

Power Supply	:	240V AC, 50 Hz. From UPS
Accuracy	:	+/-1% of full scale span.
Stability	:	±1% of full scale per month non-cumulative
Repeatability	:	+/-1% of span
Protection class	:	IP - 65
Process connection	:	¼ inch NPT (F) / SCRD for on line type. ¾ inch NPT (M) SCRD for pipe mounted
Electrical connection	:	½ inch NPT (F) SCRD
Accessories	:	Automatic temp. Compensation in the range of 0-100 Deg.C

5.12.00 Technical Specification of pH Cell and Transmitters

a)	Applicable Standard	pH electrodes shall conform to IS: 6804-1972 except as modified in this specification
b)	Type:	
	i) Cell	Measuring and Reference Electrode Combination with Flow through type (SS316/Polypropylene flow chambers) for power plant's steam & water application. Sensor shall not be affected by flow variation. Sensor shall be designed for power plant applications.
	ii) Monitors	Electronic (microprocessor based) indicating type with adjustable range facility.
c)	Material:	
	i) Measuring & reference	Toughened sensitive
	ii) Electrode	pH glass
	iii) Monitor body	Carbon steel/Aluminum/Polycarbonate
d)	Monitor output	i) 4-20 mAmp D.C. with HART protocol spare out put ii) 4-20mA DC with HART protocol for DDCMIS Output load : 500Ω
e)	Power supply	240V AC, 50 Hz from UPS
f)	Accuracy/repeatability	+ 0.03 pH/+0.02PH
g)	Resolution	+ 0.01 pH or 1 mV. 1C
h)	Stability	0.02 pH per week
i)	Annunciation contacts from monitors:	

- | | | | |
|----|-------------|---|--|
| | i) | Number | 2 SPDT 'Hi' and 'Lo' |
| | ii) | Type | Snap action micro switch |
| | iii) | Rating | 5 amp, 240V AC, 0.2 Amp, 220V DC |
| j) | Connection: | | |
| | i) | Process | One-quarter (1/4)inch NPT(F) SCRD
ON-LINE |
| | ii) | Electrical | Half (1/2) inch NPT(F) SCRD |
| k) | Mounting: | | |
| | i) | Cell | Pipe Mounted |
| | ii) | Monitors | Flush panel mounting |
| l) | Accessories | | |
| | i) | Automatic temperature compensation with fast response integral temperature sensors in the range 0-100°C | |
| | ii) | Co-axial cable as required | |
| | iii) | Sample coolers | |
| | iv) | low and pressure regulators | |
| | v) | Standard pH solutions | |
| | vi) | SS316 impulse tubing and fittings | |
| | vii) | Isolation & drain valves as required | |
| | viii) | Electrode holders | |
| | ix) | Other accessories as required | |
| | x) | Sample rate set valves | |
| | xi) | Alarm settings and indications on monitor. | |
| | xii) | RFI/EMI shielded, weather and corrosion proof casing | |

5.13.00 Technical Specification of Dissolved Oxygen Analyser

- | | | | |
|----|----------------------|--|---|
| a) | Applicable Standards | ASTM PTC 19.11-1970 except as modified in this specification | |
| b) | Type | Microprocessor based Electro-chemical | |
| c) | Material | Die-cast aluminum/SS/Polycarbonate | |
| d) | Output | i) 4-20 mAmp DC spare output
ii) 4-20 mAmp, DC Isolated output for DCS. | |
| e) | Supply | 240V AC, 50 Hz from UPS | |
| f) | Accuracy | <u>± 5 %</u> of reading | |
| g) | Response: | | |
| | i) | Sensitivity | <u>± Two (2)</u> per cent overall |
| | ii) | Time (sensor) | Less than 30 seconds for 90% step change. |
| h) | Connection: | | |

i)	Process	One quarter (1/4) inch NPT(F) SCRD
ii)	Electrical	Half (1/2) inch NPT (F) SCR D
i)	Accessories	i) Sample cooler assembly with shut off valve at cooling water inlet, with thermometer and reducing valve at sample outlet. ii) Flow stabilizer iii) Automatic temperature compensation iv) Other accessories as required v) Calibration device.
j)	Ranges	As per sample stream detail table
k)	Mounting	Flush
l)	Annunciation contacts:	
i)	Number	2 SPDT
ii)	Type	Snap action microswitch
iii)	Rating	5 Amp 240V AC, 0.2 amp 220V DC

5.14.00 Technical Specification of Silica Analyzer (SI OX)

a)	Applicable standard	ASME PTC 19.11-197 except as modified in this specification
b)	Type	Multi Channel (max of each Three channel) Colorimetric Analyzer (with auto reagent shut off feature in case of sample loss or power loss) built in phosphate inhibition feature. Micro processor based.
c)	Material:	
i)	Case	Die cast aluminum
d)	Cycle/Response Time	Twelve (12) minutes Maximum
e)	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
f)	Power supply	240V AC, 50 Hz from UPS
g)	Accuracy	$\pm 1\%$ of span
h)	Repeatability	$\pm 2\%$ of full scale
i)	Sensitivity	0.2 micrograms/liter
j)	Connection:	
i)	Process	Quarter (1/4) inch NPT(F) SCR D
ii)	Electrical	Half (1/2) inch NPT (F) SCR D
k)	Ranges	As per sample stream detail table

- | | | |
|----|------------------------|--|
| l) | Mounting | Flush |
| m) | Annunciation contacts: | |
| | i) Number | 2 SPDT |
| | ii) Type | Snap action micro switch |
| | iii) Rating | 5 amp 240V AC 0.2 Amp 220V DC |
| n) | Accessories | |
| | i) | Automatic temperature compensation between 5 to 50 deg C |
| | ii) | Automatic zeroing provision |
| | iii) | SS316 tubing & vessels |
| | iv) | All chemical reagents for 12 months operation of the analyzer |
| | v) | Sample rate set values |
| | vi) | Comprehensive diagnostic and alarm features. |
| | vii) | Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided. |

5.15.00 Technical Specification of Hydrazine Analyzer

- | | | |
|-------|------------------------|---|
| i) | Type | Microprocessor based Electrochemical |
| ii) | Case material | Die-cast aluminum/SS/Polycarbonate |
| iii) | Analyzer output | |
| | i) | 4-20 mA DC for spare output |
| | ii) | 4-20 mA DC isolated output for DDCMIS |
| iv) | Power supply | 240V AC, 50 Hz from UPS |
| v) | Accuracy | $\pm 2\%$ of full scale |
| vi) | Response Time | <4 minutes. |
| vii) | Sensitivity | 1.0 microgram/liter |
| viii) | Annunciation contacts: | |
| | - | Number |
| | - | Type |
| | - | Rating |
| | - | Mounting |
| | | 2 SPDT |
| | | Snap action micro switch |
| | | 5A 240V AC, 0.2 A, 220V DC |
| | | Flush mounting |
| ix) | Accessories | |
| | i) | Flow regulator |
| | ii) | Flow gauges |
| | iii) | Other accessories as required |
| | iv) | Sample rate set valves |
| | v) | Chemical reagents as applicable for 12 months consumption |

5.16.00 Technical Specification of Sodium Ion Analyzer

- | | | |
|----|------|---|
| i) | Type | Microprocessor based Continuous flow through sample type with sodium responsive |
|----|------|---|

		electrode and reference electrode having pH adjustment facility (Max 3 streams)
ii)	Case material	Die-cast aluminum/SS/Polycarbonate
iii)	Analyzer power supply	240V AC, 50 Hz from UPS
iv)	Analyzer output	i) 4-20 mA DC for spare output ii) 4-20 mA DC isolated output for DDCMIS
v)	Accuracy	Better than $\pm 5\%$ of full scale
vi)	Response Time	6 minutes. max
vii)	Sensitivity	0.1 ppb
viii)	Annunciation contacts:	
	- Number	2 SPDT
	- Type	Snap action microswitch
	- Rating	5A 240V AC, 0.2A, 220V DC
	- Mounting	Flush
ix)	Terminal points	All components piped & wired to terminal points
x)	Accessories	i) Flow regulator ii) Flow gauges iii) Sample rate set valves iv) Other accessories as required to make the system complete v) Chemical reagents as applicable for 12 months consumption

5.17.00 Technical Specification of Phosphate Analyzer

i)	Type	Microprocessor based Continuous flow through sample type with colorimetric detection system (Max 3 streams)
ii)	Case material	Die-cast aluminum/SS/Polycarbonate
iii)	Analyzer power supply	240V AC, 50 Hz from UPS
iv)	Analyzer output	i) 4-20 mA DC for spare output ii) 4-20 mA DC isolated output for DDCMIS
v)	Accuracy	Better than $\pm 4\%$ of full scale
vi)	Sensitivity	Better than 1 ppm
vii)	Annunciation contacts:	
	- Number	2 SPDT
	- Type	Snap action micro switch
	- Rating	5A 240V AC, 0.2A, 220V DC
	- Mounting	Flush
viii)	Terminal points	All components piped & wired to terminal points
ix)	Accessories	i) Flow regulator

- ii) Flow gauges
- iii) Sample rate set valves
- iv) Other accessories as required to make the system complete
- v) Chemical reagents as applicable for 12 months consumption

5.18.00 Technical Specification of Chloride Analyzer

- i) Type Microprocessor based Continuous flow through sample type.
- ii) Analyzer power supply 240V AC, 50 Hz, Single Phase from UPS
- iii) Analyzer output
 - i) 4-20 mA, DC spare output
 - ii) 4-20 mA, DC isolated output for DDCMIS
- iv) Accuracy Better than ± 10 % of full scale
- v) Sensitivity Better than 1 ppm
- vi) Range As per Requirements.
- vii) Annunciation contacts:
 - Number As per schedule, 2 SPDT
 - Type Snap action micro switch
 - Rating 5A, 240V AC, 0.2A, 220V DC
 - Mounting Flush
- viii) Terminal points All components piped & wired to terminal points
- ix) Accessories
 - i) Flow regulator
 - ii) Flow gauges
 - iii) Sample rate set valves
 - iv) Other accessories as required to make the system complete

5.19.00 Technical Specification of Chlorine Analyzer

- i) Type Microprocessor based Continuous flow through sample type with automatic temperature compensation.
- ii) Analyzer power supply 240V AC, 50 Hz, Single Phase from UPS
- iii) Analyzer output
 - i) 4-20 mA, DC spare output
 - ii) 4-20 mA, DC isolated output for DDCMIS
- iv) Accuracy 0.005 mg/ltr. or 1% of range.
- v) Sensitivity 0.001 mg/ltr. (1 ppb)
- vi) Range As per schedule.
- vii) Annunciation contacts:
 - Number As per schedule, 2 SPDT

-	Type	Snap action micro switch
-	Rating	5A, 240V AC, 0.2A, 220V DC
-	Mounting	Flush
viii)	Terminal points	All components piped & wired to terminal points
ix)	Accessories	<ul style="list-style-type: none"> i) Flow regulator ii) Flow gauges iii) Sample rate set valves iv) Other accessories as required to make the system complete

5.20.00 Technical Specification of Residual Chlorine Analyser

SENSOR

Method	:	Amperometric
Electrodes	:	Gold Cathode/Silver Anode
Cell Material	:	PVC
Electrolyte	:	Potassium Bromide

TRANSMITTER

Type	:	Microprocessor Based with self diagnostic features
Transmitter Output	:	4 – 20 mA
Enclosure Protection	:	IP65
Enclosure Material	:	Polyester coated Al.
Electrical Connection	:	½” NPT (F)
Mounting	:	FIELD
Display Type	:	LCD
Display Details	:	4 digit backlit LCD matrix
Diagnostics	:	Required
Meter Range	:	0-1 mg/l
Resolution	:	0.01 ppm
Area Classification	:	SAFE
Electromagnetic Compatibility	:	BUILT – IN
Temp. Compensator	:	AUTO – BUILT – IN
Temp. Compensating element	:	PT100

5.21.00 Technical Specification of Turbidity Analyser

SENSOR

Reference type	:	On Line
Operating principle	:	Alternating Light Source
Cleaning	:	Self Cleaning
Electrode holder – type	:	Flow Through
Body Material	:	CPVC
Process Connection	:	½” NPT (F)

CCTV network configuration shall be built on the Stackable Managed Ethernet switches for better control of data traffic & performance and future expansion. Switch configuration shall be redundant with seamless changeover without any upset in the CCTV operation. MTBF of the switch shall be more than 20 Years. Configuration shall be automatic.

