

VOLUME: II-E

SECTION-VI

TECHNICAL SPECIFICATION

CONTROL AND INSTRUMENTATION SYSTEMS

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SECTION-VI**TECHNICAL SPECIFICATION****CONTROL AND INSTRUMENTATION SYSTEMS****1.00.00 FIELD INSTRUMENTS**

This section provides general guidelines for field instruments and equipment to be supplied under this specification. All measuring instruments/equipment and subsystems offered by Bidder shall be from reputed experienced manufacturer of specified type and range of equipment, whose guaranteed and trouble free operation has been established. All instruments/equipment shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance and comply with the acceptable international standards. All instruments/equipment and accessories shall be supplied as per technical specifications, ranges, make as approved by Owner.

- i) HART management system shall be integral feature of the DCS and shall be provided for centralised configuration, maintenance, diagnostics & record-keeping for all electronic transmitters.
- ii) Bidder shall provide following facilities as a minimum through software:
 - a) Constant scanning to monitor faults of changes to instrument configuration.
 - b) Owner-defined and standard calibration and configuration procedures for all transmitters.
 - c) Constant signal data collection facilities to maintain continuously updated records.
 - d) Automatic tracking of configuration changes made in the field, such as may be introduced by hand-held communicator. All configuration function associated with hand-held communicators shall be available in the system.
 - e) Event and log reports on screen as well as on printer.
 - f) Any addition/deletion of transmitter will be reported on printer and logged in hard disk.
 - g) Field Instruments, Actuators, Analyzers (SWAS, CEMS, DM water system) shall be provided from reputed make and model having global presence. Customized equipments with limited availability shall not be acceptable.

1.01.00 Pressure Transmitter

- 01. Type : Microprocessor based Smart, HART protocol compatible

02. Transmission : 2 - Wire
03. Output Signal : Simultaneous transmission of digital and 4-20 mA DC signal.
04. Signal Processing : Silicon solid state electronic circuitry
05. Sensor type : Capsule / Diaphragm
06. Element material : AISI-316 or better
07. Static Pressure : 150 % of maximum span continuously, without affecting the calibration.
08. Turn-down ratio : 10 : 1 for vacuum/very low pressure application ; 30 : 1 minimum for other applications.
09. Span and Zero : Locally adjustable non-interacting. Facility for elevation and suppression by 100% of span
10. Enclosure Class : Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required)
11. Output Indicator : Backlit LCD type
12. Nameplate : Tag number, service engraved in stainless steel tag plate
13. Body : Forged Carbon Steel (SS for DM Water & corrosive service).
14. Power supply : 16 - 48 Volts D.C.
15. Load : 500 Ohms (min.) at 24 Volts D.C.
16. Ambient Temperature : 0 - 50°C
17. Performance :
 - i) Accuracy : $\pm 0.075\%$ of Span or better
 - ii) Repeatability : $\pm 0.05\%$ of Span or better
 - iii) Response time : 100 msec or better
 - iv) Stability : $\pm 0.1\%$ of Calibrated Span for 6 months up to 70 Kg/cm² and $\pm 0.25\%$ of Calibrated Span for more than 70 Kg/cm²
 - v) Zero and span drift : $\pm 0.015\%$ per deg. C at max span and 0.11% per deg. C at min span
18. Sealing/Isolation : Extended diaphragm with 5 meters SS armored capillary for corrosive, viscous and

dirty fluid applications. Material for separator diaphragm shall be as per application. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application

19. Diagnostics : Self indicating feature
20. Accessories :
 - a) Universal mounting bracket suitable for 2" pipe mounting.
 - b) High tensile carbon steel U- bolts.
 - c) Installation accessories as per relevant installation drawing.
 - d) Syphons for steam and hot water services.
 - e) ½" NPT 2-valve stainless steel manifold for pressure transmitters constructed from SS316 bar stock. In case it becomes necessary to use a DP transmitter for gauge pressure measurement then a 2-valve manifold should be used in place of 5-valve manifold.
 - f) Companion flange with nuts, bolts and gaskets.
 - g) Hand held configurator kit for calibration of Smart Transmitter.

1.02.00 Differential Pressure Transmitter

01. Type : Microprocessor based Smart, HART protocol compatible
02. Transmission : 2-Wire
03. Output signal : Simultaneous transmission of digital and 4-20 mA DC signal.
04. Signal Processing Unit : Silicon solid-state electronic circuitry
05. Sensor type : Capsule/Diaphragm
06. Element material : AISI-316 (Stainless Steel) or better
07. Static Pressure/

- Overload Pressure : Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy
08. Turn-down ratio : 10 : 1 for vacuum/very low pressure application; 30 : 1 minimum for other applications.
09. Span and Zero : Locally adjustable, non-interacting
10. Enclosure class : Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required))
11. Zero suppression / elevation : At least 100% of Span
12. Output Indicator : Backlit LCD type
13. Nameplate : Tag number and Service engraved in stainless steel tag plate
14. Body : Forged Carbon Steel (SS for DM Water)
15. Ambient temperature : 0 - 50° C
16. Power supply : 16 - 48 Volts DC
17. Load : 500 Ohms (min.) at 24 Volts DC
18. Performance :-
- i) Accuracy : ± 0.2 % of span or better
 - ii) Repeatability : ± 0.05 % of span or better
 - iii) Response time: 100 msec or better
 - iv) Stability : $\pm 0.1\%$ of Calibrated Span for 6 months up to 70 Kg/cm²
 - v) Zero and span drift : $\pm 0.015\%$ per deg. C at max span and 0.11% per deg. C at min span
19. Sealing/Isolation : Extended diaphragm with 5 meters. SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator diaphragm depending on application.
20. Diagnostics : Self indicating feature
21. Accessories : a) Universal mounting bracket suitable for 2" pipe mounting.

- b) High tensile carbon steel U-bolts.
- c) Installation accessories as per relevant installation drawing.
- d) Syphons for steam and hot water services.
- e) ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock.
- f) Companion flange with nuts, bolts and gaskets.
- g) Hand held configurator kit for calibration of Smart Transmitter.

1.03.00

Displacer Type Level Transmitters
(This type of level transmitters shall not be used in critical applications)

- 01. Type : SMART
- 02. Stages of operation : Continuous
- 03. Material -
 - i) Displacer : AISI 316 SS
 - ii) Suspension wire : AISI 316 SS
 - iii) Torque tube housing : Carbon steel or SS as per application
 - iv) Torque tube : Inconel
 - v) Displacer chamber : Carbon steel or SS as per process application
 - vi) Transmitter Housing : Die cast aluminium or better
- 04. Power supply : 16-48 Volts D.C.
- 05. Transmission : 2-wire
- 06. Output Signal : Simultaneous transmission of digital and 4-20 mA DC signal. Standard HART protocol.
- 07. Signal processing : Solid-state electronic circuitry
- 08. Static / overload pressure : Maximum static pressure without permanent deformation or loss of accuracy.

09. Turn-down ratio : 10 : 1 or better
10. Zero & Span : Easily accessible (local zero & span adjustment and non-interactive type)
11. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12. Output Indicator : Yes, Backlit LCD type
13. Nameplate : Tag number and Service engraved in stainless steel tag plate
14. Ambient Temperature : 0 - 50°C
15. Load Impedance : 500 Ohms at 24 Volts (minimum)
16. Process Connection : 2" Companion flange with nuts, bolts and gaskets
17. Performance - Accuracy : $\pm 0.2\%$ of span or better
18. Accessories :
 - a) Counter Flange, nuts, bolts, gaskets etc.
 - b) Weights for 5 point calibration of instruments.
 - c) Vent and drain plugs
 - d) Special calibration tool/configurator, if any.
19. Preferred Features :
 - a) Test plug connection and cutout terminals physically separated from other electronics.
 - b) Electronic Damping facility (adjustable).

1.04.00 Mass Flow meter

- A. Sensor
 01. Measuring Principle : Coriolis Mass flow.
 02. Primary Element : Flow Tube of 316SS or better
 03. Temperature Control : To be provided for heavy fuel oil application. Heating arrangement shall be integral.
For Heating
 04. Process Connection : Flanged and rating as per process requirement.
 05. Drain : Self-draining facility
 06. Enclosure : Stainless steel

07. Accessories : Counter flanges, Mounting nuts, bolts, gaskets etc.

B. Transmitter

01. Measured quantities : Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.

02. Input Signal Processing : Digital Processing.

03. Display : Digital Display (LCD).

04. Output : 2 Nos. isolated output of 4-20mA DC with HART protocol, selectable from four measured quantities & field bus output for softlink with DCS

05. Load : < 750 ohms.

06. Power supply : "UPS", (if the external power supply is 230V AC, 50 HZ).

07. Turn Down : 100:1

08. Accuracy : $\pm 0.2\%$ of measured value

09. Housing : IP 65 (Explosion proof for NEC Class-1, Division 1 area).

10. Hazardous duty Version : FM Standards.

11. Nameplate : Tag number, service engraved in stainless steel tag plate

12. Accessories : a) As required for field mounting
b) Handheld configurator
c) Mounting U-bolts, nuts, bolts, prfab cable etc.

1.05.00 Turbine Flow Meter

A. Sensor

01. Type : Turbine (in line full-bore, based on magnetic pick up pulses)

02. Output Signal : Pulse

03. Material of

- Construction : a) Body : AISI 316
b) Rotor: AISI 431 or 410
c) Bearings: Tungsten Carbide / Stellite Sleeve

04. Flow rate range : As required.

05. Linearity : $\pm 0.25\%$ or better.

06. Repeatability : $\pm 0.02\%$ or better.

07. Ambient temperature : 50°C

08. Mounting : On-Line, flanged

09. Enclosure : IP 65

B. Transmitter

01. Electronics : Solid State

02. Power Supply : "UPS", if the external power supply is 230V AC, 50 HZ.

03. Input : Input from Sensor

04. Display : Backlit LCD

05. Output : Isolated 4-20mA DC with HART protocol.

06. Measuring Accuracy : $\pm 0.5\%$ of full scale range

07. Totalized Value : Required

08. Housing : IP-65 (Explosion proof for NEC Class-1, Division 1 area)

09. Nameplate : Tag number, service engraved in stainless steel tag plate

10. Accessories : a) Clamping strip, bracket, prefab cable etc.
b) Calibration or configurator kit.

1.06.00 Vortex Flow Meter

A. Sensor

01. Type : Vortex

02. Output Signal : Pulse

03. Material of

- | | | | |
|---------|---------------------|---|--|
| | Construction | : | AISI 316 |
| 04. | Sensor Seal | : | PTFE / higher based on temperature |
| 05. | Flow range | : | As required. |
| 06. | Linearity | : | $\pm 1\%$ or better. |
| 07. | Repeatability | : | $\pm 0.2\%$ or better. |
| 08. | Ambient temperature | : | 50°C |
| 09. | Mounting | : | On-Line, flanged. |
| 10. | Enclosure | : | IP 65 |
| 11. | Accessories | : | Nuts, bolts, gaskets etc. |
| B. | Transmitter | | |
| 01. | Electronics | : | Solid State-remote mounting |
| 02. | Power Supply | : | 24 V DC. |
| 03. | Input | : | Input from Sensor |
| 04. | Display | : | Backlit LCD |
| 05. | Output | : | Isolated 4-20mA DC. |
| 06. | Protocol | : | HART |
| 07. | Totalized Value | : | Required |
| 08. | Housing | : | IP-65 (Explosion proof for NEC Class-1, Division 1 area) |
| 09. | Nameplate | : | Tag number, service engraved in stainless steel tag plate |
| 10. | Accessories | : | a) Clamping strip, bracket, prefab cable etc.
b) Special tool kit for calibration/ configuration. |
| 1.07.00 | Rotameter | | |
| 01. | Type | : | Online upto 2" and Bypass above 2" line size" |
| 02. | Metering tube | : | Borosilicate glass |
| 03. | Float | : | AISI 316-SS unless the process fluid demands some other material. |

- 04. Body MOC : SS as per fluid condition.
- 05. Scale : Aluminium Graduated - Engraved black on white background.
- 06. Process connection : Flanged to line size or threaded for connection size ½" or less.
- 07. Accuracy : $\pm 2\%$ of full scale detection or better for on-line type and $\pm 4\%$ of full-scale detection or better for by-pass type.
- 08. Nameplate : Tag number, service engraved in stainless steel tag plate
- 09. Accessories : Slip-on orifice plate of 316-SS and taps of / SS as per application. Applicable SS Isolation valves and SS Range Orifice - for bypass type rotameters.
- 10. Housing protection class : IP- 65.

1.08.00 Pressure Gauge And Differential Pressure Gauge

- 01. Type : Bourdon/Bellows/Diaphragm
- 02. MOC Sensing & Socket : AISI-316 SS
- 03. Movement Material : AISI-304 SS
- 04. Case Material : Stainless steel..
- 05. Bezel Material : SS 304.
- 06. Socket Material : SS 316
- 07. Enclosure : IP-65.
- 08. Dial Size : 150 mm
- 09. Scale : Black lettering on white background in 270 Deg. arc.
- 10. Window : Shatterproof glass
- 11. Range Selection : Normal process pressure – 50 ~ 70 % of range (approximately).
- 12. Over-range Protection : 125% of maximum range by internal stop. External stop at zero

13. Adjustment : Micrometer screw for zero adjustment.
Internal micrometer screw for range adjustment.

External zero adjustment for glycerine filled gauges.
14. Element Connection : Argon welding
15. Process Connection : 1/2" NPT(M) Bottom connection for local mounting, back connection for panel mounting.
16. Performance : Accuracy of ± 1.0 % of span or better.
17. Operating ambient temperature : 0 - 50°C
18. Safety Feature : Blow out disc./diaphragm at the back
19. Accessories : a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge.

b) Stainless steel Diaphragm chemical seals for corrosive, viscous and solid-bearing or slurry type process fluids. diaphragm chemical seal shall be provided with the following:

1) Top chamber : SS 304

2) Bottom Chamber: SS 316

3) Sealing fluid: Silicon DC 200

4) Diaphragm: SS 316

c) 3-way SS gauge cock/ 2-Valve SS-316 barstock manifold for pressure gauges with 1/2" NPT process connection..

d) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection 1/2" NPT.

e) Union, nut & tail piece and other Installation accessories as required.

f) Syphons for steam and hot water services.
20. Applicable standard : IS-3624 / 1996 , EN-837-1
21. Nameplate : Tag number, service engraved in stainless steel tag plate

1.09.00 Temperature Gauge

01. Type : Inert gas filled remote mounting system.
02. Sensing Element Material : Bourdon - AISI-316 SS
03. Capillary Armoring : Stainless steel flexible
04. Movement Material : AISI 304 SS
05. Bulb / Stem Diameter : 12 mm
06. Bulb / Stem Material : AISI 316
07. Capillary : Stainless Steel
08. Thermometer connection to well : ½" NPT
09. Case Material : Stainless steel
10. Dial Size : 150 mm in general (100 mm for SWAS gauges)
11. Scale : Black lettering on white background in 270 Deg. arc.
12. Mounting : Surface/Panel
13. Over range Protection : 125 % of range or more
14. Instrument connection : Bottom connection for local mounting and back connection for panel mounting.
15. Range : Normal temperature – 50 ~ 70% of range approximately.
16. Zero adjuster : Micrometer screw adjustable from front.
17. Window : Shatterproof glass.
18. Accuracy : ± 1 % or better
19. Enclosure Class : IP-65
20. Capillary : 5 meters (local)/15.0 meters (local panel) - armoured stainless steel
21. Compensation : Capillary and Case Compensation

22. Accessories : a) Forged/barstock SS316 thermowell screwed as per ASME PTC code. Process connection M 33X2 (M). Material of construction of thermowell:
1) SS 316: in general
2) Inconel: For flue gas application
3) Tungsten carbide: For coal mill application
b) Installation accessories as required.

23. Nameplate : Tag number, service engraved in stainless steel tag plate

1.10.00 Thermocouples

01. Type : a) Type-K (Chromel Alumel) / Type-R (Pt.- Rhodium Pt.) / Type-E (Chromel Constantan) [As per application]
b) Duplex (Triplex incase of turbine/Generator/excitor bearing temperature may be used)
c) Ungrounded

02. Wire gauge : 16 AWG for Type-K, 24 AWG for Type-R

03. Standard : ANSI-MC 96.1.

04. Protecting Tube :-

- i) O.D. : 8 mm
ii) Material : 316-SS Seamless
iii) Filling : Magnesium Oxide (Purity above 99.4%)

05. Response time with Thermowell : a) Less than 20 seconds for measurement.
b) Less than 10 seconds for control.

06. Accuracy : $\pm 1.1^{\circ}\text{C}$ upto 300°C & 0.4% of measured temperature range above 300°C .

07. Head :

- i) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
ii) Material : Die cast aluminum or better

- iii) Terminal blocks : Nickel plated Brass - screw type / silver plated
 - iv) Instrument connection : ½" NPT to well
 - v) Cable connection : ½" NPT gland and grommet.
 - vi) Others : Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells"
08. Accessories :
- a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection
 - b) Compression fittings/unions
 - c) Flanges etc. (for flanged connections only)
 - d) Barstock thermowell of stepless tapered design as per ASME PTC19.3 code.
- Process connection M33x2 (M) in general or 1 1/2" flanged for flue gas/Furnace/air etc. application.
- Material of construction of thermowell:
- 1) SS 316: in general
 - 2) Inconel: For flue gas application
 - 3) Tungsten carbide: For coal mill application.
09. Nameplate : Tag number, service engraved in stainless steel tag plate

1.11.00 Passing condition of various drain valves shall be monitored by measuring drain pipe metal temperature at the downstream of the drain valves. Also Drum, SH, RH metal temperature measurement shall be provided. Necessary thermocouples shall be provided as per the following specification.

- 01. Measuring medium : Metal temperature
- 02. Metal of thermocouple element : Chromel-Alumel Type-K
- 03. Type of thermocouple : Duplex with separate hot junctions, ungrounded type.
- 04. Insulation : Mineral insulation Magnesium Oxide
- 05. Thermocouple wirer

- gauge : 16 AWG
- 06. Protective Sheath : SS 321
- 07. Protective Sheath Dia : 8 mm O.D.
- 08. Characteristics of thermocouple : Special limits of error as in ANSI MC 96.01.1975
- 09. Mounting Accessories : 1/2" BSP SS sliding end connector, weld pad, weld on clamps of heat resistant steel SS 310.
- 10. Cold end sealing : SS pot seal with colour coded PTFE headed sleeve insulated flexible tails. Sealing compound - Epoxy resin
- 11. Minimum Bending Radius : 30 mm
- 12. Length of T/C : 30 mtrs. (minimum)

1.12.00 Resistance Temperature Detector

- 01. Type : Platinum (Duplex), Ungrounded
- 02. Resistance : 100 ohm at 0°C
- 03. Base : Wound on ceramic (anti-inductive)
- 04. Wiring : 3 / 4 Wire
- 05. Protecting Tube :-
 - i) O.D. : 8 mm
 - ii) Material : SS-316, Seamless
 - iii) Filling : Magnesium oxide (Purity above 99.4%).
- 06. Response time :
 - a) < 20 seconds for measurement.
 - b) < 10 seconds for control.
- 07. Calibration : DIN 43760
- 08. Accuracy : $\pm 0.5\%$ of range
- 09. Head :
 - i) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
 - ii) Material : Die cast aluminum or better
 - iii) Terminal blocks : Nickel plated Brass-screw type / silver plated

iv) Cable connection : ½" NPT gland and grommet.

v) Others : Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells"

10. Accessories :
- a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection
 - b) Compression fittings/unions
 - c) Flanges etc. (for flanged connections only)
 - d) Barstock thermowell of stepless tapered design as per ASME PTC19.3 code.

Process connection M33x2 (M) in general or 1 1/2" flanged for flue gas/Furnace/air etc. application.

Material of construction of thermowell:

- 1) SS 316: in general
- 2) Inconel: For flue gas application
- 3) Tungsten carbide: For coal mill application.

11. Nameplate : Tag number, service engraved in stainless steel tag plate

1.13.00 Pressure Switch

01. Type :
- i) Piston for high pressure application (above 40 bar)
 - ii) Bellow /Diaphragm for low pressure application (below 40 bar)
02. Sensing element material : AISI SS-316. All other wetted part SS316.
03. Case Material : Die-cast aluminum alloy with neoprene gasket.
04. Setter Scale : Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.

- 05. Over range : 150 % of maximum pressure
- 06. Adjustments : a) Internal Set Point
b) Differential adjustment
- 07. End Connection : 1/2" NPT (M) bottom connected
- 08. Switch configuration : Two SPDT
- 09. Switch Rating : 240V, 5A AC/220V, 0.5A DC
- 10. Switch Type : Snap acting, shock & vibration proof
- 11. Terminal Block : Suitable for full ring lugs for cable connection.
- 12. Elect connection : Plug in socket
- 13. Enclosure Class : IP-65 weather and dust proof (Explosion proof for NEC Class-1, Division 1 area).
- 14. Performance : a) Repeatability $\pm 0.5\%$ of full range
b) Accuracy of Setting Indication of $\pm 1.5\%$
- 15. Ambient temperature : 0 – 50°C
- 16. Nameplate : Tag number, service engraved in stainless steel tag plate
- 17. Accessories : a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. MOC of seal material shall be as per process fluid requirement.
b) Snubbers for pulsating fluid application.
c) Syphons for steam and hot water services.
d) Retention ring and screws for surface mounting.
e) 1/2" NPT 2 Valve SS-316 manifold constructed from barstock
f) Brass cable gland

1.14.00 Differential Pressure Switch

- 01. Type : Bellows / Diaphragm / Piston actuated
- 02. Sensing element material : AISI SS-316. For all other wetted part SS 316

03. Case Material : Die-cast aluminum alloy with neoprene gasket.
04. Setter Scale : Black graduation on white scale with 0-100% graduation and provided with red pointer for set point adjustment
05. Over range : Static pressure on any one side, the other side being open to atmosphere.
06. Adjustments :
 - a) Internal set point adjustment
 - b) Differential adjustment
07. Process Connection : 1/2" NPT (M) bottom connected / back connected.
08. Switch configuration : Two SPDT
09. Switch rating : 240V, 15A AC / 24V, 8A DC.
10. Switch type : Snap acting type contacts, shock and vibration proof.
11. Terminal Blocks : Suitable for full ring lugs for cable connection.
12. Elect connection : Plug in socket
13. Performance :
 - a) Repeatability $\pm 0.5\%$ of full range
 - b) Accuracy of set point Indication: $\pm 1.5\%$
14. Operating Ambient Temperature : 0 - 50°C
15. Enclosure : IP-65 (Explosion proof for NEC Class-1, Division 1 area).
16. Accessories :
 - a) Snubbers for pulsating fluid application.
 - b) Syphons for steam and hot water services.
 - c) Retention ring and screws for surface mounting.
 - d) 1/2" NPT 3-Valve SS-316 manifold constructed from barstock
17. Nameplate : Tag number, service engraved in stainless steel tag plate
18. Remote Seal type for

- special application : a) Silicone oil / fluorolube filled remote diaphragm seal for dirty / viscous / corrosive fluid.
- b) SS armoured capillary at least 3 meters each.
- c) Adapter flanges with nuts, bolts and gaskets for instrument and process side.

1.15.00 Temperature Switch

01. Type : Inert gas filled-in
02. Sensing Element Material : Bellow / Bourdon AISI SS-316
03. Bulb Material : AISI SS-316
04. Capillary : Stainless steel armoured
05. Movement Material : AISI SS-304
06. Case material : Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07. Scale : Black lettering on white background
08. Over range Protection: 120 %
09. Instrument connection: Bottom
10. Switch configuration : Two SPDT
11. Switch rating : 240V, 5A AC/220V, 0.5A DC
12. Switch type : Snap acting, shock and vibration-proof.
13. Adjustability : Internal Set point adjustable over span range
14. Elect connection : Plug in socket
15. Compensation : a) Capillary compensation with invar wire throughout the capillary length.
b) Case compensation
16. Performance :
 - i) Scale Accuracy : ± 1.0 % of full scale

- ii) Repeatability : < 0.5 % of full range
- iii) Response time : Less than 40 seconds with thermowell
- 17. Capillary length : 5 meters (minimum) for local mounting/15 meters for local panel mounting.
- 18. Nameplate : Tag number, service engraved in stainless steel tag plate
- 19. Accessories : Thermowell from SS barstock, Mounting accessories, ½" NPT cable gland.

1.16.00 Level Switch

- 01. Type : External cage float operated. Magnetically coupled.
- 02. Float Material : AISI-316 stainless steel or better
- 03. Other wetted parts : AISI-316 stainless steel or better
- 04. External Cage : Carbon steel / Stainless steel or better as per process requirements, welded type / flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
- 05. External cage mounting : Side-Side.
- 06. External cage connection : 25 NB socket welded.
- 07. Switch housing : Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
- 08. Type of switch configuration : 2 SPDT (two nos.)
- 09. Contact rating : 5A, 240V/AC, 0.25A, 220V DC
- 10. Accessories :
 - a) Counter flange, nuts & bolts, suitable gasket etc.
 - b) Steel globe type drain valve.
 - c) ½"NPT cable gland
 - d) Stainless steel alpha-numeric engraved for service and tag.
 - e) Globe drain valve

11. Preferred feature : Switch operating point marked on cage
12. Mounting : On standpipe

1.17.00 Conductivity Type Level Switch

01. Type : Conductivity discrimination.
02. Application : Drain pots viz. on CRH line
03. Mounting : Flanged – on external cage.
04. Probe MOC : Stainless steel with high purity ceramic.
05. Probe rating : > Maximum design pressure of vessel.
06. Input : Four independent channel with selectable switching threshold for water conductivity.
07. Relay Output : Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
08. Contact type & rating : 2SPDT or 1 DPDT @ 5A 30V DC.
09. Local Display : Coloured LEDs for Hi, Lo, Hi-Hi, Lo-Lo, Power & fault.
10. Power supply : Dual 240V AC, 50 Hz, 1Ph UPS supply.
11. Enclosure : IP–65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
12. Accessories :
 - a) PTFE cable from probe to electronics
 - b) Mounting accessories
 - c) External cage
 - d) Washer & gasket
13. Test pressure : Two times rated pressure
14. Elect connection : Plug in socket

1.18.00 Capacitance Type Level Switch

01. Type : Capacitance type
02. Probe :
 - a) Rod or suspended electrode

b) Rope type probes may be used only where required probe length is greater than 1.5 meters.

c) Reference rod for non grounded tank.

- | | | | |
|-----|----------------------------|---|---|
| 03. | Probe Mounting : | : | 1-1/2" Flanged |
| 04. | Material of construction : | : | 316 SS and to suit fluid type |
| 05. | Insulation : | : | PTFE/PP/Kynar Part/Full as required |
| 06. | Enclosure : | : | Powder coated Die cast aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area). |
| 07. | Ambient temperature : | : | 0-60°C. |
| 08. | Mounting : | : | Top Mounting |
| 09. | Supply voltage : | : | 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC |
| 10. | Relay output : | : | 2 SPDT |
| 11. | Contact rating : | : | 5A min. at 240V AC on resistive load |
| 12. | Response time : | : | 100 msec or better |
| 13. | Elect connection : | : | Plug in socket |
| 14. | Accessories : | : | Counter flange, cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric. |

1.19.00 RF Type Level Switch

- | | | | |
|-----|-------------------------|---|----------------|
| | Sensing Probe : | : | |
| 01. | Type : | : | Rigid |
| 02. | Material : | : | SS-316 |
| 03. | Mounting : | : | Threaded |
| 04. | Probe Head Housing : | : | Cast Aluminium |
| 05. | Protection : | : | IP-66 |
| | Electronic Controller : | : | |
| 01. | Supply Voltage : | : | 240V AC (UPS) |
| 02. | Relay Output : | : | 2 nos. SPDT |

- 03. Contact Rating : 240V AC,5A/ 220V DC, 0.25A
- 04. Housing Material : Cast Aluminium
- 05. Protection : IP-65
- 06. Local LED Indication : Power On, Alarm Level, Probe Healthy
- 07. Switching Repeatability : $\pm 0.5\%$
- 08. Accessories : Coaxial cable probe connection to controller
1/2" NPT Cable Gland

1.20.00 Ultrasonic Level Switch

- 01. Principle of operation : Ultrasonic contact level technology
- 02. Input Power : 24V DC/ 240V AC
- 03. Output Contact : 2 SPDT (240V AC, 5A/ 220V DC, 0.25A)
- 04. Switch Mounting : Integral
- 05. Sensor Material : SS-316
- 06. Enclosure : Cast Aluminium (IP-65)
- 07. Process Connection : 2" Flanged
- 08. Repeatability : 2 mm
- 09. Power supply : 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC
- 10. Cable connection : 1/2" NPT with cable gland
- 11. Accessories : Cable gland, cable, companion flange, bolts & nuts, gaskets etc. along with all mounting hardware

1.21.00 ULTRASONIC LEVEL TRANSMITTER

- 01. Principle of operation : Detection of reflected ultrasonic pulse
- 02. Signal processing : Microprocessor Controlled Signal Processing
- 03. Type : Smart
- 04. Display : Large alpha-numeric back lit LCD/LED
- 05. Calibration & configuration : Accessible from front of panel

- | | | | |
|-----|--------------------------|---|---|
| 06. | Diagnostic | : | On-line |
| 07. | Status | : | For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc. |
| 08. | Construction | : | Plug-on board |
| 09. | Power supply | : | 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC |
| 10. | Signal Output | : | 4-20 mA DC (isolated) - 500 Ohm load with HART protocol. |
| 11. | Hysteresis | : | Fully adjustable preferred |
| 12. | Output contacts | : | 2SPDT Potential free changeover contacts @ 5A 230V AC. |
| 13. | Accuracy & Repeatability | : | 0.25% of span or better |
| 14. | Resolution | : | 0.1% of span |
| 15. | Operating temp. | : | Transmitter- 0 to 50° C and Sensor 0 to 80° C |
| 16. | MOC Sensor | : | SS 316 in general / PTFE, PP for corrosive application. |
| 17. | Humidity | : | 1% to 95% non condensing. |
| 18. | Enclosure | : | IP-65 powder coated die cast aluminium |
| 19. | Cable connection | : | ½" NPT with cable gland |
| 20. | Mounting | : | 2" flanged for sensor and Transmitter on panel / surface. |
| 21. | Accessories | : | Cable gland, prefab cable, mounting accessories. |

1.22.00 Conductivity Type Electronic Level Indicator

- | | | | |
|-----|----------------|---|---|
| 01. | Type | : | Conductivity discrimination. |
| 02. | Application | : | Boiler Drum Level . |
| 03. | No. of Probes | : | As per manufacturer standard. |
| 04. | Probe Mounting | : | Flanged – on standpipe. |
| 05. | Probe MOC | : | Stainless steel with high purity ceramic. |
| 06. | Probe rating | : | > Maximum design pressure of vessel. |

07. Input : Independent channel with selectable switching threshold for water conductivity.
08. Relay Output : Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
09. Contact type & rating : 2 SPDT or 1 DPDT @ 5A 30V DC.
10. Current output : Isolated 4-20 mA DC
11. Local Display : a) Coloured (Red & Green) LEDs for level.
b) Flashing LEDs for fault.
12. Remote Display : Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.
13. Power supply : Dual 240V AC, 50 Hz, 1Ph UPS supply.
14. Enclosure : a) IP-65, corrosion resistant & wall mounting type for local electronics.
b) IP-42 for remote indicator
15. Accessories : a) PTFE cable from probe to electronics
b) Mounting accessories.
c) Standpipe
d) Washer & gaskets
e) Double isolation valves on each connection, double drain valves & double vent valves with mechanical lock.
f) ½" NPT cable gland
16. Test pressure : Two times design pressure

1.23.00

Air Filter Regulator

01. Filter Element : Sintered Bronze
02. Filter Size : 5 microns
03. Input Air : 10.0 Kg/Sq. cm (maximum)
04. Output : Adjustable from 0-2.0 Kg / Sq. cm or 0-7.0 Kg / Sq. cm (continuous) as applicable.
05. Effect of Supply : Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm

- 06. Bowl Material : Metallic.
- 07. Accessories : 2" dial size output pressure gauge
- 08. Feature : No perceptible drop of pressure on opening the drain port.

