinets and interconnecting cables between Bidder's panels to equipment / instruments/ Plant Control Room. All field JB's / all field instruments/MCC/SWGR to DDCMIS/DCS cabinets in CER/ PLC cabinets/Relay cabinets/local control panels/desk etc. All power, Signal & Special cables from Sensor to JB, JB to MCC, JB/Drives to PLC/DDCMIS/DCS, MCC/SWGR to DDCMIS/DCS/PLC cabinets wherever one end or two ends are in EPC bidder's scope. Complete Cables shall be supplied, laid, terminated & commissioned by EPC bidder including preparation of Cable schedule and supply of cable Trays irrespective of other end scope.
- c) All co-axial cables/*fibre optic cables* and any other special cables for *interfacing with other packages via soft link (covering all packages irrespective of scope).*
- d) K Type Thermocouples Extension cables, T Type thermocouple Extension cables and S/R type Thermocouple Compensating cables
- e) Interfacing cables (*Coaxial, fibre optic etc*) between owner supplied PLC/control systems (if any) to DDCMIS.
- f) Fire survival cable
- g) Preparation of Complete cable schedule, Interconnection diagram & JB schedules shall be in bidder scope.
- h) All others cables not included above however required for completeness and operation of plant.
- i) The cables shall be provided in non returnable wooden drums. The drum length shall be 1000 m $\pm$ 5% up to & including 12 pair cables and 500 m $\pm$ 5 % for above 12 paired cables.

The quantity of the above types of cables shall be estimated by the Bidder based on his experience.

Any shortfall in cable quantity during actual laying at site shall be compensated by the Bidder at no extra cost to the owner.

Bidder shall supply the specified type of cable on as required basis for different cabling and interconnection work, provided the same meet the requirements of Bidder's I&C application.

9.06.02 SPECIFICATION AND STANDARDS

9.06.02.01 Except where specified otherwise all materials , cables and construction shall conform to the Indian Electricity Act and Rules and the Indian and other international standards with latest revisions and amendments issued up to date.

9.06.03 MATERIAL SPECIFICATIONS

9.06.03.01 General

9.06.03.02 All materials shall be new and of tested quality conforming to applicable National and Manufacturer's Standards and Indian Electricity Rules.

9.06.03.03 All materials shall be transportable to and suitable for installation at site with ease and without any damage. It shall give continuous reliable operation over long period under worst specified site conditions.

9.06.03.04 All materials shall be designed to withstand extremes of all magnetic, electrical, mechanical and thermal stresses which may be encountered during normal and abnormal operating conditions.

9.06.04 Cables – Design Criteria

9.06.04.01 Cables shall be so designed and manufactured that damage does not occur in handling, during transit, storage, installation and operation under any or all the climatic and operating conditions which they may be subjected to. Outer sheath of cables shall have rodent and termite repulsion property.

Cables shall be suitable for laying in conduits, ducts, trenches, trays or for direct burial in ground in both and wet locations.

9.06.04.02 Cables shall be capable of operating satisfactorily under the power supply voltage and frequency variations as specified in the specification. Current ratings and ratings factors of cables shall not be worse than the ones specified in IS: 3961.

9.06.04.03 Performance characteristics of cables shall be based on the following conditions of laying:

1. All cables shall be laid in multilayer and touching each other.
2. Cables shall be suitable for laying in duct or burying in ground upto a depth of 1.5 meters with uncontrolled back fill and chances of flooding by water.

9.06.04.04 Fillers in multiple conductor cables shall be flame retardant and moisture resistant.

- 9.06.04.05 All cables shall be provided with marking including manufacturer's name, insulation material, conductor sizes, no of pairs, voltage ratings, type of cable, etc, progressive markings to read marking of the length of the cable at each meter interval and "FRLS".
- 9.06.04.06 All cables shall be suitable for continuous operation at 85 deg C except for high temperature resistant Teflon insulated cables, which shall be suitable for continuous operation at 205 deg C.
- 9.06.04.07 All the cables used in the Hot/high temp. Zone (Combustor region), for emergency trip push buttons, Fire alarm system, safety critical circuits, Trip protection circuits and for other services specified elsewhere in the specification shall be fire survival cable conforming to IEC 60331, BS6387 (CWZ), BS6207 standard and this specification. The instrumentation cables in other area shall be FRLS conforming to IEC 60332 standards and this specification.
- 9.06.04.08 All external field signals for DDCMIS/DCS/PLC shall be terminated in separate marshalling/termination cabinets. Under no circumstances, Field cabling to be directly terminated in DDCMIS/DCS/PLC system cabinets.
- 9.06.04.09 All cables shall be paired cables.
- 9.06.04.10 All cables shall be provided with anti termite, Anti Rodent & moisture resistant properties.
- 9.06.04.11 All spare contacts/terminals on relays, control switches, limit switches or similar devices, process switches, duplex RTDs & Duplex T/Cs shall be wired to accessible terminal blocks/JBs for Owner's future connections. All wiring leaving a junction box or enclosure shall leave from terminal blocks and not from other devices in the enclosure. Two (2) pair (individual & overall shielded) cables shall be provided for terminating the thermocouples, transmitters & switches i.e Analog & Binary signals to local JB's. Similarly four (4) pair (individual & overall shielded) cables shall be provided for terminating the Duplex (3/4 wire) RTD to local JB's.
- 10% spare pairs or min 1 pair cable (which ever is more) shall be provided with all type of cables.
- 9.06.03.12 Cable size & type shall be as below for different type of signals and control system.
- a) Cables for analog signals shall be instrumentation cable of 0.5 sq. mm copper conductor size, with individual pair shielding & over all shielding as per cl. No. **9.06.04.02** mentioned below.
 - b) Cables for binary signals shall be instrumentation cable of 0.5 sq. mm copper conductor size as per cl. No. **9.06.04.02** mentioned below with exceptance of over all shielding only.
 - c) Cables for binary signals in relay based system and Fire protection & detection system shall be instrumentation cable of 1.5 Sq.mm conductor size, overall shielded as per cl. No. **9.06.04.01** mentioned below.

- d) Cable for power supply to each solenoid valves shall be control cable of 3C x 2.5 Sq.mm copper conductor size. Specification shall be as mentioned elsewherein the Electrical part.
- e) For cables single length more than 500 meters, the size of conductor shall be 1.5 sq. mm only irrespective of type of signals.

9.06.05 **Cable Specification**

9.06.05.1 The Instrumentation cables shall function without breakdown for surges experienced in the control system. Voltage class and insulation levels shall be compatible with the signals they convey.

9.06.05.2 **Cable Specifications**

Cable shall have the following specification: -

<u>Sr.No.</u>	<u>Description</u>	<u>Cable N</u>
1.	Voltage Grade and Type	660 V/1100 V grade multipair annealed tinned copper conductor overall shielded armoured instrumentation cable.
2.	IS Reference	IS: 1554 (Part-I Generally)
3.	Conductor	Nominal 1.5 Sq. Area concentric lay Annealed tinned high conductivity Stranded 7x0.53 mm dia. Electrolytic Copper conductor.
4.	Insulation	Extruded HR PVC type – C to IS:5831
5.	Shield	Minimum 0.06mm thick aluminum mylar tape shall be provided on each pair with hundred percent coverage, 25% overlap and tinned copper drain wire of diameter 0.8mm with 7 strands.
6.	Inner sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207. Colour Black.
7.	Armouring	Galvanized steel wire/strip to IS:3975 & IS 1554 Part II
8.	Outer sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207. Colour Blue.
9.	Lay	Twisted pair with 25 - 40lay/mt
10.	Tests for FRLS Properties	1. <u>Flammability Test</u> The cables shall pass The requirement of IEEE-332 part B fire propo- gation test in this regard.

2. Smoke generation by Sheath under fire
When tested as per ASTM-2843, the cable shall meet the requirement (60%) smoke density.
3. Acid gas generation of sheath during fire
When tested as per IEC-754-1, the maximum Acid gas should be less Than 20% by weight.
4. Oxygen Index Test
The oxygen index when tested under ASTM D 2863 shall be minimum 29.
5. Water immersion test shall be carried out as per VDE 0815
6. Swedish Chimney Test

Other Tests:

1. Fire resistance test to IS-5831 for 20 minutes. (PVC insulation & sheath of electrical cables)
2. Thermal stability at 200 deg. C to IEC-540 for 100mts.
3. Rodent and termite proof.
4. Heat shock test to IEC-502.

11. Conductor and Pair : The wires of pairs shall be coded by base colours on insulation which are repeated in every unit. Base colours of the pairs in a unit shall be as follows:

Pair	1	2	3	4
------	---	---	---	---

- | | | | | | |
|----|------|------|--------|-------|-------|
| a) | wire | Blue | Grey | Green | White |
| b) | wire | Red | Yellow | Brown | Black |

The units shall be coded by colours of rings on the insulation cores as tabulated below in order to distinguish between wires of various units in cables :

Unit:	Ring Colour:	Ring Group
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3.5 x 10¹¹ at 85 deg C

k)	High Voltage Test	:	Duration
	Conductor to Conductor	:	2000 Vrms, 50 Hz for 1 min.
	Conductor to Shield	:	2000 Vrms, 50 Hz for 1 min.

9.06.05.3 Cable Specifications

Cables shall have the following specifications:-

<u>Sr.No.</u>	<u>Description</u>	<u>Cable – M</u>
1.	Voltage Grade and Type	660V/1100 V grade multipair annealed tinned copper conductor individual pair and overall shielded armoured instrumentation cable.
2.	IS Reference	IS:1554 (Part-I) (Generally)
3.	Conductor	Nominal 0.5 Sq.mm. area concentric lay annealed tinned high conductivity stranded 7 x 0.307 mm dia. Electrolytic Copper conductor
4.	Conductor size	: Overall dia of each conductor including insulation should be between 1.4 to 1.65 mm. For 0.5 sq mm. size conductor.
5.	Insulation	Extruded HR PVC type-C to IS:5831
6.	Shield	Through aluminum mylar tape min 0.06 mm (0.075 mm) with min 25% overlap and 0.8 mm dia tin coated copper drain wire (7 stranded) laid under the contact with aluminum side of the tape.
7.	Inner sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207, Colour Black
8.	Armouring	Galvanised steel wire/strip to IS:3975
9.	Outer sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207, Colour Black
10.	Test for FRLS properties	"See details as specified in Cable Type N".
11.	Colour Coding & Marking	- do-
12.	Electrical Properties	- do-

9.06.05.4 Specification for Co-axial Cables Cable-C

Co-axial cables are used for high frequency equipments and systems for transmission and reception purposes and computers. Co-axial cable should have minimum following characteristics:-

Construction	:	Solid silica coated, annealed tinned copper conductor.
Di-electric	:	Low loss solid polyethylene foam, semi and spaced construction.
Outer conductor	:	Braided or longitudinal tube of copper or Aluminum giving 100% coverage with slight overlap.
Outer sheath	:	FRLS PVC type ST2
Diameter over Di-electric	:	7.24 sq.mm.
Outer diameter	:	10.29 sq.mm.
Nominal impedance	:	75 ohms
Nominal capacitance	:	20.5 pF/ft.
Nominal attenuation	:	8 dB at 1000 MHz Per 100 ft.