3.00.00 CONTROL PANEL/DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES

3.01.00 Coupling Relay

01. Type : Octal base plug-in type/ DIN rail Mounting
02. Coil voltage : 24 V D.C. in general / other as required
03. Contact : 2 NO & 2 NC (Minimum)
04. Contact rating : 250 V/5A (A.C)/220V/2A (D.C)
05. Operating range : 70 to 110% of rated voltage.
06. Insulation : 2 KV for 1 minutes between terminal & earth.
07. Mechanical life : 20 million operations
08. Coil protection : Diode
09. Indication : Coil on LED
10. Enclosure : Transparent cover
11. Connection : Screw terminals.
12. Mounting : Projection mounting inside panel / DIN rail mounting

3.02.00 Bar graph Indicator

01. Type : Bar graph
02. Number of channels : One / Two (as required)
03. Input : 4-20 mA/1-5 V/Thermocouple/RTD
04. Indication : Green LED / LCD
05. Scale : 100 mm vertical one for each channel graduated in engineering unit (linear scale)
06. Readable Distance : 3 meters (minimum)
07. Mounting : Flush panel
08. Face Dimension : 36(W) x 144(H) mm (approx) / 72 x 144 (H) mm
09. Resolution : 1% of scale or better
10. Power Supply : 240V, 1 Phase, 50 Hz AC
11. Operating Conditions :-
 - a) Temperature : 0-50 ° C
 - b) Relative Humidity : 5%-95%
 - c) Supply Voltage : -15% to +10%
12. Connection between

- | | | | |
|---------|---------------------------------|---|--|
| | Indicator and Tray | : | Prefab Cable |
| 13. | Accessories | : | i) Mounting Tray
ii) Engraved phenolic nameplate affixed to front flange to identify each indicator by tag number and each point by measured variables. |
| 14. | Alarm Facility | : | 1 HI and 1 LO for each channel independently adjustable over span. Voltage free outputs |
| 15. | Reference Junction Compensation | : | Built-in cold junction compensation for thermocouple inputs |
| 16. | Feature | : | i) Alarm level indication by flashing cursor
ii) Green Digital display of parameter value in front panel with a 3.1/2 digit display. |
| 3.03.00 | Valve Position Indicator | | |
| 01. | Input | : | 4-20 mA DC/1-5 Volts DC |
| 02. | Indication | : | Pointer and Scale. Moving Coil Meter |
| 03. | Readable Distance | : | 3 meters (minimum) |
| 04. | Pointer Deflection | : | 90 Deg Sector or linear |
| 05. | Mounting | : | Flush Panel (Horizontal/vertical) |
| 06. | Accuracy | : | ±1% or better |
| 07. | Protection Class | : | IP-42 |
| 08. | Operating Ambient Temp. | : | 0-50 °C |
| 09. | Scale | : | 0-100% |
| 10. | Bezel Size | : | DIN Standard |
| 3.04.00 | Digital Indicator | | |
| 01. | Type | : | Four and half digit LED seven-segment display with sign. |
| 02. | Face Dimension | : | 72 x 144 mm / 48 x 96 mm (as applicable) |
| 03. | Display Character | : | 13.8 mm, Green (LED) |
| 04. | Accuracy | : | 0.1% of reading, ±2 digit |
| 05. | Input | : | 4-20mA DC/1-5 V DC/RTD/Thermocouple |
| 06. | Mounting | : | Flush Panel |
| 07. | Power Supply | : | 240V ±10%, 50 ±2.5 Hz |
| 08. | Output Contact | : | 2 nos SPDT, contact rating 5A at 240V AC/0.25A at 220V DC |
| 09. | Power/Signal Connection | : | Screwed |
- Large Display (150x300 mm) indicators shall be provided for MW, MVAR and frequency indications.

- 3.05.00 Push Button
- 01. Type : Shrouded square format
 - 02. Face Dimension : 32 x 32 mm (maximum)
 - 03. Contact Configuration : 2 NO + 2 NC
 - 04. Contact Addition : Add-on block up to 4 each with 2 pairs of contacts
 - 05. Contact Material : Hard Silver Alloy
 - 06. Contact Rating : 500V / 10 A
 - 07. Utilization Category : AC11 / DC11
 - 08. Insulation Voltage : 2 KV for 1 minute between terminals and earth
 - 09. Mechanical Life : 1 million operation
 - 10. Construction : Aluminum shrouding with plastic lens
 - 11. Colors : Red, Green, Yellow, Black, etc.
 - 12. Connection ; Screw terminals
 - 13. Enclosure Class : IP-52
 - 14. Legend : Engraving
- 3.06.00 Illuminated Push Button
- 01. Type : Square format
 - 02. Face Dimension : 32 x 32 mm (maximum)
 - 03. Contact Configuration : 2 NO + 2 NC (minimum)
 - 04. Contact Addition : Add-on-Block up to 4 each with 2 pairs of contacts
 - 05. Contact Material : Hard Silver Alloy
 - 06. Contact Rating : 500 V/ 10A
 - 07. Utilization Category : A C11 / DC11
 - 08. Insulation Voltage : 2 KV for 1 minute between terminals and earth
 - 09. Mechanical Life : 1 Million Operation
 - 10. Lamp : LED with built-in resistors as required
 - 11. Lamp Rating :-
 - a) Voltage : 240 V AC
 - b) Watt : 2 Watt (approx.)
 - 12. Lamp and Lens Replacement : From front
 - 13. Construction : Transparent Plastic Lens
 - 14. Color : Red, Green, Amber, Yellow etc.
 - 15. Connection : Screw terminals

- | | | | |
|---------|-------------------------------|---|---|
| | 16. Enclosure Class | : | IP-52 |
| | 17. Legend | : | Engraving |
| 3.07.00 | Selector Switch | | |
| | 01. Type | : | 2/3/4 position stay put type with rotary lever actuator. |
| | 02. Face Dimension | : | 32 x 32 mm (maximum) |
| | 03. Contact Configuration | : | 4 pair of contacts |
| | 04. Contact Addition | : | Add-on-Block up to 4 each with 2 pairs of contact |
| | 05. Contact Material | : | Hard silver Alloy |
| | 06. Contact Rating | : | 500 V/10 A |
| | 07. Utilization Category | : | AC11 / DC11 |
| | 08. Insulation Voltage | : | 2 KV for 1 minute between terminals and earth |
| | 09. Mechanical Life | : | 1 million operation |
| | 10. Construction | : | Aluminum shrouding |
| | 11. Connection | : | Screw terminals |
| | 12. Enclosure Class | : | IP-52 |
| 3.08.00 | Indicating Lamp | | |
| | 01. Type | : | LED with built-in resistor |
| | 02. Face Dimension | : | 32 x 32 mm (maximum) |
| | 03. Voltage | : | 240 V AC |
| | 04. Watt | : | 2.5 Watt (approximate) |
| | 05. Lamp and Lens Replacement | : | From front |
| | 06. Construction | : | Transparent Plastic lens |
| | 07. Color | : | Red, Green, Amber, Yellow etc. |
| | 08. Connection | : | Screw terminals |
| | 09. Legend | : | Engraving |
| 3.09.00 | Indicating Meters (A.C) | | |
| | 01. Type | : | Rectifier type |
| | 02. Face Dimension | : | 96 x 96 mm |
| | 03. Scale | : | Radial arc of 240 Deg. |
| | 04. Accuracy | : | 1.5% of full scale.
±0.5 Hz for frequency meter |
| | 05. Input | : | 0-1/0-5A for current measurement, 0-240V, 50 ± 2.5 Hz for voltage / frequency measurement |
| | 06. Zero Adjustment | : | Screw on meter face |

- 07. Enclosure : Shielded Case
- 08. Mounting : Flush Panel
- 09. End Scale Suppression : 6 times the measuring range only for motor ammeters

3.10.00 Indicating Meters (D.C)

- 01. Type : Taut band moving coil
- 02. Face Dimension : 96 x 96 mm
- 03. Scale : Radial arc of 240 Deg.
- 04. Accuracy : 1.5% of full scale
- 05. Input : 0-75 mA for current measurement. Direct reading for voltage measurement.
- 06. Zero Adjustment : Screw on meter face
- 07. Enclosure : Shielded case
- 08. Mounting : Flush Panel
- 09. End Scale Suppression : 2 times the measuring range only for motor ammeters.

For electrical system's meter and for synchronization, Bidder shall refer to electrical volume of the specification

3.11.00 Auxiliary Relay

- 01. Type : Electromagnetic
- 02. Coil voltage : 240 V A.C / 220V DC. For any other voltage bidder to make his own arrangement.
- 03. Contact Configuration : 2 NO & 2 NC (Minimum), additional contacts as per requirement with provision for additional contact block expansion
- 04. Contact rating : 250V/5A (A.C/D.C.)
- 05. Operating range : 80 to 110% of rated voltage
- 06. Insulation : 2 KV for 1 minute between terminals & earth.
- 07. Mechanical life : 20 million operations
- 08. Coil protection : Diode/surge suppressor
- 09. Connection : Screw terminals.
- 10. Mounting : Projection mounting inside panel

3.12.00 Electrical Transducer

Transducers shall be provided for conversion of AC electrical quantities such as voltage, current and power. Transducer shall be suitable for 220V DC auxiliary supply. Transducers shall be of low burden type having 4 – 20 mA DC linear galvanically isolated output compatible with secondary indicating instrument. Transducer shall be dual channel type. Accuracy class of Transducers shall be as per IS14570:1998 or IEC688:992

3.13.00 Synchroscope

Synchroscope shall be designed to provide an illuminate and indication of phase and frequency difference between bus voltage and Generator voltage. It shall denote the actual frequency difference corresponding to the inverse of time taken for one rotation of the illuminated vector spot. The instrument shall be designed for industrial applications, which require precise, reliable and robust instruments for the display range and indication. Synchroscope shall be designed as per the DIN / IEC / BS standards.

4.00.00 **CONTROL VALVES, ACTUATORS & ACCESSORIES**

General Technical Guidelines for the Control Valves shall be as follows :

- a) Bidder shall exercise caution in selecting severe service control valves like BFP recirculation valves, HP & LP bypass valves, superheater & reheater attemperator valves, PRDS valves for Boiler & Turbine, Soot blower steam pressure control valve, control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control, condenser make up water control valve, separator level control and CEP minimum flow control valve. For such critical applications, Bidder shall offer valves which are proven for similar application. Above valves shall have leakage class equal or better than class-V with metal-to-metal seating.
- b) Wherever, steam conditioning calls for Pressure reducing & desuperheating, combined PRDS type valves shall be offered.
- c) Bidder shall provide redundant control valves for Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum for high availability. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.
- d) Control valves shall be located near floor or platform for ease of access and with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream isolating valve, inching duty motorized bypass valve and manual drain valves. Each redundant control valve shall have its upstream motorized and down-stream manual isolating valves. Where quick shut off requirement is foreseen such as in case of SH & RH attemperation valves, upstream isolation valve shall be pneumatic type.

4.01.00 General

4.01.01 Control valves for regulating service shall normally be globe body, preferably cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs having ANSI leakage class-IV except for the control valves indicated above.

4.01.02 Where the operating time is critical for the operation of the plant, as in case of HP or LP bypass valves, hydraulic actuators with electro-hydraulic interface shall be offered.

4.01.03 Bonnet joints for all control valves shall be of flanged and bolted type.

4.01.04 Flanged valve shall be rated at no less than class 300 lbs.

4.01.05 Valve Body / End Connections

- 4.01.06 Valve end to end dimension and connection shall be according to ANSI standard, straight through pattern. However, Bidder may offer angle body valve for high pressure drop applications. For high pressure drop applications, construction of the valve shall be such that the gland is not exposed to inlet pressure.
- 4.01.07 Control valves of 40 mm. size and above with line pressure up to 50 Kg / Sq. cm may have flanged or welded end connections.
- 4.01.08 Control valves, used in high pressure services shall have butt welded end connections for size 65mm and above and socket weld end connection for size 50 mm or below.
- 4.01.09 Control valve body shall be selected as per the ISA guideline. Generally control valve body shall be cast and machined for pressure rating up to 1500 lbs. Above 1500 lbs, valve body shall be of forged steel. For Demineralized Water application, valve body shall be Stainless Steel.
- 4.01.10 The direction of flow shall be clearly engraved on the body .
- 4.02.00 Valve Body Material (material shall match the process condition for super critical boiler)

SR. No.	SERVICE	MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature up to 275°C	Cast carbon steel ASTM A216 Gr. WCB
2.	Non corrosive, non-flashing and non cavitating service for fluid temperature above 275°C	Cast alloy steel ASTM A217 Gr. WC9
3.	Severe flashing / cavitating services	Cast alloy steel ASTM A217 Gr. WC9
4.	Low flashing / cavitating services	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

4.03.00 Valve Size

The control valve sizing (Cv / Kv) shall be based on following guidelines :

- a) The valves shall pass normal flow (MCR condition) with 60 to 70 percent opening for linear characterised valves and between 70 to 80 percent opening for equal percentage characterised valves.
- b) The valves shall have adequate rangeability to pass the minimum and maximum flows at 10% and 85% of the valve opening respectively. Valve stem travel range from minimum to maximum flow condition shall not be less than 50% of the total valve stem travel.

