Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V

(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

CONSTRUCTIONAL DETAILS OF CABLES SELECTED

(A) LT POWER & CONTROL CABLES

S.NO.	PARTICULARS	DETAILS	
		LT POWER CABLES	LT CONTROL CABLES
1	**REFERENCE STANDARD**	IS: 7098 -PART -1	IS -1554 PART -1
2	**SYSTEM**	415 V AC , 240 V AC & 220V DC	220V DC & 110 V AC
3	**VOLTAGE GRADE**	1.1 KV	1.1 KV
4	**CONDUCTOR**		
4.1	MATERIAL	STRANDED COMPACTED PLAIN ALUMINIUM CONDUCTOR OF H2 GRADE CLASS 2 / STRANDED HIGH CONDUCTIVITY ANNEALED PLAIN COPPER.	STRANDED,NON COMPACTED, HIGH CONDUCTIVITY ANNEALED PLAIN COPPER
4.2	REFERENCE STANDARD	IS 8130	IS 8130
4.3	SHAPE	CIRCULAR/ SHAPED	CIRCULAR
4.4	MINIMUM SIZE	ALUMUNIUM- 16 SQ.MM. COPPER- 2.5 SQ. MM.	2.5 SQ.MM.
4.5	MAXIMUM CONDUCTOR TEMPERATURE WHEN CARRYING CONTINUOSLY CURRENT	90°C	70°C
4.6	MAXIMUM CONDUCTOR TEMPERATURE AT THE TERMINATION OF SHORT CIRCUIT CURRENT	250°C	160°C
5	**NO. OF CORES**	1C,2C,3C,3.5C,4C	AS PER CLAUSE 4.2.1
6	**INSULATION**	EXTRUDED XLPE	EXTRUDED HRPVC, TYPE-C
6.1	REFERENCE STANDARD	IS: 7098 -PART -1	IS -5831 & IS-1554 PART-I
7	**CORE IDENTIFICATION**	BY COLOR CODING AS PER IS: 7098 - PART -1	i) CONTROL CABLES UPTO 5 CORE- COLOR CODING AS PER IS 1554 (Part-1) (ii) CONTROL CABLES ABOVE 5 CORES- BY NUMBERING AS PER IS 1554 (Part-1). INSULATION TO HAVE BLACK COLOR.
8	**INNER SHEATH**	EXTRUDED HRPVC FRLS TYPE -ST2 FOR MULTI CORE CABLES. SINGLE CORE SHALL HAVE NO INNER SHEATH.	EXTRUDED HRPVC TYPE -ST2 FRLS FOR MULTI CORE CABLES. SINGLE CORE SHALL HAVE NO INNER SHEATH.
8.1	REFERENCE STANDARD	IS: 5831 & IS-7098 PART-I	IS: 5831 & IS-1554 PART I
9	**ARMOUR**	NON-MAGNETIC HARD DRAWN ALUMINIUM ROUND WIRE ARMOUR OF H4 GRADE FOR SINGLE CORE CABLES AND GS ROUND STEEL WIRE ARMOUR FOR MUTI- CORE CABLES	GS ROUND STEEL WIRE ARMOUR FOR TWIN & MULTICORE CABLES
9.1	REFERENCE STANDARD	IS:3975 & IS 7098 PART I	IS 3975 & IS-1554 PART I
10	**OUTER SHEATH**	EXTRUDED FRLSH HRPVC TYPE ST2	EXTRUDED FRLSH HRPVC TYPE ST2
10.1	REFERENCE STANDARD	IS: 5831 & IS-7098 PART-I	IS: 5831
11	**MARKING**	(i) CABLE SIZE (CROSS SECTION AREA AND NO. OF CORES, VOLTAGE GRADE, WORD 'FRLS', REF. IS, TYPE OF CABLE, TYPE OF INSULATION/ SHEATH, MANUFACTURER'S NAME AND/OR TRADE NAME, YEAR OF MANUFACTURE-AT EVERY 5M (BY EMBOSSING), 'BHEL-PEM' and 'CUSTOMER' Name @5m (by embossing), (ii) PROGRESSIVE SEQUENTIAL MARKING OF LENGTH OF CABLE IN METERS- AT EVERY 1M (BY EMBOSSING/PRINTING)	
12	**CABLE DRUMS**		
12.1	TYPE OF DRUM	WOODEN (HEAVY CONSTRUCTION) AS PER IS 10418	
12.2	STANDARD DRUM LENGTH	500M FOR LARGER SIZES / 1000M FOR SMALLER SIZES (±) 5% (AS SPECIFIED IN BOQ)	
12.3	PAINTING	ENTIRE SURFACE TO BE PAINTED. ALL FERROUS PARTS USED SHALL BE TREATED WITH SUITABLE RUST PREVENTIVE FINISH OR COATING TO AVOID RUSTING DURING TRANSIT OR STORAGE. WOODEN CABLE DRUMS SHALL BE TREATED BY IMMERSING IN COPPER-NITRATE SOLUTION. DRUM NUMBER SHALL BE INDICATED ON EACH DRUM.	
12.4	OUTERMOST LAYER	TO BE COVERED WITH WATERPROOF POLYETHYLENE	
12.5	CONSTRUCTION	ALL WOODEN PARTS FROM SEASONED WOOD AND FERROUS PARTS SHALL BE TREATED WITH SUITABLE RUST PREVENTIVE FINISH OR COATING. WOODEN DRUM SHALL BE TREATED BY IMMERSING IN COPPER NITRATE SOLUTION.	

12.6	PARTICULAR INFORMATION ON DRUM	BOTH THE END OF CABLES SHALL BE PROPERLY SEALED WITH HEAT SHRINKABLE SEAL. THE CABLE DRUMS SHALL CARRY THE FOLLOWING DETAILS IN PRINTED FORM: A) MSPGCL B) MANUFACTURER'S NAME OR TRADE MAKE C) TYPE OF CABLE & VOLTAGE GRADE D) YEAR OF MANUFACTURE E) TYPE OF INSULATION E.G. XLPE/HRPVC/IE2 F) NO. OF CORE AND SIZES OF CABLES G) CABLE CODE E.G. FRLS/FS H) SINGLE LENGTH OF CABLE ON DRUM I) DIRECTION OF ROTATION, BY ARROW J) APPROX GROSS MASS