Co-axial cable shall be low smoke (ASTM- E 662), flame retarded (IEEE 383) and halogen free (IEC 754: 1 & 2), MIL C-17 G.

9.06.05.5 Extension & Compensating Cables

1.	Applicable Standards	:	ANSI MC96.1; IS:1554 (Part-I) IS:5831-1984
2.	Type	:	Single / Multipair twisted and shielded type as per ANSI MC96.1
3.	Conductor Size	:	1.31sqmm, solid alloy (16 AWG)
4.	Conductor Diameter	:	1.29 mm
5.	Insulation	:	PVC insulated, heavy duty, Self extinguishing type. Colour coded extruded PVC inner sheathed with overall PVC sheathed Type ST2 FRLS IS: 5831. Insulation of each wire with high grade 0.6 mm 85 deg.C Extruded HR PVC Type C as per IS: 5831, voltage grading shall be 1.1 kV.
6.	Lay	:	Twisted pairs within 50 mm max. lay.
7.	Shield	:	Single pair cable assembly only. Multiple pair - each pair and cable assembly. Each conductor shall be individually and overall shielded Through aluminum mylar tape min 0.06 mm (0.075 mm) with min 25% overlap & 100% coverage and 7 strand 20 SWG minimum size tin coated copper drain wire.
8.	Outer sheath	:	FRLS HR PVC type ST-2 to IS:5831
9.	Conductor Identification	:	See "Cable Details" as below
10.	Armour	:	Galvanised steel wire/strip to IS:3975
11.	Multiple pair identification	:	Each pair numbered every 250 mm

12. Electrical Parameters:

Thermo electric specification, limit of error shall be as per IEC, ANSI

Description	KX type	SX/RX Type	TX Type
E.M.F at 100 Deg.C	4.095mV	0.646/0.647 mV	4.279 mV
E.M.F at 200 Deg.C	8.137mV	1.441/1.469 mV	9.228 mV
Tolerance	$\pm 2.2^{\circ}\text{C}$ from 0°C to 200°C	$\pm 1.5^{\circ}\text{C}$ from 0°C to 200°C	$\pm 1.0^{\circ}\text{C}$ from 0°C to 100°C
Conductor loop resistance for 1.31 sq. mm (16 AWG) size as per ANSI MC96.1 at 20 Deg.C Ohms/K.Mtr	760 (Typ)	95 (Typ)	390 (Typ)

Insulation Resistance (min) : 100 M ohm x KM
Mutual Capacitance at 0.8 resp. 1 KHz (max):

- Single pair and pair screened : 120nf/KM
- upto 4 pair overall screened : 96 nf/KM
- above 4 pairs overall screened : 80 nf/KM

13. CABLE DETAILS

ANSI Type	Conductor Material		ANSI Colour Code		
	Positive	Negative	Positive	Negative	Overall
KX type Extension cable for K type Thermocouple	(NICH/NIAI) Cromel	(NICHr/NiAl) Alumel	Yellow	Red	Yellow
SX/RX type Compensating cable for type S & R thermocouple	Cu (Copper)	Cu Ni (Copper-Nickel alloy)	Black	Red	Green
TX type Extension cable for type T thermocouple	Cu (Copper)	Constantan	Blue	Red	Blue

14. Tests to be conducted:

- Thermo-e.m.f characteristics
- Continuity test
- Measurement on capacitance, inductance and loop resistance.
- Insulation resistance
- High voltage tests as per IS(latest)
- Tensile and elongation tests
- Flame retardency as per IEC 332
- Oxygen index test

9.06.05.6 Fiber Optic Cable

A	Fiber: The optical fiber core shall be of ultra pure fused silica glass coated with UV-cured acrylate suitable to withdraw temperature of about 80 Deg C (continuous). Fiber Optic cables shall be suitable for installation on cable tray, duct bank, cable trench, direct burial as necessary.		
1	Type	Multiple single mode & Multi-Mode Fiber to avoid usage of any repeaters.	
2	Core Diameter	Multimode Fiber cable	Singlemode Fiber cable
		62.5 ± 2 microns or 50 ± 2 microns depending upon distance between source & destination.	9 ± 1 microns
3	Cladding Diameter	125 ± 2 microns	
4	Fiber Proof test	As per IEC/EIA & other international standard.	
5	Coating Diameter Test	As per IEC/EIA & other international standard.	
6	Number of Fibers/core	Six (Colour Coded) with min. 100% spare core (Fibers)	
B1	Optical Characteritics – Bandwidth, Attenuation & Numerical Aperture	For multimode fiber cable with core diameter 62.5 ± 2 microns:	For multimode fiber cable with core diameter 50 ± 2 microns:
1	Bandwidth @ 850 nm Bandwidth @ 1300 nm	160 MHz-Km min 500 MHz-Km min	500 MHz-Km min 500 MHz-Km min
2	Attenuation @ 850 nm Attenuation@ 1300 nm	3.0 dB/Km max 0.8 dB/Km max	3.0 dB/Km max 0.8 dB/Km max
3	Numerical Aperture	0.275 ± 0.015	0.200 ± 0.015
B2	Optical Characteritics - Attenuation	for Singlemode fiber cable outside plant:	for Singlemode fiber cable inside plant:
1	Attenuation@ 1310 nm Attenuation@ 1550 nm	0.35 dB/Km max 0.2 dB/Km max	1 dB/Km max 1 dB/Km max

C	Cable Construction:	
	Fiber Optic cable shall be of loose tube design. Typically, fibres shall be housed in groups of 6 (minimum) within gel-filled buffer tubes to protect against ingress of moisture and vibration. The tubes shall be manufactured with industry standard material tools & practices. The buffer tubes shall be stranded around the central strength member utilizing reverse oscillating lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure. Fillers shall be flame retardant and moisture resistant. The cable shall be of dual jacket & armoured. Optic Fibre cable shall be polymer coated, galvanised corrugated steel taped armoured, fully water blocked with central dielectric material for outdoor/indoor application so as to prevent any physical damage. Two highly visible ripcords are placed under the jacket to aid in sheath removal. A co-polymer coated steel tape is corrugated and wrapped around the inner jacket to provide additional cable compression strength and Termite & rodent protection. A ripcord is also placed underneath the armour for easy outer jacket removal.	
1	Outer Colour	Orange
2	Outer Jacket	Polyethylene minimum 1.5mm thick, Flame retardant & UV resistant.
3	Inner Jacket	Core-locked flame retardant polyethylene
4	Filler / Strength member	As per Manufacturer's standard
5	Central Strength member	FiberGlass reinforced plastic (FRP) and Buckle resistant material to provide both tensile and anti bucking strength to the cable.
6.	Details marked at every meter on outer sheath.	Manufacturer's Name, Month and Year of Manufacturer, Coded description of the cable based on telcordia's (bellcore) SR-2014 suggested optical cable code (SOCC), Sheath identification Number, Sequential Length marking in meter, A telephone Handset symbol to distinguish communication from power cable as per NESC section-35G.
7.	Life Expectancy	Fiber Optic cable shall provide a long life expectancy of minimum 25 years under continuous operation without degradation to optical or mechanical performance.
D	Stripping Ability	All layers easily removed with Commercially available tools
E	Installation:	
1	Minimum bending radius	20 X D (D=core Diameter) - During Installation , Short Term , loaded 15 X D (D=core Diameter) – Installed, Long

		Term , No load
2	Maximum Tensile Load/Strength	During Installation: 2200 N Installed: 1500N
3	Method of laying	Directly laid in cable trays / duct bank / clamped with available structure
4	Pulling	Ordinary cable grips
F	Storage Temperature	- 20 ° C to 60 ° C
G	Operating Temperature & Humidity	- 20 ° C to 70 ° C & 100%
H	Data Speed performance	10 Gbps minimum
I	Test Specification (EIA/TIA – STD455 or Equivalent):	
1	Impact Resistance	2000 Impacts minimum
2	Crush Resistance	4000 N/10cm minimum
3.	Compressive Strength	3000 N minimum
J	Moisture/Water Resistance	Water blocking layer, Cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end.
K.	Optical time Domain reflectometer	a. A recording optical time domain reflectometer (OTDR) will be utilized to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with data storage, printer, help feature, compare trace features and OTDR software. The data storage unit must include a built-in floppy disk drive capable of storing a minimum of 100 test traces. b. Data traces saved to disk shall include the following labels. i. Fiber Identification (ID) with a minimum of 10 characters. ii. Cable ID with a minimum of 10 characters iii. OTDR location with a minimum of 20 characters iv. Far End location with a minimum of 20

		characters. v. Test operator initials with a minimum of 3 characters. c. The printer shall preferable be internal. The printer shall be able to print data traces within 30 seconds or less. The machine setting used to repeat tests at a later time shall include index, range, wavelength, average time, pulse width and scale settings. The test results (on printout) shall provide information including: loss, distance, reflectance, data and time. d. The requirements for the compare trace feature include the ability to recall two historical traces from a diskette and display them simultaneously for analysis and printing. The compare trace must compute and display a single graph representing any differences between two traces. The compare trace must be able to recall historical traces from a discrete and perform the same tests on connected live fibers. The compare trace shall perform a two point loss measurement test for any two particular fibers in a comparison analysis. The losses between the two points on the each fiber shall be displayed, and the differences between the two readings clearly shown. e. The OTDR must be equipped with software to support all of the required functions. The software shall provide for printing of whole set of traces (batch print) with minimal commands eliminating the time spent for printing traces individually. f. Bidder shall provide all mounting accessories, cables and connectors required to establish data communication.
L.	Fiber Optic splicer, terminator and tool kit box	Bidder shall provide new unused tools comprise of splicer and fusion jointer and tool kit comprise of cutter, stripper,

		polishing tool, handheld microscope, heat shrinkable sleeve, scissor, knife etc as required for maintenance and commission.
M.	Standards	Optical cable shall be conform to i) IEC 60794/IEC 60793 & EIA/TIA 455. ii) Low smoke(IEC 1034 -light transmittance of 80%). iii) Halogen free(IEC 754: 1&2- maximum acid gas generation shall be 2% by weight and PH >4.3). iv) Fire & flame retarded (IEC 331,IEEE 383). v) Rodent resistant. vi) Crush Resistant (EIA -455-41). vii) Impact Resistant (EIA -455-25). Bidder shall submit Type test report for review ,conform to IEC 60794, IEC 60793, IEEE 383, IEC 754: 1 & 2,IEC 331 ,IEEE 1034 and EIA/TIA standard. Colour codes shall be as per EIA/TIA 598-A.
N.	TESTS	Following minimum test as per any approved standard shall be carried out on the cables: a. Attenuation and Dispersion characteristics tests b. Proof Tests c. Macro-Bend resistance Test d. Mechanical Test e. Low and High Temperature cable Bend Test f. Impact resistance Test g. Compressive strength Test h. Tensile strength Test i. Cable Twist test j. Cable cyclic flexing test k. Environmental characteristics Test l. Temperature cycling test m. Colour permanence Test n. Cable Aging test o. Water penetration test p. Lightning Test q. Kink Test r. Crush Test

9.06.05.7 Data Cable:

Data transmission cables are control & signal cables used in electronics of computer system, electronic control equipment etc. in power plant data processing system. The cable has an overall screening which suppresses external electrical influences and ensures precise pulse transmission. The screen braiding of tinned copper wires is wrapped around the core or inner sheath.

i) Min. bending radius for flexing	:	15x cable diameter.
ii) Temp. Range	:	(-30 to +80) deg. centigrade
iii) Loop resistance	:	Max.78.4 ohm/km.
iv) Inductance	:	0.65 mH / Km.
v) Coupling	:	200 pF / Km.