- c) Valve Cv shall be selected in such a way that the valve shall be capable of handling at least 120% of required maximum flow.
 - d) The valve selection shall be based on the highest size dictated by the above considerations unless noise, flashing or other factors dictate the final selection.
 - e) Trim outlet velocity for the control valves shall be no more than 7 m/sec for water service and Mach number less than 1/3 for steam and air service application.
 - f) The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.
- 4.04.00 Valve Top work
- 4.04.01 Top work shall be sized so that the valve shall operate properly when upstream pressure is 10 percent above maximum inlet pressure and downstream pressure is atmospheric.
- 4.04.02 Extended bonnet/Finned bonnet and high temperature packing shall be used for high temperature application.
- 4.04.03 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for lower temperature application (232°C maximum) and for high temperature application graphited asbestos glands are to be provided. For vacuum services, the glands shall be of dry seal type.
- 4.05.00 Valve Trim
- 4.05.01 Valve trim for applications up to leakage class-V shall be stainless steel 316 SS for pressure drop up to 7 Kg/ Sq. cm. For pressure drops above 7 Kg/Sq. cm hard trim (stelliting or equivalent) shall be used. Other alloys or treatment such as nitride shall be used if severe erosion is expected.
- 4.05.02 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators.
- 4.05.03 For flashing services and two stage mixtures, the trim material shall be 17-4 PH SS or equivalent.
- 4.05.04 If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trims valves. Trim of severe service valves shall be of multistage and multipath design with number of discrete pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.
- 4.05.05 Quick replacement type trim shall be considered for easy maintenance.
- 4.05.06 Trim Material

SR. NO.	SERVICE	MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature up to 275°C.	: SS 316 stellited
2.	Non corrosive, non-flashing and non cavitating service for fluid temperature above 275°C.	: SS 316 stellited

SR. NO.	SERVICE	MATERIAL
3.	Severe flashing /cavitating services	: 440 C
4.	Low flashing /cavitating services	: 17-4 PH SS
5.	DM water application (condenser hotwell normal, emergency make up etc.)	: 17-4 PH SS
4.06.00	Noise Level	
	The equivalent sound level measured at 1.5M above nearest floor level in elevation and 1 M horizontally from the control valve expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dBA. If the calculated noise is more than the above limit, even with low noise trim design, diffusers shall be included. Diffusers shall be made of stainless steel and shall be integrally connected to the control valve with spool piece. The spool piece shall be in conformity with the main line piping specification.	
4.07.00	Valve Actuators	
	Spring-diaphragm type actuators shall generally be used. Piston type actuators shall be offered in case of high shut-off pressure & quick response requirement.	
4.07.01	The actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an air line supply pressure of 5.5 Kg/Sq. cm.	
4.07.02	Diaphragms shall be designed for 200% maximum operating pressure.	
4.07.03	Nylon reinforced neoprene is preferred as diaphragm material.	
4.07.04	Valve actuators shall be capable of operating at 80O C ambient, continuously.	
4.07.05	Entire actuator assembly shall be painted with corrosion inhibiting paint.	
4.07.06	Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be stainless steel.	
4.07.07	Bidder shall indicate the stroking time of the valve assemblies with positioner and ensure that the stroke time shall meet the process and equipment dynamics and shall be better than 20 seconds.	
4.07.08	All actuators shall be of fail safe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. "Failure to Open" or "Failure to Close" shall be marked on the actuator.	
4.08.00	Valve Positioners	
4.08.01	Regulating duty valves shall be offered with Electro Pneumatic Positioners to ensure accuracy and repeatability of response.	
4.08.02	Positioners shall have integral non contact (LVDT) type position transmitter, input and output gauges, local keypad & display.	
4.08.03	Positioners shall be capable of functioning under hot, humid and vibrating conditions.	
4.08.04	Positioner casings shall be dust tight, corrosion resistant and weatherproof.	
4.08.05	In general, positioner shall operate at signal range 4 - 20 mA DC for the full travel of the valve.	

- 4.09.00 Valve Accessories
Accessories shall include side mounted hand wheels, limit switches, junction boxes, airlock relays etc.. Solenoid valve wherever required shall be furnished.
- 5.00.00 **CONTROL DESK / PANEL / RACK**
- 5.01.00 Convenient and logical approach to operational interfaces and aesthetics in the overall view of the panel /desk shall be considered.
- 5.02.00 For items susceptible to vibration, suitable anti-vibration padding shall be provided to prevent damage or malfunction.
- 5.03.00 All items inside the panels/cabinets shall be neatly arranged with easy access/maintenance approach.
- 5.04.00 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.
- 5.05.00 Desk / panel shall be provided with interior illumination, utility receptacles with plug and cooling fan.
- 5.06.00 Panel / Desk shall have gland plate at cable entry to panel. Thickness of gland plate shall not be less than 3 mm.
- 5.07.00 Wire shall be routed / laid through covered trough.
- 5.08.00 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.
- 5.09.00 Nameplate
- a) Nameplate shall be provided for instrument or device mounted on the panel.
 - b) Nameplates for panels shall be provided both in front and rear.
- 5.10.00 Control Desks
- 5.10.01 Devices mounted on the desks shall be flush type. Devices shall be so mounted that their removal and replacement can be accomplished without interruption of services to others.
- 5.10.02 Desk shall be ergonomically designed to suit working on a 24 X 7 basis. Aesthetics, ergonomics and illumination shall be considered while positioning of the desk, large video screen and panels in control room.
- 5.10.03 Control desk shall be free standing floor mounting type of table-top design with compartments for locating the hardware. Desk shall be constructed from aluminum extrusion with high pressure laminate MDF board for work surface of approved colour. Aluminium structure shall be anodized or powder coated paint finish.
- 5.10.04 Monitors with retractable keyboard, emergency push buttons shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate..
- 5.10.05 Desks shall be of modular, scalable and industrially ruggedized design and shall have Telephones and Intercom connections.
- 5.10.06 Desks shall have concealed cable trays for wire dressing.

- 5.10.07 Design shall include Earthing bolts.
- 5.10.08 Back installed items shall be suitably concealed from front view.
- 5.11.00 Back Up Panel
- 5.11.01 Construction shall be from sheet steel of thickness not less than 3mm.
- 5.11.02 Electrical upright Panel construction & design shall be similar to back up panel. Control switches, meters, indicators, synchronizer, excitation control switch, annunciation window etc. along with associated mimic diagram, as recommended, shall be provided for manual synchronization of generator.
- 5.12.00 Cabinets / Enclosure / Panels
01. Material of construction : Cold rolled steel sheet
02. Thickness of Sheet : a) 3.0 mm for faces supporting instruments / terminals.
b) 2 mm for other sides and top.
03. Construction : Welded throughout as per approved National Standards.
04. Panel height : 2300 mm (approx)
05. i) Corners : 7 mm inner radius
ii) Dimensional Tolerances : a) In height & length - 3 mm
b) In height between adjacent sections - 2 mm.
c) Total for a group - 6 mm
06. Doors : Double, recessed, turned back edges
i) Thickness of Sheet : 2 mm
ii) Hinges : Stainless steel
iii) Door latches : Three point type
iv) Door gaskets : Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure.
v) Opening of the doors : Outward
vi) Louvers : With removable wire mesh to ensure dust and vermin proof.
07. Color of interior : Brilliant white
08. Colour external : RAL 7032
09. Painting : Epoxy powder coated or better
10. Gland plates : Removable 4 mm thick (bottom)
11. Cable entry : Bottom
12. Hardware : a) Anti vibration pad- 15 mm
b) Predrilled base channel ISMC - 100 or equivalent for all sides.

- c) Stainless steel buff- finished 2 mm thick kick plate for all sides.
- d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws.
- e) Rubber strips to ensure air tightness between kick plate and finished floor.
- f) Lifting hook / Eye bolt
- g) Drawing pocket
- h) Door switch, lamps, thermostat, heaters and fans

13. Enclosure Protection : As per environment condition of the area of installation. Refer section-I of this vol.

5.13.00 Local Instrument Racks & Enclosure

5.13.01 General Requirements

- a) Devices located in the field shall be grouped and installed in the enclosure (Open / Closed Rack) in Boiler and TG Building.
- b) Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.
- c) No more than six instruments shall be grouped in a single rack / enclosure.
- d) Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.
- e) Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.
- f) Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.
- g) Instrument piping and tubing shall be hydrostatically tested at one and one-half times the maximum system pressure except for low pressure and vacuum measurement for which the test pressure will be as per piping standard.
- h) Service air connection shall be provided for continuous and intermittent purging of impulse pipe in dusty medium. Continuous purging shall be adopted for differential pressure measurement such as flue gas and coal air mixture application. Pressure measurement shall have only intermittent purging whenever required. In case of continuous purging, an air header shall be formed this shall receive service air through isolation valve and air filter regulator. Air shall be fed from the air header to both the impulse pipes near to take off points through isolation valves and flow regulators. Air header shall be constructed from stainless steel. Impulse pipe for such applications shall have a four-way valve. One port of the valve shall have an adaptor to connect flexible stainless steel braided nylon hose to the service air. Rating of the hose shall not be less than 10 Kg/sq.cm.

Four way valve shall have two position operations. One position for service and other one for purging. Required pressure gauges shall be provided for monitoring of air pressure. Complete purging arrangement shall be integral to the enclosure and racks.

- i) Gate or ball type (full ported) instrument isolation valve and globe type blow down drain valve adequate for duty requirement and for withstanding continuous design pressure and temperature of main process medium shall be provided in the hook up plumbing. For process pressure equal or above 40 kg / sq.cm single instrument isolation valve and double blowdown valves shall be used before connecting to blowdown header. Whereas for line pressure less than 40 kg/ sq.cm, single instrument isolation valve and single blow down valves can be used before connecting to blow down header. Instrument manifolds shall be non integral and shall be installed close to the instrument.
- j) Drawing K9213R-DWG-I-0200 shall be referred for typical arrangement of Local instrument enclosure and rack.

5.13.02 Closed Instrument Rack

- a) Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load-bearing posts shall be suitably supported by gusset plates or moment members.
- b) Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.
- c) 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any member, which would reduce access, shall be avoided.
- d) Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.
- e) Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box.
- f) Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.
- g) All internal wirings between the instruments and junction box shall run through flexible conduits.
- h) Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Header shall be of 2" NB ASTM A 106, Sch-80 Gr. C installed at a slope of 1:25 and extended beyond the rack for connection to plant drain header.
- i) Each rack shall be provided with one receptacle, light fixtures each at instrument & Junction box compartments with wire guard.

5.13.03 Open Instrument Rack

- a) Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or falling objects and shall be epoxy painted. Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable protective grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project. Canopy shall be of CRCA steel sheet of at least 3 mm thickness. Center posts or any member, which would reduce access, shall be avoided.
- b) 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.
- c) All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.
- d) All racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Header shall be of 2" NB ASTM A 106, Sch-80 Gr. C installed at a slope of 1:25 and extended beyond the rack for connection to plant drain header.

5.13.04 Junction Box

Junction boxes of FRP construction with protection class conforming to IP 55.

- a) Junction box shall be provided at a dry compartment at one side of the enclosure / rack with front opening type door. Earth stud shall be furnished at rack for safety grounding.
- b) Terminals shall be screwless cage clamp type of reputed make and 20% spare terminals shall be furnished in the junction box.