(B) SCREENED CONTROL CABLES

S.NO.	PARTICULARS	DETAILS
1	**VOLTAGE GRADE**	1100V
2	**TYPE OF CABLES**	TYPE F (INDIVIDUAL & OVERALL SCREENED) & TYPE G (OVERALL SCREENED)
3	**CODES AND STANDARD**	IS-1554 PART-1, IS-5831, IS-8130, IS-694, SEN-4241475, IEC-60332 (I).
3(i)	**CONDUCTOR**	
(a)	CROSS SECTION AREA	0.5 sq.mm
(b)	CONDUCTOR MATERIAL	STRANDED, TINNED ANNEALED HIGH CONDUCTIVITY COPPER
(c)	CONDUCTOR GRADE	ELECTROLYTIC
(d)	NO. & DIA OF STRANDS	7 X 0.3 mm
(e)	NO. OF PAIRS	0.5 sq.mm. - 2P, 4P, 8P,12P, 24P
(f)	REFERENCE STANDARD	IS-8130
(ii)	**INSULATION**	
(a)	MATERIAL	EXTRUDED HR PVC TYPE-C AS PER IS-5831
(b)	THICKNESS IN mm	0.6 (NOMINAL) AS PER IS-694
(c)	VOLUME RESISTIVITY (MIN) IN ohm-cm	i. 1 x 10^13 Ohm-cm at 27 deg.C / room temp. (Min). ii. 1 x 10^10 Ohm-cm at 85 deg.C (Min.)
(d)	VOLTAGE RATING	1100V
(e)	REFERENCE STANDARD	IS-1554 PART-1 & IS-5831
(f)	OD OF COND. INCLUDING INSULATION	AS PER MANUFACTURER'S CALCULATIONS / STD. PRACTICE
(iii)	**PAIRING & TWISTING**	
(a)	MAX. LAY OF PAIRS (mm)	60
(b)	CONDUCTOR /PAIR IDENTIFICATION	AS PER ATTACHED **ANNEXURE D**
4	**SHIELDING**	
(a)	TYPE OF SHIELDING	AL-MYLAR TAPE
(b)	INDIVIDUAL PAIR SHIELDING	TO BE PROVIDED FOR TYPE-F CABLE ONLY
(c)	OVERALL SHIELDING	TO BE PROVIDED FOR BOTH TYPE-F & TYPE-G CABLES
(d)	MINIMUM THICKNESS OF INDIVIDUAL PAIR SHIELDING	28 MICRONS
(e)	MINIMUM THICKNESS OF OVERALL CABLE ASSEMBLY SHIELDING	60 MICRONS
(f)	SHIELDING COVERAGE	100% WITH AT LEAST 25% OVERLAP
5	**DRAIN WIRE (To be provided separately for individual pair shield and overall shield.)**	
	Material	Multi stranded Annealed tinned copper drain wire.
	Size (No. of strands/ Dia. of each strand)	0.5 sq. mm. (7/0.3 mm.)
6	**FILLERS (if applicable)**	
(a)	TYPE	NON -HYGROSCOPIC WITH FRLS PROPERTY (AS REQUIRED FOR MAINTAINING CABLE CIRCULARITY)
7	**INNER SHEATH**	
(a)	MATERIAL	EXTRUDED HR PVC TYPE ST-2 AS PER IS-5831
(b)	THICKNESS	AS PER IS-1554 PART-1
(c)	Whether FR-LSH Applicable	YES
(d)	COLOUR	**BLACK**
(e)	REFERENCE STANDARD	IS-1554 PART-1 & IS-5831
8	**RIP CORD**	NON-METALLIC RIP CORD UNDER THE INNER SHEATH
9	**ARMOUR**	GALVANISED STEEL ROUND WIRE / STRIP AS PER IS-3975 & IS-1554 PART-1

10	**OUTER SHEATH**		
(a)	MATERIAL	EXTRUDED HR PVC TYPE ST-2 AS PER IS-5831	
(b)	THICKNESS	AS PER IS-1554 PART-1	
(c)	Whether FR-LSH Applicable	YES	
(d)	COLOUR	**GREY**	
(e)	REFERENCE STANDARD	IS-1554 PART-1 & IS-5831	
(f)	MARKING	(i) CABLE SIZE (CROSS SECTION AREA AND NO. OF CORES, VOLTAGE GRADE, WORD 'FRLS', REF. IS, TYPE OF CABLE, TYPE OF INSULATION/ SHEATH, MANUFACTURER'S NAME AND/OR TRADE NAME, YEAR OF MANUFACTURE-AT EVERY 5M (BY EMBOSSING), 'BHEL-PEM' and 'CUSTOMER' Name @5m (by embossing), (ii) PROGRESSIVE SEQUENTIAL MARKING OF LENGTH OF CABLE IN METERS- AT EVERY 1M (BY EMBOSSING/PRINTING)	
11	**TECHNICAL PARAMETERS (C & I) AT 20 DEG C**	0.5 sqmm (IS & OS) Type F	0.5 sqmm (OS) Type G
(a)	MUTUAL CAPACITANCE (MAX.) AT 0.8 KHz, nF / Km	120	100
(b)	CONDUCTOR LOOP RESISTANCE (MAX.), Ohm / Km	78	78
(c)	INSULATION RESISTANCE (MIN.), M Ohm / Km	100	100
(d)	CROSS TALK ATTENUATION (MIN.) AT 0.8KHz, dB / Km	60	60
(e)	CHARACTERISTIC IMPEDANCE (MAX.) AT 1KHz, Ohm	320	340
(f)	ATTENUATION (MAX.) AT 1KHz, dB / Km	1.2	1.2
12	**FR-LSH CHARACTERISTICS**		
(b)	SMOKE DENSITY RATING	Max. 60% (As per ASTM D 2843): Area under coverage.	
(c)	ACID GAS EMMISION	Max. 20% by weight (As per IEC-60754-1)	
(d)	OXYGEN INDEX	Min 29 at room temperature (As per ASTMD 2863)	
(e)	TEMPERATURE INDEX	Min. 250 deg.C at oxygen index value of 21 (As per ASTMD 2863)	
13	**FLAMMABILITY TEST**	(1) AS PER IEC-332-1 (2) Swedish Chimney test SEN-SS-424-1475-F3	
14	**TEST VOLTAGE & DURATION (High Voltage Test)**		
(a)	Core to core	1.5 kV for 1 minute	
(b)	Core to shield	1 kV for 1 minute	
15	**CABLE DRUM DETAILS**		
(a)	Material Type	Wooden, as per IS 10418	
(b)	Standard drum length	1000 metres: upto and including 12 Pairs. 500 metres: above 12 pairs.	
(c)	Tolerance on drum length	±5%	
(d)	Painting	ENTIRE SURFACE TO BE PAINTED. ALL FERROUS PARTS USED SHALL BE TREATED WITH SUITABLE RUST PREVENTIVE FINISH OR COATING TO AVOID RUSTING DURING TRANSIT OR STORAGE. WOODEN CABLE DRUMS SHALL BE TREATED BY IMMERSING IN COPPER-NITRATE SOLUTION. DRUM NUMBER SHALL BE INDICATED ON EACH DRUM.	
(e)	Outermost layer	TO BE COVERED WITH WATERPROOF POLYETHYLENE	
(f)	Construction	ALL WOODEN PARTS FROM SEASONED WOOD AND FERROUS PARTS SHALL BE TREATED WITH SUITABLE RUST PREVENTIVE FINISH OR COATING. WOODEN DRUM SHALL BE TREATED BY IMMERSING IN COPPER NITRATE SOLUTION.	

CONDUIT AND PIPE

GENERAL TECHNICAL REQUIREMENTS
OF
CONDUITS AND PIPES
SPECIFICATION NO. PES-507-27
REV 0

1.0 GENERAL

1.1 This specification covers the manufacture, inspection & testing at vendor's works and delivery to site of conduits, pipes and their fittings for electrical installation.

2.0 CODES AND STANDARDS

2.1 The material, constructional features and various processes involved in manufacture shall comply with currently applicable Indian Standards.