Co axial and fibre optic cables are also used as data cables.

9.06.05.8 **NOTE:** All cables near high temperature zone shall be high temp cables, which shall be terminated at a junction box in normal temperature zone. Thermocouple extension cables and copper conductor cables for high temperature applications shall be with insulation of individual conductor and outer sheath of extruded FEP (i.e. Teflon) as per VDE 0207 Part 6 and ASTM D 2116. The thickness of insulation shall be 0.5 mm nominal (i.e. 0.4 mm minimum). These cables shall be single / Multipair twisted & shielded.

9.06.05.9 Fire survival instrumentation Cables shall be similar to the Fire survival control cables specified in electrical section (Vol. IV) except that Cables for analog signals shall be annealed tinned copper conductor 0.5 sq. mm sized, with individual pair shielding & over all shielding and Cables for binary signals shall be annealed tinned copper conductor 0.5 sq. mm sized with over all shielding only. In addition the cables shall have high degree of immunity from electromagnetic interference.

9.06.06 **TYPE AND ACCEPTANCE TESTS FOR INSTRUMENTATION CABLES**

9.06.06.01 After completion of manufacture, type and acceptance tests as specified in relevant standards and herein shall be conducted and requisite number of copies of test certificates as per Distribution Schedule shall be furnished.

9.06.06.02 The Owner may, at his discretion, waive type tests provided type tests reports of tests carried out on identical materials(s) manufactured by the Bidder in India in last 5 years are furnished. The Bidder shall furnish copies of such type test reports with the Bid or indicate when they expect to make these available.
After completion of manufacture, following minimum type and acceptance tests as specified in relevant standards and herein shall be conducted and requisite number of copies of test certificates shall be furnished. The Owner may, at his discretion, waive type tests provided type tests reports of tests carried out on identical materials(s) manufactured by the Bidder in India are furnished. The Bidder shall furnish copies of such type test reports with the Bid or indicate when they expect to make these available.

I. TYPE TESTS:

The type tests shall be carried out on one drum out of every 10 drums or less for each size of cable in each lot, in presence of Owner's representative as per applicable standards in Govt. approved Laboratory if adequate testing facility is not available at works of the supplier.

Sr. No.	Name of Test	Governing standard	Special requirements as per owner's specification.
1.	Annealing test (for copper)	IS : 8130/84	As per IS: 8130/84
2.	Conductor resistance test & Diameter test	IS : 10810	As per approved G.T.P.
3.	Per sulphate test (for tinned copper wire)	IS : 8130/84	As per IS: 8130/84
4.	Test for armours wires / strips	IS : 3975	As per IS:3975
5.	Test for measurement of DC resistance of armour	IS: 1554 (I)	As per approved G.T.P.
6.	Test for measurement of thickness of insulation & sheath & other dimensions.	IS : 1554 (I)	As per approved G.T.P.
7.	Measurement of volume resistivity of HRPVC insulation	IS : 5831-1984	i. 3.5×10^{14} Ohm-cm at 27°C / room temp.(Min). ii. 3.5×10^{11} Ohm-cm at 85°C (Min.)
8.	Tensile strength and elongation test for insulation & sheath.	IS:5831/1984	As per IS:5831/84
9.	Ageing test for insulation & sheath. Loss of mass test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
10.	Shrinkage test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
11.	Shrinkage test for PVC insulation & sheath	IS:5831/84	As per IS:5831/84
12.	Hot deformation test for PVC insulation & sheath	IS:5831/1984	As per IS:5831/84
13.	Cold bend test for PVC insulation.	IS:5831/1984	As per IS:5831/84
14.	Cold impact test for PVC sheath.	IS:5831/1984	As per IS:5831/84
15.	Heat shock test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
16.	Thermal stability test for PVC insulation and sheath.	IS:5831/1984	As per IS:5831/84

17.	Test for bleeding and blooming of pigments for PVC insulation of sheath.	IS:5831/1984	As per IS:5831/84
18.	Colour fastness to water.	IS:5831/1984	As per IS:5831/84
19.	Colour fastness to day light.	IS:5831/1984	As per IS:5831/84
20.	High voltage test (water immersion test)	IS:1554(I)	IS:1554(I)
21.	Test for rodent & termite repulsion property of sheath.	-	Presence of lead shall be detected.
22.	Oxygen index test on inner & outer sheath material.	ASTM:D-2863/77	Min.29
23.	Temp. index test on inner & outer sheath material	ASTM:D-2863/77	Min.250°C
24.	Acid gas emission test on inner & outer sheath material.	IEC-754-1	Acid gas generation shall be less than 20% by weight.
25.	Smoke Density test on inner & outer sheath material	ASTM-D-2843/77	Min. 40% light transmission during test.
26.	Flammability test on finished cable samples as per following methods: i. Swedish chimney test ii Vertical tray flame propagation test. iii. Single vertical cable fire resistance test.	SS-424-14-75 Cl. F-3 IEEE-383 IEC-332-1	SS-424-14-75 Cl. F-3 IEEE-383 IEC-332-1
27.	Tests for all electrical properties at 20°C & maximum operating temp. as per GTP.	As per GTP	As per approved G.T.P.
28.	Oxygen index test & Acid Gas generation test for Fillers	ASTMD – 2863, IEC 60754-1	As per approved GTP
29.	Continuity test, Shield thickness, Overlap test of Al Mylar shield	As per GTP	As per approved GTP
30.	Noise interference test, Cross talk test, Mutual capacitance, Drain wire continuity test.	IEEE Transaction, VDE 0472	As per approved GTP

II Routine Test:

Routine test shall be carried in presence of owner's representative for all types of cables.

- | | | | |
|----|---------------------------|-------------|------------------------------|
| 1. | High voltage test | IS:1554 (I) | 2 KV (RMS)
for one minute |
| 2. | Conductor Resistance Test | IS:8130/84 | As per GTP |

III Acceptance Tests:

Following tests shall be carried out on 1 drum out of every 10 drums or less for each size of cables in each lot, in presence of owner's representative.

- | | | | |
|----|--|--------------|--|
| 1. | High voltage test | IS:1554 (I) | 2 KV (RMS)
for one minute |
| 2. | Conductor Resistance Test | IS:8130/84 | As per NIT |
| 3. | Volume Resistivity | IS:5831-1984 | (i) 3.5×10^{14} -cm
at 27 deg C/room
temp (Min)
(ii) 3.5×10^{11} ohm-cm
at 850C Min. |
| 4. | Measurement of Mutual capacitance at 0.8 KHZ | | 100 NF/Km (max) |
| 5. | Calculation & Verification of Characteristic impedance on the basis of value obtain for mutual capacitance at 0.8 KHZ with the help of following formula | | |

$$Z = \frac{R}{2fc} \quad 320 \text{ Ohms(nominal)}$$

where Z = characteristic impedance in ohm

R = Loop resistance of cable per km in ohms at 20 °C
f = Frequency of test in Hz (800)
c = mutual capacitance per km.

- | | | | |
|-----|--|--------------------|------------|
| 6. | Measurement of thickness of insulation and sheath & other dimensions | IS:1554 (I) | As per NIT |
| 7. | Tensile strength and elongation at break of insulation & sheath | IS:5831/84 | IS:5831/84 |
| 8. | Oxygen index test on inner & outer sheath at room temp. | ASTM-D-2863 Min.29 | |
| *9. | Temp. index test on inner & outer sheath | --do-- | Min.250°C |

*10.	Acid gas emission test on inner sheath & outer sheath.	TEC-754-1	Max.20% by weight
11.	Smoke density test on inner sheath & outer sheath	ASTM-D-2843	Min.40% light transmission during test.
12.	Flammability test	SS-424-14-75	SS-424-14-75
13.	Additional Test	Class F-3 IEC 331	Class F-3 for fire survival characteristics

* (If no. of drums selected for acceptance test for a particular cable size are more than one, the tests marked with * i.e. 5 no. 9&10 under acceptance tests shall be carried out on one drum only).

9.07.00 SHOP TESTS FOR ERECTION HARDWARE

i) General Requirements:-

- a) The equipment as per this section shall be subject to shop tests.
- b) The Conductor shall furnish all materials, equipment, tools, instruments, bulkheads, blanking plates and all personnel required for completing these tests.
- c) Personnel performing the tests shall be qualified and experienced. Tests shall be performed as many times as necessary to assure Proper quality of materials and workmanship. If any test reveals Unsatisfactory materials or workmanship, such materials shall be Repaired or replaced to the satisfaction of the Owner.
- d) Hydrostatic and pneumatic tests shall be performed on all pipes, Tubings and systems supplied by the Bidder and shall conform To ANSI B31.1 – Code for Pressure Piping.

ii) Hydrostatic Testing

All instrument piping, which connects to process piping, shall be Hydrostatically tested.

CHAPTER-11

CONTROL VALVES WITH ACTUATORS

11.00.00 CONTROL VALVES, ACTUATORS AND ACCESSORIES

11.01.00 GENERAL REQUIREMENTS

11.01.01 This section covers the design and construction requirements of Control Valves, their Actuators and Accessories. Except as otherwise specified herein, the Control Valves and accessory equipment furnished under this specification shall be designed, constructed and tested in accordance with the latest applicable requirements of code for Pressure Piping ANSI B 31.1, the ASME Boiler and pressure vessel code, Indian Boiler Regulation (IBR) and other standards referenced herein as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA", or acceptable equal standards.

11.01.02 The design of Control Valves shall comply with relevant codes and standards, account for relevant design criteria viz. environmental conditions, power and air supply, established reliability (reliability target and life expectancy), design of enclosures as specified in Sections earlier.

11.01.03 All Control Valves and accessories furnished under the Section shall be of Owner approved make, fully meeting the qualifying requirements.