1.24.00

Solenoid Valve

- 01. Operating Principle : Electromagnetic (noiseless)
- 02. Coil voltage rating : 24V DC (in general) other 220V DC /240V AC /110V AC as required
- 03. Ways : 3 ways in general other depending on requirement
- 04. Port size : 1/4" NPT all ports
- 05. Body : SS Bar Stock
- 06. Trim : AISI SS-316
- 07. Manual Operator : In built
- 08. Duty : Suitable for continuous energization
- 09. Sealing : Airtight and leak proofing with nitrile (NBR) and polyurethane (PUR) material
- 10. Ambient Temperature : 0 - 50° C
- 11. Fluid Temperature : 0-150° C (approx.)
- 12. Coil Enclosure : Stainless Steel
- 13. Insulation : Class-H
- 14. Coil Casing : IP-65 (Explosion proof for NEC Class-1, Division-1 area)
- 15. Response time : 4-7msec
- 16. Mounting : On pipe or on panel
- 17. Cable Connection : ½" NPT cable gland
- 18. Accessories : Mounting brackets, nuts and bolts
- 19. Special feature : (i) LED indication for power
(ii) Double coil type for open & close operation of valve / damper.

- (iii) Solenoid valve directly integral to actuator body shall have NAMOOR interface for uniformity

1.25.00 Orifice Plate

01. Application : Low fluid velocity flow measurement
02. Design Standard : Concentric as per ASME PTC-19.5 (Part – II), ISA RP-3.2 or BS-1042, Part-I
03. Number of Tapings : As required plus one additional pair of taps
04. Diameter Ratio : Between 0.34 to 0.7
05. Thickness : 3mm for main pipe of diameter upto 250mm, 6mm for main pipe of diameter above 250mm and 10mm for diameter above 500 mm
06. Document : Beta ratio calculation, assembly drawing and Flow vs. DP curve.
07. Meter run pipe : Same as pipe material
08. Accessories : Flanges, gaskets, nuts & bolts, root valves (1" 316 SS globe) jack screw, meter run pipe, Drain & vent hole as per application etc.

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

1.26.00 Flow Nozzle

01. Application : High fluid velocity flow measurement
02. Design Standard : ASME PTC 19.5
03. Tapings : D and D/2 (Numbers as required plus one additional pair of taps)
04. Diameter Ratio : Between 0.4 and 0.7
05. Material : 316 SS (321 SS for high temperature)
05. Document : Beta ratio calculation, assembly drawing and Flow vs. DP curve.
06. Meter run pipe : Same as pipe material
07. Accessories : Meter run pipe, nipples and root valves (1" 316 SS globe).(Inspection port assembly for nozzles used in plant performance purpose)

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

1.27.00 Gauge Glass

01. Type : Reflex
02. Glass : Toughened borosilicate. Resistant to mechanical and thermal shocks.
03. Body material : Carbon steel / stainless steel- As per process requirements (Flanged Connection)
04. Pressure rating : Twice the maximum working pressure
05. Temperature rating : 300° C
06. Bolts and nuts : Rust proof alloy steel
07. Accessories : Suitable ball check valves of SS-304/316 body, gaskets, companion flange etc.

1.28.00 Level Gauge (Float & Board)

01. Type : Float and Board
02. Float & Tape MOC : AISI 316
03. Pulley and Pulley Housing material : SS 304
04. Guide wire : SS 316 Stainless steel
05. Accuracy : +/- 2 mm
06. Indication : Vertical dial
07. Rating : Twice the design pressure
08. Spring tension assembly : SS 304
09. Anchor plate : SS304
10. Calibrated scale
board : Aluminium with black graduation

Note: The measuring rope/tape shall be passed through conduits

1.29.00 Power Cylinders (Pneumatic)

01. Mounting Type : a) Fixed position mounting (End mounting).

- : b) Trunnion mounting
- 02. Control Signal : 4-20 mA DC to smart positioner with HART protocol for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line for open & closing purpose of on & off drive.
- 03. Supply Air : 5.5 – 7.0 Kg / Cm²
- 04. Selection : Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
- 05. Casing : IP-65.
- 06. Accessories (as required) :
 - a) Air lock relay
 - b) Hand wheel.
 - c) Air filter regulator with gauge.
 - d) Volume Booster.
 - e) Limit Switches.
 - f) Smart Positioner with integral I-P convertor, feedback position Transmitter (4-20 mA DC output), Input & Output pressure gauges, local keypad & display.
 - g) Solenoid Valve
 - h) Junction box with cable gland
- 07. Fail-safe operation : Stay put for regulating duty.
- 08. Repeatability : Better than 0.5% of full travel.
- 09. Hysterisis : Less than $\pm 1\%$ of full travel
- 10. Operating Temp. limit : 80^o C (min.)

1.30.00

Sight Glass

- 01. Type : Flap-type
- 02. End connection : Screwed / Flanged
- 03. Material :
 - a) Body : SS-304
 - b) Cover Plate : SS-304
 - c) Indicator : SS-316

- 04. Sight Glass : Toughened Borosilicate
- 05. Gasket : Neoprene
- 06. Bolts & Nuts : High tensile steel
- 07. Hydraulic Test Pressure : 1.5 times maximum working pressure
- 08. Accessories : As required

1.31.00 Smoke Density Analyzer

- 01. Type : Insitu dry visible light (through LED)
- 02. Principle of Measurement : Transmission & absorption (Dual beam type)
- 03. Sensor type : Luminiscence
- 04. Display : Back Lit LCD
- 05. Measurement range : 0-999 mg/m³, 0-999 mg/Nm³, 0-100% opacity
- 06. Measurement averaging : Selectable 10 sec to 60 minutes
- 07. Accuracy : 0.2% of F.S
- 08. Resolution : 0.1% of F.S / 1mg/m³ whichever is better
- 09. Linearity : 1.0% of F.S
- 10. Repeatability : < 0.5% of Span
- 11. Response time (upto 90% of full scale) : 5 sec
- 12. Flue gas temperature : 90°C (When FGD in operation)
135 °C (When FGD not in operation)
Max 600°C (at APH outlet)
- 13. Ambient temperature : 0 - 60°C
- 14. Operating temperature : Transmitter & receiver- 0-90°C, Electronic unit – 0-70 °C
- 15. Mounting : Transceiver on opposite side of the duct

16. Analog output : 4-20mA DC (in 500 ohm resistance) to DCS
17. Alarm output : 2 SPCO potential free rated at 230 VAC, 5A
18. Power Supply : 240V AC, 50 Hz, 1 Phase UPS
19. Automatic misalignment detection : Required
20. Automatic compensation of lens contamination : Required
21. Purge air Failure : Purge air to be provided from Blower unit and to be monitored for failure.
22. Span and Zero Check: Automatic periodic with manual override
23. Housing : Corrosion resistant painted aluminium rated at IP-65
24. Fail safe shutter : Automatic fail safe shutter against power and air failure
25. Input normalisation : Correction for temperature, pressure, oxygen and water vapour to be provided.
26. Preferred Features : "Power Supply On" LED visible from front
27. Accessories :
 - a) Mounting pads suitable for mounting projector and receiver units on duct, flanges, etc.
 - b) Blower unit (Purging System) with purge fail alarm at CCR
 - c) Enclosure for electronic units & indicators
28. Application : At chimney
At each ESP outlet

1.32.00 SO_x & NO_x Analyzer

As per Protocol for Real time (Emission & Effluent) Data Management from Industries Version-1.2 (10.06.2015); Instruments/Analysers/Equipments (each model) individually certified from Institutions like TUV, MCERTs, USEPA etc. as notified by CPCB.

01. Type : In-situ Probe
02. Gases to be measured : SO_x, NO_x
03. Principle of

- measurement : Infrared absorption/ UV Spectroscopy
04. Flue gas Temperature : As per process requirement
05. Mounting/Application : Flanged/ On chimney
06. Measurement range : Fully selectable as per process requirement
07. Units of measurement: PPM, mg / Nm³ and %
08. Power Supply : 240V, 50 Hz, 1 Phase UPS
09. Local Display : Back lit LCD / LED
11. Accuracy : 2% of measured value
12. Repeatability : 1% of full scale
13. zero & Span drift : 2% per month
14. Calibration : Zero and Span calibration in manual and automatic mode. Online Calibration facility with standard gas shall be provided. Automatic calibration interval shall be fully selectable. Remote Calibration and configuration facility from the remote location shall be possible. (i.e, the hardware and software required for Remote Calibration and configuration from Remote location to be provided).
15. Analog output : 4-20 mA DC (in 500 ohm resistor) to DCS for each channel
16. Alarm output : (1NO + 1NC) for each measured parameter and self diagnostic failure. All contacts rated at 230V AC, 5A
17. Input normalisation : Required—online with pressure and temperature sensor and also provision for key pad entry of inputs
18. Probe material : Stainless Steel 316L
19. Enclosure : Corrosion resistant epoxy painted aluminium housing & enclosure rated to IP-65.
20. Accessories : a) Compressor/Blower unit, tubes & fittings for calibration and purging, purge fail alarm in CCR
b) Calibration gas cylinders for SO₂, NO_x & N₂ (for Zero Calibration) filled in 10 Ltrs. of WC carbon cylinder with necessary

SS regulators with pressure & flow gauges, solenoid valve & SS tubings and SS fittings etc. as required.

c) Mounting flanges, gasket etc.

d) Control unit for interface with PC based data logger to be provided.

1.33.00 Oxygen Analyzer

01. Type : In-situ, Zirconium sensor, micro-processor-based transmitter,
02. Range : 0.1-10% / 0.25-25% by volume
03. Output : 4-20 mA DC linear
04. Probe Length / Material : 1800 mm (approximate depending on duct size) / SS 316
05. Process Temperature : As per Process Requirement.
06. Measurement
Reference : Instrument Air
07. Accuracy : $\pm 1\%$ of F.S.
08. Response Time : Less than 5 (five) sec for 90% of full scale
09. Amplifier Housing : IP-65
10. Calibration : Manual or Automatic periodic-operator selectable
11. Power Supply : 240V, 50 Hz, 1 Phase UPS
12. Material for Gas Carrying Components : Stainless Steel
13. Read Out : Backlit LED/LCD
14. Protection : Automatic cell protection against reducing atmosphere
15. Alarm Facility : 1 HI and 1 LO independently adjustable over span. Contact rating 500 mA at 220 V DC (minimum).
16. Preferred Features : a) HI and LO alarm LED visible from front.

- b) Power Supply On/Failure LED visible from front
17. Accessories : a) Mounting flanges, adaptor plate and protection shield (protection/abrasive shield shall be SS 316)
- b) Gasket, nuts and bolts
- c) Cable with conduit from cell to amplifier (as required) and other special cables (if any)
- d) Automatic calibration kit (complete with all accessories and standard Gas Cylinders)
- e) Solenoid valve, Pressure regulator with Filter and Flow indicator
- f) Protection tube to minimize flue gas erosion.
18. Application : a) At economizer outlet
- b) At each air preheater inlet and outlet

1.34.00 H₂ + CO₂ + Air Analyzer

01. Type : Thermal Conductivity
02. Range Selection : 3 ranges.
03. Range : As required
04. Output : 4 20mA DC (Separate outputs for H₂, CO₂ and Air facility shall be provided)
05. Operating ambient temp. : 10° C to 50° C
06. Power Supply : 240V AC, 50Hz UPS
07. Sample gas flow control : Required
08. Reference gas flow : Required
09. Reference gas pressure regulator : Required
10. Cell response : 95% of change in 30 Sec.(Appox.)
11. Accuracy : 2% of full scale
12. Repeatability : 1% of full scale

13. Local Indicator : Indicating meter of 1% accuracy Backlit LCD/LED display
14. Alarm facility : Dual (High & Low) independently adjustable.
15. Contact rating : 0.5A at 220 V AC
16. Enclosure : Flame Proof
17. Accessories : Calibration gas, mounting accessories and others as required to be provided
18. Application : Generator Gas Purity.

1.35.00

CO Analyzer

01. Operating Principle : NDIR
02. Type : In-situ, microprocessor based probe type at economiser. In-situ, microprocessor based Cross duct/Probe type at chimney
03. Range : As per process requirement
04. Accuracy : 1% Full Scale
05. Linearity : $\pm 1\%$ of Full Scale
06. Repeatability : $< 1\%$ of span\
07. Calibration : Automatic & Manual (Zero & Span)
08. Power Supply : 240V AC
09. Output Signal : 4~20 mA DC
10. Alarm annunciation : Four relay contacts, dual alarm set points (240V AC, 5A)
11. Enclosure : Cast Aluminium (IP-65)
15. Indication : LCD Display
16. Op. Temperature Range : At Economiser (350 Deg C) and at Chimney (100 Deg C)
17. Accessories : Interconnection cable (as required) in flexible conduits
Tube / fittings, mounting brackets/ pads as required
Purge system for cleaning
Surge Arrester

18. Location : At Economizer and Chimney
19. Additional Feature : Remote Calibration and configuration facility from the remote location shall be possible. (i.e, the hardware and software required for Remote Calibration and configuration from Remote location to be provided).
- 1.36.00 Mercury Analyzer
01. Operating Principle : Atomic absorption spectroscopy
02. Range : 0-100 µg/Nm³
03. Measuring Parameters : Total gaseous mercury
04. Output : 4~20 mA DC
05. Alarm/ Annunciation : Four Relay contacts, dual alarm set points (240V AC, 5A)
06. Indication : LCD Display
07. Sampling System : Extractive
08. Enclosure : IP-65
09. Power Supply : 240V AC (UPS)
10. Location : On Chimney
10. Accessories : a) Inbuilt calibration facility through calibrator. Inbuilt cell for Zero & Span calibration to be provided. Handling of Liquid Mercury to be avoided.
b) Remote calibration facility to be provided.
c) The Mercury analyser cabinet to be placed inside an enclosed AC environment.
- 1.37.00 Dew Point Meter
01. Type : Direct mounting capacitance type with change in output proportional to moisture present
02. Sensing Element : Ceramic/ Aluminium Oxide sensor
03. Service : Dry Air
04. Range : -90 Deg.C to 10 Deg.C Dew point temperature
05. Sensor Accuracy : ±2 Deg.C Dew point

- 06. Repeatability : 0.5 Deg.C Dew point
- 07. Op.Ambient Temperature : -40 Deg.C to 50 Deg.C
- 08. Op. Pressure : 0-10 Kg/cm²
- 09. Display : Combined enclosure with 5 digit seven segments LED display
- 10. Element Filter : 80 micron sintered stainless steel
- 11. Output : 4~20 mA DC loop powered
- 12. Power Supply : 24V DC nominal
- 13. Enclosure Class : IP-65
- 14. Interchangeability : Fully Interchangeable Transmitters
- 15. Accessories : Sampling System, cables, sensor holder, dessicant chambers, souble compression fittings, 3/4" cable gland, mounting fixture etc.

1.38.00 Density Meter

- 01. Operating Principle : Vibration Density measurement
- 02. Wetted Part Material : SS-316L
- 03. Case Material : Cast Aluminium
- 04. Output : 4~20 mA DC
- 05. Electrical connection : 1/2" NPT
- 06. Enclosure Class : IP-65
- 07. Local Display : Digital 5 digit, density display with temp. compensation
- 08. Accuracy : ±1.0 %
- 09. Power Supply : 240V AC (UPS)
- 10. Location : At the discharge of Gypsum bleed pump in FGD system.

1.39.00 Radar type Level Measurement

- 01. Type : Radar based on Time Domain Reflectometry
- 02. Antena : Co axial / single rod type guided wave or Horn type as required for the application

- 03. Communication : Two wire 4-20mA DC, HART protocol
- 04. Environmental temperature : 0 – 50°C
- 05. Enclosure : Explosion proof /IP 65 as per application
- 06. Cable Entry : ½” NPT
- 07. Calibration : a) Self calibration with internal reference
b) Zero & Span calibration
- 08. Programming : Handheld programmer & Local key pad
- 09. Process Connection : Flanged /screwed
- 10. Transmitter Beam Angle : 10 degree or less
- 11. Blocking distance : less than 300 mm
- 12. Electronic Housing : Epoxy painted Die-Cast aluminium alloy
- 13. Antenna / Flange assembly : 316 SS or Hest alloy (as required)
- 14. Output Indicator : Digital Integral Display (Backlit LCD/LED)
- 15. Accuracy : 5 mm or 0.1% of probe length
- 16. Accessories : a) Programming tool kit
b) Gasket

1.40.00 Chlorine Leak Detector

- 01. Type : Electrochemical
- 02. Resolution : 0.1 ppm
- 03. Display Type : Digital Indicating Meter
- 04. Operating Temperature : 0~45°C
- 05. Alarm Contacts : Dual Alarm setpoints (240V AC, 5A)
- 06. Enclosure Class : IP-65
- 07. Mounting : Wall mounting
- 08. Power Supply : 240V AC
- 09. Output : 4~20 mA DC (600 Ω load)

1.41.00 Residual chlorine Analyzer

01. Type : Amperometric
02. Electrode : Platinum/ Gold and copper electrode shall be provided with cell cleaning system
03. Display Type : LCD in Analyzer Panel
04. Range : 0 to 20.0 mg/L (ppm)
05. Accuracy : 2% or better . The measurement accuracy shall not be affected by presence of treatment chemicals as chromates, phosphates, de-former highly polluted water, change in temperature etc.
06. Sensitivity : 0.01 mg/L
07. Alarm Contacts : Dual Alarm setpoints (240V AC, 5A)
08. Enclosure Class : IP-65
09. Power Supply : 240V AC
10. Output : 4~20 mA DC (600 Ω load)
11. Calibration : Zero & Span adjustment. Final calibration adjustments of the analyzer to be done at site and duly verified bt titration. Temperature compensation range 0-50°C.
12. Mounting : Field mounting conform to IP-65
13. Accessories : Chemical reagents, sample drain, pumping system (if required) etc.

1.42.00 Electric to Pneumatic (E/P) Converters

01. Air Supply : 1.5 kg/cm²
02. Max. supply Pressure : 7 kg/cm²
03. Input Signal : 4-20 mA DC (as required by the design of control system).
04. Output Signal : 0.2 to 1.0 kg/cm²
05. Control Action : Air to Close, Air to Open and Fail free-field selectable
06. Response Time : 5 seconds for 0 to 90% output pressure
07. Repeatability : +/- 0.1% span typical

08. Accuracy : +/- 0.25% span typical
09. Linearity : 0.5% of span or better
10. Hysteresis : 0.1% of span or better
11. Ambient Temp. effect : Less than 0.02% of span per °C between - 20 °C to +60 °C
12. Supply pressure Effect : less than 1%
13. Span and zero adjustment : screw
14. Mounting : Close to Actuator (but not on the actuator)
15. Output Capacity : To suit the actuator
16. Protection Class : IP 65
17. Allowable Drift Rate : ± 2% of set point / hour maximum

On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition.

1.43.00 Smart positioner

01. Type : Universal design (linear or rotary application)
02. Input Signal : 4-20mA DC , 2 wire loop with 24V DC.
03. Output Signal (position F/B) : i) 4-20mA
ii) Configurable end position switch
04. Supply Pressure : Single acting 1.2 to 7.0 bar
Double acting 1.2 to 10.5 bar
05. Air Delivery : Single acting 10.0 SCFM at 2.1 bar supply
Double acting 7.2 SCFM at 2.1 bar supply
06. Housing : IP 65
07. Repeatability : +/- 0.3% of span or better
08. Accuracy : +/- 0.1% of span or better
09. Communication : Hart protocol
10. Power-up with position : < 150 ms or better control

11. Power interruption without reset : <100ms or better
12. Body Material : Aluminium
13. Response Time : Less than 10 sec
14. Features :
 - i) Noncontact position feedback sensor
 - ii) Integral Electro-Pneumatic convertor
 - iii) Self calibration with tunable response time
 - iv) Online diagnostics
 - v) Pressure guages to be provided on positioner (I/P & O/P pressure)

1.44.00 Magnetic Level Indicator

01. TYPE : Magnetically coupled level indicator
02. Display : Coloured flags
03. Chamber material : Stainless steel
04. Wetted part material : Stainless steel
05. Process connection : Side Side Flanged
06. Drain & Vent : Flanged
07. Scale : Standard, Stainless steel
08. Accessories : Counter flange, gaskets

1.45.00 Flow Switch

01. Type : Paddle /Piston/Disk
02. Wetted part material : Stainless steel or Hastelloy for acidic application
03. End connection Tee :
 - i) Threaded upto 1" line size with integral Tee
 - ii) Flanged for line size > 1 ½"
04. Enclosure material : Die cast aluminium
05. Enclosure class : IP 65
06. Switch configuration : 2 SPDT
07. Contact rating : 240V AC 15A

- 08. Repeatability : 2%
- 09. Cable connection : ½"NPTF
- 10. Accessories : Tee, counter flange

1.46.00 Ultrasonic type Flow Meter

- a) Ultrasonic Flow meter shall be dual path transit time clamp-on type.
- b) The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to approval.
- c) CW flow shall be measured by redundant Ultrasonic Flow meter.
- d) All accessories required for mounting/erection of these instruments shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.
- e) Flow meters shall be provided with suitable environment protection devices / structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.
- f) Technical Requirements

- 01. Type : Transit time Clamp On Ultrasonic meter
- 02. Mounting Style : Dual path with two sets of transducers on the same pipe
- 03. Flow measurement : Instantaneous Flow rate as well as totalized flow
- 04. Power supply : 240V AC, 50Hz with built –in battery back up.
- 05. Analog Outputs : Isolated 4-20mA linear outputs for each path
- 06. Binary Output : Contact relay outputs, 2 NO + 2 NC for alarm
- 07. Communication ports : RS 232 C digital
Hand held terminal port
- 08. Display/Indication : Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and

visibility.

09. Recording / Totalizing / Logging Facilities : Yes. Should be able to compute cumulative flow over intervals selectable by Owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future.
 10. Software features : Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
 11. Diagnostics : False signal tolerance , power supply failure etc.
 12. Protection Class : IP-65 or better, Weather protection against direct sunlight, rain etc for Flow meter and suitable for Cooling water for Transducer.
 13. Accuracy : $\pm 1\%$
 14. Electrical connection : Plug and socket
 15. Accessories : All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables etc.

All weather canopy for protection from direct sunlight and direct rain. Material of all fittings shall be SS 316
- g) Bidder shall submit certified flow calculation and differential pressure Vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval.

2.00.00 NOT USED

3.00.00 CONTROL PANEL/DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES (As applicable)

(For electrical System's Meter and for synchronisation, bidder shall refer to Electrical volume of specification)

3.01.00 Digital Indicator (If Required)

01. Type : Five and half digit LED seven-segment display with sign.
02. Display Character : 13.8 mm, RED (LED)
03. Accuracy : 0.1% of reading, ± 2 digit

- 04. Input : 4-20mA DC/1-5 V DC/ pulse (as applicable)
- 05. Mounting : Flush Panel
- 06. Power Supply : 240V $\pm$ 10%, 50 $\pm$ 2.5 Hz

3.02.00 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

3.03.00 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

3.04.00 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

3.05.00 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

3.06.00 Indicating Meters (A.C)

01. Type : Rectifier type taut band
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 for voltage measurement, 50 ± 2.5 Hz for Frequency measurement
06. Zero Adjustment : Screw on meter face
07. Enclosure : Shielded Case IP-52
08. Mounting : Flush Panel
09. End Scale Suppression : 6 times the measuring range only for motor ammeters

3.07.00 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 IP-52
- 08. Mounting : Flush Panel
- 09. End Scale Suppression : 2 times the measuring range only for motor ammeters.

3.08.00 Auxiliary Relay

- 01. Type : Plug-in type with base/DIN rail Mounted
- 02. Coil voltage : 240 V AC/24V DC / 220V DC
- 03. Contact Configuration : 2 NO & 2 NC (Minimum), additional contacts as per requirement
- 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. Enclosure : Transparent cover
- 09. Connection : Screw terminals.
- 10. Mounting : Projection mounting inside panel /DIN rail Mounting

Note : Coil protection: diode/surge suppressor shall be provided

3.09.00 Coupling Relay

- 01. Type : Miniature plug-in type/ DIN rail Mounting
- 02. Coil voltage : 24 V D.C. / 48 V DC or others as required.
- 03. Contact : 2 NO & 2 NC (Minimum)-Additional contact as per requirement
- 04. Contact rating : 250 V/10A (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

3.10.00 Uninterrupted Power Supply (for Control equipment room, Unitl control room and Offsite PLCs)

UPS with 2x100% configuration shall be provided for the equipments / devices located in the Control Equipment (DCS) room and Unit Control room. Normally both of the redundant UPS will run in pararell mode sharing 50% load. On failure of any UPS, its load shall automatically get transferred to the other healthy UPS. For detail specification of UPS refer Volume IIF/2 section X-A1 & X-A2.

3.11.00 Push Button Station (Emergency Stop)

- 01. Function : Hardware communication between P/B Station & DCS
- 02. Type : Mechanical keys Shrouded
- 03. Size : 48 mm
- 04. Mounting : On Auxiliary Console
- 05. Signal Level : 24V DC Binary
- 06. Ambient temperature : 0-50 ° C
- 07. Ambient Humidity : 0-95% RH (max.)

4.00.00 CONTROL VALVES, ACTUATORS & ACCESSORIES

4.01.00 General Requirements

- 4.01.01** Bidder shall exercise extreme caution in selecting severe service control valves like BFP recirculation valves, HP & LP bypass valves, superheater & reheater attemperatur valves, PRDS valves for Boiler & Turbine, Soot blower steam pressure control valve, control valves whose down stream are connected to condenser and in vacuum such as HP/LP heater emergency level control, condenser make up water control valve and CEP minimum flow control valve etc. For such critical applications, Bidder shall offer valves which are proven for similar application for not less than 2 years of continuous service in power plant environment. All the above valves shall have leakage class equal or better than class-V or as specified hereunder with metal-to-metal seating.

- 4.01.02 Control valves for regulating service shall normally be globe body, cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs having ANSI leakage class-IV as minimum. All steam temperature conditioning control valves shall be ANSI leakage class- V.
- 4.01.03 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. Auto Calibration facility for HP/LP Bypass valves shall be provided. Block valve in the spray water line for HP or LP bypass valves shall also be hydraulically operated.
- 4.01.04 All control valves shall be located near floor or platform for ease of access with adequate clearances for maintenance and lay-down and shall be placed as control station with up-stream and down-stream motorized isolating valves, manual drain valves and motorized inching bypass valve. For Superheat attemperation control and Reheat attemperation control, upstream and down stream isolation valves shall be solenoid operated pneumatic on-off valves. Block valve in the spray water line shall also be solenoid operated pneumatic on-off valve.
- 4.01.05 Control Valves and accessories shall be designed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, ASME Boiler and pressure vessel code, Indian Boiler Regulation (IBR), ISA and other standards as specified elsewhere and in accordance with the applicable requirements of the Federal Occupational Safety and Health Standards, USA or acceptable equal standards.
- 4.01.06 For large flow conditions with low pressure drops, as in case of cooling water applications, butterfly valves shall be used.
- 4.01.07 High Pressure Bypass Control Valve
1. Body shall be designed to withstand thermal cycling. Thin walled sections shall be provided in areas after pressure reduction to reduce thermal fatigue.

Transitions between thick and thin wall sections shall be gradual. The body shall be a single shape steam entry from the bottom (under the plug) to facilitate easy and clean installation.
 2. Valves shall be designed that they can operate in any orientation. For maintenance purposes the preferred orientation is vertical.
 3. The HP bypass shall have desuperheating function in the valve body. Water injection must be at a fixed point inside the valve spraying into the turbulent steam flow. Water shall not be injected through the stem due to leakage potential past internals seals and to eliminate possibility of stem cracking due to combined thermal and mechanical stress. Water spray should be fully atomized within 1m of valve outlet to ensure uniform reheater temperature and flexibility in downstream piping layout.
 4. Body shall be protected from damage due to water injection by means of multi function contoured cage. Contoured cages shall be used as they have higher mechanical strength and no tendency to resonate.

5. Cage material must be of a high alloy material such as X20Cr Mo V121 for good thermal cycling and erosion resistance.
6. Contour of cage to be of hour glass shaped form to improve the strength of the cage. The cage shall be firmly attached at one end and located radially at the other end to provide good guiding and allow axial growth due to thermal differentials.
7. Plug type shall be channel slotted design for acoustic attenuation and to allow passages of nominal contamination. Plugs of multiple holes design are unacceptable due to contamination catching between plug and seat. Contoured plug designs are not allowed because of poor acoustic performance.
8. Packing box design shall consist of two independent sets of rings separated by a metallic spacer. Packing to be compressed by means of a bolted flange design. Screwed gland type packing retainers shall not be provided.
9. Bolted bonnets are preferred. If pressure seal bonnet are used, seal areas shall be inlaid with corrosion resistant materials to minimize leakage potential.
10. The bypass valve should conform to MSS SP-61 or EN12266-1 Rate C leakage class (block/isolation valve tightness). Bidder to provide calculation.