2.2 The following Indian Standards shall be applicable, in general. However if Data Sheet A specifies conformance to other international standards, the equivalent IEC/BS/other standards shall be considered.

a) IS:9537 (All Parts) Conduits for electrical installation.

b) IS:3480 Flexible steel conduits for electrical wiring.

c) IS:6946 Flexible non-metallic conduits for electrical installation.

d) IS:1239 Mild steel tubes, tubulars and other wrought steel fittings. (for size above 63mm dia of rigid conduits)

e) IS:2667 Fittings for rigid steel conduits for electrical wiring.

f) IS:3837 Accessories for rigid steel conduits for electrical wiring.

g) IS:3419 Fittings for rigid non-metallic conduits.

h) IS:6005 Code of practice for phostating iron & steel.

i) IS:2629 Recommended practice for hot dip galvanizing on iron and steel.

j) IS:4759 Specification for hot dip zinc coatings on structural steel and allied products.

k) IS:6745 Methods for determination of mass of zinc coating on zinc coated iron and steel articles.

3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

The conduit and conduit accessories shall include conduit plugs & caps, gaskets and box cover etc in addition to any specific requirement given in Data Sheet A. The diameter of conduits and accessories shall be uniform throughout the length.

3.1 Rigid Conduits and Fittings

3.1.1 Rigid conduits shall generally conform to the requirements of IS:9537 (Part I & Part II). However conduits above 63mm diameter shall conform to the requirements of IS:1239. Unless specified otherwise in Data Sheet A, all conduits and pipes shall be of medium duty.

3.1.2 The rigid conduits shall be hot dip galvanized inside and outside. Weight of zinc shall be as per IS:4759. Conduits shall be thoroughly cleaned and pretreated, conforming to IS:6005.

3.1.3 Conduits shall be supplied in approximate length as specified below

a) Rigid Conduits 5 metres

b) Flexible Conduits 10 - 30 metres

3.1.4 Each end of conduit length shall be threaded. The ends of conduits shall be sealed with protective caps to prevent damage to threaded portions and entrance of moisture and foreign material.

3.1.5 The inside surface of all conduits shall be smooth and suitable for pulling insulated cables and wires without damage.

3.1.6 Conduit fittings shall be made out of tube or cast to the shape as to match with corresponding conduit sizes and meet their purpose without any special adjustment.

3.1.7 All fittings shall be screwed type and hot dip galvanized inside and outside.

3.2 Flexible Metallic Conduits and Fittings

3.2.1 Flexible metallic conduits shall generally conform to the requirements of IS:3480.

3.2.2 Flexible conduits shall be made of strip steel which shall be of cold rolled mild steel. The strip shall be of uniform width and thickness throughout.

3.2.3 The strip shall be electro galvanized to a minimum thickness of 25 microns as specified in IS:3480. The surface of the strip shall be thoroughly cleaned before application of protective coating. Pretreatment, before galvanization, shall conform to IS:6005.

3.2.4 The strip for making flexible conduit shall be wound tightly and so overlapped in subsequent helicals that no openings are seen in normal position.

3.2.5 Flexible conduits shall be lead coated for application in high temperature zones, if specifically mentioned in Data Sheet A.

3.2.6 The conduit shall have uniform diameter throughout its length. The internal surface of all conduits shall be smooth and suitable for pulling insulated cables and wires without damage.

3.3 PVC Conduits

3.3.1 PVC conduits shall generally conform to the requirements of IS:9537(Part I & Part III).

4.0 INSPECTION

4.1 The following stages of manufacture shall be stage inspected by Purchaser or his duly authorized representative.

4.1.1 Inspection of manufacturing processes such as shearing, punching, bending, welding, galvanizing etc.

4.1.2 Inspection of packing material and procedure.

4.1.3 Inspection of finished product.

4.2 The inspection will be carried out as per agreed quality plan.

5.0 TESTING

5.1 Rigid Conduits

a) Acceptance Tests - as per IS:9537 Part 1 & 2 upto 63mm OD
- as per IS:1239 above 63mm OD

i) Dimension checks

ii) Bending test (below 32mm OD)

iii) Compression test

b) Special Tests (as acceptance test) as applicable to galvanizing.

5.2 Flexible Steel Conduits

a) Acceptance Tests - as per IS:3480

i) Dimension checks

ii) Linear breaking test

iii) Test for flexibility

iv) Bend fracture test

v) crushing test

b) Special Tests (as acceptance test) as applicable to galvanizing.

5.3 PVC Conduits

a) Type Tests - as per IS : 9537 (Part 1 & 3)

i) Dimension checks

ii) Bending test

iii) Compression test

iv) Impact test

v) Collapse test

vi) Resistance test

vii) Resistance to burning

viii) Electrical Characteristics

b) Acceptance tests - as per IS:9537 (Part 1 & 3)

i) Dimension checks

ii) Bending test

iii) Compression test

iv) Collapse test

v) Resistance to burning

vi) Electrical characteristics

5.4 Sampling for the tests shall be done as per applicable standards mentioned above.

5.5 The testing shall be carried out as per agreed quality plan.

6.0 PACKING

6.1 The material shall be packed as per manufacturer's standard. Packing procedure shall be to the purchaser's approval.

7.0 DRAWING, DATA AND DOCUMENTS REQUIRED

7.1 The following information shall be furnished within two weeks of award of contract, for purchaser's approval.

a) Manufacturing drawings/details.

b) Recommended Field quality plan covering site handling, storing, laying etc.

c) Final quality plan.

7.3 The following information shall be furnished after testing and inspection

Type Test, routine test and special test certificates in bound volume in requisite number.

DATASHEET A

SPECIFIC TECHNICAL REQUIREMENTS

1.0	APPLICABLE STANDARDS:	IS:9537,IS: 1239, IS:3480
2.0	RIGID STEEL CONDUITS & STEEL PIPES	
a)	Material:	Cold rolled mild steel to IS:226
b)	Applicable standard	
	i) Upto 63mm OD:	IS:9537 Part I & II
	ii) Above 63mm OD:	IS:1239
c)	Surface treatment:	Hot dip galvanizing inside & outside as per IS:2629
d)	Wt. of zinc:	as per IS 4759
e)	Duty:	Medium
f)	Fittings:	Screw type as per IS:2667
3.0	FLEXIBLE CONDUITS:	
a)	Material:	Strip steel cold rolled and annealed
b)	Standard applicable:	IS: 3480
c)	Surface treatment:	Electro galvanized as per IS: 3480
d)	Whether lead coated:	YES
e)	Minimum thickness: of zinc coating	25 microns
4.0	PVC CONDUITS	
a)	Material:	PVC
b)	Applicable standard:	IS: 9537 (Part I & III)

SECTION-D3

(GENERAL TECHNICAL REQUIREMENT FOR C&I)

GENERAL REQUIREMENT

1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

2.0. The quantity of instruments for auxiliary system shall be as per tender P &ID, wherever provided, for the respective system as a minimum for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe &reliable operation of plant, bidder shall supply the same without any price implication.

3.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.

4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors, switches etc for external connection including spare contacts shall be wired out to suitably located junction boxes.

5.0 In case of any contradiction most stringent clause/condition shall prevail.

OPERATIONA AND CONTROL PHILOSOPHY

from Ion exchanger units to the resin transfer vessel and vice versa. However, connection of respective Ion exchanger unit with the main resin transfer line shall be achieved through reinforced flexible piping fitted with quick fixing (bayonet type) coupling. All Ion exchange units shall be provided with necessary permanent valve arrangement for the removal of charging of Ion exchange resins to/from the resin transfer vessel with necessary arrangement for fixing the flexible resin transfer piping.