11.01.04 Each control valve station shall be provided with pneumatic bypass control valve or Inching type motorised bypass valve as per process requirement and subject to owner approval. In addition each control valve shall also have upstream motorised valve. Downstream motorised valve shall also be provided as per process requirement and as finalized during detailed engineering.

11.02.00 CONTROL VALVE CONSTRUCTION AND SIZING

11.02.01 General

1. Valve Construction shall be in accordance with the requirements specified herein. (Bidder to also refer NIT drawing # 114-18-0100).
2. The design of all valve bodies shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.
3. The valve sizing shall be suitable for obtaining maximum operating conditions with valve opening at approximately 80% of total travel. Valves shall be open not less than 15 % of full opening for minimum flow condition and shall be capable of handling at least 120% of the required maximum flow at full open condition. Actual pressure drop is indicated in the specification sheets. Permissible pressure drop shall be calculated and

used by the Bidder for sizing calculations. Valve sizing shall be in compliance with the latest edition of ISA Handbook on control valves, ISA standards "ANSI/ISA-75.01.01, Flow Equations for Sizing of Control Valves" with due consideration for the measures to avoid choked flow. Bidder shall ensure that the valve outlet velocity does not exceed 8 meters/second for liquid services, 150 m /second for steam services and 50% of sonic velocity for flashing services by selecting proper body size for the required Cv.

4. a. The Bidder shall provide valves designed to prevent cavitations, wire drawing, flashing on the downstream side of valve and in downstream piping, when operating through full range under the specified conditions.

For cavitating services, valves with anti cavitation trims shall be offered. This shall ensure cavitation prevention by multiple stages of pressure drops. Detailed calculations shall be furnished by bidder to establish cavitations occurrence or otherwise for various process conditions each service wise.

For flashing services such as heater drains, control valve design shall be specially effected to ensure suitability for the adverse high pressure drops and minimise its detrimental effects on control valve parts.

Bidder shall furnish detailed catalogue, calculations, write ups to establish compliance to these stipulations with the selection of each valve. No price implications during engineering stage would be admissible to comply with these stipulations and intents of specification.

- b. The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services.
 - c. The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.
5. Each valve shall be designed for tight shut-off against pressure, the valves shall have maximum permissible leakage rate as per ISA RP 39.6 Leakage Class IV (0.01% of rated valve capacity) or specified other wise.

Control Valves for Application such as HP/LP heaters emergency level control, SH spray & RH Spray control, Emergency makeup to Hotwell, Deaerator drain to condenser hotwell & heavy oil heating, HFO & LDO and Pressurizing control system, condenser normal make up control valves shall have permissible leakage rate as per leakage class V (ANSI/FCI).

All SH/RH block valves, shut off valve of LDO & HFO and BFP recirculation valve shall have leakage class MSS-SP-61.

6. The valve design shall take into account noise abatement considerations. The design objective will be to limit the generation of valve induced noise to 85 dBA at 1 Meter from the valve surface under actual operating conditions. The noise abatement shall be obtained by valve body and trim design and piping arrangement and not by the use of silencers.
7. The Bidder shall be responsible for proper sizing of the valve and selection of appropriate model and materials of constructions for meeting the operating requirements specified herein and details subsequently furnished during the detailed engineering stage.
8. The valve travel time shall be less than 10 second for non critical services valves.
9. Rangeability should be 50 to 1 (min.) for non critical services valves.
10. Control Valve's Linearity, Hysteresis, Accuracy shall be $\leq \pm 1\%$ and Sensitivity shall be $\leq \pm 0.5\%$.

Bidder shall furnish the Control Valve data sheets and sizing calculations with the proposal which will be subjected to owner approval during detailed engineering. The bidder shall furnish all valves as per Owner approved data sheets and drawings.

11.02.02 **Valve Construction**

1. All valves shall be of globe body design and straightway pattern. Straightway pattern valves shall be either single or double ported as specified. Double ported and single ported valves shall have high lift cage guided plugs, unless otherwise specified.
2. Where specified, valves with cage guided plugs and quick change trim shall be supplied. The quick change trim shall consist of a cage and seat ring clamped in the valve body by the valve bonnet and sealed with a spiral wound stainless steel asbestos gasket. The trim shall be removable through the top after bonnet removal without any cutting or welding of the valve. Where applicable, plugs shall be designed to include pressure balancing for cage guided valves.
3. Direct acting and self-contained pilot type valves may have low lift plugs.
4. Cast iron valves are not acceptable.
5. Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints shall be designed for easy disassembly and for assurance of correct valve stem alignment. Bonnet joints of the internal threaded or union type will not be acceptable.
6. Plugs shall be of one-piece construction either cast, forged, or machined from solid bar stock. Plugs shall be screwed and pinned to valve stems or shall be integral with the valve stems.

7. When Teflon packing is used, the lower valve stem which passes through the stuffing box shall be polished to at least 2×10^{-4} millimeters r.m.s.
8. Valves gland packing shall normally be Teflon on liquid and gas services up to 100 kg/cm^2 and 230°C . Teflon impregnated asbestos shall be used above 230°C and graphite impregnated asbestos with lubrication shall be used for steam services.
9. All valves shall be arranged so that the plugs may be removed from the valve bodies from the bonnet side.
10. Each valve shall have an arrow permanently fixed on the valve body to indicate the correct direction of flow.
11. Each valve shall have a stainless steel name plate permanently fastened to the yoke which shall be visible when the valve is in service. The name plate shall include
 - a. Tag No. and Valve Serial No.
 - b. Body material, size and pressure rating
 - c. Trim material, size characteristics
 - d. Action on air failure
 - e. Spring range
 - f. Stem travel
 - g. Valve action, etc.

11.02.03

Valve Materials

1. Valve material shall be as specified in Supplier's approved Control Valve Specification sheets. The following table defines abbreviations used for valve materials:

S.No.	Abbreviations	Description
a	BR	Bronze ASTM B 61
b	CS	Carbon Steel Forged - ASTM A 105 Cast - ASTM A 216 Grade WCC
c	1- ¼ CR	1-1/4 % Chromium Alloy Steel Forged – ASTM A 182 Grade F11 Cast – ASTM A 217 Grade WC6
d	2- ¼ CR	2-1/4 % Chromium Alloy Steel Forged – ASTM A 182 Grade F22 Cast – ASTM A 217 Grade WC9
e	5 CR	5% Chromium Alloy Steel Forged – ASTM A 182 Grade

		F5 Cast – ASTM A 217 Grade C5
f.	SS	Stainless Steel AISI Type 316 ASTMA 351 Grade CF8M

2. Body material shall be selected by the Bidder to be compatible with the nature of the fluid, service conditions, and piping material to which it is welded and shall be subjected to Owner approval. In general, cast or forged carbon steel bodies shall be provided for non-corrosive process applications up to 275 Deg.C. Alloy Steel castings shall be provided when the media is non-corrosive and the temperature exceeds 275 Deg.C and is within 550 Deg.C. Stainless Steel of suitable grade shall be provided when media is corrosive and the temperature is below 300 Deg.C.

Sr. No.	Service	Body Material
1.	Non Corrosive, Non Flashing, and non cavitations service for process temp. up to 275 deg. C like Aux. steam flow to Deaerator, Cond. Flow to deaerator, Fuel Oil, Atomising steam service etc.	Cast Carbon Steel ASTM A216 Gr. WCB/WCC
2.	Non Corrosive, Non Flashing, and non cavitations service for process temp. above 275 deg. C. and up to 550 deg. C. and for CRH flow to Deaerator.	Cast Alloy Steel ASTM A217 Gr. WC9
3.	Severe Flashing/ cavitations service like Feed Control Valve, Spray Control valves, LP/HP heater emergency level control valve, HP BP spray control valve, Deaerator Overflow control valve etc.	Cast Alloy Steel ASTM A217 Gr. WC9
4.	Low Flashing/ cavitations service like LP/HP heater normal level control & Condensate/feed water below 275 deg. C.	Cast Alloy Steel ASTM A217 Gr. WC6
5.	DM Water Application (Condenser Hotwell normal & Emergency make up etc.)	Cast type 316 Stainless Steel ASTM A351 Gr. CF8M

3. Unless otherwise specified, all control valves shall have stems, guide bushings, plugs, seat rings, stem lock pins, stuffing box parts, and other trim, all made of stainless steel. Valve guide posts and bushings shall be stellite faced for valves where specified. Stellite faced guide posts and bushings shall be differential hardened. For applications involving high pressure drop as also for flashing and cavitation services, trim material shall be properly chosen to ensure required degree of hard facing (such as 17-4 PH SS) so as to avoid erosion.

Sr. No.	Service	Trim Material
1.	Non Corrosive, Non Flashing, and non cavitations service for process temp. up to 275 deg. C. like Aux. steam flow to Deaerator, Cond. Flow to deaerator, Fuel Oil, Atomising steam service etc.	SS316 Stellite
2.	Non Corrosive, Non Flashing, and non cavitations service for process temp. above 275 deg. C. and up	SS316 Stellite

	to 550 deg. C. and for CRH flow to Deaerator.	
3.	Severe Flushing/ cavitations service like Feed Control Valve, Spray Control valves, LP /HP heater emergency level control valve, HP BP spray control valve, Deaerator Overflow control valve etc.	440 SS
4.	Low Flushing/ cavitations service like LP /HP heater normal level control & Condensate/feed water below 275 deg. C.	17-4 PH SS
5.	DM Water Application (Condenser Hotwell normal & Emergency make up etc.)	17-4 PH SS

4. Where stellite facing is not specified, hardened stainless steel shall be furnished for all surfaces subject to wear.
5. Manufacturer recommended materials for cage guided valves may be substituted for materials specified provided they satisfy the specified service conditions. Also where substitutions are made, the manufacturer shall guarantee performance of recommended materials to be equal to or better than the specified materials for conditions specified.

Bidder may offer valve with body and trim material better than the specified material and in such case, bidder shall furnish the comparisons of properties including cavitations resistance, corrosion resistance, temp. resistance, erosion resistance, hardness etc. of the offered material vis a vis specified material for owner approval.

11.02.04 **End Preparation**

1. Valve body ends shall be butt-welded type.
2. Flanged ends shall be of a pressure class equal or greater in pressure-temperature rating to the body design pressure and temperature indicated on the control valve. Unless otherwise specified, steel flanges shall be raised face type. Flanged ends for valves shall be in accordance with ANSI B 16.5.
3. Welded end for control valves where specified shall be socket-weld per ANSI B 16.11 for control valves of sizes 50 mm (2") and below and Butt welded connections per ANSI B16.25 for control valves 65 mm (2-1/2") and above. The end preparation for butt welded control valves shall be matched to the corresponding details for the piping on which the valve is installed.
4. All end preparations shall be as per Owners requirements indicated during Contract stage.

11.02.05 **Miscellaneous Parts**

1. Extension bonnets shall be used on all valves when the maximum temperature of the flowing fluid is greater than 275 deg. C or when specifically required in the control valve.
2. Stem travel indicators shall be provided on all valves.