4.01.08 Low Pressure Bypass Control Valve

1. Body shall be designed in angle shape for ease of installation and maintenance.
2. Valves shall be designed that they can operate in any orientation.
Note that the typical orientation for LP-Bypass valves is horizontal with straight outlet to the condenser.
3. Skirted-plugs shall not be used due to potential for contamination and sticking between plug and seat. A combination of cage guiding and top guiding for plugs shall be provided to eliminate possibility of vibration.
4. No components may be screwed or welded inside the valve body for ease of maintenance.
5. Inlet cage and seat shall be easily removable for inspection maintenance and replacement. They shall be hold in place by the bonnet bolting and flexible gaskets shall accommodate differential thermal expansion.
6. Water injection to be downstream of pressure reduction to maximize evaporation.
7. Diffuser in the outlet to reduce noise and guide steam towards spray nozzles for good mixing of water and steam.
8. Water shall not be injected through the stem due to leakage potential past internals seals and to eliminate possibility of stem cracking due to combined thermal and mechanical stress.
9. Water injection shall be performed through spray nozzles. Spring loaded nozzles are preferred to maximize atomization at lower flow rates. Multiple nozzles shall be used for uniform spray pattern. Water

injection shall be perpendicular to stem flow for good penetration and mixing.

10. Packing to be compressed by means of a bolted flange design. Screwed gland type packing retainers shall not be provided.
11. Bolted Bonnets are preferred. If pressure seal bonnets are used, seal areas shall be inlaid with corrosion resistant materials to minimize leakage potential.
12. The bypass valve should conform to MSS SP -61 or EN12266 – 1 Rate C leakage class (block/isolation valve tightness). Vendor to provide calculation.

4.01.09 Spray water Valves

1. Valves shall be provided with rated cavitation index (K_{cr}) above Cavitation index for the process (K_c) where $K_c = (P_1 - P_2) / (P_1 - P_v)$
2. Valves shall be free of cavitation. Should process condition produce cavitation, valve design shall be upgraded to eliminate cavitation.
3. The trim should be quick change type. No parts should be screwed or welded.
4. Isolation valves must be provided upstream of the HP-Bypass spraywater control valves, to ensure tightness of the spraywater line whenever the steam valve is closed. Individual isolation valves per control valve are recommended. Isolation valves are to be shut whenever the steam valve is closed.
5. Isolation valves upstream of the LP-Bypass spraywater control valves are recommended to allow shut-off of the water line. Isolation valves are to be shut whenever the steam valve is closed.
6. The valves should conform to MSS SP -61 or EN12266 –1 Rate C leakage class (block/isolation valve tightness). Valve trim exit velocity should be below 23 m/sec.

4.01.10 Hydraulic System

Hydraulic actuation is used for positioning of bypass control valves to fulfill the high stroking speed, high actuation forces and accurate positioning requirements. The hydraulic actuation system consists of one or more hydraulic supply units as required by the capacity and the distances between the valves and the hydraulic actuators and accessories.

4.01.11 Hydraulic supply unit

The hydraulic supply unit shall have the following features:

- fully redundant main pumps with 100% capacity. Switch over from main to standby pump should be fully automatic. Both pumps can be main or standby pump.
- Operating pump should run continuously to avoid unnecessary switching of main pumps and power peaks.

- Filter loop with continuous filtration of the oil. Filter change possible without switching off main pumps to avoid shutting down bypass for filter change.
- Oil filling must take place with the filter pump through the filter.
- Oil cooler with controlled fan to keep oil temperature within limits for the used hydraulic oil.
- Optional oil heater if ambient temperatures are getting below minimum limits of hydraulic fluid.
- The hydraulic supply unit should be able to generate constant outlet pressure of 160 bars and should have constant pressure and forces at the actuator.
- Accumulator pressure should be above the controlled outlet pressure to ensure sufficient reserve volume in the accumulators.
- Reserve volume in accumulator should be sufficient to allow min. 2 strokes of all actuators after trip of main pumps.
- Hydraulic supply unit should be equipped and completely wired and tested with local control and power switches. Manual control of the hydraulic supply unit through push buttons on the front panel for commissioning and testing.
- Drip tray shall be supplied together with the hydraulic supply unit.

4.01.12 Hydraulic actuators

- Hydraulic actuators shall be of compact heavy duty design and shall fulfill all force, stroke and stroke speed requirements of the valves.
- Actuators shall be of compact design with proportional valves and auxiliary elements directly flanged to the actuator, without connection pipes between these elements and the actuator
- Position control shall be performed with the help of proportional valves
- System must include accessories for quick stroking and safe opening and safe closing. Quick stroking accessories are not required if control through proportional valves meets quick stroking speeds (typically 2-3 seconds).
- Energy for safe opening or closing (e.g. condenser protection) shall be independent of the oil pressure from the HSU, either through steam force or a separate hydraulic accumulator.

4.01.13 Hydraulic positioner

- Hydraulic positioner shall be LVDT type digital smart and featuring simple adjustment through digital interface.
- For easy commissioning and maintenance positioners are located close to the valve/actuator and must be suitable for the harsh environment. Connections to the actuator shall be prefabricated and pluggable.
- The positioned is the only connection point for the plant cabling to the valve/actuator.

- Positioner should be absolutely stable at stroke speeds of 2 seconds
- Positioner shall have standard 4-20 mA signals for position demand and position feedback.
- Power supply options must be available for easy adaptation to the power supply available in the plant.

4.01.14 Bypass Controller

- Control system shall be state of the art, digital type.
- Control system should have redundant power supply to ensure reliability
- Control system shall be suitable to operate from 0 to 50 degree Celsius.
- Input/output modules, Power supply modules and CPU modules shall have hot swap feature and shall be replaceable while the plant is in operation without any disturbance of the other module.
- Input/output modules, Power supply modules and CPU modules shall have no slot dependencies for easier use.
- Interface with main DCS shall be both hardwired and MODBUS. Controlling of valve through the DCS shall be hardwired.

4.02.00 Valve Construction

- 4.02.01 All valves shall generally be of globe body design and straight through pattern with single seat unless otherwise is specified or recommended by the manufacturer for particular application. 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 full line pressure.
- 4.02.02 Valves with high lift cage guided plugs and quick replacement trims shall be provided for easy maintenance.
- 4.02.03 Plug shall be one piece construction either cast, forged or machined from solid stock. Plug shall be screwed and pinned to valve stem or shall be integral with valve stem.
- 4.02.04 Bonnet joint shall be of flanged and bolted type or manufacturer standard acceptable to Owner. Bonnet joints of internal threaded or union type is not acceptable.
- 4.02.05 Extension Bonnet shall be provided for fluid temperature above 280 deg C.
- 4.02.06 Valve characteristics shall match with the process characteristics.
- 4.02.07 All valves connected to vacuum on down stream side shall be provided with packing suitable for vacuum application (i.e. double vee type chevron packing).
- 4.02.08 Flanged valves shall have minimum body rating ANSI 300 lbs.
- 4.02.09 The direction of flow shall be clearly marked/engraved on the body.

4.02.10 Valve body rating shall meet the process pressure and temperature requirement as per ANSI B 16.34.

4.02.11 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 300 Bar. Above 300 Bar, valve body shall be of forged steel. For Demineralized Water application valve body shall be Stainless Steel.

4.03.00 Valve Body

Valve body material shall generally be guided as per the Table below:

Sr. No.	Service	Body Material
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature upto 275°C (like Aux steam flow to Deaerator, condensate flow to Deaerator, CRH flow to Deaerator)	Compatible with piping material but not inferior to Cast carbon steel ASTM A216 Gr. WCB
2.	Severe flashing / cavitating services (like HP & LP heaters emergency drain, Deaerator overflow drain to hotwell etc.)	Alloy steel as per ASTM A217 Gr. WC9
3.	Low flashing / cavitating services (like HP & LP heaters normal drain level control, GSC minimum flow, gland seal steam pressure control etc.)	Alloy steel as per ASTM A217 Gr. WC6
4.	DM water application (like condenser hotwell normal and emergency make up, ECW DP control etc.)	316 stainless steel ASTM A351 Gr. CF8M

4.04.00 Valve Trim

4.04.01 Valve trim for most 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 shall be substituted if required for corrosion and other fluid conditions.

4.04.02 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators. For flashing services and two stage mixtures, the trim material shall be 17-4 PH or equivalent. If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trim valves. Trim of severe service valves as indicated in Cl. 4.01.01 shall be of multistage and multipath design with sufficient no. of discrete pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.

4.04.03 Quick replacement type trim shall be considered for easy maintenance.

4.04.04 Trim Material

Valve trim material shall generally be guided as per the Table below :

<u>Sr. No.</u>	<u>Service</u>	<u>Material</u>
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature upto 275°C.	316 SS with satellite faced guide posts and bushings
2.	Severe flashing / cavitating services	400 series SS or equivalent to suit the specific requirement
3.	Low flashing / cavitating services	400 series SS or equivalent to suit the specific requirement
4.	DM water application (condenser hotwell normal, emergency make up etc.)	316 SS

cavitation resistance, corrosion resistance, temperature resistance, erosion resistance, hardness etc. of the offered material vis-à-vis the specified material for Bidder may offer valves with body and trim material better than the specified material and in such cases Bidder shall furnish the comparison of properties including Owner's approval.

4.05.00 Valve End Preparation

Valve body ends shall be either butt welded/socket welded, or flanged (Rubber lined for condensate service). Control valves of size 65 mm and above shall have butt welded ends as per ANSI B 16.25. For valve size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends shall be of ANSI pressure-temperature class equal to or greater than that of control valve body.

4.06.00 Valve Size

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

- The valves shall pass normal rate of flow (MCR condition) with 65 to 75 percent opening for linear characterised valves and 75 to 85 percent opening for equal percentage characterised valves.
- The valves shall have adequate rangeability to pass the minimum and maximum rated flows at 10% and 80% 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.
- Valve Cv shall be selected in such a way that the valve shall be capable of handling at least 120% of required rated 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) The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.
- f) While deciding the valve size, Bidder shall ensure that valves port outlet velocity does not exceed 8 m/sec for liquid services, 150 m/sec for steam services and 50% of sonic velocity for flashing services.
- g) Control valve induced noise shall not greater than 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.
- h) Bidder shall submit the sizing calculation clearly indicating the valve outlet velocity, noise calculation during detail engineering stage for Owner's approval.

4.07.00 Valve Topwork

4.07.01 Topwork 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.

4.07.02 Bonnet material shall be same as that of valve body or equivalent forged material.

4.07.03 Extended bonnet/Finned bonnet and high temperature packing shall be used for high temperature application. Extension bonnet shall be used when the fluid temperature is high and may damage valve stem packing.

4.07.04 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for low temperature application and for high temperature application graphited asbestos glands are to be provided. For vacuum services, the glands shall be dry seal type.

4.08.00 Noise Level

The equivalent sound level measured at 1.5 M 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 necessary spool piece. The spool piece shall be in conformity with the main line piping specification.

4.09.00 Valve Actuators

4.09.01 Spring-diaphragm type valve actuators shall be used in general applications. However piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Bidder shall provide piston type actuators for regulating services for the following services as a minimum

requirement. Piston actuator shall be of double acting type for the regulating duty valves with long stem travel for better regulation and quick response.

- a) Auxiliary Pressure reducing & De-super heating stations.
- b) Superheat and Reheat Spray Control Valves.
- c) Condensate extraction pump minimum recirculation valve.
- d) Feed control valves

- 4.09.02 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.
- 4.09.03 All the actuators shall be supplied mounted on the valve with all the accessories integrally mounted. The diaphragms shall be designed for 200% maximum operating pressure.
- 4.09.04 Nylon reinforced neoprene shall be used as diaphragm material.
- 4.09.05 Valve actuators shall be capable of operating at 60 deg C ambient, continuously.
- 4.09.06 Entire actuator assembly shall be painted with corrosion inhibiting paint.
- 4.09.07 Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be of stainless steel construction.
- 4.09.08 Bidder shall indicate the stroking time of the valve assemblies with positioner, which shall not exceed 10 sec unless otherwise stated.
- 4.09.09 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.
- 4.09.10 HP and LP bypass and spray valves, turbine inlet stop & control valves shall be electro-hydraulic actuators and all other control valves shall have pneumatic actuators.
- 4.10.00 Valve Positioners
- 4.10.01 All regulating service valves shall be offered with HART protocol based Smart Electro Pneumatic Positioners to ensure accuracy and repeatability of response.
- 4.10.02 Positioners shall have integral I-P converter, Position feedback transmitter, input and output gauges, local keypad & display .
- 4.10.03 Positioners shall be capable of functioning under hot, humid and vibrating conditions.
- 4.10.04 Positioner casings shall be dust tight, corrosion resistant and weatherproof (IP-55).
- 4.10.05 In general, positioner shall operate at signal range 4 – 20 mA DC for the full travel of the valve. Split range operation in few cases may be required. Remote calibration from control room shall be possible through HART management station.

4.11.00 Valve Accessories

The accessories of the valves shall include side mounted hand wheels, smart positioner, limit switches, tubing and air set, junction boxes, airlock relays, volume booster, solenoid valves, and any other devices as required.

4.12.00 Tests

All valves shall be tested in accordance with the Quality Assurance Programme (QAP). Bidder shall submit QAP for Owner's approval. The tests shall include but not be limited to the following :

01. Non destructive test as per ANSI B 16.34.
02. Hydrostatic shell test as per ANSI B 16.34 prior to seat leakage test.
03. Valve closure test and seat leakage test as per ANSI B 16.34 and as per the leakage class
04. Functional test : The fully assembled valves with actuator and all accessories shall be functionally tested to demonstrate from open to close position and vice versa. Valve lift shall be checked at 5 points at 0, 25, 50, 75 and 100% in both the directions with increasing and decreasing inputs. Performance of the valve with Positioner shall be as follows :
 - a. Linearity : +/- 1%
 - b. Hysteresis : +/- 1%
 - c. Sensitivity : +/- 0.5%
 - d. Deadband : +/- 1%
 - e. Reproducibility : 0.3% of total stroke
 - f. Overall accuracy : +/- 1%
05. CV test : Cv test shall be carried out as type test on each size, type and design of the valves as per ISA 75.02 standard and test report shall be submitted for Owner's approval.

5.00.00 CONTROL DESK / PANEL / RACK

- 5.00.01 Convenient and logical approach to operational interfaces shall be considered to enhance aesthetics in the overall view of the control room..
- 5.00.02 For items susceptible to vibration, suitable rubber gaskets or padding shall be provided to prevent damage or malfunction.
- 5.00.03 All items like MCB, Terminals, instruments, lamps etc. inside the panels/cabinets shall be neatly arranged with easy access/ maintenance approach to avoid undue disturbing the wiring.
- 5.00.04 Incoming power supply feeders shall be Redundant UPS Power supply feeders, so that a single failure shall not affect the operation of the unit. Required isolation & protection through MCB shall be provided in all cases. Alarm shall be provided against failure of a single power supply.

Duplication/looping of Power supply feeders at the Panel terminal is not acceptable. Redundant UPS power supply feeders shall form Primary & Secondary power supply Bus and further power distribution shall be from these busbars.

- 5.00.05 Desk / panel shall be provided with interior illumination lamp with door switch, space heater with thermostat and 5A, 3 Pin receptacle with plug. Exhaust/cooling fans with fan failure alarm shall be provided.
- 5.00.06 Lamp, heater, exhaust fan and receptacle circuits shall be suitable for available AC supply and furnished with individual ON-OFF switch. The ON-OFF switch of the 3 pin receptacle circuit shall be illuminating type.
- 5.00.07 Panel / Desk shall have gland plate at cable entry to panel. Thickness of gland plate shall not be less than 3 mm.
- 5.00.08 Panels / enclosure shall be provided with 20% spare terminals. In addition, the spare hot on rail mounted input output channels /modules shall be in fully wired & terminated condition for system cabinets.
- 5.00.09 Wire shall be routed/laid in the covered PVC cable trough/tray.
- 5.00.10 Nameplate
- a) Nameplate shall be furnished for each instrument or device mounted on the panel/desk.
 - b) The material shall be laminated phenolic, 3 mm thick with white letters on black background.
 - c) The nameplates for panels / consoles shall be provided both on the front and the rear.
 - d) Nameplates for all devices shall be located adjacent to the respective devices.
- 5.01.00 Unit Control Desks
- 5.01.01 All devices mounted on the control desks shall be flush type. Instruments / devices shall be so mounted that the removal and replacement can be accomplished individually without interruption of services to others.
- 5.01.02 Aesthetic, ergonomics and room illumination shall be considered while positioning of the desk, large video screen and panels in control room.
- 5.01.03 Control desk shall be free standing floor mounting type table top design for placing computer monitor and other hardware. Desk shall be of latest technology aesthetic design and constructed from aluminium with high density fiber. All operators' LED monitors & keyboards, emergency push buttons like MFT, Turbine trip & Unit trip, alarm annunciation PBs shall be mounted on the desk. Desk shall be arranged in arc like shape. Exact profile & shape shall be finalized during detailed engineering.
- 5.01.04 Crating of the desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing and all panel mounted equipment shall have adequate

protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

- 5.01.05 The control desk shall have adequate space for mounting one no. EPABX Telephone handset and one no. PA system desktop mounted type field call station.
- 5.01.06 OWS and other application terminals mounted on the control desk shall be powered from UPS feeders and each feeders shall be provided with MCB at the upstream of the permanent Power receptacles A minimum of two set of Alarm Accept/Reset Push Button shall be provided on each Control Desk.
- 5.01.07 Technical Specification of Unit Control Desk
- i) The frame / structure should be minimum 2mm thick Powder Coated Extruded Aluminum profile.
 - ii) The Table Top / Work Surface shall be 36mm thick, Medium Density Fiber (MDF) board with high pressure laminate or Acrylic Plastic Solid Surface (APSS).Top surface shall be finished with anti-scratch material.
 - iii) The curvilinear angles shall be 4 - 10 degree..
 - iv) Foot extension shall be of Cast Aluminum & painted.
 - v) Foot Leveler shall be injection molded glass filled nylon foot with steel insert.
 - vi) END Caps & Extruded PVC Caps shall be provided where required.
 - vii) Front edge shall be extruded PVC or rounded post-formed laminate
 - viii) Concealed cable tray shall be powder coated steel.
 - ix) Provision shall be made for keeping Multi-media speakers..
 - x) Design shall include Earthing bolts on left side end and right side end of the Workstation Desk / Rack.
 - xi) Design should include cutouts for Push buttons, Public Address System and Function Keyboard mounting on the Furniture.
 - xii) Retractable keyboard tray in the control desk shall be provided.
 - xiii) Retractable tray with telescopic slide for CPU/PC blockshall be provided.
 - xiv) Front and Rear door shall be considered.
- 5.02.00 Back Up Panel / electrical panel
- 5.02.01 Back Up Panel shall be of free standing type vertical panel with doors at the back. Construction shall be made from sheet steel of thickness not less than

3mm with mosaic grid structure of approximate size 24 X 48 on the front surface. Grid shall be heat resistant, flame retardant, self extinguishing, shrinkage free, non reflecting type. Finish shall be mat type without flaring. Indicators /ammeters, conductivity type EWL for seperator, electromatic safety valve controls etc. shall be mounted on the panel..

5.02.02 Electrical Panel construction & design shall be similar to back up panel. Required control switches, meters, indicators, synchronizer, excitation control switch, annunciation window etc. alongwith associated mimic diagram shall be provided for manual synchronization of generator.

5.02.03 Crating of the panels shall protect against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

5.03.00 Cabinets / Enclosure / Panels

01. Material of construction : Cold rolled steel sheet
02. Thickness of Sheet :
 - a) 3.0 mm for faces supporting instruments / terminals. Mounting plate shall also be 3.0 mm.
 - b) 2.0 mm for other sides inclusive of top.
03. Construction : Welded throughout as per (metallic parts) approved National Standards.
04. Panel height : 2300 mm maximum
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. Doors shall have 4 point IP Lock
 - 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. Door swing shall be Min. 110-120 Degree
- vi) Louvers : With removable wire mesh to ensure dust and vermin proof.
- 07. Color of interior : Brilliant white (Approval shall be accorded by owner during detail engineering)
- 08. Colour external : RAL 7032
(Approval shall be accorded by Owner during engineering)
- 09. Painting : Epoxy powder coated or better. Minimum Paint thickness shall be 80-100 microns
- 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) Lifting hook / Eye bolt
 - d) Drawing pocket
 - e) Door switch, lamps, thermostat, heaters and fans
- 13. Enclosure Protection : As per environment condition of the area of installation. Refer to Section-I of Vol-IIIE clause 6.16.00.

5.04.00 Local Instrument Racks & Enclosure (Except offsite/bop areas)

Transmitters and switches located in the field shall be grouped together and shall be installed in the enclosure (Closed Transmitter Racks) in case of outdoor area such as Boiler area etc. and in Open Type Rack in case of covered area. Racks shall be factory prefabricated & painted and complete with internal tubing, manifold, isolation valves, integral junction box with outside access door, illumination etc. Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging. Following requirements for LIE/LIR shall be met:

- 1) Not more than Six (6) Instruments shall be grouped in a single Rack/enclosure".

- 2) Racks shall be installed above the tapping points for air, flue gas and coal air mixture application where as for applications such as for water and steam, racks to be installed below the source point.
- 3) Service air connection shall be provided for continuous and intermittent purging of impulse pipe in dusty medium. Continuous purging shall be adopted for differential and guage Pressure measurements such as flue gas, furnace and coal air mixture applications. Intermittent purging shall be adopted for Pressure measurements in air application or wherever required.

5.04.01 Closed Type Transmitter Racks

- a) Required number of transmitter racks shall be furnished to house transmitters, switches and converters by grouping them suitably, area-wise / function-wise. Closed type Instrument rack to have the list of the Transmitters & Switches along with the service and KKS tag on the inner face of the front door. Moreover each Transmitter/switches mounted on the 2" pipe shall have label indicating the KKS tag.
- b) The transmitter enclosures shall be constructed of 3 mm thick steel plate. The enclosures shall preferably be of modular construction and with two end plate assembly bolted to the frame. Base frame shall be made of ISMC 100 and black colour finish
- c) The enclosure shall approximately be 1200 millimeters wide, 1000 millimeters deep and 2200 millimeters high to allow easy access to the internals. Racks shall be reinforced as required to ensure true surfaces and to provide adequate support for instruments and equipment mounted therein. Double interlocking doors shall be provided and shall be arranged for maximum possible access to the interior. Center posts or any member which would reduce access shall not be provided.
- d) 2"NB Galvanised pipes shall be laid horizontally and supported at two end channels to mount transmitters/switches at accessible height. Adequate support for Manifold, impulse pipe and cable tray to be provided and the same shall be adjustable.
- e) Doors shall have concealed quick removal type pinned hinges and locking handles. Doors locks shall accept the same key all over the plant. Gaskets shall be used between all mating sections to achieve dust proof enclosure rating for the modules and a IP-65 waterproof and dust tight rating on the terminal boxes. All enclosures shall have access doors on front side. Doors shall have three point Locking system. Doors shall have concealed quick removal type pinned Stainless steel hinges.
- f) Bulkheads, especially designed to provide isolation from process line vibration shall be installed on modular bulkhead plates of the transmitter enclosures to meet the process sensing line connection requirements. Removable top and bottom plates shall be furnished. Removable bulk head plates of thickness not less than 6mm shall be mounted on the racks with suitable high temperature gasket impulse line within the enclosures shall be properly clamped.

- g) All internal wirings and/or data bus connections, if any, between the transmitters and terminal junction box shall run through flexible dust tight conduits connected to the terminal box hub. No exposed wirings within transmitter racks, both open and closed type, is admissible.
- h) All racks shall have a common closed drain trough to connect transmitter drain points to a common header after suitable pressure breaking. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. The trough shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header. Individual Instrument blowdown line shall be connected to the common blowdown drain header through regulating globe type blowdown valves. The common blowdown drain header shall be 2" NB ASTM A106, Sch-80 Gr. C installed at a slope of 1:25
- i) Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations.
- j) Service Power and Lighting
 - i) Each enclosure shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.
 - ii) Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.
- k) Control Air
 - i) A control air supply header shall be furnished in each enclosure having pneumatic devices. The header shall be 25 mm NB brass header stock drilled and tapped for 8 millimeter valves.
 - ii) A valve with double compression end fittings shall be installed in each tap. Not less than three spare connections shall be furnished in each enclosure. The air header shall originate at a bulkhead penetration or fitting located in one of the bulkhead plates. Each pneumatic instrument shall have an individual air shut-off valve.
 - iii) Pressure reduction shall be achieved by air filter regulator sets. One filter regulator shall be furnished for each group of components making a system.

l) Service Air

In case of Continuous air purging, a 25NB (1") service header shall be formed which shall receive air through isolation valve and air filter regulator. Air shall be fed from air header to impulse pipes near to take-off points through isolation valves and flow regulators. Service Air header shall be Stainless steel. Impulse pipe for such applications shall have four-way valve. one port of the valve shall have an adaptor to connect flexible stainless steel braided nylon to the service air. Rating of the hose having a burst pressure 15 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.

m) Power Supplies

Contractor shall supply all required transformers, regulators and other power supply equipment to adapt sources of power to the requirements of the enclosure mounted equipment. This shall include but not be limited to internal instrument illumination transformers. The circuits shall be separately isolated with MCBs.

n) Equipment Installation

Special attention shall be given in the piping layout to avoid air traps in liquid filled piping, or water pockets in piping.

o) Impulse Piping /Tubing

- i) Transmitter enclosures shall be complete with impulse piping & tubing, valves from enclosure bulkhead connection to all instruments and necessary drain / blow down connections. The type, size, material and pressure class of pipes/tubes, fittings, valves etc. shall be suitable for the intended applications.
- ii) Blow down piping / tubing may be shared, but individual instrument piping / tubing and valves shall be furnished. Piping / Tubing material within enclosures shall conform to the application requirements. The final flexible connection to each instrument shall be fabricated with a double offset so that it may readily be disconnected to permit "in situ" calibration of the instrument.
- iii) Bulkhead connection shall be used when instrument piping/ tubing enters the enclosure. For instrument lines which enter through the bottom of the enclosure, the primary process line from the instrument valve shall be neatly installed, anchored and terminated at approximately 150 millimeters above the floor of the enclosure. The enclosure shall have a removable, gasketed floor plate to provide an effective seal around the incoming field primary process line. An angle shall be installed 600 millimeters above the floor, running the length of the enclosure for anchoring of incoming field process lines.

- iv) Pulsation dampeners shall be furnished wherever required.
- v) Drain pots shall be furnished for instruments measuring flue gas parameters and vacuum.
- vi) All liquid filled blow down lines, except those measuring vacuum shall be connected to a header extended through one end of the enclosure and turned downward for directing the blow down into drain. Gas filled lines and lines equipped with drain pots shall not be connected to the blow down header. The connection between the blow down valve and blow down header shall be constructed so that it can be removed to permit the connection of test instruments to the blow down valves.
- vii) The draft instrument line four-way valves shall be installed so that the quick disconnect fitting is readily accessible for connection with the service air hose.
- viii) Pipe and stainless steel tube welding shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.
- ix) Instrument piping and tubing shall be hydrostatically tested at one and one-half times the maximum system pressure for that instrument except for low pressure and vacuum measurement the test pressure will be as per piping standard.
- p) Instrument Tubing
 - i) Pneumatic tubing shall be installed in a neat workmanlike. It shall be supported frequently enough that it does not shake when subjected to vibration. All tubes which enter or leave the enclosure shall be terminated on bulkhead fittings in the bulkhead plate.
 - ii) Pneumatic tubing material shall be 6 mm OD stainless steel tubing, unless otherwise specified. Flare less tubing fittings shall be used for tubing connections smaller than one inch. Tubing shall be stretched before installation to assure straightness. Special tools shall be used for all bending and forming operations. Tubing shall be carefully handled to avoid flat spots, kinks, and short bends. All piping and tubing shall be air blown after erection and before attachment to equipment at either end.

5.04.02 Open Type Transmitter Racks

- a) Open type transmitter racks may be provided for mounting transmitters, switches, gauges, converters and other accessories in rooms, buildings and closed areas like the power house building.
- b) The open type racks shall be shop fabricated. Transmitters, switches, converters and transducers of enclosure class IP-65 or better can be directly mounted on open racks. However, enclosures not conforming to the above protection standard shall have to be housed in

enclosures conforming to IP-65 class prior to mounting them on open structures.

- c) The following shall be provided for open type transmitter racks:
1. Rack shall be constructed from 6mm thick steel channel frame.
 2. Canopy shall be of 3mm thick CRCA steel.
 3. 2"NB Galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters/switches at accessible height.
 4. Adequate support for Manifold, impulse pipe and cable tray to be provided and the same shall be adjustable.
 5. Individual Instrument blowdown line shall be connected to the common blowdown drain header through regulating globe type blowdown valves. The common blowdown drain header shall be 2" NB ASTM A106, Sch-80 Gr. C installed at a slope of 1:25
- d) For operational convenience, the open type racks shall be used for mounting pressure and temperature gauges and switches and the local operating stations for electrical drives in the vicinity. Gauges mounted in racks shall be bottom connected and secured by double lock nuts. All gauges shall be located within 1500 mm from the floor for easy readability.
- e) The structural design shall be such that no item shall interfere with maintenance and removal of instrument, equipment and their accessories.
- f) Service Power and Lighting
- i) Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack.
 - ii) Power supply for receptacles and lighting shall be arranged. Power supplies for miscellaneous devices shall be provided with MCB located within the rack JB. MCBs shall be mounted in blocks. MCB ratings will be given on electrical schematic diagrams. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.
- g) Control Air
- Same as for closed type transmitter rack. Refer 5.04.01 (j) above
- h) Service Air
- Same as for closed type transmitter rack. Refer 5.04.01 (k) above
- i) Power Supplies

Same as for closed type transmitter rack. Refer 5.04.01(l) above

j) Equipment Installation

Contractor shall prepare rack fabrication and piping drawings indicating the layout of each instrument. The drawings shall clearly indicate Contractor's piping arrangement for the sharing of process connections between two or more instruments. Special attention shall be given in the piping layout to avoid air traps in liquid filled piping or water pockets in piping intended to be dry.

k) Impulse Piping / Tubing

Same as for closed type transmitter rack. Refer 5.04.01 (n) above

l) Instrument Tubing

Same as for closed type transmitter rack. Refer 5.04.01 (o) above

5.04.03 Wiring of the Racks

- a) A fully enclosed IP 65 type junction box shall be provided in each rack for housing the terminal blocks connectors, power supply fuses and other electrical accessories, as required.
- b) Junction boxes for modular enclosures shall be fabricated externally on one end of each enclosure assembly to accept field wiring/cablings through the top or bottom of the junction box. A hinged door shall give access to the interior of the junction box.
- c) All electrical connections between instruments and the junction box terminal blocks shall be made. In addition, all utility wiring for lighting and service power shall be installed.
- d) All wiring used within the enclosures shall conform to NEC /IEC standards. All wiring shall run through flexible or rigid conduits and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrument leads and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.
- e) High impedance circuits shall be connected using shielded or coaxial wire suitable for the service.
- f) Conduits shall be supported properly at regular intervals with suitable conduit clamps.
- g) Wire shall be neatly arranged and routed/laid in PVC trough/tray.