The resin from the various ion exchange units shall be transferred to the resin transfer vessel hydro pneumatically to minimize loss of water. The suggested mode of transfer of resin is shown in flow diagram. However, the bidder may propose any alternative mode for the same, if felt more appropriate by him. Resins after treatment shall also be taken back to the respective ion exchange units, from the resin transfer vessel hydro-pneumatically. The bidder may offer any alternative method considered more suitable by him.

All resin transfer piping shall be mild steel rubber lined construction. Proper velocity in the pipeline shall be adopted such that an attrition loss of the resins and blockage in the pipeline does not occur.

3.14 PIPING

3.14.1 For Material of Construction of pipes under various services, Bidder may please refer to Volume III - F.

3.14.2 For Pipelines carrying water, chemicals, air etc. & its velocities, Bidder may please refer Volume III - F.

3.15 VALVES

For valve design and testing standard, Bidder may please refer Volume III - F.

4.0 OPERATION AND CONTROL PHILOSOPHY

DCS BASED

4.1 The control concept of DM plant shall be so designed that the Plant can be controlled and monitored from TFT monitor based Operator's Station located in Control Room inside Demineralization Plant Building.

4.2 ~~The basic mode of operation of Demineralization Plant is envisaged to be automatic in nature through a Programmable Logic Controller and TFT Monitors.~~

~~4.3~~ ~~There shall be two (2) Operator's Station and one (1) Engineering Station to be located in the DM Plant Control room. Engineering station shall perform engineering activities e.g. program generation, control loop tuning, Program modification debugging etc. Operator's/Engineer's Stations shall be complete with 24" color TFT monitor, keyboard, mouse etc. Two (2) A3 size color laser printers are envisaged for printing of various logs, reports, graphics etc.~~

4.4 Filters/Ion exchange units shall be automatically isolated from the system under the conditions as follows:

(a)	Activated Carbon Filter	:	On output of predetermined volume of treated water or high differential pressure across the filter bed, whichever occurs first.
(b)	Cation Unit	:	On output of predetermined volume of treated water or high sodium leakage, or conductivity comparison ratio exceeding above pre-set limit, whichever occurs first.
(c)	Anion Unit	:	On output of predetermined volume of treated water or high conductivity or high silica, whichever occurs first.
(d)	Mixed Bed Unit	:	On output of predetermined volume of treated water or high conductivity or high silica, whichever occurs first.

4.5 On exhaustion, the particular filter/exchanger shall be completely isolated from the system automatically and an alarm status be displayed on the Operator's station. 'Differential Pressure high' switch shall be provided across Resin traps.

4.6 The operator shall initiate the operation of backwashing/regeneration/ rinsing/of a particular filter/ion-exchange unit and the change from one step of the sequence to the next shall be automatic. The system shall employ a logical system, which shall link the various steps such as closing /opening of different valves, starting/stopping of various pumps, which make a sequence. The logical system shall adhere to the correct sequence of operation and the pre-determined (adjustable) time-intervals. The system shall be interlocked so that the necessary pre-requisite for each step, are completed prior to proceeding to the next step. The automatic sequence of operations shall be interruptible at any time by the operator and operator shall be able to take over the control to manual from that step onwards.

4.7 During regeneration, the progress of different sequence/sub-process shall be displayed to the operator in the form of step description, which is in progress, the set time for that step, the elapsed time for that step etc. Failure in any operation shall also be indicated.

4.8 It shall be possible for the operator to extend the time of a particular step. The timer shall restart once the operator puts back the system in auto and the other steps shall then follow as programmed. The progress of the sequence shall be displayed to the operator. The system shall incorporate the necessary safety systems, locking systems and manual emergency system. On failure of logic system in between, the failure shall be displayed to the operator and the valves corresponding to that unit, being regenerated shall automatically open or close as required.

4.9 Once a filter/exchanger has been backwashed/regenerated, it shall not be put back into service automatically, but operator shall have to manually put back into service through a Selection Key.

4.10 Apart from complete automatic regeneration which includes fixed time rinsing facility, separate rinsing facility shall also be provided for each of the exchanger units to carry out rinsing remote manually, which shall be required in cases:

(a) When a regenerated unit had been off the service for quite some time.

(b) When additional rinsing during the regeneration operation apart from the fixed programmed rinsing of automatic regeneration process is required to be carried out.

4.11 During automatic progress of the sequence, the opening and closing of different valves shall also be indicated to the operator. The pumps which shall be under operation in course of regeneration, need to be interlocked with reference to the required parameters for safe regeneration. To provide additional manual over-ride facility for individual type of filter or exchanger, each of them shall be provided with "Auto-Off-Manual" Key. Automatic sequential operations shall be carried out with individual A/M Key in Auto position only.

4.12 However, A/M keys in "Manual" position shall permit over riding facility for respective unit through "Service-Off-Regeneration-Off-Extra Rinse-Off" key provided for each filter/ion-exchanger unit and another Multi Position Manual Regeneration Key common for particular type of filter/exchanger. For cation and anion exchangers, a separate key shall be provided for backwash, which is an optional step in a regeneration sequence. A "Double Regeneration Key" shall also be provided for these exchangers. Indication on Operator's station display shall be there for each step of "Service-Off-Regeneration-Off-Extra Rinse-Off" Selection Key.

4.13 All the above operations shall be performed through programmable logic controller. All the above functions shall be carried out from operator's console via keyboard/mouse based operation.

4.14 The options in Operator Station display unit as described hereinafter are required to be provided:

(a) Auto-Manual Selection Keys for each filter/exchanger.

(b) Auto-Manual Selection Keys for all drives.

(c) Tank selection, drive selection, valve selection etc as required.

(d) Regeneration Advance, Hold, Hold Reset, Stop, Skip etc.

4.15 The complete process shall be represented in various graphic pages to be displayed in the work stations. These graphic pages shall indicate various equipments/components of the plant and their status/parameters like different filters, exchanger units, measuring tanks, opening/closing of different valves, ON/OFF status of different pumps and blowers, etc. Colour coding shall be used to differentiate lines for different services such as service water line, backwash lines, acid/alkali lines etc.

4.16 Quality parameters such as pH, conductivity, Silica etc and level and flow rate shall be displayed on the TFT monitor.

4.17 Pneumatically operated valves shall be installed at inlet, outlet, back wash, regeneration and rinse line of each filter, ion-exchange units etc. The valves shall be closed or opened, as required, in automatic cycles by PLC. Pneumatic operated valves not connected with semi-automatic regeneration system, shall have individual open/close Selection Key at monitor.

4.18 Air Vent valve of all filters/exchangers shall have open/close Selection Key at monitor. This shall also be connected to PLC.

4.19 All on-off type control valves shall be diaphragm type with diaphragm actuator. The valves shall be provided along with the accessories like air filter regulator, air lock relay, position transmitter as applicable and shall have facility for operation from housing itself.