11.03.00 **VALVE OPERATIONS**

- 11.03.01 All control valves shall be furnished with pneumatic spring opposed diaphragm, spring less diaphragm, or piston operators as specified herein.
- 11.03.02 The bidder shall be responsible for proper selection and sizing of valve operators in accordance with the pressure drop and maximum shut-off pressures.
- 11.03.03 Valve operators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance of stem force, at least 0.15 kg/sq. cm per linear millimeter of seating surface, shall be provided in the selection of the operator to assure tight seating unless otherwise specified. The operators shall be designed to produce the required stem force with supply air pressure of 3.5 kg/sq. cm maximum unless otherwise specified.
- 11.03.04 Diaphragms shall be moulded synthetic rubber and diaphragm housing shall be of pressed steel construction. Diaphragms shall not be fabricated of natural rubber.
- 11.03.05 Piston operators shall use cast pistons and cylinders with O-ring seals. Operators shall be supplied with name plates which indicate the diaphragm air pressure at full open and full closed positions. for single seated valves the pressures shall be listed for maximum differential and for zero differential across the valve.
- 11.03.06 Pistons and cylinders shall be cast aluminum. Piston rod and extension shall be chrome plated stainless steel. Cylinder seal bushings shall be brass and seal rings shall be nitrile. Yoke shall be cast iron.
- 11.03.07 Valve operators shall be capable of operating at 60 °C continuously.

11.04.00 **CONTROL VALVE ACCESSORIES & DEVICES**

The following accessory equipment shall be provided for control valves:

- 11.04.01 **Air Locks:** Air locks shall be designed to shut off the diaphragm loading air line if the supply air pressure to the associated pilot or Positioner fails. Air locks shall be of the automatic reset type and shall be furnished with alarms.
- 11.04.02 **Hand Wheels:** Hand Wheels shall be provided. Hand wheels shall be side mounted unless specified to be top mounted. However the mounting shall be as decided during engineering to offer maximum accessibility.
- 11.04.03 **Limit Switches:** Each control Valves shall be provided with limit switches for monitoring of end position in DDCMIS/DCS/PLC. Switches shall have not less than two normally open and two normally closed contacts in both open and close directions. Electrical rating of the limit switch contacts shall be 240V AC, 5 amp or 220V DC, 0.5 amp. Limit switches should be National Acme Co., or Honeywell micro switch type or Owner approved equal. The enclosures of the limit switches

shall be as per NEMA-4 Standard. Limit switches shall be constructed to withstand the temperatures encountered in the actual service. Explosion proof construction shall be furnished where required by applicable code or these specifications. Limit switches shall be factory mounted on the valves with provisions for adjusting the mounting. The Bidder shall stroke the valves to check limit switch operation prior to shipment.

Limit/micro switches can be offered as an integral part of Smart valve positioner.

11.04.04

Smart Valve Positioner: Control valve actuators for modulating and throttling services shall be provided with HART protocol based smart electro pneumatic valve Positioner to ensure accuracy & repeatability of response. The valve Positioner shall be designed suitable for vibration and service conditions of a steam electric power station.

The Positioner shall have the following features:

- a) Shall provide a pneumatic output signal of range 0.2 to 1.0 kg/cm² or as desired for the actuator.
- b) Shall have integral type position transmitter, input & output gauges, local keypad, display, 4-20 mA input and 4-20 mA output for position indication in DDCMIS/CCR/PLC.
- c) Shall be suitable for direct mounting on control valve assembly both for rotary & linear valves.
- d) Shall be capable of functioning under hot, humid & vibrating conditions.
- e) Shall have dust tight, corrosion resistant & weather proof IP 65 metal casing.
- f) Shall be operated at signal range of 4-20 mA for full travel of the valve. Split range operation in few cases may be required. This facility shall also be available in positioner.
- g) Shall have in built mechanical position indicator.
- h) Shall have fail safe & fail freeze function as per loop process requirement.
- i) Shall have in built auto tune facility.

11.04.05

Solenoid Valves: Solenoid Valve will be provided for the following

- i. **ON / OFF Duty type Control Valve**
- ii. For over-riding the controller signal with Modulating type Control valves.
- iii. For control valve stay put position requirement on controller signal failure with Modulating type Control valves.
- iv. For construction and detailed specification of Solenoid valve, Chapter 3, Vol. V shall be referred by bidder.

11.04.06

Diffusers : Diffusers shall be provided as per service application requirements. The diffuser shall be designed to reduce the pressure drop across the control valve below the critical value and reduce the sound pressure level. Details of the diffusers shall be submitted.

11.04.07 **External Volume Chambers:** External volume chambers with adjustable bleed valves shall be provided for Control Valve. Volume chambers shall be furnished, mounted on the control valve yoke assembly.

11.04.08 **Position Transmitters:** Position transmitters shall be provided for control valves as a part of smart positioner. The signal shall be 4-20 mA DC range, 24 V DC. For non smart positioners applications and power cylinders, contactless position transmitter shall be provided by bidder.

11.04.09 **Tubing and Air Sets:** All pneumatic tubing required to interconnect devices assembled together shall be furnished complete with each control valve. The tubing shall be fully annealed soft temper copper tubing conforming to ASTM B68 to B75 (USA). Swage Lock flareless tubing fittings shall be used for tubing connections (Swage lock or approved equal).

Each device requiring an air supply shall be equipped with a combination filter-regulator. Devices mounted together on a valve yoke may be served by a single regulator, provided the supply pressure is satisfactory and the regulator capacity is not exceeded. Filter-regulators shall be mounted on the device served.

Filter-regulators shall be suitable for a 10 kg/sq. cm maximum inlet pressure. Filter-regulators shall have built-in housing blow down valves and a 2 inch pressure gauge. The filter shall be of size not more than 5 microns and shall be made of sintered bronze.

11.04.10 **Pressure Switch**

Pressure switch suitable for the above pneumatic system shall be provided. The contact rating shall be 2 A for 240 AC, 2 A, 220 VDC 2 SPDT Contact. Enclosure IP 65.

11.04.11 **I/P Converter**

For non smart positioners applications and power cylinders i/p converters shall be required and owner approval shall be obtained for the use of i/p converter for such applications.

Electro-pneumatic, outdoor type, field mounted Linear. 4-20 MA DC input and 0.2 – 1.0 kg /Cm² output. Die cast aluminum casing with IP65 or equivalent enclosure class. Accuracy of $\pm 0.5\%$ of span or better and repeatability of $\pm 0.5\%$ of span or better will be provided. Easily accessible span and zero adjustment will be provided I/P converter shall be provided with all accessories and erection hardware. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters.

11.04.12 **Separate moisture separator unit** for ensuring dryness of air entering I/P as well as the power cylinder is to be supplied **with each control valve and control damper.**

11.05.00 **FOR FOLLOWING CRITICAL APPLICATION SPECIAL CONTROL VALVES ARE REQUIRED.:**

1. HP & LP Bypass Valves and Control System
2. BFP – Minimum Re-circulation Valve
3. Feed Water Control Valve
4. SH & RH spray Control Valves
5. APRDS System
6. Soot Blower control valve

11.05.01

General Requirements for Critical Application Control Valves for -.

- i) The valve accessories shall include hand wheels, limit switches, smart valve positioner (4-20mA D C t ype), el ectro pneum atic converter, A ir l ock r elay, Solenoid valve and a ll other i tems required for t he co mpleteness and t he accessories shall be explosion proof type as per hazardous area classification wherever applicable.
- ii) Control valves shall be furnished with IBR certification wherever required.
 1. **Noise:** The maximum allowable noise level shall be 85 dba or less at 1 m. distance from the downstream bare pipe surface. T he specified noise l evel sh all be at tained w ithout t he use of or ifices, mufflers, diffusers. No credit for thermal or acoustical insulations shall be taken.
 2. **Valve Trim:** Valve shall have quick change type trim utilizing top entry. No components shall be screwed or welded into the body. The valve shall have equal pressure distribution around the plug to avoid chattering / vibration.

Trim of severe/critical service valve shall be of multi stage & multi path design with sufficient no. of discrete pressure drop stage to eliminate the ch ance o f er osion, cavitations, noi se, v ibration t hrough out the control range of valve.
 3. **Leakage Class:** The valve shall have minimum class-V leakage for all steam appl ications including APRDS, H P/LP bypass spray co ntrol valves & Low Load feed water control valve.

In case of minimum boiler feed pump re-circulation applications, RH/SH sp ray co ntrol v alves and H P/LP B ypass control v alve application, the leakage class should be MSS-SP 61 (block valve leakage).
 4. **Actuator:** Actuator type should be pneumatic double acting piston/Hydraulic.

11.06.00

Specific Requirements / Specifications for Different Valves:

11. 06.01

Design Criteria for selection of Feed Water Control Valve :

The v alve t rim sh ould be m ulti – stage, m ulti – path, m ulti – disk de sign hav ing sufficient no.'s of discrete pressure reductions (turns / stages) to ensure elimination

of vibration, cavitations, erosion and noise effects. Pressure reduction / drop achieved by valve designs incorporating single or multistage orificed cage, diffusers are not acceptable. Bidder should work out no. of pressure drop turns in the trim of the valve and should provide calculations of trim exit velocity. Seat ring and trim fitment should not have any part screwed or welded. It should be easily replaceable type.

Flow vs. valve opening characteristic: The trim is to be so designed that the min. flow indicated in the bid specifications of the valve is achieved with min. lift of 20mm of valve plug from "Close" position. Subsequent characteristic should be "equal percentage" i.e. corresponding to the parabolic characteristics. Characterizing the cam of the positioner to minimise the required flow char is not acceptable.

Rangeability should be 50 to 1 (min.). Each pressure - reducing element should have a uniform pressure distribution around the plug to avoid mechanical vibrations (pressure equalizing rings / grooves). To prevent flow induced vibrations and the line trash damage to seat, the flow direction should be over the plug. During throttle opening of the control valve, flow should be diverted away from the body seat.

Required leakage should be better than ANSI – B - 16 – 104 Class – V with metal to metal seating. Soft seat is not acceptable. Requisite calculations in support of above leakage class to be submitted with the offer. The bidder should indicate how this will be achieved in their valves and actuators. Actuators should be pneumatic double acting piston type. Diaphragm type actuators are not acceptable.

The seating force on the valve seats to achieve the required leakage class (better than ANSI – B - 16 – 104 Class – V) should be about 180 kg / cm on seat ring. PI. indicates the closing force on the seat in Kgf / cm of seat circumference applied for actuator. Trim exit velocity should be less than 22.5 M / sec. Calculation sheet should be attached demonstrating satisfactory compliance of this requirement.