5.04.04 Junction Box

Junction boxes shall be of metallic construction.

- a) Junction box shall be provided with front opening type cover. Junction box shall be of sheet steel construction with thickness not less than 2 mm. Junction box shall be complete with DIN rail mounted terminals, MCB, receptacles and earth bar. Earth bar shall be made of tinned copper of 25 X 6 MM size. Earth stud shall be furnished for safety grounding.
- b) Terminals shall be screw less cage-clamp type and 20% spare terminals shall be furnished. Power terminals shall be screw type.

6.00.00 PROGRAMMABLE LOGIC CONTROLLER (PLC)

Make and model of the PLC system shall be same as that of existing PLC of other units. Latest available operating system and latest hardware shall be considered. No obsolete items or software/hardware with limited availability will be considered.

Make: AllenBradley
Model: Studio 5000
Controller: L72

6.00.01 Programmable Logic Controller (PLC) shall meet the following general requirement:

- 1) Each PLC shall have redundant Central Processing units (CPUs) of word length of 32 bits minimum.
- 2) Each CPU rack shall have redundant Power supply units, CPU, IO communication processor (between IO Rack & CPU), Communication processor (between CPU & HMI via ethernet switch), memory module (if applicable etc).
- 3) Each IO rack shall have redundant Power supply units, IO communication processor (between CPU & IO rack) and IO modules.
- 4) The redundant CPU rack and IO rack shall be connected through redundant data highway.
- 5) The CPU rack shall be connected to the operator station through redundant 10/100 Mbps data network.
- 6) IO racks shall be backplane type. i.e, the IO cards mounted on the rack shall be on the back plane

Two CPUs shall operate on fault tolerant mode with continuous self and cross-monitoring facility. 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 bumplessly within fastest possible transfer time without causing any output to drop during the transfer period. The bump less change over shall be accomplished within one Scan-cycle. Transfer speed shall not be less than 1

Gbit/sec. CPU Redundancy shall be achieved through dedicated hardware Synchronised Link between active and standby CPU.

In the event of both the CPU failure, the system shall revert to the fail-safe mode. CPUs shall not be loaded over 60% of the individual 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. Module shall have adequate status and diagnostic indication on the front panel and as well as on the engineering station.

- 6.00.02 The system shall be of modular construction and expandable by adding hardware modules and incorporating them in the address register. Bidder shall provide at least 20% or minimum one number, whichever is higher, spare channels as hot-on-rail spares in each configured cards/modules. In addition to this 10% or minimum one number, whichever is higher, extra assigned complete spare modules mounted on rails in racks for each type of I/O modules shall also be provided. The spare channel and cards shall be fully wired and terminated. Each IO rack shall have 10% spare rack space for IO module installation in future.
- 6.00.03 The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient for complete system operation and shall have the capability for future expansion at least to the tune of 25%. The application program/sequence logic etc. shall be stored in nonvolatile memory (EEPROM). However, all the dynamic memories shall be provided with battery back up at least for 360 hours. The batteries shall be lithium or Ni-Cd type.
- 6.00.04 The number of input / output points per card shall not exceed 32 (Thirty-Two) for digital and 16 (Sixteen) for analog/ thermocouple/ RTD. Individual input channels shall have galvanic/optical isolation. Output points shall also have optical/galvanic isolation. Merely fusing of individual or a group of channels is not acceptable.
- 6.00.05 The 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) Redundant communication controller shall be provided for the purpose of communication between the I/O modules (including remote I/Os if any) and the PLC as well as in between PLC and the operators work stations.
 - c) The communication system design shall ensure that any single point failure on the system bus/media shall not disrupt more than single message and disrupted message shall be automatically retransmitted.
 - d) Failure or physical removal of any station/modules connected on the system bus shall not lead to any loss of communication.
 - e) Diagnostics message shall be issued on fault detection.

- f) Bus change over from active bus to stand by bus, during failure of active bus shall be performed automatically and bumpless. Such event shall be suitably logged or alarmed.
- g) Noise immunized and reliable high speed dual fault tolerant optical fibre communication cable between CPUs and remotely located remote I/O modules with standard communication protocol shall be provided.
- h) Main data network shall be noise immune high-speed communication link with bit rate in the range of 10 / 100 MB/sec and shall comply with the International Standard IEEE-802.3 (Ethernet) for data exchange and communication.

6.00.06 All PLC based controls shall have interface with DCS. The PLC system shall be open protocol at both layers(OPC compliant) i.e. Supervisory layer (between PLC & HMI) and Control Layer (between PLC & I/O). Supervisory level Ethernet must be unmodified with non-proprietary application layer.

Communication for selected data transfer with DCS shall be through OPC soft link. Bidder shall furnish the necessary connectivity, optical fiber cables & interface for transmitting data from the redundant PLC ports.

6.00.07 One(1) no. OWS and One (1) no. OWS cum EWS to be provided. Moreover, one no. LAPTOP loaded with engineering software shall be furnished. Operator work station shall be complete with PC and latest windows version operating system. 23" LED monitors, membrane / Qwerty / ASCII KB, mouse, colour laser printer shall be provided as peripherals. The OWS, EWS and Printer shall be mounted over the control desk (which is in Bidder's scope) and for detail specification please refer Clause no. 5.00.00 of volume IIE section VI. For specification of operator / engineering station Bidder shall refer to clause no.7.11.00 of this section.

One (1) no. A3 colour Laser Network Printer to be provided.

6.00.08 HMI function of PC based operator's station shall not be limited to the following:

- a) Selection of auto/Manual, open/close operation, sequence auto, start/stop operation etc.
- b) Dynamic Mimic display depicting the entire process for control and monitoring purpose.
- c) Alarm monitoring, report generation, logs, calculations and printing of logs, reports, trends etc.
- d) On-line / historical trending, historical storage and retrieval of data. Data shall be stored for minimum one year.

6.00.09 Annunciation System

- a) For PLC controlled area / plant, window based annunciation wherever required shall be an integral part of the PLC system. Sequence for annunciation shall be configured in PLC and shall conform to ISA sequence. Window lamps will be driven by PLC. For the systems where only monitor & keyboard based operator workstation has been

envisaged, alarm/ annunciation will be displayed in the operator workstation.

- b) The window lamps for the system shall be driven through output modules of the PLC. Each window shall have removable lamp box. The window shall have black lettering inscription on white background. However, for trip application red background shall be provided. Each of the annunciation windows shall be backlighted with minimum two groups of clustered LED lamps with minimum readable distance of 3 Meter. The window design shall be such that the lamp replacement can be done easily from the front.
- c) Immaterial of whether the annunciation is window based or HMI based, one no. Electronic hooter with adjustable sound level and intensity controls to be provided as audible device for the annunciation system..

6.00.10 Software

- a) All the necessary software for fulfilling the complete implementation of the control logics, operational displays & logs, data storage, retrieval and other functional requirements as indicated in this specification, shall be provided.
- b) Offered PLC system must use Tag based addressing structure. Tags must be inherent in the controller not in the HMI. The HMI shall support directly by referring the Tags resident in the controller.
- c) Licensed version of required software including operating system, configuration and HMI software shall be provided.
- d) Programming language shall be user friendly. Detail documentation on the all programming softwares shall be furnished by Bidder and this shall be a part of the O&M Manual.
- e) Contractor shall provide software locks and passwords to Owner's engineers at site for all operating and application software so that Owner's engineers can take back up of these software and are able to do modifications at site.

6.00.11 Control & Power Supply Scheme

Bidder shall provide two nos. redundant 240V AC $\pm$ 1% UPS (Uninterruptible Power Supply) Power feeders for the PLC system from the unit UPS systems. All required hardware/ equipment etc. for conversion and/or stabilization of the power source to all other levels which may be necessary for meeting individual requirements of equipment/ systems shall be furnished by the bidder.

Separately mounted I/O racks, shall be provided with separate power supplies. . Power supply module shall be of ample capacity to feed all the modules. In addition 20% spare capacity for future shall be provided. All the drives shall be switched ON/OFF through 24 V DC interposing relays to be located in HT/LT SWGR panels. All other interposing relays for solenoid drives etc. shall be mounted in a separate cabinet or a separate section of the cabinet.

Power supply distribution to all the consuming points shall be in the scope of Bidder. The exact power supply scheme shall be submitted by Bidder during detailed engineering stage for Owner's approval.

- 6.00.12 Bulk power supply units for interrogation, relay and solenoid voltage shall be separate from system power supply units and shall be redundant in all cases.
- 6.00.13 The system shall have high MTBF and shall be hot maintainable. The 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 up to module/card level is immediately detected. Each of the modules shall have its self-diagnostic system. The operator workstation located at the local area control room shall be used for fault data presentation and monitoring purpose.
- 6.00.14 It is preferred that Termination & Relay cabinet shall be separate from the system and RIO cabinets.
- 6.00.15 Data exchange in a bus shall be fully monitored and checked for validity.
- 6.00.16 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.
- 6.00.17 Following operations will be performed on I/Os, as required:
- a) Square root extraction
 - b) Pressure & temperature compensation
 - c) Reasonability check of all inputs (analog specially), validate and quality tagging like good, bad, suspect etc.
 - d) Channel wise engineering unit conversion
 - e) Contact bounce filtering with adjustable time constant.
- 6.00.18 All controllers shall be freely configurable with respect to requisite control algorithms. An extensive library of macros shall be included for the purpose. Adequate 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
- 6.00.19 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) The automatic sequence control to ensure sequential start up and shutdown of auxiliaries/equipment. Sequence control shall be performed in 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', and it shall output an action on the process. System shall have the capability to bypass a step if desired by the operating personnel from the operator workstation. Such action however shall be registered as an exception or alarm.
- c) Increase the reliability and availability of the plant as a whole, for example, by timely and correctly switchover to standby drives etc.
- d) Priority of the following commands shall be as follows:
 - 1. Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.
 - 2. A forcing facility shall be provided for changing the states of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements. It shall be possible to display the signal flow during operation of the program."

6.00.20 Interface of the system with MCC/Switchgears shall be in the form of potential free contacts via interposing relay modules mounted in the respective MCC/Switchgear unit. All other interposing relays (like solenoid valve etc.) 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 RIO rack shall have 10% spare rack space for future up gradation.

6.00.21 The operator's station shall be responsible for handling all commands as well as in generating desired displays and print outs.

6.00.22 Programming shall be with an easily understandable high-level language. Programming shall also be permissible by drawing Ladder or Boolean Diagram. 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'.

6.00.23 Updating time and reaction time under worst case loading condition (system's response to an operator's command) for operator stations 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)

6.00.24 Programmable Controller shall be responsible for real time process parameter monitoring, storage & display. Basic requirements are (i) Operator Interface, (ii) Basic Calculation, (iii) Alarm Monitoring with display & audio & Reporting, (iv) Display generation, (v) Logs, (vi) Trend Recording & (vii) Historical Storage & Retrieval.

6.00.25 The displays at the operator console shall be classified into overview display, group display, point display and trend display.

- a) Overview display - This display is to enable the operator to set an overview of the entire plant section.
- b) Group display - The group display page shall display several sub-sections & present status information.
- c) Point display - Along with the specified parameter value, this page should indicate historical trend of the parameter.
- d) Trend display - This display include real time/historical trend display facility including Dynamic Graphic Display & Bar Graph Display.
- e) Alarm Message Display - It shall be possible to display process as well as system alarms for operator's attention and action. Alarm shall appear immediately on the operator workstation as and when they occur on priority basis. In addition to alarms appearing on different displays, the system shall also be able to display alarm summary and alarm history listing the date and time of occurrence, tag number, point description, type of alarm (absolute value or deviation), serial number of alarm in the sequence of occurrence etc. Alarm shall disappear from display only when they are acknowledged and cleared. Abnormal condition in the system shall be displayed as system alarm message on the operator workstation irrespective of display selected. In all cases occurrence of an alarm shall be logged.

6.00.26 Logs shall not be limited to the followings. The printing of these logs shall be initiated automatically at prescribed time intervals, or initiated on demand by the occurrence of predefined events.

- a) Shift/Daily Log

A shift/daily log shall be provided to furnish data for routine analysis of plant performance. This log shall be automatically printed at specified time each day and on demand at any time.

- b) Summary Log (On Demand)

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

6.00.27 The salient hardware/ software features of the PLC system for I/O handling shall be as follows.

- a) Input filters to attenuate noise.
- b) SWC of 500V DC common mode and 500V AC peak to peak
- c) Common 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 individual signal.
- f) All the outputs shall be with individual fuse.
- g) K type thermocouple mV input where applicable.
- h) Pt-100 three / four wire resistance thermometer input where applicable.
- i) Non change over/change over type of contacts
- j) 24 V DC power supply to field mounted two wires transmitters.
- k) 4-20 mA Input
- l) 4-20 mA output
- m) 24/48 V DC output signals for energizing interfacing relays

6.00.28 The salient hardware/ software features of the CPUs as follows:

- a) CPU Type : Single slot CPU module
- b) Max. scan time for I/O : I/O scan time must be less than 50% of the processor scan time.
- c) Maximum Scan Rate : 0.25 ms (Per K Word) or better
- d) Memory capacity : 25% spare capacity after full utilization. Expandable in multiples of 16 K.
- e) Communication processor : Integral / Separate
- f) Battery back up for RAM : Ni-Cd / lithium type, at least for 360 hrs continuous operations during power failure.
- g) Watch dog timer : Periodical reset. Alarm and interruption, if not reset within stipulated time.
- h) Diagnostic feature : Periodic, automatic self-diagnostic. Result available at the operator workstation.
- i) Communications : LAN-supporting multidrop.

6.00.29 The salient features of the Input / Output modules are as follows.

- a) All modules
 1. Ambient temp. : 0-50° C
 2. Surge withstand capability : IEC-255.4
- b) Digital General
 1. No. of channels / module : 32
 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
 3. Rating : To switch ON/OFF interposing relays of approx. 3 VA at 24 VDC.
- e) Analog General
 1. No. of channels / module : 16
 2. Isolation : Galvanic/Optical
- f) High level Analog Input Module
 1. Type of input : 4-20 mA DC / 1-5V DC. Each channel shall be isolated.
 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 Wire type
- g) Low Level Analog Input Module
 1. Type of input : Pt-100; T/C (As required). Each channel shall be isolated.
 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. Each channel shall be isolated.
 - 2. Accuracy : + 0.1% or better
 - 3. A/D Converter : 11 bits + Sign (or better)
 - 4. Load : 500 Ohm
 - 5. Diagnostic : Module fault

Note : Electrical isolation of 1.5 KV with optical couplers between the plant input/output and controller shall be provided on the I/O cards.

7.00.00 DISTRIBUTED CONTROL SYSTEM (DCS)

7.01.00 System Functional Description

7.01.01 Integrated functionally & geographically distributed hierarchical Control System (both binary and modulating) including data acquisition, historization and Management Information System (MIS) system synthesized from one general family of identical interchangeable multifunction hardware with adequate redundancy has been envisaged for the plant. Make and model shall be same as that of existing DCS of other units. Latest available operating system and latest hardware shall be considered. No obsolete items or software/hardware with limited availability will be considered.

Make : VALMET
Model : MaxDNA
Release : 7.0.1
Controller : DPUMR2

7.01.02 Connectivity of the system with other plant control system & MIS network or Station LAN has been envisaged. For connectivity of the DCS system with MIS/Station LAN, bidder shall keep provision for spare ports in L3 core switch for future connection of Unit #5 DCS network with the Station LAN.

7.01.03 Bidder shall provide Remote Input Output as a data concentrator for acquisition of non critical monitoring parameters like Boiler metal temperature. RIO shall be located in air conditioned environment.

7.01.04 Controls of some plant auxiliaries and off site plants such as CW & ACW Pumps and Condensate Polishing Unit (CPU) controls shall be realized in the Remote Processing Unit (RPU). RPU consisting of CPU and input / output with their local operator stations shall be located in the respective air conditioned local area control room. RPU shall have redundant controllers and redundant communication modules and shall be considered as an

extension of the DCS node/network and complete with optical fiber cable and accessories.

- 7.01.05 Unit#4 DCS should be capable of data exchange with Unit#3 MaxDNA DCS. Any hardware, software, cable and accessories required for interface and Data exchange on both side shall be under bidders scope.
- 7.01.06 The system shall be based on open system architecture, shall be modular, expandable and upgradable technological advancement.
- 7.01.07 The control equipment hardware for the unit shall be located in the respective Control Equipment Room (CER) and the HMI & other peripheral devices shall be located in the Unit Control Room (UCR) at Power House Building. Both UCR and CER shall be air conditioned.
- 7.01.08 The DCS shall be configured to broadly perform the following basic functions:
- a) Automatic sequencing of the start-up, shutdown and load rejection of equipment and auxiliaries including group / plant level start-up to minimize operator's intervention under normal operating conditions ensuring safety of man and machine as well as to ensure high plant availability (OLCS & Sequence functions).
 - b) Automatic regulation of various control valves and dampers to achieve guaranteed performance of various controlled variables and to achieve most fuel-efficient operating regime (CLCS functions).
 - c) Acquisition, display, real time & history trend, logs, report generation and archiving of plant data and maintain historical data for a defined period (DAS functions).
 - d) PLC Gateway for collection of selected data from plant auxiliaries and off-site plant PLCs.
 - e) Major functional sub systems of DCS are conceived like SG control, TG control, Station C&I (Regenerative area & balance of plant) and Electrical Distribution & Management System (EDMS). DCS interface with other systems like Rotating Machine Condition Monitoring System, Unit Performance Calculation etc. are also envisaged.
 - f) Presenting salient plant parameters to plant executives to display the health and condition of the plant and to aid the decision making (MIS functions).
 - g) Energy management and audit of the plant and equipments by measuring consumption of power of all salient equipment and measurement of fuel, steam, water and all other relevant cost-bearing parameters.
 - h) The DCS system should have a facility for simulation of control loops /logic, Control loop tuning and debugging and offline system configuration.

- i) System shall have the tool for automatic generation of documents like loop & logic diagram. Logic and loop diagram such prepared can be functional in AUTOCAD environment..
- j) FO cable based network connecting all numerical protection relays shall also be interfaced with the unit DCS.

7.01.09 DCS shall consist of the following broad sub-systems functionally independent of each other except for mutual signal exchanges: -

- a) Input / Output Subsystem
- b) Open & Closed Loop and Sequential Control Subsystem (OLCS & CLCS)
- c) Data Acquisition Subsystem (DAS) [implemented in same CLCS/OLCS controller]
- d) Historical Storage Subsystem (HSS)
- e) Performance calculation station (PCS)
- f) Human Machine Interface (HMI) / Operator workstation
- g) Engineering and Diagnostic Station (ES)
- h) Sequence of Event Monitoring Subsystem (SOE)
- i) Management Information System (MIS)

All these subsystems shall be connected together through Redundant and fault tolerant real time high speed data highway at both control and information level. The functional independence between various subsystems shall be to the extent that failure of any subsystem shall not affect the availability of other subsystems. The mutual interdependence between the subsystems shall be limited to sharing the global database of the plant, which shall be resident at various locations within the system, to facilitate rapid response of the control system. The same database will be accessed, shared and updated by various consumers of the data, seamlessly and transparently. High Speed information network shall be considered at MIS level for reports, logs, history etc.

7.01.10 Independent nodes and section shall be provided in DCS for interfacing with inputs and outputs from equipment/system like DM water supply to Condensate Storage tank, , CW & ACW system, CW treatment & CW chlorination system, CPU, COLTCS, Debris Filter, SCS, FGD, common Electrical distribution system etc. for control and availability of information without any limitation.

7.01.11 Owners' offsite plant PLCs i.e CHP, AHP, MRHS etc. shall be interfaced with DCS of unit# 5 via existing phase II DCS network bridge for the purpose of monitoring of selected data at DCS.

7.01.12 The MIS shall be developed to display Plant Key Performance indicators, On-line as well as Historic Trends, Real time Analog values of Tags, Status of Binary Tags, Pie Charts & Bar Charts of various Tags. In addition to that the system shall import data from Unit Performance Calculation Station. MIS shall be Admin/User level configurable. The system shall have comprehensive reporting tool to configure, print as well as export reports in standard file formats like cvs, .pdf, and spread sheets.

The MIS subsystem and related network should have provision for interface with the existing Plant Wide LAN with necessary standard network security. The exact nature of the interface shall be finalized during detailed engineering. However, following minimum features shall be included while configuring the MIS and its interface with DCS Network.

- Layer-3 Chassis based Gigabyte Ethernet Switch with hot pluggable redundant power supply and gigabyte back plane capability to be used.
- To protect against any unauthorized access of the DCS as well as Plant Wide network, adequate security in the form of Firewall(s) appliances shall be deployed.
- Trusted and De-militarized zones (if required) to be configured
- Intrusion detection with IDS (Intrusion detection system) shall be employed.
- Intrusion Prevention System (IPS) with anti-virus software with centralized server based administration shall also be provided. The security solution should have standard protection from vulnerabilities like Virus, Worms, Trojan horses, hacking and Denial of Services Attacks.
- A separated hardware (workstation/ server) to be provided for hosting Anti-virus / Security application.
- A Network Management Software (NMS) with suitable workstation / server to monitor Network Traffic in DCS and Plant wide Network to be provided

The Specification of the MIS server shall comply the specification as detailed in the Historian server.

7.01.13 No back-up discrete hardware based control or hard-manual operation is envisaged for normal operation of the unit. Bidder shall, however, perform a failure analysis to establish that the plant can be shut down safely or can be brought to a safe holding condition without any damage to equipment and/or personnel under the unlikely event of catastrophic failure of DCS. Any back-up instrument or controls necessary to achieve the above condition shall be provided at back up panel, which shall otherwise house emergency start & stop PB of critical drives, valves & dampers etc.

7.01.14 It has been envisaged that in addition to automatic synchronization through turbine run up system, manual synchronization of generator shall also be provided and for this purpose required synchroscope, synchro check relay, switches, speed control switch, voltmeter, ammeter, indication lamps etc. shall be provided in the Generator control panel.

- 7.01.15 Bidder shall furnish all required equipment and materials including system hardware and firmware components, peripherals and operator workstation, all necessary licensed software platforms - compilers, interpreters, builder packages etc; programming, diagnostic and test routines, instruments and equipment; development of application software, data base, screens, graphics and other functional programs; establishing the network structure, debugging and loading; develop and follow a quality assurance plan, system integration, simulation and checkouts; offering the system for owner's shop inspection and testing including hardware, software and heat-run tests, packaging for transportation, delivery at plant site, unloading, warehousing, installation, site integration, program loading and documentation, system check-out, interconnection with field inputs, pre-commissioning checking, commissioning including tuning of control loops and put the complete system in operation with necessary site modifications, conduct performance guarantee tests, system availability test and develop as-built documentation.
- 7.01.16 Bidder shall supply all related documentation including original software manuals, application software manuals, operation and maintenance manuals, instruction handbooks for graphic and data-base building and other related documents and manuals in hard copies as well as in soft medium. Bidder shall furnish the entire plant database and configuration in as-built condition in CDs for reloading/ record.
- 7.01.17 Bidder shall also supply maintenance and trouble shooting tools viz. test instruments, extender cards, CDs containing programs including virus detection and elimination programs etc for copying, diagnostic programs etc.
- 7.01.18 Bidder's scope of supply shall include the supply of commissioning, recommended and mandatory spares as per guidelines given in the specification.
- 7.01.19 Bidder shall supply a fully engineered and operative system meeting the general purpose and intent of the specification. Bidder shall include all equipment, component and sub-systems necessary for the completeness of the system, irrespective of whether such items have been specifically identified in the text.
- 7.01.20 Bidder's scope of work shall also include the training of Owner's personnel at original equipment designer / manufacturer's office and providing the warranty for the equipment supplied.
- 7.01.21 Suggested configuration of the DCS is illustrated in the Drawing no. 24A11-DWG-I-001 enclosed which also gives an indication of the different peripherals & their provisional assignment.
- All inputs/outputs to/from the DCS, from field or other cabinets in and beyond Control Equipment Room shall preferably be routed through separate Buffer Termination Cabinets.
- 7.01.22 Operator stations of unit ESP controls shall be installed in the unit control room in addition to ESP local control room installation.
- 7.01.23 Bidder shall consider dual power supply feed for all control cabinets.

7.01.24 The operator work stations (OWS) on the DCS network (5nos.) and the LVS cubes' control stations (3 nos.), Unit performance monitoring stations (1no.), shall be PC based work stations. PC for the OWS stations shall be located in the CER in side a perforated network enclosure. The Monitor, Keyboard and Mouse shall be mounted on the control desk.

Normal duty operation & assignment for human machine interface, servers and other peripherals are envisaged as follows. Each of this HMI devices shall be connected together through the redundant unit data highway. Unit data highway shall have printers having graphic capability and any printer shall be accessible from any operator workstation.

- i) All closed loop, open loop and sequence controls & monitoring of SG ,TG, Station C&I / Balance of Plant and Electrical Distribution & Management System (EDMS) shall be performed from 6 (six) nos. of operator workstations (OWS). It shall be possible to operate and monitor any of the main plant area from any of the 5 operator workstations. Alarms and SOE shall also be displayed in the operator workstations.
- ii) Large Video Screen Display (3 nos.) shall interface with DCS network through dedicated PCs to display any graphic with salient plant parameters.
- iii) Engineering cum diagnostic Terminal (2 nos.) to be located in the computer room..
- iv) Unit Performance Calculation Terminal (1 no) shall be located in Computer Room adjacent to the Unit Control Room.
- v) A common Plant View Server for Management Information System (MIS) shall be located in the Computer Room adjacent to the Unit Control Room.
- vi) Shift charge Engineer's Terminal (1 no.) shall be located in Shift charge Engineer Room adjacent to the Unit Control Room.
- vii) Server based Historical Storage Terminal (Redundant) shall be located in the Computer Room adjacent to the Unit Control Room. Historical storage and retrieval system shall be redundant with minimum 3 X 600 GB SATA (RAID 5) Hard disk. Historical Data storage server should not have any limitation and may be considered up to 20000 Analog and Digital tags for historical trend.
- viii) Printers shall be available in the data highway and shall be freely assignable to any operator station. Printer configurations shall not be limited to the following:
 - a) A3 colour laserjet – 04 nos.-Reports, Graphics, Logs
 - b) Dot Matrix printer - 01 no.-Alarms

In addition to the above there shall be One (1) no A3 laserjet printer with HMI for Rotating machine condition monitoring station.

7.01.25 The DCS System shall have the following capabilities, as minimum: -

- a) Scan, acquire, validate, time-tag, process, store, update, archive, retrieve and display all analog and digital data and parameter.
- b) Monitor real and calculated variables for multi-level alarm conditions.
- c) Accept and execute operator's commands and pre-programmed routines and run-times.
- d) Perform all open and closed loop control functions.
- e) Display plant mimics, bar-graphs, control faceplates, point description, trend graphs (real time & history) in interactive mode with the operator.
- f) Prepare and print logs and reports.
- g) Performance calculation based on real-time and manually entered data.
- h) Dynamically reconfigure itself on command from engineering station.
- i) Run its own diagnostics, watch dogs, system checks and consequent fallback routines.
- j) All system information and diagnostic alarm like failure of I/O module, Multifunction controller, communication modules, node failure, CPU loading, Network loading, workstation diagnostic etc. shall be annunciated and displayed at any workstation.
- k) It shall be capable of monitoring & alarming with display in case of failure of any one of its own redundant power supplies.
- l) Dynamic data exchange through OPC with other control systems for monitoring purpose only..

7.02.00 DCS Hardware Specification

DCS modules shall be environmentally hardy in respect of temperature, humidity and dust prevailing in the coal fired power plant. The following section describes the general requirements regarding the hardware components and features of the Distributed Digital Control System.

7.02.01 System Cabinet

- a) The electronic modules located within operator's terminal shall be of completely enclosed type for protection from dust and / or mechanical damage.
- b) All electronic cards and modules located in electronic cubicles in Control Equipment Rooms shall be neatly arranged in sub-racks. Each racks shall have redundant power supply modules catering to the cards mounted in the sub-racks.

- c) Separate cabinets shall be provided for each functional group and data acquisition sub-system.
- d) The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Redundant Cooling fans shall be provided.
- e) The modules shall be arranged logically and sequentially in the sub-racks. Modules associated with a closed loop / open loop controller viz. input cards, output cards etc. shall be housed together with the corresponding controller in the same cabinet.
- f) If after housing a controller with associated cards in a sub rack 25 % or less card slots are left vacant, the same shall not be used to accommodate any card related to any other system.
- g) Adjacent slots to dissipative cards shall be left vacant for proper cooling air circulation within the panels.
- h) In each subrack 10% spare module slots shall be provided to accommodate spare modules for future modification.
- i) In case cards related to a particular controller spill over beyond one sub rack, the remaining cards shall be placed to the next sub rack with at least 4 blank slots in between the cards related to other systems. Vacant slots shall preferably be covered with blank plates.
- j) Cards, in a sub rack, shall be uniformly grouped, type-wise and functionality wise.
- k) The system hardware should be designed to immune against radio frequency & electromagnetic interference.
- l) Cabinet temperature monitoring and monitoring of each individual power supply (at downstream) for each panel shall be done.

Panel specification is described elsewhere in this volume.

7.02.02 Termination & Relay Cabinet

- a) Incoming cables originating from beyond the control room and control equipment room area shall be routed through the termination cabinets (TC) located in control equipment room except for the cases like special cables, network /highway cables, thermocouple cables where standard termination concepts are not applicable.
- b) Termination cabinets shall be free standing, closed type, bottom entry, front and rear accessible cabinets with terminal blocks arranged in vertical rows on side walls and partition walls. Panels shall be provided with internal illumination operated through door switch. Adequate area shall be provided for glanding field cables.