~~6.00.00 **DISTRIBUTED CONTROL SYSTEM (DCS)**~~

~~6.01.00 System Functional Description~~

~~6.01.01 Integrated functionally distributed and hierarchically structured real time control (both binary and modulating), Data acquisition, Man machine interface, Historization units and Management Information System (MIS) system synthesized from one general family of identical interchangeable multifunction hardware has been envisaged.~~

~~6.01.02 System shall be highly reliable with the availability of not less than 99.7% with adequate redundancy and fault tolerant configuration.~~

~~6.01.03 The system shall be unitized and connectivity with other plant control system.~~

~~6.01.04 Remote input output stations as a data concentrator for acquisition and monitoring of Boiler metal temperature are foreseen. RIO shall be industrially ruggedized and shall be provided with integral air conditioner considering the harsh environment.~~

~~6.01.05 For Power supply to system refer Volume IIE Section I.~~

~~6.01.06 Controls of some plant auxiliaries for CW & ACW Pumps and Fuel oil heating & pressurizing system controls shall be realized in DCS through Remote I/O (RIO) cabinets.~~

~~6.01.07 Off-site & BOP plants such as Coal Handling Plant, Ash Handling Plant, Raw water & Pretreatment plant, Compressed Air System, Mill Reject System and Demineralized water plant etc. having microprocessor based or PLC based~~

14. Indication : Processor status and fault display
15. Features : Power fail hold, Automatic restoration on power

7.03.07 Operator's & Engineering Station:

The specification shall be as below or the latest available at the market at the time of contract:

- a) Operator's Station / Engineering Station (PC Based)
1. Intel Pentium Core 2 Duo processor with latest available speed;
 2. Windows XP Professional preloaded with CD media;
 3. 2 GB RAM;
 4. 320 GB HDD;
 5. 64 MB SVGA graphics card;
 6. 2 MB L2 Cache;
 7. 1 DVD Read / write;
 8. Antivirus protection software with license;
 9. 1 PCI Express x 1 slot 3 PCI 2.2 slot (5v, 32 bit) on Mini Tower, one PCI Express x 16 graphics slot;
 10. 4 x USB ports, 1 Serial Port, 1 Parallel Port, PS/2 Port for Mouse & Keyboard;
 11. 1 x 104 keyboard;
 12. Integrated sound Blaster Compatible Audio Controller 16-bit along with internal speaker;
 13. 10 / 100 / 1000 Mbps embedded Network Interface Card. Additional NIC with 2 nos. Intel Pro / 100S PCI Network Adapter Card;
 14. Minitower Chassis;
 15. 240 VAC 50 Hz power supply
- b) Client Server
- In case of Client Server Architecture this shall be of the latest model / version and shall have the following minimum requirements:
1. Two Intel Xeon up to 3.4 GHz Processors, 800 MHz FSB;
 2. Windows 2008 Server 10 user license preloaded with CD media;
 3. Interaction with at least 10 Clients;
 4. 2 GB ECC DDR (1GB Installed in two slots and two slots free) SDRAM;
 5. Dual 73 GB Ultra 320 SCSI internal storage; HDD partitioning C: 36 & D: 36;
 6. 64 MB SVGA graphics card;
 7. 2 MB L2 Cache;

8. DVD Read/Write;
9. Antivirus protection software with license;
10. 20 / 40 GB Internal DAT Drive;
11. 4 x 64 bit and 2 x 32 bit PCI slots;
12. 4 x USB ports, 1 Serial Port, 1 Parallel Port, PS/2 Port for Mouse & Keyboard;
13. 1 x 104 keyboard;
14. Integrated sound Blaster Compatible Audio Controller 16-bit along with internal speaker;
15. 10 / 100 / 1000 Mbps embedded Network Interface Card. Additional NIC with 2 nos. Intel Pro / 100S PCI Network Adapter Card;
16. 240 VAC 50 Hz power supply;
17. Tower Chassis;
18. 1 x 24" SVGA High Resolution TFT Monitor.

c) Monitor

1. Type : TFT monitor
2. Screen diagonal : 24" flat
3. Display : XGA or better
4. Resolution : 1680x1050 or better
5. Degree of protection : IP-30
6. External Controls : Brightness, contrast, Horizontal / Vertical amplification & shift
7. Power supply : 240 V, 50 Hz, 1 phase
8. Ambient temperature : 0-50 ° C
9. Humidity : 95% non-condensing
10. Version : To suit industrial application

d) Key Board

1. Type : Flat spill proof membrane type or Positive depression type
2. Different keys
 - a) Soft and user defined function keys for software/ programming including text correction, scan rate alteration, zooming/ flashing color selection etc.
 - b) Panel select keys for alarm summary, control loop display, overview, trend,

- graphic, operator guide message etc.
- c) Standard Alphanumeric keys
 - d) Alarm acknowledge keys
 - e) Cursor keys
 - f) Mode/loop status switching keys
 - g) Setting change keys
 - h) Print-out command keys
 - i) Other keys as required to operate the system
- 3. Key lock : Lockable type push button mounted on keyboard
 - 4. Life Expectancy 50 million cycles per key
 - 5. Version : To suit industrial application
- e) Laser Printer
- 1. Type : Electro-photographic laser, tabletop
 - 2. Printer Memory : 256 MB (min.)
 - 3. Speed : Monochrome 24 ppm - A4, Color 6 ppm - A4
 - 4. Resolution : 1200 x 1200 DPI in color
 - 5. No. of color (Basic) : 4 (four) minimum
 - 6. Duty cycle : Monochrome 75000 pages / month
 - 7. Power supply : 240 V, 50 Hz, 1 phase
 - 8. Ambient temperature : 0-50 Deg C
 - 9. Humidity : 95% non-condensing
 - 10. Size of paper : Letter, A4, Legal, Ledger, A3
 - 11. Print media : Plain paper, transparencies, thick stock, glossy stock, envelopes
 - 12. Accessories : Adapters, Connector Cable, Multiplexer switch (4 point)

7.03.08 Stackable Managed Switch

Data highway shall be of high speed Ethernet and full duplex configuration. Network shall be built on the Stackable Managed Ethernet switches for better control of data traffic & performance and future expansion. Switch configuration shall be redundant with seamless changeover without any upset in the process or equipment. Failure reporting shall be available at HMI. MTBF of the switch shall be more than 20 Years. Configuration shall be automatic.

7.03.09 Furniture

Bidder shall include a complete set of furniture for the Control Room and computer Room of ergonomic design from reputed manufacturer especially designed for computer peripherals. The set of furniture shall include but not be limited to control desk, chair, printer table, computer tables etc, all necessary furniture for Computer Room peripherals, cabinets for storage of manuals / booklets/recorder charts, storage racks for special tools/ diskettes and Shift Charge Engineer's desk/chair/side rack etc.

7.04.00 Software Specification

7.04.01 General

The system shall utilize a readily upgradeable, public domain software platform proven for real-time operation environment at the control and monitoring level overlaid with a relational database program. The desirable features are enumerated below.

- a) The operating system shall be suitable for real-time operation both at process as well as HMI end.
- b) The software system shall be fully modular.
- c) The software shall meet the following general requirements.
 - i) Simple, easy-to-learn language for editing and on-line operation.
 - ii) Wide range of peripheral support.
 - iii) Effective task scheduling and support of multiple priority structure including event based interrupt etc.
 - iv) Effective debugging.
 - v) Provision for on-line editing and program development without interrupting on-line functions.
 - vi) Self-diagnostic routines.
 - vii) Efficient memory management and effective utilization of system time.
 - viii) Quick start-up and loading.
 - ix) Support of multiprogramming and multi-user operation.

7.05.00 Memory Management / Operating System

- a) The main memory capacity shall be adequate to minimize swapping.
- b) Individual task shall reside in partitions, which can be split into sub-partition for parallel task handling.
- c) The operating system shall automatically perform housekeeping functions including file management.
- d) Task swapping shall be dynamic.

8.18.01 A Portable data collector shall be provided for taking periodic collection of non critical machine data. Machine condition monitoring system shall be capable to analyze the data. Instrument shall be microprocessor based and ready for use in harsh environment. Integral LCD display shall provide the necessary display of readings & spectral data. Minimum 02 channels along with additional input for phase reference measurement shall be available with the instrument.

8.18.02 Instrument shall include necessary accelerometers and other devices with accessories for collection of machine parameters. A long life Ni-Cd battery pack shall be used. Replacement of battery shall not lead to loss of stored data.

8.18.03 Shaker table shall be provided for testing & calibration.

9.00.00 INSTRUMENTATION & CONTROL CABLE

9.01.00 Cables shall be flame retardant low smoke (FRLS) type. In hazardous areas cables of suitable R/L ratio shall be provided for intrinsic safety.

9.02.00 Durable marking shall be provided on the surface of the cable at intervals not exceeding 5 mtrs. Marking shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / triads / type of compensating /extension cable), Insulation material, FRLS etc.

9.03.00 Sequential length marking shall also be provided at every meter interval on outer sheath of cable.

9.04.00 Standard seasoned wooden drum containing minimum 500 /1000 M \pm 5% length. Drum shall be anti rodent, anti termite and smooth finish. Both end of cable shall be capped by means of non hygroscopic sealing material.

9.05.00 Thermocouple Extension & Compensating Cable

- | | | |
|-----------------------------|---|--|
| 01. Conductor | : | Solid conductor |
| 02. Conductor size | : | 0.75 sq.mm |
| 03. Type | : | KX (Extension) (Chromel Alumel)
RX (Compensating) (Copper-Copper alloy)
JX (Extension) (Iron Constantan) |
| 04. Conductor Insulation | : | HR PVC Type-C (IS-5831,1984) 0.6 mm thick |
| 05. Operating Voltage | : | 300V /500V RMS (Core to earth / core to core) |
| 06. Twisting | : | Pair twisted with lay of 60 mm (max) |
| 07. Twisting Direction | : | All pairs in the same direction. Lapped to form bunch with mylar tape. |
| 08. Screen (Pair & Overall) | : | Aluminium mylar tape with a thickness of 28 μ m (min.) for individual pair screen and 60 μ m (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire. |

09.	Drain wire	:	Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
10.	Inner Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) HR PVC Type ST2 of IS-5831,1984 Thickness as per IS-1554Part-I 1976
11.	Rip Cord	:	Non metallic under sheath
12.	Armouring	:	GI wire / strip as per IS 3975
13.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) HR PVC Type ST2 of IS-5831,1984 Thickness as per IS-1554Part-I 1976
14.	Filler	:	Non hygroscopic with FRLS property
15.	Temperature Range	:	Up to 85 °C
16.	Insulation at 20 ⁰ C	:	100 MOhms/Km [Min]
17.	Capacitance at 800 Hz	:	120 nf/km
18.	Cross talk	:	60 dB
19.	Attenuation	:	1.2 dB/Km
20.	Codes & Standards	:	a) IEC 332-1 b) ANSI MC 96.1 c) IS-8784-1987
21.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863) b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I c) Temp Index : Min 250 DEG C at 21Oxy. Ind. (ASTM-D-2863) d) Smoke Density Rating : Max.60% (ASTM-D-2843). e) Flammability Test : as per IEC 332 Part-I /IEEE-383 Swedish Chimney Test - SS-424- 1475 F3 f) High voltage test Core to core- 1.5 KV for 1 min. Core to screen- 1.0 KV for 1 min. g) Insulation Resistance 100 M Ohm / Km Min

- h) Rodent & Termite repulsion test (Presence of lead shall be confirmed)

22. Conductor material & sheath color for thermocouple cable as per ANSI MC 96.1

CABLE TYPE	OVERALL SHEATH COLOR	WIRE	SHEATH COLOR	CONDUCTOR MATERIAL
KX	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Aluminum
JX	Black	Positive	White	Iron
		Negative	Red	Constantan
RX	Green	Positive	Black	Copper
		Negative	Red	Copper Nickel Alloy

23. Durable printed or embossed numbering at regular interval of 50mm shall be provided for identification of pairs.

9.06.00 Instrumentation multi Paired Signal Cable

01. Conductor type : Stranded (7) annealed tinned copper
02. Conductor size : 0.5 / 1.0 / 1.5 Sq.mm (as required)
03. Conductor resistance : 39 Ω/Km/18 Ω/Km/12 Ω/Km
04. Conductor Insulation : HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05. Operating Voltage : 300 / 500V RMS (Core to earth / core to core)
06. Twisting : Twin twisted with lay of 60 mm
07. Twisting Direction : All pairs in the same direction. Lapped to form bunch with mylar tape.
08. Screen (Pair & Overall) : Aluminium mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire.
- * Analog signals- Individual pair & overall shield to be considered.
 - * Binary signals- overall shield to be considered.

09. Drain wire : Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
10. Inner Sheath : Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
HR PVC Type ST2 of IS-5831,1984
Thickness as per IS-1554, Part-I 1976
11. Rip Cord : Non metallic under sheath
12. Armouring : GI wire / strip as per IS 3975
13. Outer Sheath : Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
HR PVC Type ST2 of IS-5831,1984
Thickness as per IS-1554, Part-I 1976
14. Filler : Non hygroscopic with FRLS property.
15. Temperature Range : 85 °C
16. Insulation at 20 Deg.C : 100 MOhms/Km [Min]
17. Capacitance at 800 Hz : 120 nf/km
18. Cross talk : 60 dB
19. Attenuation : 1.2 dB/Km
20. Codes & Standards : a) IPCEA-S-61-402
b) BS 5308
c) IEC 332-1
d) ASTM-B-33
e) IS-8130-1984
f) IS 1554 Part-1
g) IS 10810
21. Sheath colour : Inner- Black and Outer- Gray
22. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
c) Temp Index : Min 250 ° C at 21Oxy. Ind. (ASTM-D-2863)
d) Smoke Density Rating : Max.60% (ASTM-D-2843).
e) Flammability Test : as per IEC 332 Part-I
f) Swedish Chimney Test-SS-424-1475 F3
g) Insulation Resistance 100 M Ohm / Km Min

- h) High voltage test
 - Core to core- 1.5 KV for 1 min.
 - Core to screen- 1.0 KV for 1 min.
- i) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)

23. Colour of core for Instrumentation Cable (As per IS-9938)

PAIR	CORE	COLOR
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black

Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

9.07.00 Cables near high temperature zone shall be capable of withstanding high temperature and terminated in junction box / panel in normal temperature zone. Teflon insulated and sheathed thermocouple extension cables and copper conductor cables shall be used in high temperature zone. Conductor and sheath shall be extruded FEP (Teflon) as per VDE 0207 Part 6 and ASTM D 2116. These cables shall be pair, multipair, triad, multitriad and twisted & shielded.