4.20 All bleed valves coming on backwash water line and regenerant chemical line and also air vent valve of each filters/exchanger vessels shall be "Spring to Open - Air to Close" type. The valves coming on inlet and outlet lines of filters/exchanger units, regenerant chemical inlet lines and all other lines except those mentioned above shall be "Spring to Close - Air to Open" type. The pump recirculation valve shall however be "Spring to Open - Air to Close" type. Solenoid valves for all "Spring to Open - Air to Close" type valves shall be de-energized to open while those for "Spring to Close - Air to Open" valves shall be energized to open. The valves shall be closed or opened, as required, in automatic cycles.

NOTE: PLC shall be read as DCS (BHEL Scope)

4.21 All actuators shall be slow acting type to prevent water hammer in the system and pipeline. Each auto-valve shall have limit switch for indication of opening and closing status in the TFT monitor.

4.22 All pneumatic/motor-operated valves shall also have local device for emergency local manual operation.

4.23 All pumps, discharge valves of all pumps, pneumatic valves, drive motors, shall have facility for remote manual operation from Operator's Station LCD.

4.24 Solenoid valves shall be mounted in the racks of the local panels. The valves shall be provided with all accessories such as isolating cocks, filters, air supply headers as required etc. and shall have facility for operation from rack itself. Name plates with tag number shall be provided for each and every valve.

4.25 Separate conductivity cells shall be employed for measuring the conductivity in the service outlet and in the rinse line of ion exchanger units for normal and rinsing operation. The cell in the rinsing line shall be automatically isolated during the first half of the rinsing cycle and shall be connected automatically during the second half of rinsing cycle when the conductivity is less than 100 micromhos/cm excess over the rinse water conductivity.

4.26 All drive motors shall be provided with arrangement of local starting and stopping. Local starting shall be possible through remote/local Selection facility in MCC. Tripping of drive motors from local Push-Button stations shall be permissible irrespective of the position of remote/local Selection facility. Local Stop Push-Button shall be locked after tripping the motor from local. All pumps and blowers shall also be provided with Auto-off-Manual Selection Key except Transfer pumps. All motors, valves, etc. shall be connected to PLC and all the above functions described above shall be performed (even local operation as required) in PLC except the drives as enlisted below:

(a) Transfer pumps - No PLC operation.

(b) A/C and Ventilation System - fans, pumps and other drives - No PLC operation.

4.27 Although the basic operation of Demineralization Plant is semi- automatic in nature, following operations shall be performed manually.

(a) Transfer of Acid

(i) Hydrochloric acid shall be unloaded from the road tank-cars by operation of any one of the Acid Transfer Pumps and shall be stored in Bulk Acid Storage Tanks. Operation shall be controlled from local panel.

(ii) Hydrochloric acid, stored in tanks, shall be led remote manually or by automatic sequence by gravity to the Acid Measuring Tanks for cation, mixed bed units to fill up to the desired level. Necessary tank selection key shall be provided in Operator Station display unit. Subsequent transfer of acid from the Measuring Tanks to the Ion-Exchanger Units as required in regeneration operation is however automatic.

(b) Transfer of Alkali

(i) Sodium hydroxide in lye form shall be unloaded from road tank cars by operation of one of the Alkali Transfer Pumps and shall be stored in Bulk Alkali Storage Tank. Operation shall be controlled from local panel.

(ii) Transfer of alkali from Storage Tanks to the respective Measuring Tanks for Anion and Mixed Bed Exchanger Units shall be done remote manually or by automatic sequence by gravity. Necessary Selection key shall be provided for this in Operator Station display. However, subsequent transfer of alkali to respective Ion Exchanger Units shall be automatic.

(c) Neutralization of Waste from DM Plant

(i) After completion of regeneration, the waste generated during regenerations shall be thoroughly recirculated in the

neutralization pit and if necessary acid/alkali shall be added to make the pH of waste within permissible range.

(ii) When required pH of waste solution has been reached, the waste solution shall be disposed to effluent treatment plant. The pump shall automatically be tripped when the level in neutralization pit reaches very low.

(iii) Priming of pumps operating under suction lift and operations as in (i) and (ii) shall be done manually by priming ejectors. Operation of all pumps, blowers and pneumatically operated valves shall be manually controlled from the local start/stop panel or Operator's Station.

FIELD INSTRUMENT AND CONTROL VALVE DETAILS

SR. NO.	ITEM	DESCRIPTION
1.0	FIELD INSTRUMENTS	
	This section provides general hardware guidelines for field instruments and equipment to be supplied under this specification.	
1.1	PRESSURE TRANSMITTER	
1.1.1	Working Principle	SMART, HART Protocol.
1.1.2	Type	2 – Wire.
1.1.3	Output Signal	4-20 mA DC.
1.1.4	Signal Processing	Silicon solid state electronic circuitry.
1.1.5	Measuring Element	Capsule/Diaphragm.
1.1.6	Element material	AISI-316 (Stainless Steel) or better.
1.1.7	Static Pressure	150 % of maximum span continuously, without affecting the calibration.
1.1.8	Turn-down ratio	100:1
1.1.9	Span and Zero	Locally adjustable non-interacting. Facility for elevation and suppression by 100% of span.
1.1.10	Enclosure Class	IP-65.
1.1.11	Output Indicator	LCD Type.
1.1.12	Nameplate	Tag number, service engraved in SS tag plate.
1.1.13	Body	Forged Carbon Steel for air and flue gas application and SS for other

SR. NO.	ITEM	DESCRIPTION
		application.
1.1.14	Operating Voltage	16 - 48 Volts D.C.
1.1.15	Load	600 Ohms (min.) at 24 Volts D.C.
1.1.16	Ambient Temperature	0 - 50 °C.
1.1.17	Performance :	
	(a) Accuracy	± 0.1% of Span or better.
	(b) Repeatability	± 0.05% of Span or better.
	(c) Stability	a) +/- 0.1% of calibrated span for 5 year for ranges upto and including 70 Kg/cm2 b) +/- 0.25% of calibrated span for 5 years for ranges more than 70 kg/cm2 (g)
1.1.18	Sealing/Isolation	Extended diaphragm with 5 meters SS armoured capillary for viscous fluid applications.
1.1.19	Accessories	(a) Universal mounting bracket suitable for 2" pipe mounting.
		(b) High tensile carbon steel U- bolts.
		(c) Siphon for steam and hot water services.
		(d) ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock.

SR. NO.	ITEM	DESCRIPTION
		(e) Companion flange with nuts, bolts and gaskets.
		(f) Hand held configuration kit for calibration of SMART Transmitter.
		(g) ½" NPT cable gland.
1.2	DIFFERENTIAL PRESSURE TRANSMITTER/FLOW TRANSMITTER	
1.2.1	Working Principle	SMART, HART Protocol.
1.2.2	Type	2-Wire.
1.2.3	Output signal	4-20 mA DC.
1.2.4	Signal Processing Unit	Silicon solid-state electronic circuitry.
1.2.5	Measuring element	Capsule/Diaphragm.
1.2.6	Element material	AISI-316 (Stainless Steel) or better.
1.2.7	Static Pressure/Overload Pressure	Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy.
1.2.8	Turn-down ratio	100 : 1 minimum.
1.2.9	Span and Zero	Locally adjustable, non-interacting.
1.2.10	Enclosure class	IP-65.
1.2.11	Zero suppression/elevation	At least 100% of Span.
1.2.12	Output Indicator	LCD Type.
1.2.13	Nameplate	Tag number and Service engraved in SS tag plate.