- c) Each Termination cabinet shall typically be of 1000mm (W) X 1000mm (D) X 2300mm (H).
- d) In no case the number of terminal blocks accommodated in each section shall exceed 1000. Terminal blocks shall preferably be arranged in four vertical rows in two sidewalls with two sets of cable troughs (one for incoming and one for outgoing) arranged on two sides of the terminal block. At least 20% terminal blocks shall be left as spare. This shall be in addition to the terminal blocks for 20% wired channel.
- e) Troughs shall be slotted PVC type. The gland plate shall be removable and shall be in sections. Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.
- f) Terminal assignment in the termination cabinet will be such that cables originating from a field junction box shall be terminated in one termination cabinet only. This will facilitate use of multi-pair cable for field wiring. For each incoming cable an additional terminal block shall be provided adjacent to signal wire termination point for termination and continuation of cable screen.
- g) Relay used for interfacing with other system shall be modular, plug in type and provided with snap on transparent cover. Rating shall be of 24V DC and shall have at least 2 changeover contacts. All contacts of the relay shall be terminated in terminal blocks. Each relay shall be provided with "Coil on" indication LED and coil protection diode. At least 10% of installed capacity shall be kept as spares.

Panel specification is described elsewhere in this volume.

7.02.03 Printed Circuit Cards

- a) All Printed Circuit cards shall be suitable for operation at 70 °C (maximum) and 95% RH (non-condensing).
- b) Card failure status shall be indicated in LED mounted in the module front panel.
- c) The insertion of cards / module guides shall be polarized to eliminate the possibility of wrong insertion of cards / modules.
- d) All the similar and interchangeable cards may be marked similarly.
- e) All modules shall be replaceable from front and hot replaceable type.
- f) All on-card volatile memory elements shall be battery backed for at least 90 days retention.
- g) All Printed Circuit card connectors shall be gold plated.

7.02.04 General - Input / Output Interface For DCS

All cards shall be in standard 19" sub rack format. Preferred features are as follows:

- a) Modules shall be available to accept all required signal levels and all module should reject the common mode voltages that might appear between sensor ground and A-D converter ground.
- b) All modules (analog and digital) should meet IEEE standard 472-1974 "Surge withstand capability (SWC)/ ANSI C37.90a-1974.
- c) Manual adjustment or calibrations should be minimized by automatic calibration, automatic zeroing and automatic ranging.
- d) IO modules shall be capable of installation or removal with the backplane energized and without disturbing adjacent cards and field wiring. Modules shall be designed in a manner which will prevent damage or misoperation if they are installed in wrong cage slot. Alarm shall be generated in case of module failure or removal.
- e) All fuses shall be accessible for inspection and replacement from front without removing the module from service. It is recommended that critical fuse status shall be monitored in the monitor.
- f) Quality of incoming signal shall be evaluated. Immediate reporting of bad quality signal shall be reported to higher level program to take corrective action. Excursion of signal beyond sensor range shall be detected. Wherever appropriate detection of open or shorted field wiring or failed coils shall be implemented.
- g) Redundant configuration support.
- h) A.C input Isolation as per manufacturer's standard.

7.02.05 Process Interface Modules of DCS (Analog / Binary Signal Conditioning)

- a) The process interface section of DCS shall comprise of various signal interface cards. I/O processing shall be totally independent of control processing so that IO scan rates are independent of controller loading. It is preferred that the Input Interface Modules (IIMs) shall be intelligent and shall form a common IO bus to the controller/s they are catering to. Generally the following types of modules shall be included:
 - i) High level analog input modules (SMART interface modules with HART compatibility)
 - ii) Low level analog input modules
 - iii) Binary input modules (Fast scan SOE resolution)
 - iv) Pulse input modules
 - v) Analog output modules (SMART interface modules with HART compatibility)

- vi) Binary output modules
- b) The IIMs shall, generally, perform the following functions :
 - i) Provide isolated inputs and isolated & short circuit proof outputs.
 - ii) Data Acquisition with time stamping.
 - iii) Data validation and quality tagging.
 - iv) Generation of interrupts.
 - v) Data processing like linearization, A/D conversion, multiplexing, noise filtration, Engineering Unit conversion, limit value detection etc.
 - vi) Extensive diagnostics and fail-safe operation, with reporting.
 - vii) Automatic start up.
 - viii) Automatic calibration of analog input and output modules during start up and periodic calibration of analog input modules to compensate temperature effects.
- c) Following shall be provided:
 - i) Test sockets for on-line monitoring of signals.
 - ii) Front panel display in each module for fault alarm/ status etc..
 - iii) Bidder shall provide 20% or minimum two numbers, whichever is higher, spare IO channels per module. In addition to this 10% spare of each category of IO module shall be provided on overall basis in each group such as SG, TG, BOP, Electrical etc.. The spare channel and cards shall be fully wired upto termination cabinets.
 - iv) Isolated power supply for transmitter and contact interrogation of 24V DC unless the system design calls for other voltage levels viz. 48V DC.

7.02.06 High Level Analog Input Modules

Refer Smart Transmitter Interface Module (Clause 7.02.10). Each channel shall be isolated.

7.02.07 Low Level Analog Input Modules

- | | | | |
|-----|---|---|---|
| 01. | Number of inputs/module | : | 8 (Each Channel Shall be isolated) |
| 02. | Types of input
[Grounded & Ungrounded] | : | Thermocouples (J,K,R,S,T)

RTD (Pt -100 Ohm)
[Four wire, three wire] |
| 03. | Cold junction compensation | : | On module |
| 04. | Accuracy | : | 0.15% or better (Linearized) |

- | | | | |
|-----|--------------------|---|---|
| 05. | A/D converter | : | Integrating, 15 bit + sign or better |
| 06. | Temperature effect | : | 0.01% / Deg.C or better |
| 07. | CMRR | : | 120 db (at 50 Hz) or better |
| 08. | NMRR | : | 60 db (at 50 Hz) or better |
| 09. | Stability | : | 0.03% year or better |
| 10. | Diagnostics | : | i) A/D converter fault
ii) Channel / module fault
iii) Wire break detection
iv) Short circuit
v) Auto gain correction
vi) Auto calibration at start up & periodic
vii) Auto CJC for TC input
viii) Auto start up
ix) LED status |

7.02.08 Binary Input Module (Fast Scan)

- | | | | |
|-----|-----------------------------|---|--|
| 01. | Number of inputs/module | : | 16 |
| 02. | Types of input | : | 24/48V DC
NO / NC / Changeover contacts |
| 03. | Contact bounce filtering | : | Soft or hardwire adjustable |
| 04. | Resolution | : | 1 msec |
| 05. | Maximum switching frequency | : | 100 Hz |
| 06. | Diagnostics | : | i) Input simulation
ii) Short circuit
iii) Module fault
iv) Wire break detection
v) LED status for input, Power supply and communication |

7.02.09 High Level Analog Input Module (Smart Transmitter Interface Modules)

- | | | | |
|-----|-------------------------|---|---|
| 01. | Number of inputs/module | : | 8 (Each Channel Shall be isolated) |
| 02. | Types of input | : | From Smart Transmitters. It shall also be capable to accept 4-20 mA DC from non smart transmitters. |

- | | | | |
|-----|---------------|---|---|
| 03. | Protocol | : | HART |
| 04. | Communication | : | Bidirectional |
| 05. | Accuracy | : | 0.1% or better |
| 06. | Function | : | I) Signal processing
ii) EU conversion
iii) Alarm, Diagnostic etc.
iv) Configuration Tx. database
v) Reranging & Tx. calibration |
| 07. | Diagnostics | : | i) Limit check
ii) Channel /Module fault
iii) Wire break detection
iv) Short circuit
v) Auto calibration at start up and periodic.
vi) Auto start up |

7.02.10 Pulse Input Module

Generally same as Binary input modules but with 8 inputs/module (maximum) and leading/trailing edge detection. Minimum pulse width 1 m sec.

7.02.11 Analog Output Modules

- | | | | |
|-----|--------------------------|---|---|
| 01. | Number of points/module | : | 8 (Each Channel Shall be isolated) |
| 02. | Types of output (Linear) | : | 4-20 mA to Smart positioners |
| 03. | Accuracy | : | 0.4% or better |
| 04. | Load | : | 500 Ohms (min.) [Current]
1 K Ohm [Voltage] |
| 05. | Diagnostic | : | i) Channel /Module fault
ii) Auto calibration at start up & periodic
iii) Auto start up |

7.02.12 Binary Output Modules

- | | | | |
|-----|----------------------|---|----|
| 01. | No. of points/module | : | 16 |
|-----|----------------------|---|----|

- | | | | |
|-----|------------------------|---|---|
| 02. | Type of output | : | Relay with 1 change-over contact or voltage output |
| 03. | Contact rating | : | 5 amps, 240V AC / 0.25 amps , 220V DC |
| 04. | Contact voltage rating | : | 60 Volts |
| 05. | Switching frequency | : | 2 Hz |
| 06. | Contact life | : | 1 million operations |
| 07. | Output protection | : | Short ckt. Proof & Individual HRC fuse |
| 08. | Diagnostic | : | i) Module fault
ii) LED status for power & communication |

7.02.13

Controller

- | | | | |
|-----|-------------------------------|---|--|
| 01. | Type | : | Microprocessor based, multi-loop, multi-function |
| 02. | Number of loops | : | 40 (maximum / per controller) |
| 03. | Word length | : | 32 bits |
| 04. | Register add cycle time | : | 1 microsecond |
| 05. | Instruction cycle time | : | 75 microseconds (maximum) |
| 06. | I/O address capability | : | 256 points (minimum) |
| 07. | Memory | : | RAM - 256 MB (battery backup) or better |
| 08. | Redundancy Supported | : | Yes |
| 09. | Switch over time | : | 5 milli sec. |
| 09. | Whether fall back transparent | : | Yes |
| 10. | Power supply | : | 24 V D.C. |
| 11. | Mounting | : | Sub-rack |
| 12. | Configuration | : | From Engineering Terminal through plant data hiway. |
| 13. | Diagnostics | : | Invalid command checking, (Automatic periodic illegal address detection, routine check and memory parity check, watch dog report to engineering terminal) time - |

out checking, processor status display
LED, processor fault.

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

7.02.14 Stackable Managed Switch

DCS 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 made available on the HMI. MTBF shall be more than 20 years. Configuration shall be automatic.

7.02.15 Computer & Printer Furniture

Bidder shall include a complete set of furniture for the Unit Control Room, & its adjacent Computer Room, Unit Equipment Rooms, CW/ACW Pump House, and CPU Control 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.

All the above furnitures shall have permanent Modular type power receptacles of ISI standard having five Plug points (15Amps rated) with individual isolation switches. Permanent I/O receptacles shall be provided.

7.03.00 Software Specification

7.03.01 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 editing language for editing and on-line operation.
 - ii) Wide range of standard and non-standard peripheral support capability by modular controllers/supervisors.

- 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.

7.03.02 Memory Management / Operating System

- a) The main memory capacity shall be adequate to minimize swapping in the processors.
- 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 house keeping functions including file management.
- d) Task swapping shall be dynamic.
- e) Programs called frequently or requiring rapid access shall remain as resident in main memory.
- f) Individual program partitions shall be suitably linked.

7.03.03 Device Support

The operating system shall support the following devices.

- a) Hard/ CD (R/RW) /DVD (R/RW) /Blue-ray Disk/USB devices
- b) Monitors.
- c) Printer, key board ,mouse.
- d) Random Access Memories.
- e) Communication interface (10/100 Base-T Ethernet , TCP/IP etc.)
- f) Controller and other 32 bit systems

7.03.04 I/O Management

The I/O Management system shall have the following features.

- a) Device independent address processing.
- b) Peripheral diagnostic.

- c) Retransmission on request.
- d) Exclusive, shared and priority mode of device assignment.
- e) Flagging of device failure, etc.

7.03.05 Program Development And System Generation

Engineer shall have the flexibility to customize or develop program to suit the system requirement.

- a) The system generation shall be on-line without interruption to the program under processing.
- b) It shall be possible to introduce new programs dynamically.
- c) The program development system may include its own assembler, editor, loader etc.
- d) The program development process shall be conversational and shall reject faulty or erroneous entry with proper flagging.
- e) New programs shall be automatically integrated into the system by interfacing with existing programs.

7.03.06 Power Failure Restart

- a) I/O transfer stoppage shall not be abrupt.
- b) Provision shall be there for manual restart and auto-restart on resumption of power supply.
- c) In case of power failure interrupt the boxing-up sub-routine shall be automatically initiated.
- d) In case of power failure, all data including register content, volatile memory content etc. shall be transferred to the bulk memory.
- e) The program status shall be latched.
- f) On resumption of supply. registers shall be loaded and programs shall start from the status where they were latched earlier.
- g) All system devices/logics shall be provided with dual power supply in order to ensure that any supply failure does not hamper the system performance.

7.03.07 Check Routines & System Failure

On-line diagnostic routine shall be run continuously or periodically, as applicable. Detected failures shall be displayed in monitor & printer. The following checks shall be performed.

- a) Peripheral / Operator's Terminal failure.

- b) Memory Failure/ Error.
- c) Parity Error, Interrupt Error.
- d) Program Hang-up.
- e) Power Supply Failure.
- f) Input Card Failure.
- g) Interface Failure.
- h) Output Card Failure.
- i) SC/OC Tests,
- j) Controller Failure
- k) Highway failure and communication failure etc.
- l) Failure shall lead to graceful degradation of the system.

7.03.08 Database and Database Management

Data shall be keyboard addressable. It shall be safe-guarded against unwanted and unauthorized manipulation of data.

The database management system shall have the following salient features.

- a) Modular expandability, dynamic partitioning.
- b) Sequential and random access to data and files.
- c) It shall be possible to update, display, dump (selectively), create, search data by simple keyboard entries.
- d) The editing language shall be simple and easy-to-learn type, requiring no detailed programming.
- e) Easy to install through Windows procedure.

7.03.09 Utility Programs

The utility program shall constitute a modular system. The priority status of lengthy routines shall be low as to be interrupted from operator's terminal. Individual functions in the routine shall be amendable. Provision shall be there to initiate utility program from user programs. Broadly, the system shall perform the following functions by utility requests.

- a) Selective dumping.
- b) Dump memory (file to file or file to peripheral)
- c) Execute a program selectively.
- d) Tracing and break-pointing errors.
- e) List debug commands and error messages.
- f) Change debug input devices.

- g) Operation on octal or hexadecimal numbers.
- h) Memory search by interactive editor.
- i) Reschedule job priorities, etc.

7.03.10 Programming Language

The programming languages shall support Relational Data Base Management in a global and truly distributed Client-Server environment and shall have the following minimum features.

- a) Modern high-level block structures type.
- b) Powerful, compact syntax.
- c) Logical organization that facilitates documentation, modification and maintenance of programs.
- d) Early detection of errors at compile and run time.
- e) Fast debugging.
- f) Improved program reliability.
- g) Clearly defined data structure complemented by flexible user- declared data types.
- h) Fast execution.

7.03.11 Editing Functions

- a) The following editing functions shall be performed on the variable via on-line database editor. The editing of an access to the database shall be by simple English like easy-to-learn language.
- b) For analog inputs the variables shall have different scan rate, linearization options, software filtering option etc. as can be assigned externally via the keyboard. Option is to be provided to perform the following operation on each of the variables.
 - i) Provision to assign scan frequencies of 1 sec., 2 secs., 5 secs., 30 secs., or 60 secs.
 - ii) Provision to continuous scan and store in working/main memory and display or print-out on demand. Changing the scanning rate for trend display.
 - iii) Provision to continuous scan, store and printout of values at a specified interval as routine.
 - iv) Provision to execute immediate scan for a specified interval with or without display and/or print-out.
 - v) Provision to assign abbreviated engineering unit in display and print-out along with absolute value.
 - vi) Provision to assign Hi and Lo alarm limits.

- vii) Provision to assign Hi and Lo transducer range limits.
- viii) Provision for analog points to be deleted from and restored to scan status.
- ix) Provision for checking whether the variable is within a specified limit of at a slow scan rate and immediate restoration of storage status at a higher scan rate in case of anomaly.
- x) Provision to specify individual coded sub-routines, which shall be executed when any alarm or return-to-normal message occurs.
- xi) Provision to define time averaging of analog inputs.
- xii) Provision to assign significant change/increment alarm limits.
- xiii) Provision to assign alarm dead bands.
- xiv) Provision to assign rate of change alarm limits and dead-bands.
- xv) Provision to specify software filtering constant individually.
- xvi) Provision for linearization routines by polynomial approximation with specified or adaptive coefficients up to 5th order.
- xvii) Provision to assign an alphanumeric point value to each analog input and each calculated point.
- xviii) Rounding-off facility when fed to MONITOR, graphic or digital display units.
- xix) Serial tabulations on demand in time sequence with HH :MM :SS tag.
- xx) Storage of maximum and minimum value amongst specified values or within a specified interval of time.

7.04.00 DCS DRAWINGS AND DOCUMENTS

7.04.01 Bidder shall furnish adequate information of the system offered and shall not be limited to the following:

- a) System architecture and BOM to establish completeness of supply.
- b) Write up and catalogues
- c) Expected duty cycle of each controller with the proposed assignments.
- d) Capacity (baud rate) of each level of highway and expected data traffic at each level under normal and worst-case situations.

- e) Failure analysis of the complete system detailing the MTBF and MTTR. The analysis shall be projected to system availability computation.
- f) Spare capacity in respect of controller, IO modules, network, operator workstation.
- g) Number of displays and logs offered.
- h) Response time of the control keyboard (from initiation to execution of a command).
- i) System auto start up and initialization time.
- j) Operating limit of temperature, humidity, voltage, frequency of the system/modules, susceptibility to contaminants in the ambient etc.
- k) Hot repairing of modules

7.05.00 GPS Master Clock

The Unit#5 control systems shall receive the synchronizing pulses from the existing (Units #3 & 4) Global Positioning Satellite (GPS) system and form a common time reference for recording of any alarm, sequence of event, logs and reports, which may take place in any portion of the network distributed throughout the plant.

Secondary pulses from the existing units shall Synchronise the entire system for uniform time stamping of all parameters of the units as well as other sub-systems of the plant. All the microprocessor based control systems like DCS, PLC based systems, CCTV, TSI & Rotating machine condition monitoring system, shall be time synchronized with the master clock system of the existing units to have common time reference.

Cable and other hardware accessories for receiving the time synchronisation signals from the existing (U#3&4) GPS for the new U#5 microprocessor control systems like DCS, PLC, CCTV, Energy Management System etc. is in the scope of bidder

7.06.00 Control System Description

Broadly, DCS shall comprise closed loop control, open loop control, sequence control, data acquisition (both hard and soft data) and data archiving sub-systems.

7.06.01 The closed loop, open loop and sequential controllers are envisaged to be a single subsystem synthesized from Multi-loop Multifunction Controller cards / blocks from the same family of hardware capable of handling both Closed Loop and Open Loop Controls.

7.06.02 DCS shall be configured such that degradation of performance in the event of a single failure of control equipment shall be eliminated. However, such failures shall be suitably annunciated to draw the attention of the plant

personnel. Multifunction controllers, Communication Processors and Power supply modules (both for control and field supplies) for all open- and closed-loop controls shall be hot redundant to minimize risk arising out of failure. Similarly, output modules of all HT drive, critical LT drive and all modulating control drives shall be redundant. All redundant cards and modules shall be hot-withdrawable and hot-insertable. Critical LT drive list shall be finalized by Owner during detail Engineering.

- 7.06.03 A single multi-loop controller pair based on 32-bit processor or above shall not handle more than twenty (20) PID functions.
- 7.06.04 The hardware and software for the DCS shall be from the latest proven design for real-time environment meeting the pre-qualification requirement of this specification. The system shall operate on a global database with authorized access of any data at any point of the network.
- 7.06.05 Comprehensive automatic diagnostic system shall periodically verify the integrity of the system and shall cause auto-transfer to the stand-by equipment without any loss of data or shall lead to fail-safe situations in case of catastrophic failures with reporting at higher level.
- 7.06.06 Following guidelines regarding the data loading of various components of DCS and the response time of the system will determine the extent of functional distribution.

The maximum permissible loadings are as follows:

- Multi-loop Multifunction Controller – 60%.
- Input / Output - 80%
- Console – 80%
- Historical Storage - 75 % (considering redundant Historical Storage)
- Data Highway / communication link – 60%
- Other computing modules – 60%

- 7.06.07 Control functions shall be judiciously assigned to various controllers such that,
- Controllers are uniformly loaded.
 - Loops are assigned logically to the controllers so that peer-to-peer active data transactions are kept at minimum.
 - There remains a simple correlation between plant equipment / system and corresponding controller (hardware-wise).
- 7.06.08 The maximum permissible response time for various functions are as follows:
- CLCS scan time - 100 msec for Separator level, Hotwell level & Furnace draft control; 250 msec for others

- DAS data update time – 250 msec to 1 sec
- SOE data update time - 1 msec
- OLCS scan time - 50 to 100 msec
- Protective logic-1 to 100 msec
- Refresh real time data on screen - 1 sec
- Operator's command execution time – 1-2 sec

7.06.09 For hardware configuration, following guidelines shall be followed:

- a) Boiler protection system shall be 2 of 3 logic configured in three processors in 2 of 3 configuration.
- b) Turbine Protection system shall also be implemented in 2 out of 3 voting logic. Three independent trip channels each having its own dedicated processing modules, controllers, input/output modules etc. shall be provided to achieve 2 out of 3 voting logic. The outputs of the three channels will be used to implement 2 out of 3 voting logic in two relay units, the output of which will be fed to the two turbine trip relays.
- c) All other controllers shall be dual redundant in fault tolerant mode. The Turbine EHG and Generator mechanical Protection controller shall be duplex controller having redundant inputs and outputs cards .
- d) Rack power supplies for DCS modules shall be redundant in all cases. Sensors / transmitters shall be redundant for all critical control loops and for non-critical control & measurement the transmitters / sensors can be non-redundant. Separate redundant bulk power supplies for powering field sensors, relay, solenoids shall be provided. This power supplies shall not be derived from the DCS rack power supply used for control modules.
- e) Analog & Digital output modules shall be dual redundant for all HT drives, critical LT drives, all modulating duty control valves etc. so that failure of a single channel shall not lead to any abnormality of the process.
- f) Cabinet Power supply feeders, power supply modules, control & HMI data hi-ways and network interface units shall be redundant.
- g) Each system cabinet shall have both protective and electronic ground.
- h) Offsite & plant auxiliaries PLC and Rotating machine condition monitoring system shall be interfaced with DCS through redundant gateway / converter / serial link with STP / OFC connectivity for information & monitoring.

7.06.10 Input / Output modules shall have the following features:

- a) Signal conditioning, A/D conversion, Signal validation, Diagnostic, Engineering conversion, Time stamping, Limit value monitor etc.

- b) Capability of interfacing smart transmitter through smart interface module with optical and galvanic isolation. HART management system is integral to DCS.
- c) All analog & digital inputs and outputs shall necessarily be either galvanically or optically isolated. Function of input / output module shall not be disturbed in case of failure or damage of a channel.
- e) The channels in the modules can be individually addressed during routine diagnostic check.
- f) Any failure in the module and any signal input crossing the range domain on either side (below 4 mA and above 20 mA in case of analog input) are immediately detected at I/O level and reported to monitoring console. Similarly, thermocouples shall be checked for open circuit condition. Resistance temperature detectors shall be validated against open and short circuit conditions. Non coincidence monitoring shall be provided for important trip & interlocking contact.
- g) Number of channels in IO module shall not be more than the following:
- Analog input- 8 channel
 - Analog output –8 channel
 - Digital input-16 channel
 - Digital output-16 channel
 - Analog input & output (combined) -8 [as applicable]
 - Binary input & output (combined) - 16 [as applicable]
- (For digital inputs, one changeover contact is counted as 2 inputs. Minimum 20% or 2, whichever is higher, spare channels shall be kept in each of the input/output modules)
- h) Replacement of module shall be possible to carry out in system power on condition.
- i) Signals for panel mounted recorders, indicators, annunciators etc, where provided, shall be fed from I/O level.
- j) Lower level bus viz. I / O bus and I / O communication processor shall be redundant. Alternatively, IO bus can be a backplane encapsulated not exposed to external environment.
- k) Redundant IO modules shall be placed in separate rack.

7.06.11

Controllers shall have the following minimum features:

- a) Controller shall have 32 bit CPU with RAM size of 256 MB or better with at least 360 hrs. battery backup for storing process data, calculation etc. and flash memory of size 32 MB or better for real time multi tasking operating system, control algorithm and control strategies

to achieve power fail hold condition and automatic restoration on power on.

- b) Communication speed shall be 10Mbits/s / 100Mbits/s.
- c) Communication shall be deterministic and peer-to-peer with other controllers on the network.
- d) Redundant controllers shall be placed separately and shall not share the same motherboard to avoid any common point failure.
- e) Controllers, power supply, communication modules /processor & associated links cables shall be redundant. Failure of any single component shall not lead to failure of the system.
- f) CPU and memory capacity shall be utilized upto maximum 60% in worst data loading condition.
- g) Replacement of electronic modules like controller, communication module /processor, IO modules can be done in system power on condition.
- h) The application/configuration program shall be resident in non-volatile flash memory/EEPROM so that no down loading of program is required in case of system restart.
- i) Processing time of any parameter shall be freely configurable.

7.06.12 Closed Loop Control System (CLCS) shall act on modulating control valves, dampers, or other regulating devices to achieve stable control action under steady state condition, for load swings in the step / range over the entire load range with permissible variation in parameters and under failure/trip or limiting condition of process equipment.

7.06.13 CLCS controllers shall have system resident library functions including linearizers, characterizers, square root extractors, signal limiter, one-out-of-two selector, two-out-of-three voting system, averaging, PID block, logical functions, Auto / manual selector and other software configured mathematical blocks to be strung together to form the desired strategy for control. Synthesizing, configuring, tuning or adjusting control loops should not involve writing elaborate programs.

7.06.14 Open Loop Control System (OLCS) shall perform interlocking, protection, sequential interlocking functions, individual drive control interlocks with their associated safety protection. The OLCS shall provide adequate and reliable protection & safeguard for various equipment and shall assist the operator in easy, safe & efficient starting, stopping and tripping of various drives in the plant.

7.06.15 OLCS shall perform all permissive, start, stop, auto-start, auto-stop, wait- and step-timing, emergency start/stop, drive interface and other related binary functions. It shall also perform to indicate drive status feed back like On, Off, Fault, Local & Remote selection, Normal & Trial selection, Switchgear disturbance, Electrical protection operated, Safety interlock operated, standby mode etc. on the screen.

- 7.06.16 OLCS controllers shall have system resident library functions including logic functions, timers, registers, counters, Boolean operators, encoders, one-out-of-two selector, two-out-of-three voting system, logical functions and other software configured mathematical blocks to be strung together to form the desired strategy for control. Synthesizing, configuring, tuning or adjusting control loops should not involve writing elaborate programs.
- 7.06.17 Each of the multi-loop controllers shall cater to a group of related loops and shall have its own in-built communication function for interfacing with the redundant control system bus.
- 7.06.18 The main and the hot stand-by controllers shall be identical in all respects. Any one of the two controllers can be selected as 'main' controller; the other shall automatically flip to stand by mode. The output of the stand by controller shall be disabled. However, the controller shall receive and update its database from field inputs and main controller. In case of failure of the main controller, the stand-by controller shall come on line automatically and transparently without any upset in the process.
- 7.06.19 When a controller is put back after removal for maintenance or if a new controller is put in service, there shall be provision for high speed down loading of data from the hot controller without affecting the main highway traffic.
- 7.06.20 It is preferred that in case of an internal diagnostic failure of a multi-loop controller pair, all concerned loops shall trip to manual and drive will go to fail safe mode.
- 7.06.21 The functional capabilities of the multi-loop multifunction controller shall include but not limited to the following :-
- a) Accepting operator's commands from and providing operator feedback to Operator's Terminal via redundant hiway.
 - b) Interact with other subsystems via Control System Bus.
 - c) Verification of signals against cable failure
 - d) Carry out computation actions (Square root, Addition/Subtraction, Limiter, Multiplication/division, High/Low Selectors, Totalizer, Non-linear function, Ramp generator/Time delay, Integrator/Differentiator)
 - e) Carry out and control actions (viz. P, PI, PID, Cascade, Feed-forward, Ratio, Lead/lag compensation, Override, PI Adaptive gain etc.)
 - f) Perform binary and sequential operations (AND, OR, NOT, gates, timers, etc.)
 - g) Self-monitoring and auto-diagnostic leading to transparent changeover to stand-by and reporting of failure.
 - h) Program modification and configuration via Engineering Terminal, on line.

- i) On line system tuning and setting via Operator's terminal / Engineering Terminal.
 - j) Testing and simulation from Operator's terminal / Engineering Terminal
- 7.06.22 Transfer of control mode from automatic to manual and vice-versa shall be of procedure less and bump less, incorporating necessary output tracking facilities.
- 7.06.23 Excursion of a control related current / voltage beyond acceptable values shall cause the corresponding control loop to trip automatically to manual mode with the control output latching-in at the last value, until manipulated in manual mode.
- 7.06.24 Controllers shall not be assigned without validation check function of the field inputs. All failures shall be duly alarmed and reported.
- 7.06.25 In addition to CLCS control, artificial intelligent adaptive control for critical loop such as SH & RH temperature control loop shall be provided. Bidder shall furnish write up on the same.
- 7.06.26 Controller assignment /partitioning shall be judiciously decided considering minimum outage of the equipment/system in case of failure of a functional group and shall not lead to complete unit outage. Bidder shall furnish his partitioning scheme based on the equipment /system offered for Owner's approval during detailed engineering. Minimum forty (40) pairs of controller shall be provided in addition to 3 nos each for MFT and Turbine Protection. Another one (1) pair controller shall be provided for remote processing unit of CW & ACW systems having two (2) RIOs for CW treatment & CW Chlorination. Seperate 1 pair controller shall be provided for remote processing unit of CPU regeneration and service area vessel.
- 7.06.27 Data Acquisition Sub-System meant for acquiring plant data for monitoring purpose shall be implemented in multi-loop processor in fault tolerant mode and shall acquire, process and store the following types of plant data for display, performance calculation and monitoring purpose. Data acquisition subsystem shall also include various gateways capable of acquiring, processing and storing data from third party system data highways.
- Data Acquisition sub-system shall acquire, process and store data of following types:
- a) Data from field transmitters and sensors, both analog and digital.
 - b) Hardwired analog & digital inputs from other systems.
 - c) Data acquired through OPC links and gateway of stand-alone unit systems such as Rotating machine condition monitoring system etc.
 - d) Acquisition of data from OLCS & CLCS
 - e) Binary inputs for sequence of event monitoring.

The data collected by the DAS may also be used for SOE, overview, logging, historical storage and performance calculation.

The data acquisition sub-system shall be built around the hardware of similar make as that of OLCS & CLCS and the acquired data shall seamlessly blend with the rest of data acquired.