9.08.00 Control & power Cable

Bidder shall refer to Volume IIF of the electrical specification for detail.

10.00.00 **ERECTION HARDWARE**

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

10.01.00 Electrical Accessories

Electrical conduit and associated materials shall conform to the requirements of the articles which follow :

- a) Rigid Steel Conduit
 - i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.

- ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.
- iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with ANSI C 80.1 and UL6. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.
- iv) All conduit fittings shall conform to the requirements of ANSI C 80.4 and UL-514 where these standards apply.
- b) Flexible Conduit
 - i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.
 - ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.
- c) Special Fittings
 - i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.
 - ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

10.02.00

Electrical Junction Box

1.	Type of Enclosure	: Dust tight & weatherproof conforming to IP 65
2.	Material	: 3 mm sheet steel
3.	Type of Cover	: Solid unhinged with retention chain
4.	Paint	: RAL 7032
5.	Mounting	: Surface
6.	Cable Entry	: 3 mm (min) Gland plate
7.	Gasket	: Neoprene
8.	Grounding	: Brass earth lug with green screw head External-2 nos , Internal-1no.M6
9.	Number of Drain Holes	: Two at bottom capped
10.	Identification	: Label for JB and Tags for cable

11.	Accessories	: Rail mounted cage clamp type screwless terminals with markers, Cable gland, Ferrules, Canopy at top
-----	-------------	---

10.03.00 Cable Gland

1.	Type	: Double compression
2.	Entry Thread	: NPT
3.	Material	: Brass
4.	Finish	: Cadmium Plated.
5.	Protection	: IP 54 or better
6.	Accessories	: Neoprene gasket, locknuts, reducers etc

10.04.00 Cable Tray

1. Material : Mild steel, slotted
2. Thickness : not less than 2.0 mm
3. Finish : Hot dip galvanized
4. Perforation : As per MFR standard
5. Cover : Suitable for tray

10.05.00 Process Hook Up Accessories & specification

Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for owner's approval.

10.05.01 Seamless Stainless Steel Pipe

1. Reference : ASTM A-312 TP 316
2. Material Grade : TP 316
3. Type : Seamless /Plain end
4. Size : ½" NB
5. Schedule : 40
6. Standard Length : 5 meter

10.05.02 Stainless Steel Pipe Fittings

1. Reference : ASTM A-182 F 316 / ANSI B16.11

2. Type : Forged
3. Rating : 3000 lbs / 6000 lbs / 9000 lbs
4. Size : ½" NB
5. End connection : Generally socket weld
6. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

10.05.03 Seamless Stainless Steel Tube

1. Reference : ASTM A-213 TP 316
2. Material Grade : TP 316
3. Size : ½" OD X 2.1 MM Thick
4. Type : Cold drawn annealed, pickled, passivated, de-scaled,hydraulically cleaned seamless tube.
5. Properties : The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
6. Test Pressure : 400 Kg/Sq. cm (minimum)
7. Tolerance : ± 0.13 mm for outside diameter
: ± 15 % for wall thickness
8. Standard Length : 5 meter
9. Test : Flare, Hardness, Ball and Bubble Test

10.05.04 Stainless Steel Tube Fittings

1. Reference : ASTM-A-182
2. Type : Double ferrule double compression
3. Material : 316 Stainless steel forged
4. Ferrule : 316 Stainless Steel
5. Type of Fittings : Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
6. Size : To suit SS tubing and NPT end connection

- 10.05.05 C.S. Pipe
1. Reference : ASTM-A 106 Gr. C
 2. Material : Cold drawn seamless black C.S.
 3. Type : Seamless / Plain ends
 4. Size : ½" NB
 5. Schedule : 80, 160, XXS as required
 6. Standard Length : 5 meter
- 10.05.06 C.S. Pipe Fittings
1. Reference : ASTM-A 105 / ANSI B16.11
 2. Type : Forged
 3. Rating : 3000 lbs / 6000 lbs / 9000 lbs
 4. Size : ½" NB
 5. End connection : Generally socket weld
 6. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.
- 10.05.07 A.S. Pipe
1. Reference : ASTM-A 335 P22 AS PER ANSI B 36.10
 2. Material : Cold drawn seamless A.S.
 3. Type : Seamless / Plain ends
 4. Size : ½" NB
 5. Schedule : XXS
 6. Standard Length : 5 meter
- 10.05.08 A.S. Pipe Fittings
1. Reference : ASTM-A 182 F22 AS PER ANSI B 16.11
 2. Type : Forged
 3. Rating : 9000 lbs
 4. Size : ½" NB
 5. End connection : Generally socket weld

6. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.
- 10.05.09 Carbon Steel Globe Valve
1. Reference : ASTM A-105
 2. Type : Globe
 3. Construction : Forged Body Cadmium Plated
 4. End Connection : ½" Socket Weld
 5. Rating : Cl. 800 / CL. 2500
 6. Material : Body - Carbon steel
: Stem - Hardened Steel
: Plug - AISI 316 SS
: Seat- Stainless steel stellite
 7. Packing : Teflon / Grafoil as required
 8. Yoke : ASTM A105
 9. Hand wheel : Carbon steel
 10. Design standard : As per ANSI B 16.34
- 10.05.10 Stainless Steel Globe Valve
1. Reference : ASTM A-182 F316
 2. Type : Globe
 3. Construction : Forged Body
 4. End Connection : Socket Weld
 5. Proof Pressure : 400 Kg/Cm2
 6. Material : Body - Stainless steel
: Stem - Hardened Steel
: Plug - AISI 316 SS
: Seat- Stainless steel stellite
 7. Packing : Teflon as required
 8. Yoke : ASTM A182 F316

-
- | | | | |
|----------|-----|---------------------------|--|
| | 9. | Handwheel | : Carbon steel |
| | 10. | Design standard | : As per ANSI B 16.34 |
| 10.05.11 | | Alloy Steel Globe Valve | |
| | 1. | Reference | : ASTM A-182 F22 |
| | 2. | Type | : Globe |
| | 3. | Construction | : Forged Body |
| | 4. | End Connection | : ½" Socket Weld |
| | 5. | Rating | : CL. 2500 |
| | 6. | Material | : Body - Alloy steel
: Stem - Hardened Steel
: Plug - AISI 316 SS
: Seat- Stainless steel stellited |
| | 7. | Packing | : Grafoil as required |
| | 8. | Yoke | : ASTM A182 F22 |
| | 9. | Handwheel | : Carbon steel |
| | 10. | Design standard | : As per ANSI B 16.34 |
| 10.05.12 | | Condensate Pot | |
| | 1. | Reference | : ASTM A182 F22 /ASTM A105 |
| | 2. | Material | : Alloy steel / carbon steel as per application |
| | 3. | Construction | : Drilled from barstock |
| | 4. | End connection | : 3 nos. ½" socket weld end |
| | 5. | Accessories | : Vent valves |
| 10.05.13 | | Instrument Valve Manifold | |
| | 1. | Type | : Two valve manifold
: Five valve manifold |
| | 2. | Mounting | : Remote 2" Pipe Mounting |
| | 3. | Construction | : Single block (bar stock) |
| | 4. | Material | : Forged body and bonnet AISI 316 stainless |

- steel
5. Ports : 1/2 " NPT (F)
 6. Rating : 420 Kg/Sq. cm at ambient
 7. Operating Temperature : (-)30 to (+)170 Deg C
 8. Packing : PTFE Wafer
 9. Seat & Stem : AISI 316 SS
 10. Plug : AISI 316 SS free to turn on stem / 17-4 PH
 11. Handle Bar : AISI 316 SS
 12. Connection : Straight
 13. Accessories : Plugs for all ports, Mounting Bracket , bolts , nuts

10.06.00 Pneumatic Hook Up Accessories

10.06.01 Air Header

Technical Particulars	For Panel	For Field
Material of Construction	: Stainless steel	: Stainless steel
Inlet Connection	: 2" NPT (M)	: 1" NPT (M)
Header Take-off Material	: stainless steel	: stainless steel
Take off connection	: 1 / 2" NPT (M)	: 1/ 2" NPT (M)
Take-off Valves Material	: stainless steel	: stainless steel
Tube Take-off	: Tube adapter on valve	: Tube adapter on valve
Drain	: SS drain valve at lowest point	: SS drain valves at lowest point

10.06.02 Seamless Stainless Steel Tube

1. Reference : ASTM A-269 TP 316
2. Material Grade : TP 316
3. Size : ¼" OD X 0.049" wall thickness

4. Type : Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
5. Properties : The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
6. Test Pressure : 400 Kg/Sq. cm
7. Tolerance : ± 0.13 mm for outside diameter
: ± 15 % for wall thickness
8. Standard Length : 5 meter
9. Test : Flare, Hardness, Ball and Bubble Test

11.00.00 **SPECIAL TOOLS & TACKLE AND TEST EQUIPMENT FOR AND OTHER SYSTEMS**

- 11.01.00 Bidder shall supply a complete set of new, unused and reliable type of special tools and tackle and test equipment which are necessary or convenient for erection, commissioning, maintenance and overhaul of the plant and equipment provided under this specification.
- 11.02.00 The tools & tackle and Test Equipment shall be shipped in separate container, clearly marked with names of the equipment for which they are intended.
- 11.03.00 Bidder shall furnish list of tools & tackle and test equipment proposed to be supplied along with the bid.

material with suitably colored lettering engraved on the back.

- c) The nameplates shall be held by self-tapping screws. The size of nameplate shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for the panels.
- d) Items of plant such as valves, which are subject to handling, are to be provided with an engraved chromium plated nameplate or label with engraving filled with enamel, suitably mounted or affixed with strong rustproof chain.
- e) All such nameplates, instruction plates, lubrication charts etc. shall be with English inscriptions.

8.00.00 **METERING BASES AND CHART UNITS**

The following system of units shall be followed for various displays and scales unless otherwise mentioned:

- i) Pressure : Kg/cm²
Differential Pressure : mm of H₂O column / Kg/cm²
- ii) Draught : mm of H₂O column
- iii) Vacuum : Kg/cm² (abs)/mm of Hg column
- iv) Temperature : Degree Celsius (° C)
- v) Flow (Steam, Water) : Tonnes / hr, M³/Hr
- vi) Flow (Oil) : M³ / Hr, Litter/Hr
- vii) Flow Air : Tonnes / hr / M³ / Hr.
- viii) Density : gms / c.c.
- ix) Level : mm /%
- x) Conductivity : μS / cm or mS/cm
- xi) Gas Analyzer : Percentage by weight or as specified in respective case.
- xii) Dissolved Oxygen / Silica / Sodium : ppm /ppb

9.00.00 **PROCESS CONNECTION & INSTRUMENT HOOK UP**

9.01.00 Instrument connection to the process system (piping, vessel etc.) shall be according to the process & piping specification upto and including the root valves. Root valves shall be installed as close as possible to the piping or vessel.

- 9.02.00 Each instrument shall have its own independent connection to the process except for instruments located on standpipe. Each instrument shall be connected independently to the standpipe through isolation valve.
- 9.03.00 Isolation and blowdown drain valves adequate for duty and capable of withstanding continuous design condition of main process shall be provided. Instrument blow down valve near to the instrument shall be of gradual opening type. For process pressure equal or above 40 kg/ sq.cm double blowdown valves shall be used connecting to blowdown header. Instrument manifold / gauge valve shall be installed close to the instrument.
- 9.04.00 The nominal size of the takeoff connections on line shall not be less than NPS 1/2" for source conditions not in excess of either 900 psi or 425OC and NPS 3/4" (for adequate physical strength) for design conditions exceed either of these limits. Where the size of the main is smaller than the limits given above, the takeoff connections shall not be less than the size of the main line.
- 9.05.00 Process connection for instruments lines and vessels shall be in accordance to standards such as ASME or other recognized international standards. Table below indicates the type of connection generally to be used.