Noise level at 1 meter distance from the valve should be less than 85 dB without insulation, orifices, silencers, mufflers etc. Calculation sheet to be attached for each valve offered. Critical cavitation index (Kc) for all control valves should be 1 (one). This is specific requirement to avoid even remote possibility of cavitation damage to valve internals. Material of the valve internals should be as under:

Guide	:	400 series SS
Plug / Seat ring	:	400 series SS
Stem	:	17 – 4 PH

11.06.02 Control Valve Specifications For Turbine By Pass System

11.06.02.01 Turbine Bypass Control System: Standalone turbine by pass control system for each unit shall be provided. The control system shall include operator selectable manual or automatic modes with bumpless transfer between modes. The turbine bypass system shall be included in the plant automation sequence for unit start-up and bypass operation.

Complete operational design for the control system, including logic, modulating controls, schematics and wiring shall be provided. The design shall integrate the operation of both the HP & LP bypass stations into a single coordinated operation. The bypass system shall be operationally tested to assure acceptable functional performance of the bypass control system.

Hardware, instrumentation, wiring interconnections and accessory devices necessary to be interfaced and will be implemented in the DDCMIS for control.

The turbine bypass system shall be utilized to warm up the boiler and main steam lines after an appropriate vacuum is established.

The HP/LP bypass system shall cut in operation automatically in case of (a) generator breaker opening, (b) Turbine trip (i.e.) E SV/CV close, and (c) sudden reduction in load.

11.06.02.02 The bypass system shall comprise of the following:

HP BYPASS: Angle body high pressure bypass valve complete with hydraulic actuator spray valve --- 1 No. for each HP bypass valve complete with hydraulic actuator Isolation valve --- a common isolation valve complete hydraulic actuator.

Hydraulic power Unit (HPU) complete with main pump and a redundant main pump.

On – Line filter pump as well as an automatic cooling fan to keep the oil temperature below 60 degree C.

LP BYPASS: having angle body complete with hydraulic actuator

Spray valve for each LP bypass valve complete with hydraulic actuator

Isolation valve – with hydraulic actuator

Common hydraulic catering to HP & LP bypass valves as referred to above

The HP bypass will have desuperheating function in the valve body, however, in case of LP bypass, the desuperheater may be placed downstream of the valve.

Control systems with State Controller with Observer techniques shall be implemented in the DDCMIS.

- All the actuators shall be fitted with proportional valves and smart positioner for fast positioning. This will also have safety control unit with additional accumulator to provide sufficient movement / stroking.

11.06.02.03 HP-Bypass Steam Conditioning Valve: The HP-Bypass valve shall be angle body flow to open design so that valve internals and bonnet are all on the low-pressure side. Bypass from main steam to cold reheat line shall have integral steam assisted desuperheater. Bypass valve body shall be protected from damage due to water injection by means of multi-function contoured cage minimizing vibration compared to a cylindrical cage. The cage shall be firmly attached at one end, and located radially at the other end to provide good guiding and allow axial growth due to thermal differential. Cage material shall be X20CrMo V121 or equal for good thermal cycling and erosion resistance. Plug shall be of channel slotted type design for acoustic attenuation.

Spray water shall be injected directly downstream of the seat/plug in the area of maximum velocity and turbulence to ensure excellent atomisation and mixing of the

injected spray water. Water shall not be injected through the stem due to leakage potential past internal seals and to eliminate possibility of stem cracking due to thermal shocks. Water spray should be fully atomised within a meter of valve outlet to ensure uniform reheater temperature and to allow pipe bends directly after the valve and to allow carbon steel piping downstream of the valve.

Packing shall be compressed by means of a bolted flange, design, screwed gland type packing retainers shall not be provided. Bolted bonnets are preferred. If pressure seal bonnets are used, seal areas shall be inlaid with corrosion resistant materials to minimise leakage potential. Valve shall be mounted with actuator in vertical direction for ease of maintenance.

- 11.06.02.04 LP-Bypass Steam Conditioning Valves: The steam conditioning valves shall be angle flow to close type combination pressure reduction and desuperheating control valves. Multi-hole plugs shall not be used due to potential for contamination sticking between plug and seat. A combination of cage guiding and top guiding for plugs shall be provided to eliminate possibility of vibration. Conical diffusers as required shall be of wrought construction provided with higher mechanical strength and to allow for optimum velocity distribution downstream of the diffusers. The diffusers shall be removable through bonnet to allow for inspection and maintenance. No components may be screwed or welded inside the valve body for easy maintenance. Packing shall be compressed by means of a bolted flange design. Screwed gland type packing retainers shall not be provided. Bolted bonnets are preferred. If pressure seal bonnets are used, seal areas shall be inlaid with corrosion resistant materials to minimise leakage potential. The valve body shall be 2-1/4 percent chromium alloy steel with martensitic chromium steel internal trim steel. Valve packing shall be pure graphite.

The spray water injection shall be downstream of the seat but part of the valve. Spring-loaded nozzles shall be used to ensure good atomisation and good penetration of the spray water into the steam. The outlet cage shall be shaped that it guides the steam towards the injected water for good mixing of the steam and the spray water. Spray through stem shall not be provided due to leakage potential past internal seals and to eliminate possibility of stem cracking due to thermal shocks. No downstream pipe liner shall be required and thus carbon steel materials can be used on the downstream of the valve. The steam conditioning valve shall have a quick closing emergency function with a completely independent solenoid valve on the actuator. The quick closing shall still be equipped with a separate accumulator for operation independent from the Hydraulic Supply unit. The valves shall be provided with body taps upstream of the valve seat; and piping, valves and orifices as required for providing a pre-warming flow path.

- 11.06.02.05 Spray Water Control Valves: Trim exit velocity of liquid shall not exceed 30 m/s to prevent flow induced vibration. To protect the valve internals from foreign particles such as weld slag, flow direction shall be "flow to close" (over the plug) configuration for liquid applications. Valve shall have quick change type trim utilising top entry. No components shall be screwed or welded into the body. The valve shall have equal pressure distribution around the plug to avoid chattering / vibration. The leakage class shall be minimum class-V.

a) HP-Bypass Spray:

The trim for pressure reducing stages shall be of multistage type to ensure elimination of erosion, cavitation, noise and vibration throughout the stroke length of the valve. Bidder shall indicate the number of pressure reduction stages in the proposed valve by furnishing calculations demonstrating compliance to the trim exit velocity.

b) LP-Bypass Spray:

The spray water control valve shall be cage guided valves sized as required to provide spray water to the steam conditioning valves. The spray water valve shall be carbon steel with stainless steel internal trim. Velocity of water at trim exit shall not exceed 30 ms/ Valves shall be free of cavitation.

11.06.02.06 Valve Operators: The steam conditioning valves and the spray water control valves shall be provided with double acting electro-hydraulic piston operators. All valves shall be quick opening and closing and shall be modulating valves with positioners designed to receive a 4 to 20 milli-ampere signal. The LP-Bypass steam conditioning valve shall have a quick closing emergency stop function with a completely independent solenoid valve on the actuator and a separate accumulator for operation independent from the hydraulic supply unit. The operator time shall be as required to protect the condenser from overpressure and temperature.

A single hydraulic power unit shall be provided and sized to operate and control all the steam conditioning valves, and spray water control valves for each unit. The hydraulic unit shall be complete with 2x100% capacity motor driven pumps, valves, piping instrumentation, tubing, reservoir and a accumulator(s), control cabinet with accessories all mounted on a common base. The motors shall be connected two (2) different power supplies. The hydraulic system shall have online filtration arrangement to keep hydraulic oil clean. The system shall have automatic temperature control device mounted on the tank to maintain hydraulic oil temperature below 60 deg. C.

11.06.03 Specification of BFP Recirculation Control Valve :

Trim should be of multistage, multipath, multiturn type having sufficient number of discrete pressure drop stages to ensure elimination of erosion, cavitation, noise and vibration throughout the stroke length of the valve.

Supplier shall identify the number of pressure drop stages in proposed valve and shall also provide calculations demonstrating compliance to the trim exit velocity.

The trim exit velocity for liquid (water) shall not exceed 22.5M/sec. The supplier shall provide calculations demonstrating satisfactory compliance to the above criteria.

For liquid service, the flow direction shall be ' OVER THE PLUG' i.e. FLOW TO CLOSE to prevent flow induced vibration and to protect damage on the valve internals from foreign particles such as weld slag etc.

The flow path shall be radial and each disk element should be capable of reducing the entire pressure independency. No orifice, No mufflers / diffusers are permitted.

The maximum allowable noise level shall be less than 85 dba at 1 meter distance on bare pipe surface. No orifice Plate downstream of the control valve should be used for pressure reduction.

The specified noise level shall be achieved without the use of orifices, mufflers or diffusers. No credit for thermal or acoustical insulations shall be given.

No orifice Plate downstream of the control valve should be used for pressure reduction.

The supplier shall provide calculations demonstrating compliance to the noise requirement.

The valve shall have minimum **MSS-SP-61 Leakage class** in metal to metal seating with minimum seating force of 180kgf per linear mm of seat ring circumference. Soft seat is not acceptable.

Vendor to provide calculations to indicate close force on the seat applied by actuator.

Vendor shall confirm that the proposed valve shall maintain tight shut-off leakage class even after 3 years of field service.

The valve shall have quick change type trim utilizing top entry. No components shall be screwed or welded into the body.

The valve shall have equal pressure distribution around the plug to avoid chattering/vibration.

Pneumatic double acting piston actuator shall be preferred.

11.06.04

SH/RH Spray Control Valves (Technical Requirement) :

- a) Seat ring and trim fitment should not have any part screwed or welded. It should be easily replaceable type.
- b) The valve trim should be multi – stage, multi – path design having sufficient numbers of discrete pressure reductions (turns/ stages) to ensure elimination of vibration, cavitation, erosion and noise effects.

Pressure reduction/ drop achieved by valve designs incorporating single or multistage orificed cage, diffusers are not acceptable because of our bad experience with this type of design.

Bidder should work out number of pressure drop turns in the trim of the valve and should provide calculations of trim exit velocity.

- c) Flow Vs. Valve opening characteristic:

The trim is to be so designed that the minimum flow indicated in the bid specifications of the valve is achieved with minimum lift of 8 mm of valve plug from "close" position. Subsequent characteristic should be "EQUAL PERCENTAGE" i.e. corresponding to the parabolic characteristics. Characterizing the cam of the positioner to mimic the required flow characteristics is not acceptable.