- 7.06.28 The System Data Highways & links shall be dual redundant at all levels.
- 7.06.29 Network elements like gateways, bridges, controllers etc, and interfacing with the data highways shall have two independent couplers linking the dual highways. All messages received through dual highways shall be validated individually for error and between themselves for fidelity of both the highways. Faulty data highway shall be automatically isolated, without any loss of data but with appropriate alarm. Erroneous messages shall be flagged and rejected. The previous value shall be retained until the fault is cleared.
- 7.06.30 Plant data highway and all other major internal highways shall be high speed digital links of speed 1 GBPS minimum. Slow speed buses viz. RS-232C etc. are unacceptable at these levels. Bus protocols at control levels shall conform to OPC compliant ISO 7-layer protocol in master less, token ring or token bus (as per IEEE-802) or any standard proven & accepted protocol in deterministic mode. Extensive error checking (CRC-16/12) or error correcting codes shall be used in these levels to improve the reliability of communication.
- 7.06.31 All the Controllers and gateways shall be connected to the redundant common high speed data highways for global distribution and access of data. Any data shall be available at any point on the network as and when required.
- 7.06.32 Redundancy shall be provided for the following:
- a) All control processors and communication modules
 - b) I/O bus including remote I/O bus, bus extenders and repeaters
 - c) Data bus
 - d) Allpower supply modules
 - e) Serial link modules
 - f) Serial links
 - g) Ethernet switches
 - h) Historian
 - i) Any other communication bus
- 7.07.00 Historical Storage Unit (HSU)
- 7.07.01 It shall augment the global memory in the system and will archive data and parameters for logs and historical records including trends, alarms and events. These will be used for analysis, data presentation and performance calculation. The historical storage unit shall be a stand-alone unit on the data highway performing as file server.

7.07.02 Redundant Historical storage units shall be a fail over solution with separate Servers in Active/Active or Active/Passive availability mode. Each Server shall have features like RAID 5 with data mirroring facility, Hot pluggable/ swapable hard disks and power supply units so that any single failure shall not lead to complete loss of historical data.

a) Minimum Hardware Requirements for the HSU Servers

- | | | |
|-----------------------------|---|--|
| 01. Processor | : | Intel Xeon or higher version prevalent during engineering or procurement stage |
| 02. Clock Speed | : | 2.66 GHz |
| 03. NIC | : | 4 No.1000Base-T |
| 04. RAM | : | 10 GB DDR |
| 05. Graphic Card | : | 256 MB 3D |
| 06. Hard Disc | : | 3x600 GB SATA (RAID 5) hot plugable/swapable |
| 07. Mounting Arrangement | : | Rack mounted to be mounted in a common Server Rack (rack to be supplied by bidder) |
| 08. Mouse | : | Optical scroll |
| 09. Keyboard | : | English |
| 10. DVD drive | : | 52 X DVD +/- RW SATA |
| 11. Operating Voltage Range | : | 90 V to 260 V, 50 Hz |
| 12. Display Resolution | : | 1920 X 1080 or greater |
| 13. Serial Interface | : | 9 Pin |
| 14. Parallel Interface | : | 25 Pin Hz |
| 15. USB Interface | : | Yes |
| 16. Monitor Interface | : | Yes |
| 17. LAN Interface | : | RJ45, 10/100/1000 MB/s |
| 18. Operating System | : | Windows 2008 standard R2 server 64 bit edition or higher version prevalent during engineering or procurement stage |
| 19. Other Accessories | : | Mouse, Keyboard |

b) Monitor for the Server

- | | | |
|--------------------------|---|--|
| 01. Type | : | LED colour monitor |
| 02. Screen diagonal | : | 23" |
| 03. Display | : | Full HD or better |
| 04. Resolution | : | 1920 X 1080 or better |
| 05. Degree of protection | : | IP-30 |
| 06. External Controls | : | Brightness, contrast, Horizontal / Vertical amplification & shift |
| 07. Power supply | : | 240 V, 50 Hz, 1 phase |
| 08. Ambient temperature | : | 0-50° C |
| 09. Humidity | : | 95% non-condensing. |
| 10. Version | : | To suit industrial application (latest version as per availability at the time of detailed Engineering/procurement). |

7.07.03 Assignment between globally distributed memory and the historical storage shall be judiciously determined during system engineering stage. While the historical data storage function shall be exclusively performed in HSU, some invariant application programs / data like mimic diagram (the fixed part) may be resident in selected fixed sectors of the HSU provided the display latency requirements can be fulfilled. The latency between addressing a display to its appearance on screen shall be less than 3 seconds. The latency for historical trend display shall be less than 10 seconds. If these latency criteria cannot be met, the relatively invariant application programs shall also be globally distributed for faster response.

7.07.04 Data to be stored in HSU shall include alarm, event list, periodic plant data, selected logs/reports such as start up, trip analysis logs, shift logs, daily logs etc..

Bidder shall furnish data/information to be stored and frequency of storage and retrieval for approval.

7.07.05 Data shall be stored in the Historian on exception basis whenever any deviation from last stored data takes place or by any other suitable scanning techniques. Module shall also have the capability of storing both snapshots and average value.

7.07.06 System shall be provided with DVD writers for long term data archiving.

7.07.07 Provision shall be kept at the module for adding new tags. Sizing of the HSU shall be carried out in such a way that at least 25% over the already configured tags can be added in future.

7.07.08 Historical storage should permit trending of all analog inputs with time scale (X-axis) selectable as 1sec, 10 sec, 30 sec, 1 min, 4 min., 20 min., 2 hours, 8 hours & 24 hours on MONITOR Screen. Vertical scale (parameter range) shall be freely programmable. It shall be possible to map the real time and history trend on the same trend group display. History data storage shall be for minimum 30 days and after expiry, data shall be automatically/manually transferred to the external storage device such as DVD writer. Data related to plant life shall be stored in the HSU for the complete plant life. Bidder to note that History is required for all signals - analog input, output, digital input, output, pulse input, critical block PID intermediate points and the system shall be configured accordingly.

7.07.09 Logs : (Provisional and Subjects to be increased based on engineering drawings)

- | | | | |
|-------|--|---|--|
| i) | Hourly Log | - | 60 plant data and 10 computed data |
| ii) | Shift Review Log | - | 40 plant data and 15 computed data |
| iii) | Daily Log | - | 20 plant data and 15 computed data |
| iv) | Monthly Log | - | 20 plant data and 15 computed data |
| v) | Yearly Log | - | 20 plant data and 15 computed data |
| vi) | Alarm Log (Digital) | - | 1000 plant data and 15 computed data |
| vii) | S.O.E. Log
(event based digital) | - | 500 Inputs and 20% spare. |
| viii) | Boiler Start-up Log
(event based / manual) | - | 30 Analog, 80 Digital and 10 computed data (1 minute interval, for 3 hours / turbine start-up) |
| ix) | Turbine Start-up Log
(event based/manual) | - | 30 Analog, 80 Digital and 10 computed data (10 seconds interval, for 1 hour / synchronization) |
| x) | Synchronization /
Loading Log
(event based/manual) | - | 40 Analog, 80 Digital and 15 computed data (10 seconds interval, for 1 hour) |
| xi) | Generator Trip Log
(event based) | - | 40 Analog, 80 Digital and 15 computed data (15 second interval, for 15 Minutes / turbine trip) |
| xii) | Turbine Trip Log
(event based) | - | 40 Analog, 80 Digital and 15 computed data (15 seconds interval, for 30 Minutes / boiler trip) |
| xiii) | Boiler Trip Log
(event based) | - | 40 Analog, 80 Digital and 15 computed data (15 second interval, for 15 Minutes) |

- xiv) HP Bypass Log (event based) - 20 Analog, 15 Digital and 20 computed data (15 seconds interval, for 30 Minutes)
- xv) Pre-Trip & Post Trip Log - 30 pre-trips and 30 post-trip readings for the pre-defined parameters but not less than 250 points, sub-divided in to 25 groups. The data collection rate shall be faster near the trip points and gradually slower with time. The exact details shall be finalized during detailed engineering stage.
- xvi) Maintenance logs - Schedule of preventive maintenance and routine equipments inspection.

Apart from system logs, not less than ten nos. of other logs are anticipated with approximately, similar composition. Such logs shall comprised of computed data typically running hours of drive, fuel consumption, water consumption, auxiliary power consumption, maximum metal temperature (about 40 points) or calculated values like efficiency etc.

7.07.10

There shall be various other event based logs corresponding to equipment / drive start-up / stop. Menu of the logs shall be chosen to record parameters related to the drive under consideration.

a) Instantaneous Logs (Manual Actuated)

- i) Boiler : 100 Analog, 10 Computed
- ii) Turbine : 50 Analog, 10 Computed
- iii) Generator : 50 Analog, 10 Computed
- iv) Auxiliaries : 25 Analog, 10 Computed

b) Trends : Analog input trend presentation at least for 300 points data rate shall be as follows.

i)	Pressure & Vacuum		Once every second
ii)	ii) Flow		Once every second
iii)	Boiler drum, Hotwell, HP Heater & Deaerator Levels		Once every second
iv)	SH & RH steam temperature	-	Once every 2 seconds
v)	Other Temperature		Once every 5 seconds
vi)	SWAS parameters	-	Once every 2 minute
vii)	Vibration	-	Once every 5 minute
viii)	Electrical parameters	-	Once every second

7.08.00 Annunciation & Alarm Display

The DCS system shall have a history of alarms in chronological order. The system shall have a minimum of 1000 alarm points with all alarm functions and related function keys like alarm acknowledge, reset, paging, summaries etc. The said system shall have design features like set point/dead band adjustments, provision of alarm priority, manual inhibition & automatic inhibition based on predefined logic, including audio annunciation.

A minimum of 600 predefined alarms from the alarm event file shall be displayed in a fixed video graphics emulating conventional Window Annunciator with Alarm Facias in matrix form. This graphical page shall be designed for SG, TG, Station C&I and Electrical system and shall be available on the DCS network.

3 (three) nos. of 70" LVS cubes shall be dedicated for display of this graphic pages. Each window shall be dedicated for a particular alarm and shall be configured in any of the three categories as 'normal alarms', 'Trip alarms' and 'First-Up alarms' which shall be differentiated through different colours (red, yellow, amber, white etc.). Each window shall have a zooming feature on occurrence of the corresponding alarm. The annunciation system shall be complete with alarm accept and alarm reset features in soft as well as hard form (PB switch mounted in the control desk). Any alarm in the window facias matrix shall be user configurable.

Graphical alarm page and alarm list shall be finalized by the OWNER during detail engineering

7.09.00 Sequence of Event (SOE)

It shall be an integral function of DCS with 1msec. time resolution. Number of SOE points shall be on as required basis but not less than 500 points. SOE inputs shall be sourced directly from the primary switches and primary relay / contactors for real time "time-stamping" following any tripping of major equipment, sub-systems and the plant as a whole. SOE Input card shall be equipped with digital filters with filter delay of minimum 4 ms (identical for points) to eliminate contact bounce such that field contact which is changing state must remain in the new state for successive 4 ms to be reported as one event. The start of data collection for SOE report shall be reported to operator station within 1 sec of SOE data collection initiation. The system shall also have provision of rejection to chattering inputs. Operator can access the SOE on activation of SOE page.

SOE report shall include a list of major equipment trip in chronological order and also include the points which initiated the SOE collection. Storage capacity for SOE in HSU shall not be less than 3 months. Format of the SOE display page shall be finalized during detailed engineering.

The SOE report collection shall begin on occurrence of change of status of any SOE point and shall be printed after an operator selectable time interval of 1 to 3 minute or 100 status changes have taken place after the first event. Adequate memory to accommodate six (6) SOE reports i.e. two buffers of 100 status changes shall be provided. Seventh SOE report shall overlap the first

SOE report memory and so on. SOE shall be available at all the operator stations resident on the network with printing on occurrence of any status change of contact.

7.10.00 Online Performance calculations

7.10..01 Performance Calculation

- a) Performance calculation shall be performed automatically by using online global plant data from DCS or retrieving data from the global data base/HSU and will perform plant efficiency, heat rate and other calculations as per ASME PTC and other relevant standards. It shall also consider the predictive analysis module (Artificial intelligence).
- b) The plant performance calculation package shall also embody programs and routines to generate parameters to provide expert guidance to the plant operator. Suitable prompts and guidance messages shall be generated in the operator's terminal to guide the plant operator towards optimal plant performance.
- c) Provision shall be made, including all required custom programmed software, for performance calculations and turbine steam supply accounting. All calculations shall use a high level language. Calculations shall be made using floating-point arithmetic. These equations shall be changeable on-line at the job site. The calculation results shall automatically be quality coded according to the worst quality of any of the inputs to each calculation. The results of these calculations shall be available through the database for appropriate logs and operator displays.
- d) All required curve fitting shall be performed at the highest value of the polynomial exponent for greater accuracy. Averages used in calculations and/or logging shall be true "load weighted" averages (load weighted with the proper variable to give true averages over the given time period). The ASME Steam Tables shall be employed. Water, steam and fuel flow equations shall be based on ASME Power Test Code.
- e) The plant performance computation are broadly subdivided into two classes of calculations :

Class (I) - Equipment protection calculations (software generated alarms)

Class (II) - Plant and equipment efficiency and Heat rate calculations.
- f).....Class-I Calculations

Class-I calculations include those calculations that are made every scan cycle of the slowest scanned input entering the calculation generally for the purpose of detecting and alarming unit malfunctions. The following lists typical Class-I calculations that shall be required.

- Cold reheat steam approach to saturation temperature.
- Superheat spray outlet approach to saturation temperature.
- Turbine steam metal temperature differences
- Turbine metal temperature rates of change
- Excess air deviation from standard
- Feed water heater temperature deviation from standard
- Separator water saturation temperature rate of change.
- Feed water heater terminal temperature difference.
- Feed water heater drain cooler approach.
- Metal temperature difference for SH 'Y' and RH 'Y' piece.

g).....Class-II Calculations

Class-II Calculations shall be performed in the real time for displaying and subsequent logging using data, which is accumulated over a period of time. This time period shall be selectively adjustable from 10 to 60 minutes. The system shall have the capability to store the data when instructed to do so. The operator shall be able to input coal analysis data and other data in the computer for Class-II Calculation.

Class-II calculations shall include the following :

- Boiler efficiency (Input/Output & Heat loss)
- Gross Turbine Generator heat rate
- Gross unit heat rate
- Net unit heat rate
- H.P. turbine enthalpy drop efficiency
- I.P. turbine enthalpy drop efficiency
- L.P. turbine enthalpy drop efficiency (using dry exhaust)
- Heat rate from Accumulated Heat input & MWH
- Plant load factor from accumulated MW hour.
- Condenser performance
- Economizer performance
- Air heater performance
- Deaerator performance.
- Unit availability calculations.
- Deviation from expected value for each calculation

7.11.00 Human Machine Interface (HMI) and Peripherals

7.11.01 Operator interface to the process & equipment shall be through HMI/operator work stations. It shall perform supervisory, monitoring and information functions.

The operator work stations (OWS) on the DCS network (6nos.) , the LVS cubes' control stations (10nos.), Unit performance monitoring stations (1no.), shall be conventional PC based workstations.

7.11.02 Operator's terminals shall permit the operation and monitoring of the unit under normal condition and in all emergencies. Each terminal shall be independent with its hardware including adequate local memory for resident database. The resident data will be continuously updated at all terminals and in no case real time plant data will have to be retrieved from other resident memories. Operator station shall have auto reboot feature and in all cases network link shall be redundant. HMI shall be built on high performance, non proprietary open system configuration. It shall suit to the equipment and process requirement.

7.11.03 Operation shall be menu driven in latest windows environment. HMI shall be user friendly and no special knowledge is required to operate the system

Each keyboard shall comprise ASCII Keys with special function keys, address keys, cursor control keypad, numeric keys for ease of operation. Each terminal shall support a printer with color graphic capability. Each HMI shall be adequate with all operator function such as access to the display, alarm, trend, control faceplate etc. and quick access to plant & process. Complete operation of the plant shall be possible from any operator station. Multiple windows, not less than 4 (four) nos., at a time shall be available on the HMI screen for operation.

Each station shall be complete with latest configuration window based PC, application software, display builders with object oriented programming like Visual basic, Active-X etc..

Display selection shall be possible with least number of keystrokes or steps. Functional requirement of an operator station shall not be limited to the followings:

- a) Issuance of control command like start/stop, set point adjustment, auto/manual, increase / decrease etc. Bidder shall ensure that when a particular operator workstation initiates a dialog, no other operator workstation shall have access to the same dialog, at the same point of time.
- b) Display of plant graphic, overview display, area display, loop/drive display, control related displays, other standard displays for monitoring, trending of parameters.
- c) Display & print of SOE/Trend/Graphic / System Diagnostic.
- d) Alarm display & acknowledgement.
- e) Print of screen, logs, operator message, etc.
- f) Last command call.
- g) Copy & paste.

- h) Display of sequential / logic and tag with facility of forcing through suitable password
- i) Multiple pop up faceplate for drive control & point detail.

In case of exigencies, operator station shall be capable to be used as an engineering / diagnostic station with Password protection & hard key switch operation.

Bidder shall provide all necessary Operator interface devices like PCs, UTP cables, LED Monitors with keyboard & mouse, colour laserjet printers, large video screen, multimedia beeper/buzzer etc. Quantity /assignment for HMI and Peripherals are described elsewhere in this section.

Bidder shall meet the following general specification.

Operator's Station / Engineering Station / Shift Charge Station

1. Processor : Latest , minimum Intel Core i7 quad core
 2. Configuration : Tower
 3. Internal clock : 3.2 GHz (minm.)
 4. Architecture : 32 bit
 5. Video Card : PCI
 6. RAM : 16 GB (Minimum) DDR
 7. Hard drive : 500 GB SATA (7200 RPM)
 8. Cache : 512 KB Level 2
 9. CD/DVD Drive : DVD - Both Read & Write for OWS.
BothDVD Read & Write for ES
 10. Audio controller : 16-bit
 11. Operating system : windows 11 Professional 64 bit
 12. Graphic accelerator : 8MB (minm.)
 13. Communication ports : (a) RJ-45 NIC- 02 Nos.
(b) USB ports – 04 nos (min.)
(c) USB 3.0 - 02 nos
- j) Monitor
01. Type : LED
 02. Screen diagonal : 23"
 03. Display : Full HD

04. Resolution : 1920 X 1080 or better
05. Degree of protection : IP-30
06. External Controls : Brightness, contrast, Horizontal / Vertical amplification & shift
07. Power supply : 240 V, 50 Hz, 1 phase
08. Ambient temperature : 0-50° C
09. Humidity : 95% non-condensing.
10. Version : To suit industrial application (latest version as per availability at the time of detailed Engineering/procurement).
- k) Key Board (for all application)
01. Type : Flat spill proof membrane type or Positive depression type.
- 02 Interface : USB
03. 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
- 04 Key lock : Lockable type push button mounted on keyboard

05. Life Expectancy : 50 million cycles per key
06. Version : To suit industrial application
- l) Color Laser Printer
01. Type : Electro-photographic laser, tabletop
02. Printer Memory : 512 MB (min.)
03. Speed : Monochrome 24 ppm - A4
Color 6 ppm - A4
04. Resolution : 1200 x 1200 DPI in color
05. No. of color (Basic) : 4 (four) minimum
06. Duty cycle : Monochrome 75000 pages / month
07. Power supply : 240V AC, 50 Hz, 1 phase UPS
08. Ambient temperature : 0-50° C
09. Humidity : 95% non-condensing.
10. Interface : USB and Ethernet (RJ45)
11. Size of paper : Letter, A4, Legal, Ledger, A3
12. Print media : Plain paper, transparencies, thick stock, glossy stock, envelopes
13. Special Features : 1) Automatic Two-sided printing.
2) Built in Networking with Fast ethernet 10/100 Base-T network port.
3) Minimum 2 Nos. Multi purpose sheet tray
14. Accessories : i) Printer table
ii) Connector & Cable
- m) Dot Matrix Printer
01. No. of Needles : 24 Pin
02. Printing speed : 300 characters per second (approx.)
03. Character dimension : 9 x 8
04. Buffer : 80 KB (Min)

- | | | | |
|-----|---------------------|---|--|
| 05. | Local memory | : | RAM with battery backup |
| 06. | Interface | : | Serial / parallel |
| 07. | Power supply | : | 240 V, 50 Hz, 1 phase |
| 08. | Ambient temperature | : | 0-50O C |
| 09. | Humidity | : | 95% non-condensing. |
| 10. | Size of paper | : | Fanfold, A4, A3 |
| 11. | Character sets | : | ASCII, IBM (Sets 1 & 2), Italics, user defined |
| 12. | Transfer distance | : | 200 Mtrs. (minimum) |
| 13. | Print features | : | Graphic printout, emphasized, double width, underlined, subscript, superscript, double strike, backspace, margin etc |
| 14. | Reliability | : | MTBF more than 8000 Hrs. |
| 15. | Noise level | : | Less than 60 dBA |
| 16. | Ribbon life | : | 2 million characters |
| 17. | Diagnostics | : | Self diagnostic. LED error code display, Audio alarm – paper exhausted |
| 18. | No. of copies | : | Minimum Original plus 3 (three) |
| 19. | Accessories | : | i) Ribbon
ii) Printer stand
iii) Table top receiving tray
iv) Interface cable
v) Paper tear box. |

7.11.04 LARGE VIDEO SCREEN (LVS)

Bidder shall supply three(3) numbers of 70 inch Large Video Screen (LVS) display. LVS shall interface with DCS network through dedicated PC's and Data Wall controller through redundant ethernet connection. 3 nos. LVS video wall shall have a common bezel.

All the Large Video Screen Displays (3 nos.) shall interface with DCS network through dedicated PCs to display any graphic with salient plant parameters.

The display wall shall consist of the Visual Display Unit, Display Controller and the Wall Management Software, which shall be supplied from a single manufacturer. with the following specifications:

A. DATA / VIDEO WALL SYSTEM:

- a) The Visual Display Unit / Rear Projection Module shall be based on single chip High Contrast rear-projection video wall with a LED-based illumination unit .
- b) The video wall shall have the scalability and upgradeability to be made up of multiple rear projection modules stacked up in rows and columns to achieve a display wall for better view ability in curved configuration.
- c) The overall resolution of the graphics wall shall be min. 9,600 x 2,160 pixels.
- d) The Aspect Ratio of every Rear Projection Display Module shall be 16 : 9.
- e) Each Visual Display Unit / Rear Projection Module shall have a native resolution of 1920 x 1080 pixels (Native HD).
- f) The Visual Display Unit / Rear Projection Modules shall have multiple independently driven redundant LED segments to ensure built-in redundancy at the light source level.
- g) The median life for the LED segments shall not be less than 55,000 hrs. The brightness uniformity shall not be less than 95%. The contrast ratio shall be 1500:1 (typical). The luminance on each rear projection module is 170 cd/m² (typical).
- h) The Optical Engine for the Rear Projection Modules shall be 100% sealed to keep off dust
- i) LVS shall have automatic color calibration and stabilization facility and shall be designed for continuous viewing (24 hours in a day) under normal control room lighting. Automatic colour matching shall ensure consistent colour on all the modules at all times without operator intervention.
- j) Control software shall be capable to integrate the entire display wall into a single display through graphical representation of the display wall on the operator PC. The health status, trouble shooting and configuration of different settings should be possible using this software from the operator work station. Master control unit shall be capable of projecting displays over a part of screen to multiple screens.
- k) Each cube shall be connected to a dedicated PC in order to have access to any standard page on the DCS network.
- l) The screen shall have non-reflective dual layer acrylic screen. The screens shall have horizontal half gain viewing angle of +/-

35 degrees and vertical half gain viewing angle of +/- 32 degrees . The full viewing angle shall be 180 degrees.

- m) The screen shall be flicker free and there shall not be any screen burn due to long display of same information.

The exact arrangement of LVS shall be finalised during detailed engineering stage

B. DATA WALL CONTROLLER:

- a) The Controller shall be not inferior to Intel Core 2 Duo TM CPU 2.13 GHz .The memory shall be 2 GB (standard) expandable up to 4 GB.
- b) The display controller shall have dual redundant hot swappable power supply.
- c) The complete system shall be interfaced on Dual Redundant 10/100/1000 Mbps Ethernet based DCS network.
- d) The Display Controller shall be WINDOWS based sytem.
- e) The controller shall have multiple DVI graphics outputs to be connected to the multiple rear projection modules and the number of such graphics outputs should be equal to the number of rear projection modules.
- f) Provision shall be kept to connect the Video and RGB to this controller to show the multiple RGB & Video sources in scalable and moveable windows on the graphics wall. It shall be capable of selecting different video images from different input and display on the video wall.
- g) The Display System shall be capable of directly capturing the video stream from CCTV Server/Ethernet and display it in native resolution on screen without downscaling so that original video quality generated by cameras is preserved till its display on video Display System.

C. Display Wall Management Software:

- a) The software shall be able to pre-configure various display layouts and access them at any time with a simple mouse click.
- b) The wall management software shall allow switching the video streams.
- c) The API of the wall management software shall allow switching the video streams.
- d) The Diagnostic Software shall support the following :
 - i) Switching the entire display wall on or off.

- ii) Setting all projection modules to a common brightness target, which can be either static (fixed) or dynamic to always achieve maximum (or minimum) common brightness between projection modules.
- iii) The diagnostic software shall also perform health monitoring that allows timely detection of faults.
- e) The hardware/software of the control unit shall be such that the command execution time of any control command from LVS cubes shall not be more than the execution time from OWS or 6 msec whichever is minimum.

Bidder shall meet the following general specifications:

f) Display Screen and Projection Device

- 01. Type of Screen : Seamless rear-projection video wall with a LED-based illumination unit; totally enclosed Non reflective dual layer acrylic screen.
- 02. Luminance : Typically 170 Cd/m².
- 03. Brightness uniformity : 95% ANSI 13
- 04. Contrast Ratio : Typically 1500:1
- 05. Angle of Vision : 180 Degree Horizontal
- 06. Resolution : 1920 x 1080 pixels or better (Full HD)
- 07. Junction Interface : Seamless.
- 08. Aspect Ratio : 16:9
- 09. Color stability : Self calibrating with spectrometer
- 10. Median Life of LED : Typically 55,000 hours
- 11. Lamp configuration : Redundant (Hot standby, cold standby and automatic switching mode)

g) Control Unit

- 01. Type : Intel core i7 Quad core CPU 3.2 GHz or better

- | | | | |
|-----|--------------------|---|------------------------------------|
| 02. | Hard disk | : | 2 X 500 GB in RAID 1 configuration |
| 03. | Drive | : | DVD R/W ROM |
| 04. | Operating System | : | Windows 11 64 bit or better |
| 05. | Output | : | Projector control |
| 06. | Communication Port | : | TCP / IP & RGB (as required) |
| 07. | Video inputs | : | From DCS network |
| 08. | Software | : | Licensed version of software. |

7.12.00 Engineering /Configuration Cum Diagnostic Station

7.12.01 It shall perform programming /configuration of complete control system and HMI alongwith system diagnostic. System shall be adequately guarded by software & hardware locks etc., against any inadvertent and un-authorized access. Two nos. of such stations shall be provided at computer room.

7.12.02 It shall be capable of storing, loading, editing, testing, tuning, monitoring etc. for all the controllers. In case if different hardware is employed for some system and the same is not possible to configure from this station, additional engineering station for those controllers shall be provided. System shall be complete with monitor, keyboard, mouse and A3 colour LaserJet printer.

7.12.03 Programming technique shall not require any special knowledge on high level programming and easy to learn.

7.12.04 Station shall archive all the addresses, setting parameters, screen statistics etc. for future downloading in case any controller/operator's terminal is replaced by a new one or any data is lost or during rebooting of the system. The unit shall remain on-line and serve as the administrator for the entire network, if required.

7.12.05 Bidder shall also provide minimum two numbers of laptop computers with latest hardware configuration and loaded with suitable operating and application program as a backup portable programming and configuration station.

7.12.06 Configuration / modification in graphics executed in the Engineering station shall be available at all the operators' station through network sharing function. No duplication of engineering efforts shall be required to build control displays at each station.

7.12.07 Each station shall be capable to execute the functions not limited to the followings:

- a) System configuration
- b) Data Base configuration
- c) Graphics display generation and modification

- d) OLCS/CLCS Control algorithm generation and modification
 - e) Report/Log configuration and modification
 - f) System access configuration
 - g) Downloading of program
 - h) High level programming language as required for the system.
- 7.12.08 Each station shall be equipped with a DVD writer for archiving of the configuration.
- 7.12.09 The station shall be capable of generating all real time graphics, trends, plots etc, necessary for optimum tuning of the controllers and shall not require any assistance from the trend recorders and controller face plate displays for performing the tuning function. This feature shall also be duplicated in the operator's station.
- 7.12.10 The open loop controllers shall be programmable from the Engineering Terminal in simple ladder network representation or in symbolic form.
- 7.12.11 Engineering/configuration stations of the unit shall also serve as Diagnostic Stations to perform system maintenance functions This shall serve as an aid to the maintenance engineer and supplement various functions available in the engineering terminal for system diagnostics and fault location upto module level identifying location on the panel and subrack where the fault has occurred. The standard diagnostic displays provided in the engineering cum diagnostic terminal and operator's terminal shall be identical.
- 7.12.12 The system maintenance function shall not be limited to the followings:
- a) Station status overview.
 - b) System alarm message display.
 - c) Individual station status display.
 - d) Data base equalization.
 - e) Date and time setting.
 - f) Network status display
- 7.12.13 Diagnostic System shall provide all relevant information about the system fault on the display screen. The fault may be grouped section-wise or station-wise on the initial screen and subsequent paging should specifically lead to the rack number, card number, type of card etc, so that any fault on the system shall become transparent to the operator and maintenance personnel without approaching individual cubicles for fault finding. The system shall also provide guidance for fault clearance and shall reduce downtime of the system.
- 7.13.00 Plant Operational Displays
- 7.13.01 Standard plant operational and monitoring displays shall be offered by Bidder, which permits easy man machine interactions. The data presented shall be easily understandable, comprehensive and presented in soothing colors so that prolonged exposure to the screens do not lead to eye fatigue.