INSTRUMENTS	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
Level Instruments		
Internal Displacer	4" - Flanged	4" - Flanged
External Displacer	2" - Flanged	2" - Flanged
Level gauge	3/4" -Flanged	3/4" - Flanged
DP Type	1/2" (min.)-welded 1" – welded for vessel like HP heaters, LP heaters, De-aerator etc. application	1/2"- NPT
External cage Level switch	1"- welded	1"- welded
Flow Instruments		
DP Type	1/2" - welded in general 1" – welded for high pressure / temperature main steam, feed water, PRDS etc. application	1/2" - NPT
Pressure Instruments		
Conventional	1/2" (min.)-welded 1"- welded for high pressure/	1/2" - NPT

INSTRUMENTS	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
	temperature main steam, feed water, PRDS etc. application	
Diaphragm type-HFO application	3"- Flanged	3"- Flanged
Temperature Instruments		
Thermowell	Generally - M 33 X2 (M); 1½" Flanged- For air/FG path application	½" NPT
Analyzer		
Liquid analyzer	½" - 1" - welded	½"

- 9.06.00 Size of impulse pipe for pressure measurement in air and flue gas duct path of boiler shall not be less than ¾" NB.
- 9.07.00 Separate stubs and take-off points with thermo well / root vlves shall be provided for performance guarantee test.
- 9.08.00 Impulse pipes shall be clamped at suitable interval not exceeding 1.5 meter. Process pipe shall not be used for supporting the impulse pipe.
- 9.09.00 Fittings shall conform to ANSI B 16.11. Threads of piping component shall be of tapered construction.
- 9.10.00 Instrument blowdown header shall in no case be lower than the material grade ASTM A 106 Gr. C.
- 9.11.00 Impulse pipe shall be laid at least with slope of gradient 1:10 to avoid any air pocket or water accumulation.
- 9.12.00 Expansion loop shall be provided at least at every 2.5 meter interval without affecting the gradient of slope in long run impulse pipe to avoid stress on the piping.
- 9.13.00 Siphon shall be provided in the impulse pipe or tube to protect the instruments where fluid temperature is 100 OC or more.
- 9.14.00 Orientation of tappings shall be as follows :
- a) For liquid service within 45 ° at lower half of the pipe horizontal plane.
 - b) For gas service within 90 ° at upper half of the pipe horizontal plane.
 - c) For steam service within 45 ° at upper half of the pipe horizontal plane.

- As a rule tap orientation of high and low pressure side should be parallel and symmetrical.
- 9.15.00 Pressure & Differential pressure instruments in steam and liquid services shall be located below the taps and the piping shall be sloped to avoid formation of air pocket.
- 9.16.00 Pressure & Differential pressure instruments in air and flue gas service shall be located above the taps and the piping shall be sloped back to process to avoid formation of any liquid.
- 9.17.00 Impulse pipe including taps for furnace, flue gas and coal mill application shall be provided with air purge connection. Differential instruments for such application shall have continuous and as well as intermittent purging. Whereas, pressure measurement shall have only intermittent purging.
- 9.18.00 Material of impulse pipe for the instruments mounted on rack and enclosure shall be same as that of main process pipe except stainless steel tube of Gr. 316 or better shall be provided for connection in between impulse pipe (from tee connection on impulse pipe) and instrument manifold valve & instruments. Impulse pipe, tubes, fittings and accessories shall have the same design pressure and temperature applicable for the related main pipe.
- ~~10.00.00 **POWER SUPPLY SYSTEMS**~~
- ~~10.01.00 Instrumentation power supply system shall include all conditioning equipment required to accommodate normal variations in the electrical supply. All panels and cabinets shall accept redundant power feeds from two different sources.~~
- ~~10.02.00 Type of power supply systems envisaged for the various I & C system including DCS are as follows:~~
- ~~a) 240V AC Redundant UPS system HMIs, Main Plant Field devices / equipment, CCTV, EWLI, CEMS, SWAS etc. and PLC of package System~~
- ~~b) 24V / 48 VDC Supply for DCS~~
- ~~11.00.00 **ENVIRONMENTAL CONSIDERATIONS**~~
- ~~I & C components should operate properly with no degradation in expected lifetime or in operation parameter in the normal power plant environment. I & C system shall be designed considering all the operating conditions which may be encountered during installation and operation.~~
- ~~11.01.00 Temperature~~
- ~~11.01.01 Where the environmental extreme exceeds the capabilities of the selected system, Bidder should take appropriate steps to control the environment.~~
- ~~11.02.00 Humidity~~
- ~~11.02.01 I & C system shall be designed to withstand the humidity limits specified for the project. Condensation shall not be allowed to form in the cabinets nor~~



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

CHECK LIST FOR PRESSURE 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			
	1.1 MODEL NO/TAG NO								
	1.2 RANGE								
	1.3 END CONN								
	1.4 NO. OF CONTACT								
2	CALIBRATION					P	V	V	
	2.1 REPEATABILITY								
	2.2 SET POINT ADJUSTMENT								
	2.3 DIFFERENTIAL								
3	OVER PR & LEAK TEST					P	V	V	
4	ELECT. INSULATION/HV TEST	ONE			P	V	V		
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT							
	5.1 SENSOR								
	5.2 MOVEMENT								
	5.3 PROCESS CONNECTION								
	5.4 HOUSING								
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST			V	V	V		
7	REVIEW OF TC OF MICROSWITCH	FOR LOT			V	V	V		

** 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 carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



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

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS	P		W	V		
6	EFFECT OF TEMP VARIATION ON ACCURACY	P		W	V		
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION		P	W	V		
13	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.
- When material correlation are not available manufacturer'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 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	ONE	APPROVED SPEC./ DATA SHEETS	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	APPROVED SPEC./ DATA SHEETS	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 LEVEL 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 / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION	ONE / LOT		P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR			P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	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 %.
- 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 ANNUNCIATORS

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	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	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 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.

	1X800 MW Wanakbori STPP	SECTION: C SUB SECTION : C&I SHEET 11 of 18
	TECHNICAL REQUIREMENTS (C&I)	

PLC SPECIFICATION

|

- 3.12.07 Individual gauge board (as per manufacturer's standard) shall be provided near each Air Drying plant for local indication of all important parameters such as pressure, temperature, flow related to the driers.
- 3.12.08 Bidder shall provide all measuring instruments with required accessories for control, monitoring, protection and interlock of the compressors and driers. Electronic analog signal transmission from field transmitters to area control rooms shall be 4-20 mA DC. All process switches, limit switches and drive feed back signals shall be provided with potential free contact. Temperature detector will be provided at each stage of the compressed air system and cooling water system of compressors for monitoring in the local control panel.
- a) The control system shall meet the requirement of monitoring, sequential starting/stopping of drives, interlock and protection, individual/sequential control metering, annunciation and on-line and all other routine functions with minimum operator's intervention.
- b) In line flow gauge & flow switch shall be provided on the cooling water line of the compressed air system.
- 3.12.09 Dew point measurement shall be provided for each Air drying plant of compressed air system. The output of the instrument shall be 4-20 mA DC to be connected to the master controller panel.
- 3.13.00 Fuel Oil Unloading System
- 3.13.01 The Fuel Oil Unloading System shall be controlled from PLC based local control system or relay based system. No operator work station has been envisaged for this system. The system shall be operated from Lamp / Pushbuttons, selector switches etc located on the panel. Integral type hardware annunciation system shall be provided at the top of the panel for alarm monitoring. Important parameters i.e. tank levels, oil flow, oil temperature etc. from this panel shall be monitored in the station DCS via RIO considered for Fuel Oil Pressurising & Heating System. Facility shall be provided in the PLC for connecting laptop for programming.
- 3.13.02 Level signals from HFO/LDO day tank shall be connected to DCS via hardwired link for control of HFO/LDO transfer pumps. Bidder shall keep these signals terminated in suitable terminal blocks of the local panel.
- 3.14.00 Ventilation And AC System
- 3.14.01 For detail Instrumentation systems, operation & control philosophy refer Vol IIB.
- 4.00.00 **TECHNICAL SPECIFICATION – CONTROL SYSTEM**
- 4.01.00 Brief technical specification of the PLC based control systems are delineated below.
- 4.01.01 Programmable Logic Controller (PLC) based control system shall have 1:1 hot redundant configuration. Central Processing Units (CPUs) shall have word length of 32 bits minimum.

- 4.01.02 Following components shall be redundant as well : communication processors, memory modules, rack power supply units, bulk IO power supply units, IO communication modules, data highway and high speed (100Mbps) data network connecting the operator stations.
- 4.01.03 Two CPUs shall operate on fault tolerant mode with continuous self and cross-monitoring. Failure of the active CPU shall not affect the operation of the plant. In the event of failure of active CPU, tasks shall be transferred to the standby CPU within fastest possible transfer time (< 5m sec.) without causing any relays to drop out during the transfer.
- 4.01.04 CPUs shall not be loaded to over 60% of their capacity even under worst data loading conditions. It shall be possible to make a manual transfer from the active to the back-up CPU from engineering station and as well as from the front panel of CPU module.
- 4.01.05 Modules shall have adequate status and diagnostic indication on the front panel.
- 4.01.06 System shall be of modular construction and expandable by adding hardware modules. Bidder shall provide at least 20% or a minimum of one off, spare channels as hot-on-rail spares in each configured cards / modules. In addition to this, 10% or minimum of one off, extra assigned complete spare modules mounted on rails in racks for each type of I / O modules shall also to be provided. The spare channel and cards shall be fully wired and terminated.
- 4.01.07 Memory unit of the CPU shall be field expandable at least by 25%. Operating system / application program / sequence logic etc. shall be stored in nonvolatile memory for automatic re-booting. Dynamic memories shall be provided with battery back up at least for 360 hours.
- 4.01.08 Number of input / output points per card shall not exceed 16 (sixteen) for digital and 8 (eight) for analog / thermocouple / RTD signals. Individual input and Output channels shall have galvanic / optical isolation. Merely fusing of individual or a group of channels is not acceptable.
- 4.01.09 Data communication system of the PLC shall not be limited to the following:
- a) Internal bus and external data network loading shall in no case be more than 60% of its capacity.
 - b) Disrupted message shall be automatically retransmitted when the system is restored.
 - c) Failure or physical removal of any module connected on the system bus shall not lead to any loss of communication.
 - d) Diagnostics message shall be issued on fault detection.
 - e) Bus change over from active bus to stand by bus, during failure of active bus, shall be performed automatically and bumplessly. Such event shall be suitably logged or alarmed.

- f) Noise immunized and reliable highspeed dual fault tolerant optic fiber cable communication with standard communication protocol shall be provided between PLC s and remote or extended I/O modules.
 - g) Main data network shall comply with the International Standard IEEE-802.3 (Ethernet) for data exchange and communication.
- 4.02.00 Operator workstation shall be complete with latest user friendly operating system, 24" colour LCD monitor, membrane KB, mouse, colour laser printer and dot matrix printer. In addition, a laptop unit loaded with engineering software shall be furnished.
- 4.02.01 The functions performed from the HMIs shall not be limited to the following:
- a) Selection of auto/Manual, open/close, sequence auto, start/stop operation.
 - b) Dynamic Mimic display depicting the process.
 - c) Alarm monitoring, report & log generation, printing of trends etc.
 - d) On line / historical trending, historical storage and retrieval of data.
- 4.03.00 Software
- a) Necessary software for implementation of the control logics, operational displays & logs, data storage, retrieval and other functional requirements, shall be provided.
 - b) Licensed version of required software including operating system, configuration and HMI software shall be provided.
 - c) Detail documentation on the programming softwares as part of the O&M manual.
- 4.04.00 Power Supply
- a) Power supply to the PLC system shall be provided from solid-state 240V AC \pm 1% packaged UPS (Uninterruptible Power Supply) units to be placed local to the control systems. UPS system shall be complete Ni-Cd type battery & battery chargers. UPS shall have adequate capacity to cater 100% load without overloading. UPS system shall be adequate to provide back up power for not less than 30 minutes.
 - b) UPS shall be complete with AC Distribution board. Two feeders shall be extended from ACDB to PLC.
 - c) Bulk power supply units for interrogation, relay and solenoid voltage shall be separate from system power supply units and shall be redundant.
- 4.05.00 System shall have MTBF better than 99.7% and shall be hot maintainable. System hardware shall be designed to be 'fault avoidant' by selecting high-grade components of proven quality and properly thermally de-rated design. The network shall have extensive fault monitoring, self-surveillance & on-line self-diagnostic capability so that failure is immediately detected.