SR. NO.	ITEM	DESCRIPTION
1.2.14	Body	Forged Carbon Steel for air and flue gas application and SS for other application.
1.2.15	Ambient temperature	0 - 50 ^{O}C.
1.2.16	Operating Voltage	16 - 48 Volts DC.
1.2.17	Load	600 Ohms (min.) at 24 Volts DC.
1.2.18	Performance:	
	(a) Accuracy	±0.1 % of span or better.
	(b) Repeatability	± 0.05 % of span or better.
	(c) Stability	a) +/- 0.1% of calibrated span for 5 year for ranges upto and including 70 Kg/cm2 b) +/- 0.25% of calibrated span for 5 years for ranges more than 70 kg/cm2 (g)
1.2.19	Sealing / Isolation	Extended diaphragm with 5 meters SS armoured capillary for viscous fluid applications.
1.2.20	Accessories	(a) Universal mounting bracket suitable for 2" pipe mounting.
		(b) High tensile carbon steel U-bolts.
		(c) Siphon for steam and hot water services.
		(d) Companion flange with nuts, bolts and gaskets.

SR. NO.	ITEM	DESCRIPTION
		(e) Hand held configurator kit for calibration of SMART Transmitter
		(f) ½" NPT cable gland.
		(g) ½" NPT generally 5-valve stainless steel manifold, constructed from SS316 bar stock. 3 valve manifold for DP application in flue gas and air.
1.3	DISPLACER TYPE LEVEL TRANSMITTERS	
1.3.1	Type	SMART, HART Protocol.
1.3.2	Stages of operation	Continuous.
1.3.3	Material -	
(a)	Displacer	AISI 316 SS.
(b)	Suspension wire	AISI 316 SS.
(c)	Torque tube housing	Carbon steel or SS as per application.
(d)	Torque tube	Inconel.
(e)	Displacer chamber	CS or SS as per process application.
(f)	Transmitter Housing	Die cast Aluminium or better.
1.3.4	Operating Voltage	16-48 Volts D.C.
1.3.5	Transmission	2-wire.
1.3.6	Output Signal	4-20 mA DC.
1.3.7	Signal processing	Solid-state electronic circuitry.

SR. NO.	ITEM	DESCRIPTION
1.3.8	Static / overload pressure	Maximum static pressure without permanent deformation or loss of accuracy.
1.3.9	Turn-down ratio	10 : 1 or better.
1.3.10	Zero & Span	Easily accessible (local zero & span adjustment and non-interactive type).
1.3.11	Enclosure Class	IP-65.
1.3.12	Output Indicator	LCD type.
1.3.13	Nameplate	Tag number and Service engraved in stainless steel tag plate.
1.3.14	Ambient Temperature	0 - 50^0 C.
1.3.15	Load Impedance	600 Ohms at 24 Volts (minimum).
1.3.16	Process Connection	2" Companion flange with nuts, bolts and gaskets.
1.3.17	Performance -	
	(a) Accuracy	±0.5 % of span or better.
	(b) Stability	a) +/- 0.1% of calibrated span for 5 year for ranges upto and including 70 Kg/cm2 b) +/- 0.25% of calibrated span for 5 years for ranges more than 70 kg/cm2 (g)
1.3.18	Accessories	(a) Counter Flange, nuts, bolts, gaskets etc.

SR. NO.	ITEM	DESCRIPTION
		(b) Weights for 5 point calibration of instruments.
		(c) Vent and drain plugs.
		(d) Special calibration tool / configuration, if any.
		(e) ½"NPT cable gland.
1.3.19	Preferred Features	(a) Test plug connection and cutout terminals physically separated from other electronics.
		(b) Electronic Damping facility (adjustable).
1.4	MASS FLOW METER	
1.4.1	Sensor	
1.4.1.1	Measuring Principle	Coriolis Mass flow.
1.4.1.2	Primary Element	Flow Tube of 316SS or better.
1.4.1.3	Heating Arrangement	Integral.
1.4.1.4	Temperature Control	For heavy fuel oil application.
1.4.1.5	Process Connection	Flanged of rating as per process requirement.
1.4.1.6	Drain	Self-draining facility.
1.4.1.7	Enclosure	Stainless steel.
1.4.1.8	Accessories	Counter flanges, Mounting nuts, bolts, gaskets etc.
1.4.2	Transmitter	

SR. NO.	ITEM	DESCRIPTION
1.4.2.1	Measured quantities	Mass Flow rate, Total Mass Flow, Density, Temperature.
1.4.2.2	Input Signal Processing	Digital Processing.
1.4.2.3	Display	Digital Display LCD Type.
1.4.2.4	Output	2 off isolated 4-20mA DC output.
1.4.2.5	Load	< 750 ohms.
1.4.2.6	Power supply	240V AC, 50 Hz.
1.4.2.7	Turn Down	100:1.
1.4.2.8	Accuracy	± 0.2 % of measured value.
1.4.2.9	Housing	IP 65.
1.4.2.10	Nameplate	Tag number, service engraved in stainless steel tag plate.
1.4.2.11	Accessories	(a) Handheld configurator.
		(b) Mounting U-bolts, nuts, bolts, prefab cable etc.
		(c) ½"NPT cable gland.
1.5	SOLID FLOW METER	
1.5.1	TYPE	On-line Impact type microprocessor based.
1.5.2	Measuring Principle	The system measurement basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of Solid flow upon on-line sensing plate. The horizontal deflection being

SR. NO.	ITEM	DESCRIPTION
		proportional to the impact forces, LVDT converts this horizontal movement into electrical signal. The inbuilt integrator converts this signal into time based flow rate indication and provides totalized flow also.
1.5.3	Sensing Plate	SS 316
1.5.4	Sensing head	Sensing mechanism shall be mounted outside the process flow line
1.5.5	Housing/Enclosure	SS 304
1.5.6	Enclosure Protection class	IP-67
1.5.7	Accuracy	± 1 %
1.5.8	Repeatability	± 0.2 %
1.5.9	Drift	Both zero and span ± 2% /month
1.5.10	Outputs	4 to 20 mA DC isolated, load 600 Ω minimum.
1.5.11	Digital communication (HART) facility	Yes
1.5.12	Power supply	240 VAC , 50Hz ± 10%
1.5.13	Ambient Condition	Temperature – 60°C, RH- 95 % Environment- Highly dusty
1.5.14	Accessories	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. whichever required for satisfactory operation.