- 7.13.02 All consoles and control room furniture supplied shall be of ergonomic design so that no strain is caused to the operators & engineers.
- 7.13.03 Bidder shall generate typical control screen displays for operation and control. However, there shall be provision for customizing at least 50 additional screens by the Owner in future for specific operational convenience. The following typical screens are recommended. There shall be provision for multiple windows & pop ups. Typical pop-up windows shall tentatively be as follows (i) display of some latest alarms, (ii) window to display messages for illegal key operation, (iii) HELP window to display user defined help messages. Over and above, all screens shall display a fixed header carrying salient information about the plant like MW generation, frequency, time & date, power factor, load demand etc, and an alarm footer to represent any major alarm in the plant.
- 7.13.04 Switching over from page-to-page or from display-to-display shall be by means of simple procedure like track ball operation and pull-down menus.
- 7.13.05 Control Overview Screen
- Display of status & values of all analog control loops and open loop controls in one screen in color graphic form. The display shall present all the controlled parameters in color bar graph representing the value on a 100% span scale and/or the control deviation in a center-zero scale. The color of the scale shall indicate the alarm / healthy / control status of the variables. The point address code shall associate with each bar to enable the operator to select parameter display by direct addressing.
- a) Group display screen - group of related control loops, and or measurement parameters and / or related drives displayed in one screen. The display can be in controller face plate form showing the controlled variable, A/M status of the controller; engineering value of measurement parameter on a 100 % span bar graph form; status of binary drives etc. Typically, a group screen shall be composed of 8 parameters or loops.
 - b) Individual display screen - displaying one control loop, tag number of associated elements, schematic representation of the loop, trend of the controlled variable/s, alarm history, sectional plant sub-system display related to the loop, various settings including tuning parameters, alarm / trip settings etc., representing a complete data bank for the loop. Similarly, for binary drives, the representation shall include a sectional mimic for the drive area, control ladder, status of the drive, tag number, different delay and other settings etc.; all in one screen.
 - c) Plant sub-system display - mimic diagrams meant for direct operation by vectoring cursor on the screen. The display shall have a fixed part representing the P&I diagram and a dynamic part refreshing parameter values and status of drives. There will be an overall plant sub-system display from which operator shall zoom into the specific area of interest. Additionally, operator shall be able to directly address specific displays by their area identification code. The displays shall be animated to represent changes. Extensive color coding shall be utilized

to represent status of drives, alarm conditions, open / close status etc., together with the color coding for various lines carrying different fluids.

- d) Flow chart / logic / ladder screens - meant for sequence logic operations to represent the progress of the sequence, time-out conditions, forced or bypass conditions, hang-ups and prompts.
- e) Operator's guidance message screen - displaying process flags and prompts to the operator to assist in selecting course of action in the events of start-up and emergencies.
- f) Trend Display - The system shall be capable to display at least eight (8) numbers of real time trends with eight (8) different colors per page with selectable time frame to implement variation in resolution. The facility to magnify trend on Y-axis by 1, 2, 5 & 10 and scrolling within the range $\pm 100\%$ shall be provided. Also the facility to magnify X-axis by 1, 2, 4 or 8 and scrolling shall be provided.
- g) Screen Partitioning - The system shall be capable to implement screen partitioning to facilitate easy comparison of trending between two or more assigned screens and also display of X-T and X-Y trends on the same page and other combinations as per the requirement of operating personnel.
- h) Multi-windows - The system shall have facility of multi-windows & pop ups to allow related information to be displayed in different windows. The types of windows shall be tentatively as follows :-
 - i) Alarm window for display of all acknowledged & unacknowledged alarms in different colours. Alarm priority shall also be distinguished by colour.
 - ii) System help window for display of messages corresponding to illegal key operations.
 - iii) Help windows for user defined help messages.
 - iv) Trend window display with trend recording graphs.
 - v) Faceplate window to display Instrument faceplate of called tag number.
 - vi) Process window for display of process data.
 - vii) MIMIC, System Diagnostic, Engineering menus etc.

Minimum quantity of major types of displays shall be as follows:

a. Control displays (group/sub-group/sequence/loops)	500
b. P&ID/mimic display	100
c. Bar chart	100
d. X-Y / X-Tt Plot	100
e. Operator guidance message	100
f. Plant starting/ shutdown guidance message	100
g. Other misc. displays	100
h. System status & other diagnostics on as required basis	25

- 7.14.00 Security
- Multiple security levels with hard and soft key lock shall be provided with two (2) or more at operator levels and one (1) at Engineer level to make it possible to restrict access to critical parameters and minimize the possibility of operator errors.
- 7.15.00 Plant Operation
- The general modes of operation from the operator's terminal shall be as follows.
- 7.15.01 The closed loop and binary controls shall be implemented in hierarchical structure.
- 7.15.02 Set point shall be varied from the Operator's terminal in incremental mode.
- 7.15.03 It shall be possible to transfer a loop from "auto" mode to "manual" mode or vice versa from operator's terminal. All such transfers shall be bumpless and procedureless. During transition from "auto" mode to "manual", the output to the final element shall be maintained until manipulated from the operator's terminal. Similarly, during transfer from "manual" mode to "auto"; when effected from the operator's terminal, the auto output shall take-off from the last value and shall regulate the final element in a predetermined and adjustable ramp to final computed value as per the control loop algorithm. This will necessitate continuous auto-tracking between "auto" mode and "manual" mode outputs. Control valve position shall be indicated on the monitor.
- 7.15.04 Binary control shall be implemented in hierarchical structure. It is proposed that the following points of control shall be available.
- a) Local Control Station (LCS) for trial start & emergency stop operation
 - b) Operator's terminal for normal operation
 - c) Control Panel (wherever applicable)
- 7.15.05 Switchgear and MCC shall be equipped with TEST, TRIAL and NORMAL operation.
- 7.15.06 In "TEST" mode, operation shall be performed from the MCC / Switchgear only to verify the integrity of electrical system. No actual operation of the main equipment will take place.
- 7.15.07 In "TRIAL" mode (for local maintenance), control can be affected from local control station (LCS). To start a drive from LCS, apart from the electrical protections critical process/drive related safety protections, if any, shall have to be ensured for safety during trial operation.
- 7.15.08 In "NORMAL" mode drives are operable from remote (CCR). During operation from remote all process, sequence and basic safety-related permissive and interlocks shall be in place.

7.15.09 The STOP functions at all points shall be active at all time, irrespective of the selection.

7.15.10 The drives, which are part of a sequence, shall be operable in sequence mode from Operator's terminal. In sequence mode, a single command shall lead to predetermined sequence of operation. Following information, as a minimum, shall be available on the monitors.

- a) All permissive
- b) Start & Stop sequence
- c) Start sequence complete
- d) Stop sequence complete
- e) Sequence fail
- f) Stepwise sequential progress of operation indication with permissive for each step to enable the operator that for particular step all permissive are met and the step is executed.
- g) Disturbance indication
- h) Sequential operation indication on monitor in the form of ladder logic diagram
- i) Override of hold-up sequence as per operator's discretion.

7.16.00 Functional Description of Auto Control loops

The functional description of major regulating loops described in this section is to be treated as typical only. Bidder shall furnish the scheme of control loops & write up on his system meeting intent of specification for approval of Owner's engineer.

7.16.01 Operation in different unit control modes

- a) Operation in CMC mode

In coordinated control mode the load demand shall be sent simultaneously to the turbine controls and boiler controls. The required load shall be set by the operator or automatically entered into the system from load dispatch center.

- b) Operation in Boiler following mode

In the boiler following mode the megawatt load control shall be the responsibility of the turbine control system with boiler controls responsible for throttle pressure control.

- c) Operation in turbine following mode

In the turbine following mode turbine control system shall maintain the main steam pressure at turbine inlet according to the main steam pressure set point given manually by throttling the turbine inlet control valves. Steam flow through the turbine shall be varied to achieve

megawatt control by varying the fuel firing in the boiler master control system.

d) Operation in manual mode

In this mode the turbine governor shall be capable of being operated manually

e) Master Pressure Control

In this mode, the responsibility of the boiler shall be to maintain throttle pressure at turbine inlet and turbine control shall be responsible for maintaining megawatt load. To enhance the speed of response, the megawatt generated signal shall be imposed on the master controller output causing the demand signal to follow load changes instantaneously as the steam flow changes.

f) Fuel Flow Control

Fuel flow control shall change feeder speeds in a defined manner based on the demand signal for fuel from combustion control. The fuel demand signal shall be distributed among available coal feeders. Total fuel flow will be computed by adding coal flow of all mills and weighted value of oil flow.

g) Air Flow Control

Air flow will be controlled by adjusting the blade pitch control of FD Fans with the air flow demand signal received from combustion control. Air flow measurement used in the loop shall be oxygen corrected.

7.16.02 Coordinated Master Control System

a) The coordinated master control system shall be implemented to synchronize the response of both the boiler and turbine control system to achieve a higher degree of unit level automation. The control system shall ensure that boiler, turbine and all major plant auxiliaries operate within their safe operating limits under all operating regimes.

b) The coordinated control system shall receive a unit load demand signal from Owner's automatic load dispatch center or from unit load setter of respective unit's operators' console and shall translate this signal into demand signal for boiler and turbine control systems.

c) Mode Selection

The system shall have facility for different mode selection such as coordinated mode, boiler follow mode, Turbine follow mode and manual mode. The system shall be provided with the facility of bump less transfer between one mode to another mode without disturbing the process.

d) Load limiting and directional blocking

The system shall have facility for setting unit load set point , limiting the maximum & minimum unit load on frequency variations, and unit load rate change under such conditions. Directional blocking of the unit load demand (increase/decrease of load) will be provided based on the equipment status and applicable process conditions.

e) Run-up and Run-down

The Run- up and Run-down actions shall be provided for reducing the specific parameter deviations when the respective associated final control elements are in the extreme positions and are unable to correct the error. Run up and run down actions shall manipulate the unit demand signal till the adverse conditions are cleared.

f) Emergency run back

The system shall provide automatic run-back facility based on the load demand signal on loss of critical auxiliary equipment. The limits and rate of run back shall be pre-determined according to the individual capacity of each auxiliary equipment and shall be supervised by Turbine Stress Evaluator. The control system shall have capability for implementation of the functional requirement with true characteristics of equipment.

g) Frequency correction

The unit load demand shall also be corrected by deviation in system frequency. This correction provides a change in unit load demand equivalent to the expected change in megawatt output due to any deviation in system frequency. However the modified load demand signal due to system frequency deviation shall be limited within maximum and minimum load set point.

h) Transient operation

Under transient operating conditions, the demand signal shall be modified to change the turbine output by utilizing stored capacity of the boiler and to raise or lower the energy levels in the boiler by over or under firing.

i) Throttle pressure error correction

Throttle pressure shall be controlled at a preset value to ensure that there is no mismatch between the output of the boiler and turbine. Throttle pressure controller shall be provided. Provision shall be made to feed the set value signal for throttle pressure controller to HP-LP bypass controller.

j) Megawatt error correction

Feed forward signals will be calibrated initially to produce a specific relationship between turbine steam flow and boiler firing rate on one hand and unit output on the other hand. However the relationship may change due to changes in system parameters such as cycle efficiency,

heating value of coal, feed water temperature etc. When such a change occurs, it will be reflected in a steady state error in megawatt output. A controller shall be provided to automatically recalibrate the feed forward signals by reducing the steady state error to zero.

7.16.03 Furnace Draft Control

Furnace pressure shall be controlled by adjusting the blade pitch control of ID fans.

7.16.04 Mill Outlet Temperature Control

Mill outlet temperature shall be maintained at set value by varying positions of hot air damper and cold air damper.

7.16.05 Deaerator And Hot Well Level Control

Deaerator level shall be maintained by regulating condensate flow control valve in the main condensate line to deaerator. This will be 3 element control consisting of Deaerator level, Feed water flow including SH & RH attemperation flow and condensate flow along with extraction steam flow to deaerator and HP heater drain flow to deaerator. Hotwell level will be maintained by regulating the DM water make up to hotwell.

7.16.06 Superheater Steam Temperature Control

The boiler shall have attemperator spray control on the high pressure steam path for SH outlet temperature control. Superheater temperature control shall be implemented in predictive mode with state-variable control to maintain superheater outlet temperature within specified band under all permissible load swing conditions. Burner tilt mechanism shall be in force in case of temperature is beyond limit of spray control.

7.16.07 Reheat Steam temperature control

Reheat attemperator water shall only function as an emergency measure to bring down hot reheat temperature. Reheater temperature control shall be implemented in a manner similar to superheater temperature control.

7.16.08 Balance of plant controls

The following are some typical BOP controls to be provided:

- a) HP Heater level control- normal & emergency drain
- b) LP heaters level controls- normal & emergency drain
- c) GSC level control
- d) Deaerator pegging steam pressure control and other control systems

7.17.00 Electrical Distribution Management System (EDMS)

7.17.01 The purpose of the EDMS is to provide supervisory Control and Monitoring of the complete in plant Electrical Distribution System in the unit DCS. Common electrical system shall have control from the DCS. No conventional hardwired panels are foreseen in the unit control room unless it is critical. For details, refer Electrical specification Volume IIF/1 Section -1..

7.18.00 PLC Gateway

7.18.01 Functional Description

Interface between “Offsite & Plant auxiliaries PLC” networks and DCS system for remote information and monitoring of offsite plants data, shall be carried out by a dual hot redundant PLC gateway. Proposed Gateway shall operate as a node pair, one in operating and the other shall be in hot standby, serving as its redundant partner, with an exact up-to-date copy of the database and ready to take over full operation should the operating member of the pair fails or be taken out-of-service. The gateway shall provide the data conversion, buffering, and sequencing to provide an efficient interchange of information between the DCS network and the programmable controllers.

7.18.02 Communication link in between the DCS and the Programmable logic controllers shall be dual and optical fiber based.

7.18.03 20 % tag handling capacity over the configured tags shall be kept as spare for future expansion.

7.18.04 Nodes shall be time synchronized with existing GPS master clock.

8.00.00 ROTATING MACHINE CONDITION MONITORING SYSTEM (RMCMS)

8.00.01 RMCMS shall automatically acquire data related to the mechanical health of rotating equipment, perform analysis of the acquired data in a proven software platform and display vibration and other machine data for Turbine, Generator & exciter, BFP drive turbine & pump and all HT motors & their driven equipment like Motor driven Boiler Feed pump & motor, Condensate Extraction Pumps & motors, Cooling Water pumps & motors, Auxiliary cooling water Pumps & motors, ID fans & motors, FD fans & motors, PA fans & motors, Boiler Circulation Pump (as applicable) etc. during all regime of operation. System shall be proven and from latest product range of the manufacturer.

8.00.02 There shall be hardwired as well as software interface for data exchange from RMCMS to DCS for display, trending, alarming and interlocking / protection. Similarly there shall also be exchange of process data from DCS to RMCMS required for analysis via soft link.

8.00.03 The system shall have the following sub systems :

- a) Field Transducers
- b) Data Interface with DCS
- c) On line Machinery Protection and Monitoring
- d) Machine data acquisition, condition management and display
- e) Automated machine diagnostic with decision support system.

- 8.00.04 The system shall be complete with sensors, proximitors, monitors, relay modules, networking hardware, machinery condition management server, dual redundant power supplies, special cables etc. for measurements, protective alarm & trip, diagnostic, advisory notes etc.
- 8.00.05 In all cases vibration shall be measured in both X-Y direction alongwith key phasor for phase reference.
- 8.00.06 The system shall have feature to bypass a relay contact in the event of sensors/ proximitor failure.
- 8.00.07 In all cases power supply modules and incoming power feeders shall be dual on line. Failure of single power supply shall not affect system functioning. Also, communication processors shall be dual redundant.
- 8.00.08 All critical measurement shall be in 2 of 3 , 2 of 2 or 1 of 2 as per the requirement.
- 8.00.09 Critical alarm & trip relay output shall be configured in 2 of 3 voting, 2 of 2 voting or 1 of 2 voting logic as required for the machine criticality.
- 8.00.10 Contact of alarm & trip relays shall be hardwired to the DCS.
- 8.00.11 Each trip channel shall be configured in separate modules to avoid single point failure.
- 8.00.12 Analog output to DCS shall be in the form of isolated 4-20 mA DC and contact output shall be potential free.
- 8.00.13 Following type of transducers shall in generally be used:
- a) For main Steam turbine and BFP Turbine :-
- Shaft Vibration: Non contact proximity transducers with mounting position reference to the bearing.
 - Bearing pedestal Vibration: Seismic vibration transducers with mounting position close to shaft vibration transducers.
 - Key phasor: Non-contact type proximity transducers for phase reference.
 - Axial Thrust position: Non-contact type proximity transducers for observing the axial position of rotor.
 - Differential expansion: Non-contact type proximity transducers to observe the differential expansion of HP / IP / LP turbine (main Turbine) and differential expansion of BFP Turbine.
 - Eccentricity: Non-contact type proximity transducers to observe rotor bow.
 - Speed & overspeed: Non-contact type proximity transducers to observe the speed of the turbine.

- Case Expansion: LVDT type transducers
- b) For Generator & Exciter:-
- Shaft Vibration: Non contact proximity transducers with mounting position referenced to the bearing.
 - Bearing pedestal Vibration: Seismic vibration transducers with mounting position as close as shaft vibration transducers.
 - Stator winding vibration - Seismic vibration transducers with mounting position (if applicable).
- Bidder shall refer to section-IV of this volume for measurement point detail of Turbine & Generator and BFP steam turbine.
- c) For other machines with Journal & Thrust bearing :-
- Bearing pedestal Vibration: Seismic vibration transducers.
 - Key phasor & Speed: Non-contact type proximity transducers for once per revolution phase reference measurement.
 - Gearbox vibration: Seismic vibration transducers.

8.00.14 Transducer data Interface and the machine monitoring & protection subsystem shall be a complete programmable on-line real time system. It shall be capable of collecting data from machine transducers and from other external devices such as DCS and shall provide it to Condition Monitoring System to assess machine condition.

- a) The system shall comprise of standard instrument rack mounted in panel, dual power supply modules, monitoring modules, relay modules, interface modules, dual redundant communication modules and required software.
- b) Communication processor /module shall be dual redundant and shall be connected to external machine condition monitoring server for configuration of monitor modules, relay modules and to monitor static & dynamic data. Data shall be transferred with high integrity and without any loss of data.
- c) Hard or soft key shall be provided to prevent unauthorized access to the system configuration.
- d) Sequence of event and machine data shall be archived in the system for long term storage.
- e) Communication processor shall be capable of collecting data better than once per second.
- f) System shall be time synchronized with the existing GPS master clock.
- g) Removal & replacement of module shall be possible to carry out in system power on condition.

- h) It shall be possible to test all the monitors in the rack. The trip and alarm relay shall be automatically bypassed during testing to prevent alarm and trip.
- i) An operator's station comprising of 23" TFT colour monitor & A3 colour laser printer for system configuration, graphic, local display of data, local alarm, system & machine diagnostic shall provided.
- j) All racks shall be connected in a network and some of the racks shall be located in remote location such as at CW pump house area. Networking shall be made through optic fiber cable & ethernet data highway cable.
- k) Redundant power supply to the system shall be taken from the UPS system of the main plant.
- l) System shall be capable of operating from 0 to 50°C and at 95% non-condensing moisture.
- m) Panels in off site area shall be fitted with local air conditioner if the area is not air conditioned.
- n) Sensors shall be dust proof & weather proof rated to IP-65 and suitable for work in harsh environment. Sensors, proximitors and monitors shall be fully compliant to API.

8.01.00 Monitor Racks / Cabinet

8.01.01 System mounting racks shall be furnished to house monitor modules, indicating/ display units, power supplies, test and calibration equipment. Grouping of modules in racks shall be equipment wise. The mounting racks shall be fully factory wired up to rear terminal blocks. Vibration Panel/cabinet shall have Flush mounted LCD display on the front door for displaying the various vibration parameters.

8.01.02 The mounting racks for all equipment shall be designed for flush mounting through the front face of upright panels.

8.01.03 The front of each mounting rack shall house a monitor test-switch, test condition indicating lamp and power on indication lamp.

8.01.04 Panel shall be provided with necessary MCBs, switch etc. Power and signal cable shall be routed in separate tray.

8.01.05 Panel shall have the provision for protective and DC system ground.

8.01.06 Each vibration monitor and mounting rack shall have nameplate engraved to indicate the main equipment to which the module is catering and the bearing details..

8.02.00 Low Noise Cable and Cable Conduit

8.02.01 Each transducer shall be furnished with flexible conduit and low noise cable. Conduit fittings shall be furnished for connection to transducer. The other end of the flexible conduit will be connected to a suitable junction box.

- 8.02.02 Junction box shall be corrosion, dust & weather proof rated to IP 65.
- 8.03.00 Machine Condition Monitoring Station:
- 8.03.01 The system shall acquire & analyze static, dynamic and transient machine data. System shall be knowledge based and guide the maintenance engineer & operator to detect the fault and to take corrective action. Data acquisition & analysis system complete with 23" LED monitor, keyboard, mouse and necessary communication link shall be furnished. System shall have the software for Configuration, Data Acquisition, Open Database like SQL and display builder etc.
- 8.03.02 Machine Condition Monitoring server shall be capable of running several software on single platform like Windows XP or higher and interfacing with multiple machinery protection racks using ethernet communication link, switches and network cable etc. Configuration and downloading of programs for different modules in Machine protection system such as monitoring modules, relay modules etc. shall be executable from this server with at least two levels password protection.
- 8.03.03 The system shall be knowledge based and shall allow to generate easy to use custom rules. The system shall be developed with automated advisory capability of the system. Rule generator shall reject any rule, which is not syntactically correct.
- 8.03.04 Bidder shall supply all licensed version of all the applicable softwares in run & edit mode for his system and for integration of his system with third party device.
- 8.03.05 Features provided in the system shall not be limited to the following:
- a) Bar graph and point display indicating the setpoints.
 - b) Graphical plant and machine area presentation with location of sensors and their current value.
 - c) Diagnostic of the system and machine data. Alarm to be retransmitted to DCS.
 - d) Current and history trend.
 - e) Spectral band and waveform plotting.
 - f) Multiple trends display including process value for data correlation.
 - g) Orbit and time base plotting.
 - h) Shaft centerline plot indicating position of a machine rotor.
 - i) Bode and polar plot.
 - j) Automatic auditing of the equipment health upon alarm / periodical / on request. Bidder shall acquire the relevant process data for completeness of audit. The audit shall guide the operator regarding location of fault, type of fault, severity of the fault, time of occurrence

and recommended actions. As a minimum, malfunctions like Shaft bow, high vibration, rotor rubbing, high runout, loose rotating parts etc shall be provided. The system shall have the facility to take a backup of the malfunction for future use.

- k) Date & Time stamped alarm list.
- l) Log & Report generation.
- m) Provision for beeping icon in case of appearance of alarm.
- n) Export & import of DCS data. Both way redundant communication link with the DCS shall be provided.
- o) Electronic documentation.

8.04.00 Special Tools & Tackle

8.04.01 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.

8.04.02 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.

8.04.03 Shaker table capable of testing & calibration of all the seismic as well as proximator probes supplied in this scope shall be provided.

List of vibration measurement parameters to be included in RMCMS as minimum:

Sl. No.	HT Drive Name	Vibration measurement point	Direction of vibration. sensor
BTG area			
1	PA Fan	PA Fan bearing vibration DE & NDE	X & Y
		PA Fan motor bearing vibration DE & NDE	X & Y
2	FD Fan	FD Fan bearing vibration DE & NDE	X & Y
		FD Fan motor bearing vibration DE & NDE	X & Y
3	ID Fan	ID Fan bearing vibration DE & NDE	X & Y
		ID Fan motor bearing vibration DE & NDE	X & Y
4	Mill	Mill motor bearing vibration DE & NDE	X & Y
5	Motor driven BFP	BFP bearing vibration DE & NDE	X & Y
		BFP motor bearing vibration DE & NDE	X & Y
6	Turbine driven BFP	BFP bearing vibration DE & NDE	X & Y
7	CEP	CEP pump bearing vibration DE & NDE	X & Y
		CEP motor bearing vibration DE & NDE	X & Y
8	DMCW pump	DMCW p/p bearing vibration DE & NDE	X & Y
		DMCW p/p motor bearing vibration DE & NDE	X & Y
9	Concrete Volute CW pump	(CW p/p bearing vibration as per vendor practice)	X & Y
10	ACW pump	ACW p/p bearing vibration DE & NDE	X & Y
		ACW p/p motor bearing vibration DE & NDE	X & Y
11	Instrument Air Compressor	motor bearing vibration DE & NDE	X & Y
12	Fire Hydrant pump	pump bearing vibration DE & NDE	X & Y
		motor bearing vibration DE & NDE	X & Y
13	Fire spray water pump	pump bearing vibration DE & NDE	X & Y
		motor bearing vibration DE & NDE	X & Y
AHP area			
1	Transport Air Compressor	motor bearing vibration DE & NDE	X & Y
2	HP pump	pump bearing vibration DE & NDE	X & Y
		motor bearing vibration DE & NDE	X & Y
3	Ash slurry pump	pump bearing vibration DE & NDE	X & Y
		motor bearing vibration DE & NDE	X & Y
CHP area:			
1	Crusher motor	motor bearing vibration DE & NDE	X & Y & Z
2	HT motor for belt conveyot	motor bearing vibration DE & NDE	X & Y
3	HT motor of Hydraulic power pack	motor bearing vibration DE & NDE	X & Y

9.00.00 PLANT WIDE NETWORK

- 9.00.01 A plant wide Fiber-optic 1 GBPS (minimum) high-speed backbone Network has been envisaged. Said network shall be used by different users of the plant for over viewing selective Plant Graphics & data on real time basis, historical data & trends and MIS reports such as Plant Generation, Unit Heat rate, Auxiliary Power consumption, DM make up water consumption, Coal / Oil stock & consumption etc.
- 9.00.02 Bidder shall provide a Fiber-optic network spread over the entire plant covering the Unit control rooms, FGD Main Control Room (by owner), CW Pump House etc. for accessing MIS and Owner's CMIMS functions. . All PLC to be communicated to existing Common network switch.
- 9.00.03 Bidder shall keep provision for FO connectivity with the existing MIS data highway of units 3&4.
- 9.00.04 Router with firewall shall be provided for connectivity in between the plant local area network and DCS network.
- 9.00.05 Bidder shall provide all network switches, required FO/UTP cables, cable trays , routers, optical patch cord, transceiver, connectors, couplers, network switch enclosure, UPS, network server, computer furniture to establish the local plant area network.
- 9.00.06 Bidder shall provide 05 (five) sets of PCs with mouse, Key board and a laser printer. Each PC shall be loaded with all requisite software shall be powered through mini UPS with 30 minutes battery backup. Raw power supply of 240V AC, Single phase, 50 Hz shall be provided to the UPS which shall be from proven design & similar make. Non-fuming type Ni-Cd maintenance free battery shall be considered.
- Bidder shall further keep provision of ports for networking of at least 05 (five) nos. of PCs in future.
- 9.00.07 Bidder shall provide all necessary computer furniture which shall be similar to that supplied in the unit control room.

10.00.00 POWER SUPPLY SYSTEM

- 10.01.00 Bidder shall provide 2 sets of UPS for 240 V AC supply requirements at the equipment room. and at the unit control room for all work stations Engineering stations, all other CRTs, LVS, printers ,and all networking peripherals etc.
- 10.02.00 The UPS shall comply to the specifications given in Electrical Section (Vol II F/2 Section X-A1 & X-A2).
- 10.03.00 Bidder shall extend UPS supply from the unit equipment room to the following panels/ instruments. The list is indicative and not exhaustive. The exact UPS load distribution shall be finalized during detail engineering.
- i) Vibration Monitoring Panel
 - ii) Accoustic Tube Leak detection Panel

- iii) Gravimetric Feeder Control Panel
- iv) SWAS Panel
- v) Conductivity type level transmitter for Boiler Separator.
- vi) Flame Monitoring Panel
- vii) CCTV System
- viii) Flue gas analysers
- ix) O₂ Measurement systems
- x) Stack Opacity Monitoring System
- xi) H₂ Purity meter & Moisture measurement system
- xii) Stator water conductivity monitoring system
- xiii) Mass Flow transmitters
- xiv) All PLCs and control systems (non DCS) within Power House building.
- xv) DCS network peripherals.
- xvi) CEMS System

10.04.00 Bidder shall provide 2 sets of ± 24 V DC Battery , Battery charger and DC distribution board complete with all accessories.

10.05.00 Additionally 2 sets of ± 24 V DC Battery , Battery charger and DC distribution board shall be provided for the DCS stations at CW & ACW pump house, FGD Absorption control room and CPU Regeneration room.

Bidder shall comply to all the specifications as detailed in Electrical Section (Vol II F/2 Section XB) for 24 V DC System.

11.00.00 INSTRUMENTATION CABLES

11.01.00 General Requirements

11.01.01 Bidder shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under his scope.

11.01.02 Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Bidder.

11.01.03 Other type of cables like co-axial cables for system bus, cables for connection of peripherals etc. (under Bidder's scope) are also to be furnished by the Bidder.

11.01.04 Bidder shall supply all cable erection and laying hardware like cable trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.

11.01.05 All instrumentation cables covered in this specification shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions) and its amendments read along with this specification.

11.01.06 The thermocouple extension cables shall be of Two pair/multi pair, twisted & shielded, PVC insulated, FRLS PVC sheathed and compatible for the type of thermocouples employed. The material of conductor shall be as per ANSI MC-96.1.

- 11.01.07 Traid cables shall be used for all RTD (3-wire) measurements. In case of 4-wire RTD, 2 pair instrumentation signal cables shall be used.
- 11.01.08 All cables near high temperature zone like burner front devices, metal temperature thermo-couples on main steam & turbine casing etc. shall be high temp cables, which shall be terminated at a junction box in normal temperature zone. Thermocouple extension cables and copper conductor cables for high temperature applications shall be with insulation of individual conductor and outer sheath of extruded FEP (i.e., Teflon) as per VDE 0207 Part 6 and ASTM D 2116. The thickness of insulation shall be 0.5 mm nominal (i.e., 0.4 mm minimum). These cables shall be single/ multipair, twisted & shielded.
- 11.01.09 Cable accessories such as harnessing components, markers, bedding, cable joiner, binding tape etc. shall have flame retardant quality.
- 11.01.10 The thickness of outer sheath shall be as per the guidelines given in VDE 0816. Thickness of outer sheath shall not be less than 1.8 mm in any case. Allowable tolerance of overall diameter of the cables shall be ± 2 mm max. over the declared value in technical data sheets. The variation in diameter and the ovality at any cross section shall not be more than 1.0 mm.
- 11.01.11 The Cables shall be supplied in non returnable standard seasoned drums. The drum length shall be 1000m ($\pm 5\%$) up to & including 8 pairs and 500 m ($\pm 5\%$) above 8 pairs. Drum shall be anti rodent, anti termite and smooth finish. Both ends of cable shall be capped by means of non hygroscopic sealing material.
- 11.01.12 Durable marking shall be provided on the outer sheath of the cable at intervals not exceeding 5 metres. Marking shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / type of compensating /extension cable, Analog or Binary), Insulation material, FRLS etc.
- Sequential length marking shall also be provided at every metre interval on outer sheath of cable.
- 11.01.13 Bidder shall furnish all documentary evidence including cross-sectional drawings, test certificates to substantiate the suitability of cables offered for different applications. Bidder shall also clearly bring out the application wise details for each type of cable offered.
- 11.01.14 All prefabricated cables shall have 10% spare cores which will not be connected to pin connectors.
- 11.01.15 All the instrumentation cables i.e. twisted and shielded multipair cables, compensating cables, pre fabricated cables etc. shall be flame retardant low smoke and low halogen (FRLSH) type.
- 11.01.16 For all Digital Output (DO) signal from DCS or PLC, Minimum 1.5 Sq mm cable shall be used, except for Solenoid valves where 2.5 Sqmm cable shall be used. Moreover, bidder shall submit the calculations for selecting the cable size.