- 4.06.00 System shall automatically check & correct gain & drift for ADCs on-line.
- 4.07.00 Data exchange in a bus shall be fully monitored and checked for validity.
- 4.08.00 Response time consisting of IO scan time, data communication time, processing time etc. shall be equal to or less than the following :
- a) OLCS & sequence control inputs : 100 ms.
 - b) CLCS inputs : 250 ms.
 - c) Monitoring analog parameters : 500 ms.
 - d) Monitoring digital parameters : 100 ms.
- 4.09.00 Following operations will be performed on I/Os, as required:
- a) Square root extraction
 - b) Pressure & temperature compensation
 - c) Reasonability check of all inputs, validation and quality tagging like good, bad, suspect etc.
 - d) Channel wise engineering unit conversion
 - e) Contact bounce filtering with adjustable time constant.
- 4.10.00 The controllers shall be time synchronized to GPS master clock via IRIG-B or Ethernet port. Software capability shall be provided to implement closed loop control functions as follows:
- a) PID control and their variations.
 - b) On-off control
 - c) Cascade control
 - d) Ratio and bias control
- 4.11.00 Features for Open Loop Control shall not be limited to following:
- a) Logic functions like AND/OR/NOT gates, timers (on-delay, off-delay), shift registers, counters, latches, flip-flops, mono-shots etc.
 - b) Automatic sequence control for start up and shutdown of auxiliaries / equipment in functional groups initiated by command from operator's console. A sequence shall be made of steps executed in predetermined order according to logic criteria. For each step there shall be a provision for `waiting time' and `monitoring time'. System shall have the capability to bypass a step, if desired, from the operator's station. Such action however shall be registered as an exception.
 - c) Inputs for protection system shall be of high priority. In the event of either loss of control power or control signal input to the drive, the drive shall remain in its last position unless specifically required otherwise. The

system shall be designed such that no upset occurs either to process or to the drive when the power is restored.

4.12.00 Interface of the system with M.C.C / Switchgears shall be in the form of potential free contacts via interposing relay modules mounted in the respective switchgear or MCC unit. Other interfacing relays shall be mounted in a cabinet separate from the system cabinet. 10% wired additional interposing relay modules shall be provided as installed spare. Freewheeling diodes shall be provided across the coil of DC solenoid and contactors / relays. For AC solenoids and contactors directly driven from output cards, arc suppressors shall be provided across the coil.

Each I / O rack shall have 10% spare rack space for future upgradation.

4.13.00 Single programming instruction / command shall be sufficient to delete a program rung from memory. Similarly, any rung can be inserted into the existing program. The active and the stand-by CPU programs shall equalize automatically, once the new program is permitted to 'RUN'.

4.14.00 Updating time and reaction time shall be as follows:

- | | | |
|------------------------------------|---|------------------|
| a) Calling up a mimic | : | 2 sec or better |
| b) Updating status signal in mimic | : | 1 sec or better |
| c) Updating variables in a mimic | : | 1 sec. or better |
| d) Issuance of command to output | : | 1 sec. or better |

(without considering process lag)

4.15.00 Displays shall be classified into overview display, group display, point display and trend display.

4.16.00 Printing of logs shall be initiated automatically at prescribed time intervals, or initiated on demand by the occurrence of predefined events.

System shall permit the operator to specify minimum of 5 summary logs each with minimum of 25 points to be printed on demand.

4.17.00 Salient features of the PLC system for I/O handling shall be as follows:

- a) Input filters to attenuate noise.
- b) Isolation of 1500V AC for the input & output module.
- c) Comm. Mode Noise rejection for analog inputs of 120 db at 50 Hz.
- d) Normal mode noise rejection for analog inputs of 60 db at 50 Hz.
- e) LED indicators on each card to show status of input.
- f) All the outputs shall be with individual fuse.
- g) J/K type thermocouple mV input where applicable.

- h) Pt-100 three / four wire resistance thermometer input where applicable.
- i) 24 V DC power supply to field mounted two wires transmitters.

4.18.00 Salient hardware/ software features of the CPUs shall be as follows:

- a) Watch dog timer : Periodical reset. Alarm and interruption, if not reset within stipulated time.
- b) Max. scan time for inputs: 1 sec. max.
- c) Maximum Scan Rate : 1 ms (Per K Word) or better
- d) Memory capacity : 25% spare capacity after full utilization. Expandable in multiples of 16 K.
- e) Comm. processor : Separate
- f) Battery back up for RAM : 360 hrs continuous operations.
- g) Diagnostic feature : Periodic, automatic self- diagnostic.

4.19.00 Salient features of the Input / Output modules are as follows:

- a) All modules
 - 1. Surge withstand capability : IEC-255.4
- b) Digital General
 - 1. No. of channels / module : 16
 - 2. Interrogation voltage : 24V DC or 48 V DC
 - 3. Status indicator : LED type.
 - 4. Isolation : Optical
- c) Digital Input Module
 - 1. Contact bounce filtering : Adjustable time constant of 15 m. sec.
 - 2. Diagnostic : Module fault
- d) Digital Output Module
 - 1. Output protection : Short ckt. Proof & Individual fuse
 - 2. Diagnostic : Module fault
- e) Analog General
 - 1. No. of channels / module : 8
 - 2. Isolation : Galvanic/Optical

- f) Hi-level Analog Input Module
1. Type of input : 4-20 mA DC / 1-5V DC
 2. A/D Converter : 11 bits + Sign (or better)
 3. Accuracy : 0.1% or better
 4. Diagnostic : Module fault
 5. Powering of transmitter : 24 V DC 2 W type
- g) Low Level Analog Input Module
1. Type of input : PT-100; T/C(As required)
 2. C-J-C : On Module
 3. Accuracy : 0.1% or better
 4. A/D converter : 15 bits + Sign (or better)
 5. Diagnostic : Module fault
- h) Analog Output Module
1. Type of output : 4-20 mA DC
 2. Accuracy : + 0.1% or better
 4. A/D Converter : 11 bits + Sign (or better)
 5. Load : 600 OHM
 6. Diagnostic : Module fault

5.00.00 **OPTICAL FIBRE CABLE**

5.01.00 This specification defines the minimum general requirements for the Design, manufacture, supply, inspection, installation, testing & commissioning of optical fiber cables and accessories, such as fiber distribution (patch) panels, adapters, connectors, joint boxes, pigtailed and other components, as required to complete the system. Bidder shall consider all related activities, such as cable stripping, cable entry in boxes and panels, cable fiber splicing/fusion, cable performance testing and other services, to achieve a properly documented and operational cable network.

5.02.00 Fiber Optic Cables shall be installed on cable tray, duct bank, cable trench, as necessary. For outdoor applications the cable shall be armoured with Poly Ethylene sheathing. Cable shall be routed through suitable grade permanently lubricated HDPE protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08 /01of suitable size @ 53% fill factor.

5.03.00 The Optical Fiber core shall be of ultra pure fused silica glass coated with UV-cured acrylate suitable to withstand temperature of about 80°C (continuous).

- 5.04.00 Fiber optic cable shall be of loose tube design. Typically, fibers 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 like Poly-Butelene Terathylate (PBT). They shall be colored for easy identification. Buffer tubes shall be approachable with industry standard tools and 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. 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.
- 5.05.00 The central strength member of the cable shall be Fiberglass Reinforced Plastic (FRP) or other material with equivalent mechanical strength to provide both tensile and anti buckling strength to the cable.
- 5.06.00 In addition to central strength member, additional strengthening substance like aramid yarns shall be helically applied over the cable core to provide additional tensile strength to the cable.
- 5.07.00 The cable shall be of dual jacket & armoured. Inner sheath consists of a medium density polyethylene (MDPE) jacket extruded over the cable core. 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 rodent protection. The armor is covered with an outer black FRLS MDPE jacket. A ripcord is also placed underneath the armor for easy outer jacket removal.
- 5.08.00 Minimum bending radius shall be equal or more to 15 D. A continuous strength member shall be provided for the entire length of the cables. Every tube and fiber shall be colour coded to provide easy identification. The outer sheath shall be marked to show fiber type and cable classification at suitable intervals.
- 5.09.00 Entire length of the cable shall be marked with the following at regular intervals:
- a) Manufacturer's Name
 - b) Month and year of manufacturer
 - c) Coded description of the cable based on Telcordia's (Bellcore) SR-2014 Suggested Optical Cable Code (SOCC).
 - d) Sheath Identification Number
 - e) Sequential Length Marking in meter
 - f) A Telephone Handset symbol to distinguish communication from power cable as per NESC section –35 G.
- 5.10.00 Fiber optic cable shall provide a long life expectancy of minimum 25 years and shall meet the industrial standard of continuous operation at temperature

of 55 O C and humidity to 100% without degradation to optical or mechanical performance.

5.11.00 Optical fiber used in the plant shall generally conform to the following specification:

ATTRIBUTES		
a)	Cladding Diameter	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
b)	Cladding non-circularity	$\leq 1.0\%$
c)	Attenuation Coefficient at (a) 1290 nm to 1340 nm (b) 1525 nm to 1575 nm	< 0.36 dB/km < 0.25 dB/km
d)	Chromatic Dispersion Coefficient at (a) 1310 nm (b) 1550 nm	< 3.5 ps/nm.km < 18 ps/nm
e)	Polarization Mode Dispersion (PMD)	$\leq 0.5 \text{ ps}/\sqrt{\text{km}}$
f)	Mode Field Diameter at (a) 1310 nm (b) 1550 nm	9.2 \pm 0.4 μm 10.50 \pm 1.0 μm
g)	Mode Field Concentricity Error	$\leq 0.5 \mu\text{m}$
h)	Proof Test	$\geq 1\%$
i)	Fiber Curl (ROC)	$\geq 4.0 \text{ m}$
j)	Macro-bend Test on Fiber at 1550 nm	$\leq 0.1 \text{ dB}$

5.12.00 Cable Assembly

5.13.00 Optical Fiber Environmental Splice Enclosure

Optical fiber environmental splice joint enclosures shall be re-enterable and rack / wall mountable. The interior splice case shall be equipped to mechanically accommodate single-mode optical fibers connected by the

fusion method. Splice case shall be equipped to organize the splice trays and the required service loops of buffered incoming optical fibers and outgoing 'pigtailed' in such a way that allows each completed splice and associated optical fiber to be maintained in an unstrained configuration. Splice enclosure shall be dust and weather proof.

5.14.00 Fiber Optic Distribution Patch Panel

Fiber optic distribution panels shall be provided as required. Fiber optic distribution panels shall be of a standard wall mounted sheet metal enclosure type. Fiber optic distribution panels shall be equipped to secure optical fiber patch cables and pigtails to prevent damage during all operation and maintenance functions. In general splice enclosure are envisaged. However, if no optical fiber splice enclosures are implemented, than the fiber optic distribution panels shall be equipped with splice trays for storage and protection of fusion splice connections of single-mode fiber optic cable and pigtails. Each fiber optic distribution panel shall be fully equipped with 'SC' type bulkhead connector sleeves or equivalent. Unused sleeve ports shall be equipped with reusable caps to prevent the intrusion of dust.

5.15.00 Pigtail and Patch Cord

All pigtails shall be factory SC-connectorized, and satisfy specified performance for optical links. All unused pigtails (including spares) shall be terminated with the connector to a bulkhead connector sleeve, protected by a reusable cap on the opposite sleeve port, to prevent the intrusion of foreign material or dust. All necessary connectorized pigtails shall be provided in the lengths required.

5.16.00 Fiber Optic Tool Kit

5.16.01 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:
 - Fiber Identification (ID) with a minimum of 10 characters
 - Cable ID with a minimum of 10 characters
 - OTDR location with a minimum of 20 characters
 - Far End location with a minimum of 20 characters
 - Test Operator initials with a minimum of 3 characters
- c) The printer shall preferably be internal. The printer shall be able to print data traces within 30 seconds or less. The machine settings 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, date 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 diskette 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 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) Contractor shall provide all mounting accessories, cables and connectors required to establish data communication.

5.16.02 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 commissioning.

5.16.03 Tests

Following minimum test as per any approved standards shall be carried out on the cables:

- a) Attenuation And Dispersion Characteristics Tests
- b) Proof Tests
- c) Macro-Bend Resistance Test
- d) Mechanical Tests
- 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) Color Permanence Test Cable Aging Test
- n) Water Penetration Test
- o) Lightning Test
- p) Routine Test / Sample Test
- q) Site Test (Like Continuity & Attenuation)



PEM :: C&I

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: **PE-QP-999-145-1036** _____
 VOLUME **IIB**
 SECTION **D**
 REV. NO. **01** DATE: **24.08.2007**
 SHEET **1** OF **8**

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	Materials /Components											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA	Visual	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2	2	1	
1.2	Power Supply/Packs, Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2	2	1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2	2	1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection <ul style="list-style-type: none"> • Identification Labels • Physical Damages • Quantity • Spare Capacity 	MA	Visual	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2	2	1	

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 PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: **PE-QP-999-145-1036** _____
 VOLUME IIB
 SECTION D
 REV. NO. 01 DATE: 24.08.2007
 SHEET 2 OF 8

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	
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2	2	1	

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 PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: **PE-QP-999-145-1036**
 VOLUME IIB
 SECTION D
 REV. NO. **01** DATE: 24.08.2007
 SHEET 3 OF 8

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	V		

2.0 Assembly													
2.1	Functional Test for HMI/OVS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2	1	1	1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2	2	1	1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2	1	1	1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100%	FAT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2	2	1	1	

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 PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: **PE-QP-999-145-1036**
 VOLUME IIB
 SECTION D
 REV. NO. **01** DATE: 24.08.2007
 SHEET 4 OF 8

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	

3.0	Factory Acceptance Test (FAT)											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	

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

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

VOLUME IIB

SECTION D

REV. NO. 01

DATE: 24.08.2007

SHEET 5

OF

8

FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

This document covers procedure to conduct/witness PLC system functional tests in order to demonstrate conformity to purchase specifications and related engineering documents. The test shall be conducted at the system suppliers works. The system supplier shall conduct all functional tests before commencing FAT and test results shall be made available during FAT. Vendor must furnish following relevant drawings, duly approved by BHEL Engineering, for reference during FAT.