SR. NO.	ITEM	DESCRIPTION
1.6	MASS FLOW METER (FOR AIR)	
1.6.1	Sensor	Thermal dispersion
1.6.2	Measuring Principle	The typical thermal mass sensing element contains two thermowell-protected Resistance Temperature Detectors (platinum RTDs). When placed in the process, one RTD is heated and the other RTD senses the process temperature. The temperature difference between the two RTDs is related to the process flow rate as well as the properties of the process medium.
1.6.3	Primary Element	316 stainless steel body with Hastelloy C thermowell sensors, 316 stainless steel compression fitting with teflon or stainless steel ferrule
1.6.4	Pressure (Maximum Operating with Damage)	
1.6.4.1	Stainless Steel Ferrule	-18°C to 121°C
1.6.4.2	Teflon Ferrule	-18°C to 93°C
1.6.5	Process Connection	1/2" MNPT or 3/4" MNPT with stainless steel or Teflon ferrule
1.6.6	Transmitter	
1.6.7	Measured quantities	Mass Flow rate, Total Mass Flow
1.6.8	Input Signal Processing	Digital Processing.
1.6.9	Display	LCD, ±9999 counts, user scalable to flow rate

SR. NO.	ITEM	DESCRIPTION
		engineering units or 0-100%
1.6.10	Output	2 off isolated 4-20mA DC output
1.6.11	Load	< 750 ohms.
1.6.12	Power supply	240V AC, 50 Hz.
1.6.13	Turn Down	100:1.
1.6.14	Accuracy	± 0.2 % of measured value.
1.6.15	Enclosure	NEMA4X (IP67) aluminum, Epoxy coated
1.6.16	Nameplate	Tag number, service engraved in stainless steel tag plate.
	Notes:	
1.	The above on-line flow meter shall not create any obstruction on flow.	
2.	Users' list shall be submitted to support on proven satisfactory performance for similar process applications.	
1.7	PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE	
1.7.1	Type	Bourdon / Bellows / Diaphragm.
1.7.2	Sensing & Socket	AISI-316 SS.
1.7.3	Movement Material	AISI-304 SS.
1.7.4	Case Material	Stainless steel, IP-65.
1.7.5	Dial Size	Generally 150 mm.
1.7.6	Scale	Black lettering on white in 270 ^{o} arc.

SR. NO.	ITEM	DESCRIPTION
1.7.7	Window	Shatterproof glass.
1.7.8	Range Selection	Normal process pressure: 50~70% of range.
1.7.9	Over-range Protection	125% of maximum range by internal stop. External stop at zero.
1.7.10	Adjustment	Micrometer screw for zero. Internal micrometer screw for range.
1.7.11	Element Connection	Argon welding.
1.7.12	Process Connection	1/2" NPT(M) Bottom for local, back for panel mounting.
1.7.13	Performance	Accuracy of ± 1.0 % of span or better.
1.7.14	Operating ambient	0 - 50 ^{O}C.
1.7.15	Safety Feature	Blow out disc /diaphragm at the back.
1.7.16	Accessories	(a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge.
		(b) Stainless steel Diaphragm seals for viscous fluids
		(c) 3-Way SS316 Gauge cock for pressure gauges.
		(d) 5-valve SS316 manifold from barstock for differential pressure gauge.
		(e) Siphons for steam and hot water services.

SR. NO.	ITEM	DESCRIPTION
1.7.17	Applicable standard	IS-3624 / 1996.
1.7.18	Nameplate	Tag number, service engraved in stainless steel tag plate.
1.8	TEMPERATURE GAUGE	
1.8.1	Type	Mercury or gas filled.
1.8.2	Sensing Element Material	Bourdon - AISI-316 SS.
1.8.3	Capillary Armoring	Stainless steel flexible.
1.8.4	Movement Material	AISI 304 SS.
1.8.5	Bulb / Stem Diameter	12 mm.
1.8.6	Bulb / Stem Material	AISI 316.
1.8.7	Capillary	Stainless Steel.
1.8.8	Connection to well	½" NPT.
1.8.9	Case Material	Stainless steel.
1.8.10	Dial Size	150 mm in general.
1.8.11	Scale	Black lettering on white in 270 ^{0} arc.
1.8.12	Mounting	Surface/Panel.
1.8.13	Over range Protection	125 % of range or more.
1.8.14	Instrument connection	Bottom for local and back for panel mounting.
1.8.15	Range	Normal temperature – 50~70% of range.
1.8.16	Zero adjuster	Micrometer screw adjustable from front.

SR. NO.	ITEM	DESCRIPTION
1.8.17	Window	Shatterproof glass.
1.8.18	Accuracy	± 1 % or better.
1.8.19	Enclosure Class	IP-65.
1.8.20	Capillary	5 meters (local surface)/15.0 meters (local panel) - armoured stainless steel.
1.8.21	Compensation	Capillary and Case Compensation.
1.8.22	Accessories	(a) Forged barstock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M). Material of construction of Thermowell: (i) SS 316: In general. (ii) Inconel: For flue gas application. (iii) Tungsten carbide: For coal mill application.
1.8.23	Nameplate	Tag number, service engraved in stainless steel tag plate.
1.9	THERMOCOUPLES	
1.9.1	Type	(a) Type-J (Iron Constantan) / Type-K (Chromel Alumel) / Type-R (Pt.-Rhodium Pt.). [As per application]
		(b) Duplex.
		(c) Ungrounded.

SR. NO.	ITEM	DESCRIPTION
1.9.2	Wire gauge	16 AWG for Type-K, 24 AWG for Type-R.
1.9.3	Standard	ANSI-MC 96.1.
1.9.4	Protecting Tube	
(a)	O.D	8 mm.
(b)	Material	316-SS Seamless.
(c)	Filling	Magnesium Oxide (Purity above 99.4%).
1.9.5	Response time	(a) < 20 seconds for measurement.
		(b) < 10 seconds for control.
1.9.6	Accuracy	± 1.1^0 C up to 300 ^{0}C & 0.4% of measured temperature range above 300 ^{0}C.
1.9.7	Head	
(a)	Type	IP-65 universal screwed type.
(b)	Material	Die cast aluminium or better.
(c)	Terminal blocks	Nickel plated Brass - screw type/ silver plated.
(d)	Instrument connection to well	½" NPT F.
(e)	Cable connection	½" NPT gland and grommet.
(f)	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

SR. NO.	ITEM	DESCRIPTION
		thermowells.
1.9.8	Accessories	(a) Adjustable nipple-union-nipple (½", Sch 80 x ½" NPT M) with thermowell connection.
		(b) Compression fittings/unions.
		(c) Flanges etc. (for flanged connections only).
		(d) Forged barstock thermowell as per ASME PTC code. Process connection M 33 x 2 (M) in general or 1½" Flanged for Flue gas / Furnace / Air etc. application. Material of construction of Thermowell: SS 316 : In general Inconel: For flue gas application Tungsten carbide : For coal mill application.
1.9.9	Name plate	Tag number, service engraved in stainless steel tag plate.
1.10	RESISTANCE TEMPERATURE DETECTOR	
1.10.1	Type	Platinum (Duplex), Ungrounded.
1.10.2	Resistance	100 ohm at 0 °C.
1.10.3	Base	Wound on ceramic (anti-inductive).
1.10.4	Wiring	3 / 4 Wire.

SR. NO.	ITEM	DESCRIPTION
1.10.5	Protecting Tube	
(a)	O.D.	8 mm.
(b)	Material	SS-316, Seamless.
(c)	Filling	Magnesium oxide (Purity above 99.4%).
1.10.6	Response time	(a) < 20 seconds for measurement.
		(b) < 10 seconds for control.
1.10.7	Calibration	DIN 43760.
1.10.8	Accuracy	± 0.5%.
1.10.9	Head:	
(a)	Type	IP-65 universal screwed type.
(b)	Material	Die cast aluminium or better.
(c)	Terminal blocks	Nickel plated Brass-screw type / silver plated.
(d)	Cable connection	½" NPT gland and grommet.
(e)	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.
1.10.10	Accessories	(a) Adjustable nipple-union-nipple (½" Sch 80 x ½" NPT M) with Thermowell connection.