11.02.00 Instrumentation Cable Specifications

11.02.01 Instrumentation Multi Paired Signal Cable

01. Conductor type : Multi-stranded annealed tinned high conductivity 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 : Extruded PVC meeting the requirements of VDE 0207 Part 4 compound Y I3. Insulation thickness for individual core shall be between 0.28 and 0.35 mm for 0.5 mm² cables, 0.5 to 0.6 mm for 1.0 mm² cables and 0.8 to 0.9 for 1.5 mm² cable.
05. Voltage Grade : 225 V (peak value)
06. Twisting : Twin twisted with lay of 50 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.) polyster 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.

Binary signals - overall shield.
09. Drain wire : Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm). Separate drain wire for individual pair shield (wherever applicable) as well as overall shield.
10. Inner Sheath : Extruded PVC (compound YM1) as per VDE 0207 Part 5 (anti rodent, anti termite & moisture resistant properties) and shall be of flame retardant low smoke (FRLS) type
11. Fillers : Non metallic flame & moisture retardant
12. Armouring : GI wire / strip

13. Outer Sheath : Extruded PVC (compound YM1) as per VDE 0207 Part 5 and shall be of flame retardant low smoke low halogen (FRLSH) type
14. Temperature Range : 70°C (continuous) except for high temperature resistant Teflon insulated cables which shall be suitable for continuous operation at 205°C
15. Sheath colour : Inner- Black and Outer- Sky Blue
16. Tests on outer sheath:
- a) Oxygen Index: Min.29% at room temp. (ASTMD-2863)
 - b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
 - c) Temp Index : Min 250° C (ASTMD-2863)
 - d) Smoke Density Rating :Max.60% (ASTMD-2843).
 - e) Complete cable assembly shall pass Swedish Chimney Test- as per SEN-4241475 AND Flammability Test as per IEEE-383.
 - f) Halogen Content Measurement as per ICEA T-33-655 (Permissible limit for halogen shall not be more than 0.2%)
17. High voltage test
- a) Core to core - 1.5 KV for 1 min.
 - b) Core to screen - 1.0 KV for 1 min.
 - c) Screen to Armour – 1.0 KV for 1 min
18. Rodent & Termite repulsion test Presence of lead shall be confirmed
19. Colour of core insulation for Instrumentation Cable

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.

- 11.02.02 Thermocouple Extension & Compensating Cable (Two Pair & Multi- Pair)
01. Conductor : Solid conductor
 02. Conductor size : 16 AWG (1.31 Sq. mm)
 03. Type : Kx (Extension) (Chromel Alumel),
Rx (Compensating) (Copper-Copper alloy),
 04. Conductor Insulation : Extruded PVC meeting the requirements of VDE 0207 Part 4 compound Y I3. Insulation thickness for individual core shall be between 0.35 to 0.45 mm for 1.31 mm² cables
 05. Voltage Grade : 225 V (peak value)
 06. Twisting : Twin twisted with lay of 50 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 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.) polyster 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). Separate drain wire for individual pair shield as well as overall shield.
 10. Inner Sheath : Extruded PVC (compound YM1) as per VDE 0207 Part 5 (anti rodent, anti termite & moisture resistant properties) and shall be of flame retardant low smoke (FRLS) type
 11. Fillers : Non metallic flame & moisture retardant
 12. Armouring : GI wire / strip

13. Outer Sheath : Extruded PVC (compound YM1) as per VDE 0207 Part 5 and shall be of flame retardant low smoke low halogen (FRLSH) type
14. Temperature Range : 70°C (continuous) except for high temperature resistant Teflon insulated cables which shall be suitable for continuous operation at 205°C
15. Sheath colour : Inner- Black and Outer- Yellow for Type Kx, Green for Rx.
16. Tests on outer sheath:
- a) Oxygen Index: Min.29% at room temp. (ASTMD-2863)
 - b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
 - c) Temp Index : Min 250° C (ASTMD-2863)
 - d) Smoke Density Rating :Max.60% (ASTMD-2843).
 - e) Complete cable assembly shall pass Swedish Chimney Test- as per SEN-4241475 AND Flammability Test as per IEEE-383.
 - f) Halogen Content Measurement as per ICEA T-33-655 (Permissible limit for halogen shall not be more than 0.2%)
 - g) Thermal EMF Test as per ANSI MC96.1
17. High voltage test
- a) Core to core - 1.5 KV for 1 min.
 - b) Core to screen - 1.0 KV for 1 min.
 - c) Screen to Armour – 1.0 KV for 1 min
18. Rodent & Termite repulsion test Presence of lead shall be confirmed
19. Conductor material & sheath color for thermocouple extension /compensating 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
Rx	Green	Positive	Black	Copper

Cable type	Overall Sheath Color	Wire	Sheath Color	Conductor Material
		Negative	Red	Copper Alloy

11.02.03 Instrumentation Triad Cables

01. Conductor type : Stranded tinned Electrolytic copper
02. Conductor size : 1.0 Sq.mm
03. Stranding : 7 x 0.43 mm
04. Conductor Insulation : HRPVC Type-C, 0.6 mm thick
05. Twisting : Triad twisted with lay of 50 mm
06. Twisting Direction : All triads in the same direction. Lapped to form bunch with mylar tape.
07. Colour : Outer sheath colour shall be black for non-IS cable and light blue for IS cable. Individual triad color code shall be Light blue-Brown-Black.
08. Individual Pair Overall Shield mm thick) : Polyethylene coated aluminum foil with 100% coverage with 25% Overlap (0.06 mm thick).
09. Drain wire : Annealed Tinned copper wire, Size 0.5 Sq. mm. minimum
10. Inner Sheath : Extruded FR PVC, Thickness as per International Standard
11. Armoring : N/A
12. Outer Sheath : Extruded FR PVC, Thickness as per International Standard
13. Rip Cord : Yes
14. Operating Voltage : 300 V / 500V R.M.S (Core to Earth / Core to Core.)
15. Temperature Range : Up to 85 °C
16. Electrical Characteristics Resistance : 18.4 Ohms/Km (max.) at 20 °C
17. Mutual Capacitance at 1 kHz : a) Between adjacent cores 150 nf / Km.

- b) Between conductor and Screen 400 nf / Km
18. L/R ratio : 25 μ H/Ohms (max)
19. Insulation at 20^o C : 100 M Ohms/Km (Min)
20. Codes & Standards : a) IPCEA-S-61-402
b) IEC 332-1 ASTM-B-33
21. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
b) Temp Index : Min 250 ^oC at 21Oxy. Ind. (ASTM-D-2863)
c) Flammability Test : as per IEC 332 Part-I
d) Swedish Chimney Test-S-424-1475
e) High Voltage Test :1.0 KV for1 Min
f) Type Test for material
22. No. of Triads : 2T, 6T, 12T

11.02.04 Cable parameters such as mutual capacitance between conductors, conductor resistance, insulation resistance, characteristic impedance, cross talk and attenuation figures at 20 deg. C ($\pm$ 3 deg. C) for various types of cables as applicable shall be as specified in TABLE-1.

TABLE- 1

CABLE PARAMETERS

Sl. No.	Parameter / Type	Type – E, F	Type – G, I	Type – A, B & C	Remarks
01.	Mutual Capacitance at 0.8 kHz (max.)	120 nF/Km.	100 nF/Km.	120 nF/Km.	
02.	Conductor Resistance (max.)	73.4 Ohm/km (Loop) For Type F, 13.3 ohm/km (loop) for Type E	73.4 ohm/km (loop)	26.6 ohm/km (loop)	
03.	Insulation Resistance (minimum)	100 M ohm/km	100 M ohm/km	100 M ohm/km	
04.	Cross-talk figure at 0.8 kHz (minimum)	60 dB	60 dB	60 dB	
05.	Characteristic Impedance (maximum) at 1 kHz	320 ohm	340 ohm	320 ohm	
06.	Attenuation at 1 kHz (maximum)	1.2 dB/Km for Type F; 0.8 dB/Km for Type E	1.2 dB/Km	1.2 dB/Km	

- 11.02.05 Identification of the cores & pairs shall be done with suitable colour coding & band marking as well as by numbering of cores/pairs as per VDE: 0815. The details of colour coding etc. shall be as approved by Owner during detailed stage. Also refer TABLE - 2 for description of various type of cables.

TABLE- 2
DESCRIPTION OF VARIOUS TYPES OF CABLES

Sl. No.	Type	Conductor size in sq.mm	REMARKS
01.	A	1.31	Two pair shielded and twisted pair thermo-couple, extension cable, ANSI type Kx, solid alloy conductor.
02.	B	1.31	Two pair shielded & twisted thermo-couple, extension cable, ANSI type Sx, solid alloy conductor.
03.	C	1.31	Two pair shielded & twisted Heat resistant Teflon insulation & outersheath thermo-couple, extension cable, ANSI type Kx, solid alloy conductor.
04.	E	0.5	Two pair individual pair and overall shielded twisted pair instrumentation cable for both analog and digital signal to be used from field mounted instruments to local junction box.
05.	F	0.5	Multipair individual pair & overall shielded twisted pair instrumentation cable (4/8/12pair) for analog signals with stranded copper conductor.
06.	G	0.5	Multipair overall shielded & twisted pair instrumentation cable (4/8/12pair) for binary signals with stranded copper conductor.
07.	H	1.0	2 Triad / MultiTriad individual pair & overall shielded instrumentation cable (2/6/12Triad) for RTD signals with stranded copper conductor.
08.	I	0.5	Type F cable / type G cable with heat resistant Teflon insulation & outersheath for high temperature application.
09.	S	As per specific standard / requirement for each applicable	Multicore / multipair shielded cable for system specific cables like conductivity type level switches, system bus cable, flame scanner etc. as applicable.

11.03.00 Instrumentation Cable Interconnection and Termination Philosophy

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group JB's at strategic locations (where large concentration of signals are available, e.g. switchgear) is done and consequently cable with higher number of pairs are extensively used. JB's to be furnished under this specification shall be of 6/12/24/36/48 way. The material dimension and interior / exterior colour of JB's shall be subject to Owner's approval. The details of termination to be followed is mentioned in TABLE – 3 :

TABLE- 3
CABLE TERMINATION TO BE FOLLOWED

Sl. No	Application		Type of Termination		Type of Cable
	From (A)	To (B)	End (A)	End (B)	
01.	Valves / Dampers Drive (Integral Junction Box)	Marshalling Cubicle / Local Group JB / Termination Control Cabinets / System Cabinets	Plug-in Connector	Post mounted Maxitermi / Cage Clamp type	G
02.	Transmitters, Process actuated switches to be mounted in LIE / LIR	Integral Junction Box of LIE / LIR	Plug-in Connector	Maxitermi / Cage Clamp (Rail mounted) type.	F, G
03.	RTD Heads	Local Junction Box	Plug-in Connector	Maxitermi / Cage Clamp (Rail mounted) type.	H
04.	Thermocouples	CJC Box	Manufacturer's standard	Screwed / Cage Clamp Type	A,B,C*
05.	Local Junction Box, CJC Box, Int. Junction Box of LIE / LIR / Group JB / MCC / Switchgear	Marshalling Cubicle / Local Group JB / Termination / Control Cabinets / System Cabinets	Maxitermi / Cage Clamp (Rail mounted) type.	Post mounted Maxitermi / Cage Clamp type	F, G
06.	Local Junction Box, MCC / Switchgear	Group JB	Maxitermi / Cage Clamp (Rail mounted) type.	Maxitermi / Cage Clamp (Rail mounted) type.	F, G
07.	Field mounted Instrument	Group JB	Maxitermi / Cage Clamp (Rail mounted) type.	Maxitermi / Cage Clamp (Rail mounted) type.	F, G
08.	Marshalling Cubicle / Termination Cabinet	Electronic System Cabinet	Post mounted Maxitermi / Cage Clamp type.	Post mounted Maxitermi / Cage Clamp type.	F, G

Sl. No	Application		Type of Termination		Type of Cable
	From (A)	To (B)	End (A)	End (B)	
09.	UCP mounted equipments	Post mounted Maxitermi / Cage Clamp type	Post mounted Maxitermi / Cage Clamp type.	Plug in Connector / Cage Clamp type (rail mounted)	F, G (with connector at one end)
10.	DCS/ PLC Cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Manufacturer Standard

Notes :

01. For Sl. No. 05, 06, 07 & 08, normally 10% spare core shall be provided.
02. For analog signals individual pair shielding & overall shielding & for Binary signals only overall shielding of instrumentation cables shall be provided.
- 03 *For high temperature application only.

11.04.00 Control & power Cable

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

11.05.00 Optical Fiber Cable

11.05.01 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. all Fibre Optic cables shall be armoured and Single Mode type.

11.05.02 Fiber Optic Cables shall be installed on cable tray, duct bank, cable trench installation as necessary. For outdoor applications the cable shall be armoured with Poly Ethylene sheathing. In all cases cable shall be routed through suitable grade HDPE permanently lubricated protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08 /01of suitable size @ 53% fill factor. Permanent route marking in FRP (Fibre Reinforced Plastic) material shall be provided at intervals not exceeding 5 meters for all FO cables layed outdoor buried under the ground.

11.05.03 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).

11.05.04 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-Butylenes 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. The fiber optic 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.

- 11.05.05 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.
- 11.05.06 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.
- 11.05.07 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.
- 11.05.08 Minimum bending radius shall be equal or more to 15 D (D= Diameter). 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.
- 11.05.09 The entire length of each cable shall be marked with the following items:
- Manufacturer's Name
 - Month and year of manufacturing
 - Coded description of the cable based on Telcordia's (Bellcore) SR-2014 Suggested Optical Cable Code (SOCC).
 - Sheath Identification Number
 - Sequential Length Marking in meter
 - A Telephone Handset symbol to distinguish communication from power cable as per NESC section –35 G.
- 11.05.10 Fiber optic cable shall provide a long life expectancy of minimum 25 years and shall meet the industrial standard of operation at temperature of 55° C and humidity to 100% without degradation to optical or mechanical performance.
- 11.05.11 Optical fiber used in the plant shall generally conform to the following specification.
- Specification for G.652 Monomode Fiber

Attributes		Value
1.	Cladding Diameter	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
2.	Cladding non-circularity	$\leq 1.0\%$
3.	Attenuation Coefficient at (a) 1290 nm to 1340 nm (b) 1525 nm to 1575 nm	< 0.36 dB/km < 0.25 dB/km
4.	Chromatic Dispersion Coefficient at (a) 310 nm (b) 1550 nm	< 3.5 ps/nm.km < 18 ps/nm
5.	Polarization Mode Dispersion (PMD)	$\leq 0.5 \text{ ps}/\sqrt{\text{km}}$
6.	Mode Field Diameter at (a) 1310 nm (b) 1550 nm	9.2 $\pm$ 0.4 μm 10.50 $\pm$ 1.0 μm
7.	Mode Field Concentricity Error	$\leq 0.5 \mu\text{m}$
8.	Proof Test	$\geq 1\%$
9.	Fiber Curl (ROC)	$\geq 4.0 \text{ m}$
10.	Macro-bend Test on Fiber at 1550 nm	$\leq 0.1 \text{ dB}$

11.06.00 Cable Assembly

11.06.01 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.

11.06.02 Fiber Optic Distribution Patch Panel

Fiber optic distribution panels shall be provided as required. The 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, then 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 bulk head connector sleeves or equivalent. Unused sleeve ports shall be equipped with reusable caps to prevent the intrusion of dust.

11.06.03 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.

11.06.04 Fiber Optic Tool Kit

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.

11.07.00 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

Site Test (Like Continuity & Attenuation)

12.00.00 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.

12.01.00 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.

12.01.01 Junction Box

01. Type of Enclosure : Dust tight & weatherproof conforming to IP 65

- 02. Material : 2 mm sheet steel
- 03. Type of Cover : Solid Hinged Door with steel handle and IP lock
- 04. Paint : 631 IS 5 Epoxy Powder Coated
- 05. Mounting : Surface
- 06. Cable Entry : 3 mm (min) Gland plate
- 07. Gasket : Neoprene
- 08. Grounding : Brass earth lug with green screw head
External-2 nos , Internal-1no.M6.
- 09. Number of Drain Holes : Two at bottom capped.
- 10. Identification : Label for JB and Tags for cable
- 11. Accessories : a) Rail mounted cage clamp type screwless terminals with markers
b) Cable gland
c) Ferrules
d) Canopy at top

12.01.02 Cable Gland

- 01. Type : Double compression
- 02. Entry Thread : NPT
- 03. Material : Brass
- 04. Finish : Cadmium Plated.
- 05. Protection : IP 65 or better
- 06. Accessories : Neoprene gasket, locknuts, reducers etc.

12.01.03 Cable Tray

- 01. Material : Mild steel
- 02. Thickness : not less than 2.0 mm
- 03. Finish : Hot dip galvanized
- 04. Perforation : As per MFR standard.
- 05. Cover : Suitable for tray

06. Height of the cable tray : 100 mm for 450mm and above width.
(width cannot be less than 100 mm)

12.02.00 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.

12.02.01 Specification for Process Hook Up Materials

PROCESS CONNECTION PIPING

Sl. No.	System / Line Description	Piping Class	Impulse Piping Material	Schedule (Size)	Materials for Fitting / Valve body	Valve Stem Material	Rating of Piping Fittings	Press. Class of Valve
01.	Main Steam / Upstream of HP bypass and auxiliary steam pressure reducing valve	A	ASTM-A335 Gr. P-91/22 (Note-2)	XXS (½ inch)	ASTM-A182 Gr. F-22	ASTM-A182 Gr. F-6a	9000 lb	3000 SPL
02.	BFP Discharge / Superheater attemperator / spray to PRDS	B	ASTM-A106 Gr. C	160 (½ inch)	ASTM-A105	ASTM-A-182 Gr. F6a	6000 lb	2500
03.	Reheater Attemperator	C	ASTM-A106 Gr. C	160 (½ inch)	ASTM-A105	ASTM-A-182 Gr. F6a	6000 lb	1500
04.	Hot Reheat / Down Stream of Aux. Steam Pressure Reducing Valve upto Desuper-heater / Flash Tank Drain Manifold	D	ASTM-A335 Gr. P-91/22 (Note-2)	160 (½ inch)	ASTM-A182 Gr.F-22	ASTM-A182 Gr.F-6a	3000 lb	900
05.	Cold Reheat upto Tee-off for HP Bypass / Extraction Steam No. 5 to HPH	E	ASTM-A335 Gr. P-22	80 (½ inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr. F6a	3000 lb	800
06.	Cold Reheat Down-steam of Tee-off (HP Bypass)	F	ASTM-A106 Gr. C	80 (½ inch)	ASTM-A105	ASTM-A-182 Gr. F6a	3000 lb	800
07.	BFP Suction / Condensate System / Extraction to LPH / Extraction-4 to BFP-T, Deaerator / Auxiliary Steam	G	ASTM-A106 Gr. B	80 (½ inch)	ASTM-A105	ASTM-A-182 Gr. F6a	3000 lb	800
08.	Air / Flue Gas Outside Furnace	M	ASTM-A106 Gr. B/C	80 (¾ inch)	ASTM-A105	ASTM-A-182 Gr. F6a	3000 lb	800
09.	Air / Flue Gas Inside Furnace	N	ASTM-A335 Gr. P-22	80 (¾ inch)	ASTM-A182 Gr. F-22	ASTM-A-182 Gr. F6a	3000 lb	800
10.	Purge Air	—	ASTM-A106 Gr. C	80 (¾ inch)	ASTM-A 105	SS or better	3000 lb	800

					Gr. F-22			
11.	DM Cooling Water	–	ASTM A312 TP 316	40 (1/2 inch)	ASTM A182 F316	SS or better	3000 lb	800
12.	CW & ACW	–	ASTM-A106 Gr. C	80 (1/2 inch)	ASTM-A 105	SS or better	3000 lb	800
Note : (1) Rating of piping / fittings / valves etc. is subjected to the design pressure & temperature during the detailed engineering. (2) In case temperature is more than 540 deg. C, the material shall be P-91 only.								

12.02.02 Seamless Stainless Steel Pipe

01. Reference : ASTM A-312 TP 316
02. Material Grade : TP 316
03. Type : Seamless /Plain end
04. Size : 1/2" NB
05. Schedule : 40
06. Standard Length : 5 meter

12.02.03 Stainless Steel Pipe Fittings

01. Reference : ASTM A-182 F 316 / ANSI B16.11
02. Type : Forged
03. Rating : 3000 lbs / 6000 lbs / 9000 lbs
04. Size : 1/2" NB
05. End connection : Generally socket weld
06. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

12.02.04 Seamless Stainless Steel Tube

01. Reference : ASTM A-213 TP 316
02. Material Grade : TP 316
03. Size : 1/2" OD X 2.1 MM Thick
04. Type : Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
05. 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.

- 06. Test Pressure : 400 Kg/Sq. cm (minimum)
- 07. Tolerance : ± 0.13 mm for outside diameter
 ± 15 % for wall thickness
- 08. Standard Length : 5 meter
- 09. Test : Flare, Hardness, Ball and Bubble Test

12.02.05 Stainless Steel Tube Fittings

- 01. Reference : ASTM-A-182
- 02. Type : Double ferrule double compression
- 03. Material : 316 Stainless steel forged
- 04. Ferrule : 316 Stainless Steel
- 05. Type of Fittings : Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
- 06. Size : To suit SS tubing and NPT end connection

12.02.06 C.S. Pipe

- 01. Reference : ASTM-A 106 Gr. C
- 02. Material : Cold drawn seamless black C.S.
- 03. Type : Seamless / Plain ends
- 04. Size : $\frac{1}{2}$ " NB
- 05. Schedule : 80, 160, XXS as required
- 06. Standard Length : 5 meter

12.02.07 C.S. Pipe Fittings

- 01. Reference : ASTM-A 105 / ANSI B16.11
- 02. Type : Forged
- 03. Rating : 3000 lbs / 6000 lbs / 9000 lbs
- 04. Size : $\frac{1}{2}$ " NB
- 05. End connection : Generally socket weld
- 06. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

12.02.08 A.S. Pipe

- 01. Reference : ASTM-A 335 P22 AS PER ANSI B 36.10
- 02. Material : Cold drawn seamless A.S.
- 03. Type : Seamless / Plain ends
- 04. Size : ½" NB
- 05. Schedule : XXS
- 06. Standard Length : 5 meter

12.02.09 A.S. Pipe Fittings

- 01. Reference : ASTM-A 182 F22 AS PER ANSI B 16.11
- 02. Type : Forged
- 03. Rating : 9000 lbs
- 04. Size : ½" NB
- 05. End connection : Generally socket weld
- 06. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

12.02.10 Carbon Steel Globe Valve

- 01. Reference : ASTM A-105
- 02. Type : Globe
- 03. Construction : Forged Body Cadmium Plated
- 04. End Connection : ½" Socket Weld
- 05. Rating : Cl. 800 / CL. 2500
- 06. Material : Body - Carbon steel
Stem - Hardened Steel
Plug - AISI 316 SS
Seat- Stainless steel stellited
- 07. Packing : Teflon / Grafoil as required
- 08. Yoke : ASTM A105
- 09. Handwheel : Carbon steel

10. Design standard : As per ANSI B 16.34
- 12.02.11 Stainless Steel Globe Valve
01. Reference : ASTM A-182 F316
02. Type : Globe
03. Construction : Forged Body
04. End Connection : Socket Weld
05. Proof Pressure : 400 Kg/Cm2
06. Material : Body - Stainless steel
Stem - Hardened Steel
Plug - AISI 316 SS
Seat- Stainless steel stellited
07. Packing : Teflon as required
08. Yoke : ASTM A182 F316
09. Handwheel : Carbon steel
10. Design standard : As per ANSI B 16.34
- 12.02.12 Alloy Steel Globe Valve
01. Reference : ASTM A-182 F22
02. Type : Globe
03. Construction : Forged Body
04. End Connection : ½" Socket Weld
05. Rating : CL. 2500
06. Material : Body - Alloy steel
Stem - Hardened Steel
Plug - AISI 316 SS
Seat- Stainless steel stellited
07. Packing : Grafoil as required
08. Yoke : ASTM A182 F22
09. Handwheel : Carbon steel

10. Design standard : As per ANSI B 16.34

12.02.13 Condensate Pot

- 01. Reference : ASTM A182 F22 /ASTM A105
- 02. Material : Alloy steel / carbon steel as per application
- 03. Construction : Drilled from barstock
- 04. End connection : 3 nos. 1/2" socket weld end
- 05. Accessories : Vent valves

12.02.14 Instrument Valve Manifold

- 01. Type :
 - a) Two valve manifold
 - b) Five valve manifold
- 02. Mounting : Remote 2" Pipe Mounting
- 03. Construction : Single block (bar stock)
- 04. Material : Forged body and bonnet AISI 316 stainless steel
- 05. Ports : 1/2 " NPT (F)
- 06. Rating : 420 Kg/Sq. cm at ambient
- 07. Operating Temperature : (-) 30 to (+) 170 Deg C
- 08. Packing : PTFE Wafer
- 09. 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 :
 - i) Plugs for all ports
 - ii) Mounting Bracket , bolts , nuts

12.03.00 Pneumatic Hook Up Accessories

12.03.01 Air Header

Technical Particulars :

For Panel

For Field

01.	Material of Construction	:	Stainless steel	Stainless steel
02.	Inlet Connection	:	2" NPT (M)	1" NPT (M)
03.	Header Take-off	:	Stainless steel	Stainless steel
04.	Take off connection	:	1 / 2" NPT (M)	1/ 2" NPT (M)
05.	Take-off Valves	:	stainless steel	stainless steel
06.	Tube Take-off :		Tube adapter on valve	Tube adapter on valve
07.	Drain	:	SS drain valve at lowest point	SS drain valves at lowest point

12.03.02 Seamless Stainless Steel Tube

01.	Reference	:	ASTM A-269 TP 31605
02.	Material Grade	:	TP 316
03.	Size	:	¼" OD X 0.049" wall thickness
04.	Type	:	Cold drawn annealed, pickled, passivated, de-scaled, ,hydraulically cleaned seamless tube.
05.	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.
06.	Test Pressure	:	400 Kg/Sq. cm
07.	Tolerance	:	± 0.13 mm for outside diameter ± 15 % for wall thickness
08.	Standard Length	:	5 meter
09.	Test	:	Flare, Hardness, Ball and Bubble Test

13.00.00 TYPE TEST REQUIREMENTS

13.01.00 General Requirements

13.01.01 Contractor shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. A list of such tests are given for various equipment in table titled 'Type Test Requirement for C&I Systems' at the end of this sub-section. For the balance equipment instrument, type tests may be conducted as per

manufacturers standard or if required by relevant standard.

- 13.01.02 Out of the tests listed, Bidder/ sub-vendor/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Owner or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests.
- 13.01.03 For the rest, submission of type test results and certificate shall be acceptable provided:
- a) The same has been carried out by Bidder/ sub-vendor on exactly the same model / rating of equipment.
 - b) There has been no change in the components from the offered equipment & tested equipment.
 - c) The test has been carried out as per the latest standards along with amendments as on the date of bid opening.
- 13.01.04 In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by Bidder within the quoted price and no extra cost will be payable by Owner on this account
- 13.01.05 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by Bidder or his authorized representative and the balance have to be approved by Owner.
- 13.01.06 The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.
- 13.01.07 For the type tests to be conducted, Contractor shall submit detailed test procedure for approval by Owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.
- 13.01.08 Bidder shall indicate in his bid, the cost of the type test for each items only for which type tests are to be conducted specifically for this project.
- 13.02.00 Special Requirement For Solid State Equipments/ Systems
- The minimum type tests reports, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like SG-C&I system, TG- C&I system, Station - C&I system, Flame monitoring system, Coal feeders control and instrumentation system, Boiler flame analysis system, Turbine supervisory system, BFP Turbine supervisory instruments, Analyzer instruments, Vibration monitoring systems, etc. shall be as indicated below:
- 13.02.01 Surge Protections for Solid State Equipments/ Systems
- All solid state systems/ equipments shall be able to withstand the electrical noise and surges as encountered in actual service conditions and inherent in a power plant. All the solid state systems/ equipments shall be provided with

all required protections that needs the surge withstand capability as defined in ANSI 37.90a/ IEEE-472. Hence, all front end cards which receive external signals like analog input & output modules, binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meets the surge withstand capability as defined in ANSI 37.90a/ IEEE-472. Complete details of the features incorporated in electronics systems to meet this requirement, the relevant tests carried out, the test certificates etc. shall be submitted along with the proposal. As an alternative to above, suitable class of IEC-255-4 which is equivalent to ANSI 37.90a/ IEEE-472 may also be adopted for SWC test.

13.02.02 Dry heat test as per IEC-68-2-2.

13.02.03 Damp heat test as per IEC-68-3.

13.02.04 Vibration test as per IEC-68-2-6.

13.02.05 Electrostatic discharge tests as per IEC 801-2 or equivalent.

13.02.06 Radio frequency immunity test as per IEC 801-6 or equivalent.

13.02.07 Electromagnetic immunity as per IEC 801-3 or equivalent.

Test listed at clause no. 13.02.05, 13.02.06 & 13.02.07 above are applicable for front end cards only as defined under clause no. 13.02.01 above.

14.00.00 SPECIAL TOOLS & TACKLE AND TEST EQUIPMENT FOR DCS AND OTHER SYSTEMS

14.00.01 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.

14.00.02 The tools & tackle and Test Equipment shall be shipped in separate container, clearly marked with names of the equipment for which they are intended.

14.00.03 Bidder shall furnish list of tools & tackle and test equipment proposed to be supplied along with the bid, if applicable. Minimum two (2) nos antistatic wrist band in each control panels are mandatory and shall be included in the bid.