- a) Technical Specification of PLC.
- b) PLC System Configuration
- c) General Assembly Drawings.
- d) Panel Wiring Diagrams.
- e) Bill of Quantity for PLC System.
- f) Logic Diagram.
- g) HMI Schematics.
- h) Input / Output List.

Further the vendor shall furnish applicable product specification, datasheets, catalogues, test-certificates, and internal inspection records to enable FAT. Vendor shall also submit, [to the inspecting agency](#), his standard test procedure, for clauses given below; where vendor's standard practice has been referred.

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

Check for correctness of addressing of racks, slots and I/O modules as per applicable PLC configuration diagram. Appropriate signal generators shall be used to simulate Inputs and outputs to check operation and SCAN time. [Check online replacement of cards, processors, power supply etc.](#)

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

- i) Redundancy

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036 ___			
VOLUME IIB			
SECTION D			
REV. NO.	00	DATE:	23.03.2005
SHEET	6	OF	8

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.

Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

Check if PSM is in redundant mode as per specification. Check the healthiness of power supply from both the modules' lamp indication/measurement. Simulate failure of one PSM and verify that standby PSM has taken over without any interruption.

4. Communication System Verification

Communication system has to be in line with approved PLC Configuration Diagram. Verify that both the communication buses are intact and connected. Communication between PLC processors, I/O rack, OWS etc. is to be checked through simulation of input data. Simulate the bus failure by disconnection of working bus. Check that the communication continues without interruption or loss of data.

Following response times are to be demonstrated as per vendor's standard practice for conformance to contract specifications:

1. Screen update time
2. I/O scan time
3. SOE resolution time
4. Data transfer time with third party system using Communication Protocol as per Contract specification and as per quantum of data as per approved signal exchange list.

5. Diagnostic Verification

Product Catalogue/Literature shall be referred for checking of all diagnostic features. Hardware failure to be simulated by removing an I/O

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036 ___			
VOLUME IIB			
SECTION D			
REV. NO. 00		DATE: 23.03.2005	
SHEET	7	OF	8

6. Control Panel /Desk Verification

- i) PLC driven annunciation system should be checked by alarm signal simulation.
- ii) Push Button and selector switch operation should be checked by verification of corresponding change of status of Data Base point.
- iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

- i). Control Logics:- Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes
- ii). Engineering features:-
 - a) Online changing of parameters, set points.
 - b) Online modification in Control Logic Diagrams.
 - c) Online configuration of Graphics, Trends, Logs, HSR.
- iii). HMI features:-
Check for configuration & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipments shall be subjected to Burn in elevated temperature test as per the procedure detailed below:

- a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145- I036			
VOLUME IIB			
SECTION D			
REV. NO. 00		DATE:	
23.03.2005			
SHEET	8	OF	8

ii) 48 hours test period shall be divided into 4 equal time segment of 12 hours duration each. For every 12 hours duration segment, after lapse of first 11 hours 110% of nominal voltage shall be applied to the panel under test for a period of 30 minutes followed by application of 90% of nominal voltage for the next 30 minutes.

b) Assembled Panels with complete wiring shall be kept under continuous energized condition for 120 hours at ambient temperature. Temperature rise in panels should be below 10 Deg C above ambient.

Checklist for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	<input type="checkbox"/> Multidrop <input type="checkbox"/> Peer to Peer <input type="checkbox"/> N/w topology attached	
3	Protocol Mode (Device is a)	<input type="checkbox"/> Master <input type="checkbox"/> Slave <input type="checkbox"/> Master/Slave	
4	Protocol	<input type="checkbox"/> RTU <input type="checkbox"/> ASCII <input type="checkbox"/> Other -----	
5	Master	<input type="checkbox"/> System maxDNA <input type="checkbox"/> Other -----	
6	Dist.bet.maxDNA System & Device*	<input type="checkbox"/> ----- Feet <input type="checkbox"/> ----- Meters	

B Electrical Specific :

1	Interface Type	<input type="checkbox"/> RS232 <input type="checkbox"/> RS422 <input type="checkbox"/> RS485	
2	Wiring at Device end	<input type="checkbox"/> 2 Wire <input type="checkbox"/> 4 Wire	
3	Transmission Channel	<input type="checkbox"/> Half Duplex <input type="checkbox"/> Full Duplex	
4	Baud Rates (bps)	<input type="checkbox"/> 1200 <input type="checkbox"/> 2400 <input type="checkbox"/> 4800 <input type="checkbox"/> 9600 <input type="checkbox"/> 19200	
5	Databits	<input type="checkbox"/> 8 <input type="checkbox"/> 7	
6	Stopbits	<input type="checkbox"/> 1 <input type="checkbox"/> 2	
7	Parity	<input type="checkbox"/> None <input type="checkbox"/> Odd <input type="checkbox"/> Even	
8	H/w & Software Handshake	<input type="checkbox"/> Yes <input type="checkbox"/> No	
9	Response Timeout time (Sec)	<input type="checkbox"/> ----- <input type="checkbox"/> Configurable timeout	
10	Data Formats Supported	<input type="checkbox"/> Boolean <input type="checkbox"/> Real <input type="checkbox"/> Char <input type="checkbox"/> Sn.Int <input type="checkbox"/> UnSn.Int	
11	Transmission mode	<input type="checkbox"/> Asynchronous <input type="checkbox"/> Synchronous	

C Application Specific : *

1	Primary Function*	<input type="checkbox"/> Data Acquisition <input type="checkbox"/> Data Acquisition & Control	
		<input type="checkbox"/> Download parameter sets	
2	Analog Points to read	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
3	Analog Points to write	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
4	Digital Points to read	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
5	Digital Points to write	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
6	Memory / Flag Points to read	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
7	Memory / Flag Points to write	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	

D Hardware Specific :

1	Cable type	<input type="checkbox"/> Boolean cable <input type="checkbox"/> Twisted pair cable	
2	Cable Details Enclosed	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3	Any specific Converter required	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	<input type="checkbox"/> Tech., Spec. <input type="checkbox"/> Operating Manual	
---	---------------------------	---	--

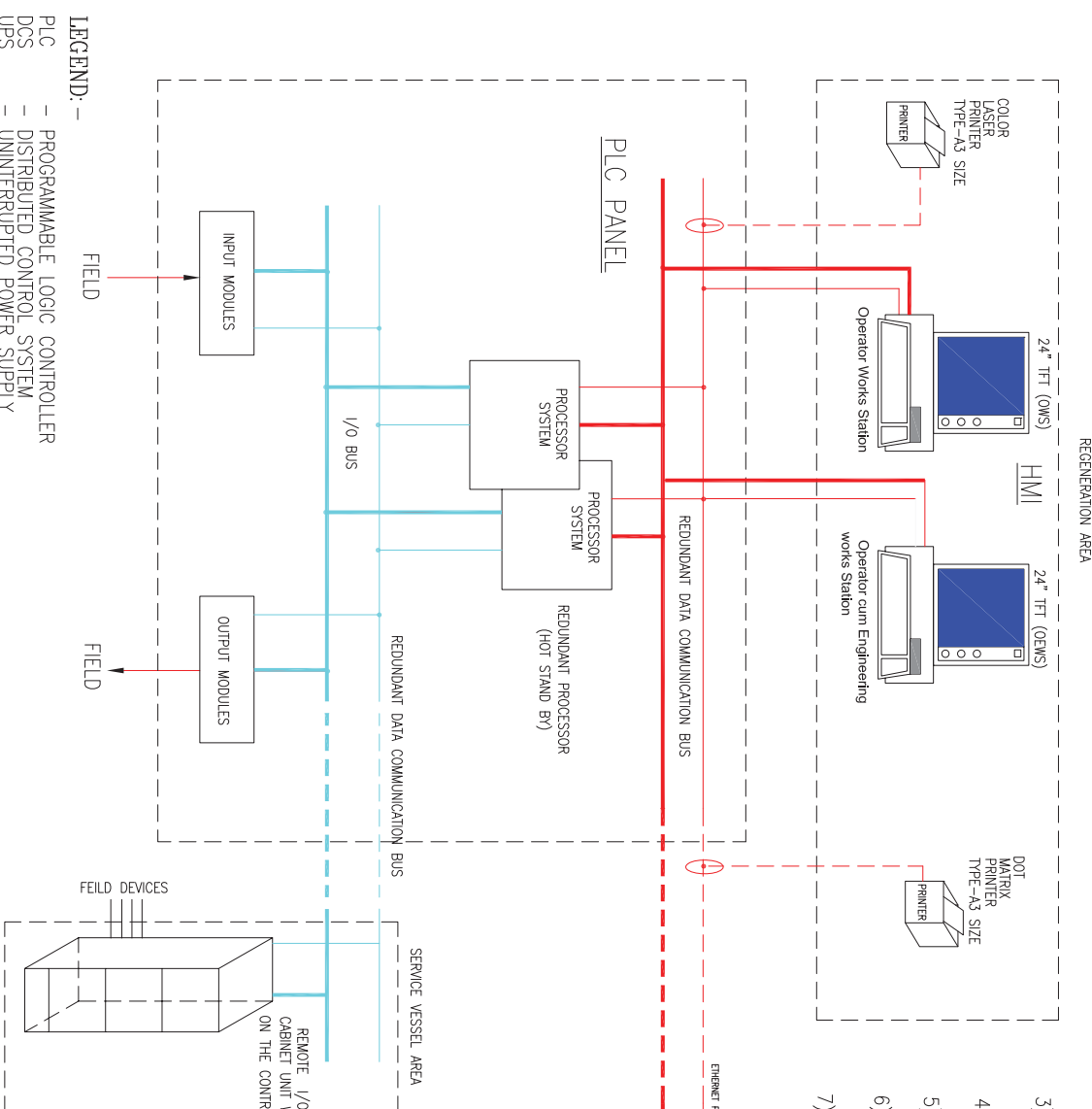
***Notes:**

A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

C1 What is the primary purpose of the communications link?

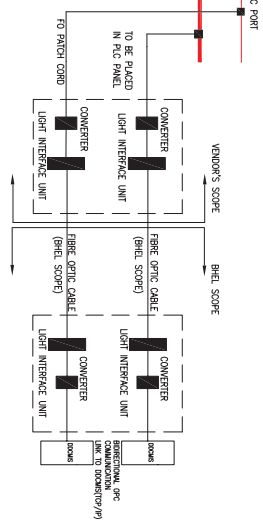
E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)



LEGEND:-

- PROGRAMMABLE LOGIC CONTROLLER
- DISTRIBUTED CONTROL SYSTEM
- UNINTERRUPTED POWER SUPPLY
- OPERATOR WORK CUM ENGINEERING WORK STATION
- HUMAN MACHINE INTERFACE
- NETWORK TIME PROTOCOL
- OLE PROCESS CONTROL

- NOTES:**
- 1) PLC SYSTEM SHALL HAVE REDUNDANCY IN PROCESSOR, COMMUNICATION SYSTEM, POWER SUPPLY, MEMORY MODULES, RACK POWER SUPPLY UNITS, BULK IO POWER SUPPLY UNITS, IO COMMUNICATION MODULES, DATA HIGHWAY AND HIGH SPEED (100Mbps) DATA NETWORK CONNECTING THE OPERATOR STATIONS.
 - 2) UPS POWER SUPPLY SHALL BE PROVIDED FOR PLC PANEL(S), OWES, NETWORK COMPONENTS.
 - 3) PLC PANEL SHALL HAVE PROVISION TO ACCEPT TIME SYNC. SIGNAL (IRIG-B) FROM MASTER CLOCK SYSTEM (PLANT AREA).
 - 4) PLC PANEL SHALL HAVE PROVISION FOR REDUNDANT DATA EXCHANGE (OPC) WITH PLANT DCS.
 - 5) INTERNAL BUS AND EXTERNAL DATA NETWORK LOADING SHALL IN NO CASE BE MORE THAN 60% OF ITS CAPACITY.
 - 6) MAIN DATA NETWORK SHALL COMPLY WITH THE INTERNATIONAL STANDARD IEEE-802.3 (ETHERNET) FOR DATA EXCHANGE AND COMMUNICATION.
 - 7) FOR OTHER TECHNICAL DETAILS FOR PLC SYSTEM REFER TECHNICAL SPECIFICATION.



PLC SYSTEM CONFIGURATION

DRG. NO.	
REV. No.	DATE
SHEET	01 OF 01