- d) Rangeability should be 30 to 1 (minimum) for valves up to 2", 50:1 for valves from 2" to 4" and for bigger valves it should be minimum 100:1. Valve should be able to throttle even below 5% opening without trim erosion.
- e) One single valve should handle zero to 100 per cent boiler feed water flow requirements. The valve should be designed for high range ability and total flow characterization from low flow to the maximum flow required.
- f) Each pressure reducing element should have a uniform pressure distribution around the plug to avoid mechanical vibrations (pressure equalizing rings / grooves).
- g) To prevent flow induced vibrations and the line trash damage to seat, the flow direction should be over the plug (for water) and under the plug for steam.
- h) During throttle opening of the control valve, flow should be diverted away from the body seat.
- i) Required leakage of MSS-SP-61 better than ANSI-B-16-104 Class-V equivalent class is achieved with metal seat. Soft seat is not acceptable. Requisite calculations in support of above leakage class to be submitted with the offer.
- j) Leakage class for these control valves required is MSS-SP-61 better than ANSI-B16-104 Class-V or equivalent as the control valves are to work as block valves when in 'CLOSE' condition. The bidder should indicate how this will be achieved in their valves and actuators. Actuators should be pneumatic double acting piston type. Diaphragm type actuators are not acceptable.

The seating force on the valve seats to achieve the leakage class of MSS-SP-61 better than ANSI-B-16-104 class-V or equivalent should be about 180kg/cm on seat ring circumference. Bidder to indicate the closing force on the seat in Kgf/mm of seat circumference applied for actuator.

- k) Trim exit velocity in both minimum and maximum flow conditions should be less than 30M/sec. in case of water and 22.5M/sec in case of flashing water conditions. Calculation sheet should be attached demonstrating satisfactory compliance of this requirement.
- l) Noise level at 1 meter distance from the valve should be less than 85dB without insulation. Orifices, silencers mufflers etc. Calculation sheet to be attached for each valve offered.

- m) Critical cavitations index(Kc) for all control valves should be 1 (one). This is specific requirement to avoid even remote possibility of cavitational damage to valve internals.

11.06.05 **SPECIFICATION FOR APRDS System:**

Brief System Description

Auxiliary steam system is to be designed to provide steam for turbine auxiliaries, Boiler auxiliaries and fuel oil heating system during start-up, low loads and normal running of units.

The system comprises of one auxiliary steam stations capable of meeting 'High capacity' and 'Low capacity requirements' by a single system to meet auxiliary steam requirements during unit start-up, Low loads and for fuel oil system and during normal running. Spray water required for desuperheating will be tapped off from boiler feed pump discharge.

The above stations will reduce the pressure and temperature of the steam tapped off from main steam line. A suitable desuperheater should be considered for reducing the temperature.

Equipment To Be Provided by Bidder:

Combined high capacity and low capacity Auxiliary PRDS comprising of:

a) Control Valves and accessories:

- | | |
|-----------------------------|---|
| a) Pressure reducing valve: | Having multiturn, multistage, multipath radial trim valve as per specification. |
| b) Spray control station: | Dedicated to Desuper-heater. The spray water control station should have multiturn, multistage, and flow trim & the same should be a combination of pressure and temperature control valve and a high rangeability desuperheater. |

Each control valve shall be supplied with the accessories as specified in the approved data sheets.

Desuperheater:

1. Direct mixing type desuperheater :

The desuperheater shall be completed with spray nozzle along with necessary attachments.

Spares, Consumables and Special Tools and Tackles:

Commissioning spares and consumables:

The bidder shall supply spares and consumables for all the above valves and desuperheaters required during start-up. A list of all spares and consumables to be supplied shall be submitted along with the bid.

Specific Technical Requirements for Control Valves, Actuators and Accessories:

Seat ring and trim fitment should not have any part screwed or welded. It should be easily replaceable type.

The valve trim should be multistage, multipath design having sufficient numbers of discrete pressure reductions (turns/stages) to ensure elimination of vibration, cavitations, erosion and noise effects.

Pressure reduction/drop achieved by valve designs incorporating single or multistage orificed cage, diffusers are not acceptable.

Bidder should work out number of pressure drop turns in the trim of the valve and should provide calculations of trim exit velocity.

Flow vs. valve opening characteristics: the trim is to be so designed that the minimum flow indicated in the bid specifications of the valve is achieved with minimum lift of 8mm. of valve plug from 'close' position. Subsequent characteristics should be 'Equal Percentage' i.e. corresponding to the parabolic characteristics. Characterising the cam of the positioner to mimic the required flow characteristics is not acceptable.

Rangeability should be 50 to 1 (minimum). Valves should be able to throttle even below 5% opening without trim erosion.

Each pressure reducing element should have a uniform pressure distribution around the plug to avoid mechanical vibrations (pressure equalizing rings/ grooves).

To prevent flow induced vibrations and the line trace damage to seat, the flow direction should be over the plug for water and under the plug for steam.

During throttle opening of the control valve, flow should be diverted away from the body seat.

The valves shall have minimum ANSI B-16-104 class-V leakage class in metal to metal seating for all applications with minimum seating force of 125kgf per linear mm of seat ring circumference. Soft seat is not acceptable. Vendor shall confirm that the proposed valve shall maintain tight shutoff leakage class even after 3 years of field service.

The bidder should indicate how this will be achieved in their valves and actuators. Actuators should be pneumatic double acting piston type. Diaphragm type actuators are not acceptable.

Bidder to indicate the closing force on the seat in kg f/mm of seat circumference applied for actuator.

Trim exit velocity in both minimum and maximum flow conditions should be less than 30M/Sec. in case of water and 22.5M/sec in case of flashing water conditions. Calculation sheet should be attached demonstrating satisfactory compliance of this requirement.

Noise level at 1 meter distance from the valve should be less than 85dB without insulation, Orifices, silencers mufflers etc. Calculation sheet to be attached for each valve offered.

Critical cavitations index (Kc) for all control valves should be 1 (one). This is specific requirement to avoid even remote possibility of cavitation damage to valve internals.

To avoid problems associated with the piston rings provided in valves of balanced design, unbalanced design for port size upto 25mm. is required. Bidder to indicate the compliance clearly.

Material of the valve internals should be as under:

Guide	:	Inconel 718
Plug/stem	:	Inconel 718
Seat ring	:	SS 316 stellited

Valve actuators:

- i) Piston actuators shall be used for all valves.
- ii) Valve actuators shall be capable of operating at 70 Degree C ambient continuously.
- iii) Castings shall be of the type to suite individual area environments.
- iv) All fix connection size shall be ¼" NPT (Female)
- v) Bidder shall guarantee that the size of the actuator is adequate to meet the operating thrust requirement for the control valve under extreme condition. Bidder shall indicate the stroking time of the valve assemblies with positioner.

Accessories:

Control valve actuators shall be equipped with air supply filter regulator, gauges and valve positioners alongwith boosters for typical applications wherever required, local poison indicator with scale and pointer, position transmitter, limit switch and hand wheel, air lock relay, solenoid valve etc.

Performance:

All control valves shall confirm to MSS-SP-61 leakage class.

11.06.06

SPECIFICATION FOR SOOT BLOWER VALVES:

Trim should be of multistage, multipath, multiturn type having **sufficient number of discrete pressure drop stages** to ensure elimination of erosion, cavitation, noise and vibration throughout the stroke length of the valve. Supplier shall **identify the number of pressure drop stages in proposed valve** and shall also provide calculations demonstrating compliance to the trim exit velocity.

The trim exit velocity for liquid (water) shall not exceed 23M/sec. The velocity head in case of steam / gas services shall be less than 480 Kpa (70 P sia). The supplier shall provide calculations demonstrating satisfactory compliance to the above criteria.

To maximize noise attenuation benefits and to allow for constant fluid expansion, flow direction shall be **'UNDER THE PLUG', i.e. FLOW TO OPEN.**

The flow path shall be radial and each disk element should be capable of reducing the entire pressure independently. No orifice, No mufflers / diffusers are permitted.

The maximum allowable noise level shall be less than 85 dba at 1 meter distance on bare pipe surface. **No orifice Plate downstream of the control valve should be used for pressure reduction.**

The specified noise level shall be achieved without the use of orifices, mufflers or diffusers. **No credit for thermal or acoustical insulations. The supplier shall provide calculations demonstrating compliance to the above noise requirement.**

The valve shall have minimum Ansi B-16-104 class-V leakage class in metal to metal seating for all applications with minimum seating force of 125 kgf per linear mm of seat ring circumference. Soft seat is not acceptable. Vendor shall confirm that the proposed valve shall maintain tight shutoff leakage class even after 3 years of field service.

The valve shall have quick change type trim utilizing top entry. No components shall be screwed or welded into the body.

The valve shall have equal pressure distribution around the plug to avoid chattering/vibration.

The valve should have high rangeability to meet low flow and high flow requirements satisfactorily with high% show at low flow condition

Pneumatic double acting piston actuator shall be preferred.

11.07.00 **TESTING AND COMMISSIONING:**

11. 07.01 All valves shall be tested in accordance with the quality assurance programme agreed between the owner and the bidder as specified in chapter 14 which shall meet the requirements of IBR and other applicable codes mentioned in chapter 1 clause-1.09.00. The tests shall include but not be limited to the following.

Valves for high pressure high temperature applications shall be subjected to 100% radiography examination test. Results shall be owner approved prior to dispatch. All castings and forging shall be visually inspected. The casting shall be radiographically examined. Ultrasonic examination, liquid penetration examination, magnetic particle examination etc. as applicable shall be performed as per applicable standards and codes. The mechanical and chemical testing shall also be performed in accordance with applicable ASTM material specification.

11.07.02 Non-destructive examinations shall be performed as required by ANSI B81.1 (Power Piping) and ANSI B16.34 (Steel Valves).

11. 07.03 Hydrostatic Test:

- ii) Valve shall be subjected to hydrostatic shell test in accordance with ANSI-B16.34 prior to seat leakage test. If the valves are reworked on the pressure parts for any reason after hydrostatic test, they must be retested.
- iii) Valves shall be hydrostatically tested in manufacturers works in accordance with code requirements. All hydrostatic testing and inspection shall be completed before any paint is applied to valve body. Certificates of inspection shall be executed in accordance with the latest codes and required codes shall be forwarded to the engineer.

All gaskets used for test shall be of the same material and design as specified for the finished product. Where mechanical gasket joints are broken following tests, new gaskets shall be furnished with the equipment, and the joints shall be retested.

11. 07.04 Leakage Test:

- i) Unless otherwise noted in the specification sheets, valve closure test and seat leakage tests shall be performed in accordance with ANSI B16.104, Leakage Class II/class IV as the case may be.
- ii) The leakage from packing shall be zero or bubble tight. For valve designs which are not covered by ANSI B16.104, the bidder shall submit the expected leakage rate with his proposal for review by Owner / Technical Specialist.
- iii) If valves are disassembled after the completion of the valve closure and seat leakage tests, these tests shall be repeated.

11. 07.05 Hysteresis Test :

The hysteresis test shall be run on completely assembled valves. The stuffing box shall be fully packed and made up hand tight. The allowable value of hysteresis specified by the bidder shall be achieved.

11.07.06 Tests for special class valves:

All valves supplied with the special class ratings per ANSI B16.34 "Steel Valves" (except flanged valves) shall be subject to the required examinations as per paragraph 8.3 of ANSI B16.34. the acceptance criteria shall be same as these given in Annexure B,C,D and E of ANSI B16.34 for the applicable examinations expect for the following.

Magnetic particle examination of castings, the linear indications shall not exceed 3/16 inch in length.

11.07.07 Functional Tests:

The fully assembled or completed valves including the operators control devices and accessories shall be functionally tested to demonstrate the operability of the valve and the operation. This may be done by cycling the valves 3 or 4 times from open to close position. The same controller can be used to test each valve. Control valve FI (Liquid pressure recovery factor) in operation test on completed valve (final inspection).

SPECIFICATION
FOR
MOTORISED
VALVE ACTUATOR

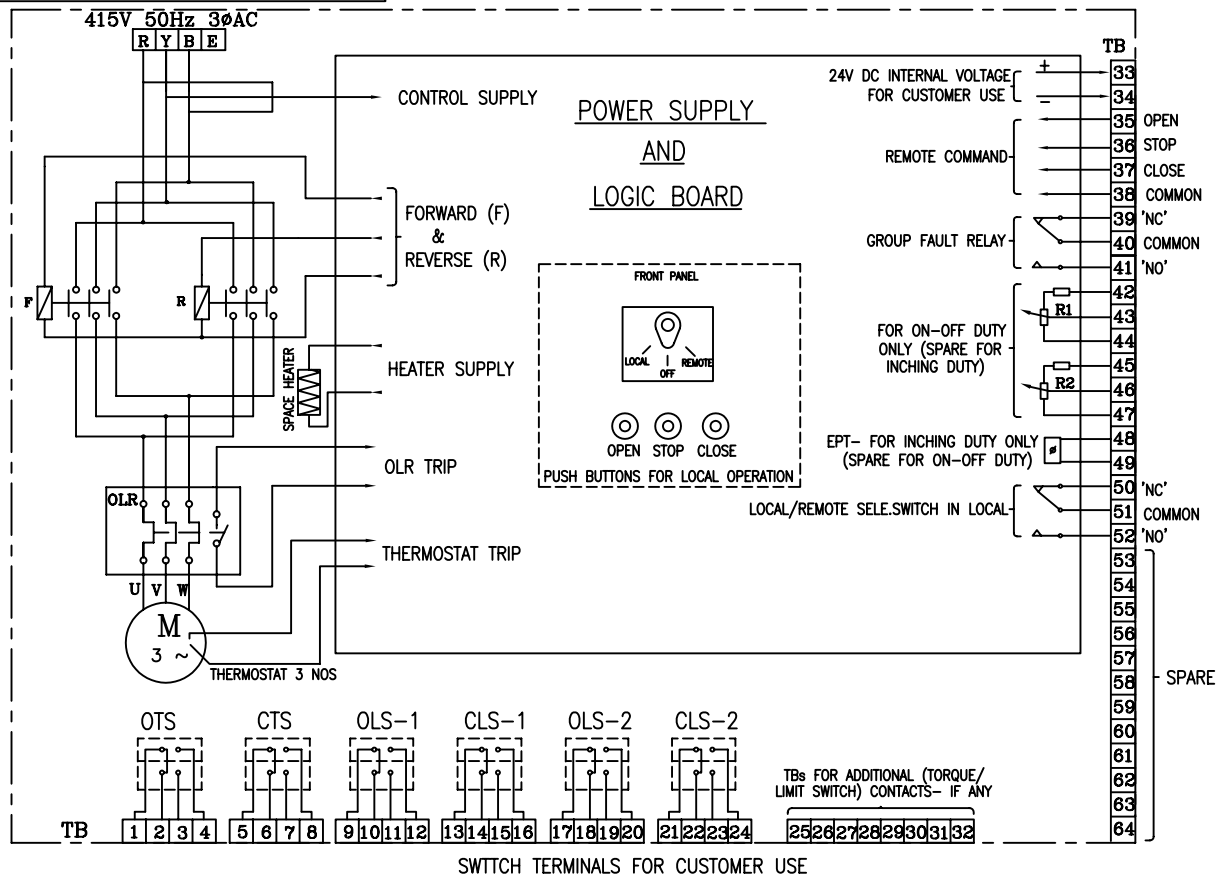
	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 01	DATE: 04.07.15
			SHEET 1 OF 3	
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	2x 660 MW ENNORE STP		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.		
HANDWHEEL	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT- INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☐ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ DURING DETAIL ENGG.		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902		
			VOLUME II B		
			SECTION D		
			REV. NO. 01	DATE: 04.07.15	
		SHEET	2 OF	3	
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)		
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ FLAME PROOF			
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B			
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos., 1 IN EACH PHASE) ☐ -----			
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED			
INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	☒ CONTACTORS ☐ THYRISTORS			
	TYPE	☒ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)			
	STEP DOWN CONT. TRANSFORMER	☒ REQUIRED			
	OPEN / CLOSE PB	☒ REQUIRED ☐ NOT REQUIRED			
	STOP PB	☒ REQUIRED ☐ NOT REQUIRED			
	INDICATING LAMPS	☒ REQUIRED ☐ NOT REQUIRED			
	LOCAL REMOTE S/S	☒ REQUIRED ☐ NOT REQUIRED			
	STATUS CONTACTS FOR MONITORING	☒ REQUIRED ☐ NOT REQUIRED			
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIP, O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, PHASE LOSS, S/S IN LOCAL/OFF MODE, STOP PB OPTD, TORQUE OPEN/CLOSE CUTOFF)			
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER			
	QUANTITY	☒ 2 NOs. ☐ 3 NOs.			
	DRIVING VOLTAGE	☒ 20.5 – 24V DC ☐ _____ V DC			
	DRIVING CURRENT	☒ 125mA MAX ☐ _____ mA MAX			
	LOAD RESISTANCE	☒ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms			
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN / CLOSE	☒ 1 No. ☐ 2Nos. / ☒ 1 No. ☐ 2Nos			
	CONTACT TYPE	2 NO + 2 NC			
	RATING	5A 240V AC AND 0.5A 220V DC			
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE			
	ACCURACY	+3% OF SET VALUE			
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN : INT : CLOSE	☐ 1 No ☒ 2 Nos.	2 Nos. (ADJ.)	☐ 1 No. ☒ 2Nos.	
	CONTACT TYPE	2 NO + 2 NC			
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC			

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-1902	
			VOLUME II B	
			SECTION D	
			REV. NO. 01	DATE: 04.07.15
		SHEET	3 OF	3
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	☒ REQUIRED ☐ NOT REQUIRED		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	☒ 24V DC ☐		
	OUTPUT	☒ 4-20mA		
	ACCURACY	± 1% FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY (NON INTEGRAL)	230V AC, 1 PH., 50 Hz		
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY		
	@ RATING			
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED		
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☒ IP 68 @ ☐		
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET (9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ☒ NOT REQUIRED ☐ 2 NOS. ☐		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	OTHER CONTROL CABLE GLANDS	QUANTITY & SIZE : Cable gland suitable for 8Px0.5 sq mm & 2P x 0.5 sq mm Cable.		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.
NOTES: 1. SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. 2. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722 3. ACTUATOR SHALL HAVE HARDWIRED CONTACTS FOR FOLLOWING SIGNALS (a) ACTUATOR IN LOCAL MODE (b) ACTUATOR IN REMOTE MODE. 4. BIDDER TO ENSURE AVAILABILITY OF SPARE 1NO + 1NC LIMIT SWITCH & TORQUE SWITCH.  5. SS TAG NAME PLATE SHALL BE PROVIDED. 6. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. 7. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, NI PLATED BRASS MATERIAL SHALL BE PROVIDED. 8. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE. 9. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. 10. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.				
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES				

3-V-MISC-24227

DRAWING NO.



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL				
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL				
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL				
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL				
OLS-1	9-10					
	11-12					
CLS-1	13-14					
	15-16					
OLS-2	17-18					
	19-20					
CLS-2	21-22					
	23-24					
SWITCH	TERMINAL NO.	FULL OPEN	a	INTERMEDIATE	b	FULL CLOSE
		VALVE POSITION				
————— INDICATES CONTACT CLOSED - - - - - INDICATES CONTACT OPEN						
CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC						

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#
# - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT				
* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)				

NOTE:-

- ALL TORQUE AND LIMIT SWITCHES (OTS, CTS, OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE.
ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
- CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
- OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
- OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
- CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
- EPT - ELECTRONIC POSITION TRANSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)
- R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
- FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
- M - MOTOR 3Φ 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS OR NAME OF CUSTOMER/PROJECT		UNIT: HIGH PRESSURE BOILER PLANT. TIRUCHIRAPALLI-620014.	
DEPT VL	SCALE	WEIGHT (KG).	REFERENCE INFORMATION
CODE			
TITLE WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER		CARD CODE U 01	DRAWING NO. 3-V-MISC-24227 REV 0

C&I Quality Assurance



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST	P		W	V		
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- IBR certificate to be provided if called for in specn.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST		P	W	V		
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE	P	W	V		
5	REVIEW OF TC FOR	FOR LOT	V	V	V		
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST	V	V	V		
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW	V	V	V		

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL	SEE NOTE-5	---	P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER	FOR LOT	---	P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	TYPE TEST	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	---	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	---	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE, WELDERS & NDT AS PER ASME FOR PR >40 KG/CM ²	SEE NOTE-1 BELOW	---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- IBR certificates shall be provided wherever required.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL						STD QUALITY PLAN NO.: PE-QP-999-145-I056					
								VOLUME		IIB			
								SECTION		D			
								REV. NO.		01		DATE: 22-02-2008	
								SHEET		1		OF 7	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks	
									P	W	V		
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2		
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---		
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---		
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---		
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---		
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1		
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---		
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---		
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---		
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1		
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---		
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics													
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.													
1 - BHEL 2 - Vendor 3 - Sub-vendor													

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL						STD QUALITY PLAN NO.: PE-QP-999-145-I056				
								VOLUME	IIB			
								SECTION	D			
								REV. NO.	01	DATE: 22-02-2008		
								SHEET	2	OF	7	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type 2. Verification of Test Certificates 3. Operation / Functional check 4. I.R. 5. H.V. 6. Calibration 7. Pick up / Drop off Voltage	CR CR CR MA MA MA MA	Visual Scrutiny of Type / Routine T.Cs. Electrical Electrical Electrical Electrical Electrical	Sample 100% Sample+ 100% 100% 100% 100% 100%	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2	--- --- --- --- --- --- ---	--- --- --- --- --- 1 ---	+ for relay & contactors only @ for all components except relays & contactors.
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics \$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor												



STD QUALITY PLAN NO.: PE-QP-999-145-I056			
VOLUME	IIB		
SECTION	D		
REV. NO.	01	DATE: 22-02-2008	
SHEET	3	OF	7

LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks	
									P	W	V		
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics													
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1 - BHEL 2 - Vendor 3 - Sub-vendor													

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
12.	FINAL Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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