SR. NO.	ITEM	DESCRIPTION
		(b) Compression fittings / unions.
		(c) Flanges etc. (for flanged connections only)
		(d) Forged / barstock Thermowell as per ASME PTC code. Process connection M33 x 2 (M). Material of construction of Thermowell: SS 316: In general. Inconel: For flue gas application. Tungsten carbide: For coal mill application.
1.10.11	Name plate	Tag number, service engraved in stainless steel tag plate
1.11	PRESSURE SWITCH	
1.11.1	Type	(a) Piston for high pressure application.
		(b) Bellow / Diaphragm for low pressure application.
1.11.2	Sensing element material	AISI SS-316. All other wetted part SS316.
1.11.3	Case Material	Die-cast aluminium alloy, neoprene gasket.
1.11.4	Setter Scale	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.

SR. NO.	ITEM	DESCRIPTION
1.11.5	Over range	150 % of maximum pressure.
1.11.6	Adjustments	(a) Internal Set Point.
		(b) Differential adjustment.
1.11.7	End Connection	½" NPT (M) bottom connected.
1.11.8	Switch configuration	Two SPDT.
1.11.9	Switch Rating	240V, 5A AC / 220V, 0.5A DC.
1.11.10	Switch Type	Snap acting, hermetically sealed, shock & vibration proof.
1.11.11	Terminal Block	Suitable for full ring lugs.
1.11.12	Cable connection	½" NPT conduit connection.
1.11.13	Enclosure Class	IP-65.
1.11.14	Performance	(a) Repeat accuracy ± 1.0%.
		(b) Accuracy of Setting Indication of ±1.5%.
1.11.15	Ambient temperature	0 – 50 Deg C.
1.11.16	Nameplate	Tag number, service engraved in SS tag plate.
1.11.17	Accessories	(a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application.
		(b) Siphons for steam and hot water services.
		(c) Retention ring and screws for surface mounting.

SR. NO.	ITEM	DESCRIPTION
		(d) 1/2" NPT 2 Valve SS-316 barstock manifold.
		(e) ½" NPT cable gland.
1.12	DIFFERENTIAL PRESSURE SWITCH	
1.12.1	Type	Bellows/Diaphragm/Piston actuated.
1.12.2	Sensing element material	AISI SS-316. For all other wetted part SS 316.
1.12.3	Case Material	Die-cast aluminium alloy with neoprene gasket.
1.12.4	Setter Scale	Black graduation on white scale with 0-100% graduation and provided with red pointer for set point adjustment.
1.12.5	Over range	Static pressure on any one side, the other side being open to atmosphere.
1.12.6	Adjustments	(a) Internal set point adjustment.
		(b) Differential adjustment.
1.12.7	Process Connection	1/2" NPT (M) bottom / back connected.
1.12.8	Switch configuration	Two SPDT.
1.12.9	Switch rating	240V, 5A AC/220V, 0.5A DC.
1.12.10	Switch type	Snap acting type contacts, shock and vibration proof.
1.12.11	Terminal Blocks	Suitable for full ring lugs for cable

SR. NO.	ITEM	DESCRIPTION
		connection.
1.12.12	Cable Connection	½" NPT conduit connection or compression gland.
1.12.13	Performance	(a) Repeat accuracy ± 1.0%.
		(b) Accuracy of set point Indication:±1.5%
1.12.14	Operating Ambient	0 - 50 ^{O}C (Maximum Continuous).
1.12.15	Enclosure	IP-65.
1.12.16	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.
		(e) 1/2" NPT Cable gland.
1.12.17	Nameplate	Tag number, service engraved in stainless steel tag plate.
1.12.18	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.

SR. NO.	ITEM	DESCRIPTION
		(c) Adapter flanges with nuts, bolts and gaskets for instrument and process side.
1.13	LEVEL SWITCH	
1.13.1	Type	External cage float operated. Magnetically coupled.
1.13.2	Float Material	AISI-316 stainless steel or better.
1.13.3	Other wetted parts	AISI-316 stainless steel or better.
1.13.4	External Cage	Carbon steel/Stainless steel as per process requirements, welded type/ flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
1.13.5	External cage mounting	Side-Side.
1.13.6	External cage connection	25 NB socket welded.
1.13.7	Switch housing	Epoxy coated die-cast aluminium alloy with neoprene gasket conforming to IP-65.
1.13.8	Type of switch configuration	2 SPDT (two nos.).
1.13.9	Contact rating	5A, 240V/AC, 0.25A, 220V DC.
1.13.10	Accessories	(a) Counter flange, nuts & bolts, suitable gasket etc.
		(b) Steel globe type drain valve.
		(c) ½"NPT cable gland.
		(d) Stainless steel nameplate with

SR. NO.	ITEM	DESCRIPTION
		alpha-numeric engraved for service and tag.
1.13.11	Preferred feature	Switch operating point marked on cage.
1.13.12	Mounting	On standpipe.
1.14	CONDUCTIVITY TYPE LEVEL SWITCH	
1.14.1	Type	Conductivity discrimination.
1.14.2	Application	Drain pots viz. on CRH line.
1.14.3	Mounting	Flanged – on external cage.
1.14.4	Probe MOC	Stainless steel with high purity ceramic.
1.14.5	Probe rating	> Maximum design pressure of vessel.
1.14.6	Input	Four independent channel with selectable switching threshold for water conductivity.
1.14.7	Relay Output	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
1.14.8	Contact type & rating	2 SPDT or 1 DPDT @ 5A 30V DC.
1.14.9	Local Display	Coloured LEDs for Hi, Lo, Hi-Hi, Lo-Lo, Power & fault.
1.14.10	Power supply	Dual 240V AC, 50 Hz, 1Ph.
1.14.11	Enclosure	IP–65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area)

SR. NO.	ITEM	DESCRIPTION
1.14.12	Accessories	(a) PTFE cable from probe to electronics.
		(b) Mounting accessories.
		(c) External cage.
		(d) Washer & gasket.
1.14.13	Test pressure	(e) Two times rated pressure.
1.14.14	Cable connection	(f) ½" NPT with cable gland.
1.15	CONDUCTIVITY TYPE ELECTRONIC LEVEL INDICATOR	
1.15.1	Type	Conductivity discrimination.
1.15.2	Application	HP heater level.
1.15.3	No. of Probes	10
1.15.4	Probe Mounting	Flanged – on standpipe.
1.15.5	Probe MOC	Stainless steel with high purity ceramic.
1.15.6	Probe rating	> Maximum design pressure of vessel.
1.15.7	Input	Independent channel with selectable switching threshold for water conductivity.
1.15.8	Relay Output	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
1.15.9	Contact type & rating	2 SPDT or 1 DPDT @ 5A 30V DC.

SR. NO.	ITEM	DESCRIPTION
1.15.10	Current output	Isolated 4-20 mA DC.
1.15.11	Local Display	(a) Coloured (Red & Green) LEDs for level.
		(b) Flashing LEDs for fault.
1.15.12	Remote Display	Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.
1.15.13	Power supply	Dual 240V AC, 50 Hz, 1Ph.
1.15.14	Enclosure	(a) IP–65, corrosion resistant & wall mounting type for local electronics.
		(b) IP-42 for remote indicator.
1.15.15	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.
1.15.16	Test pressure	Two times design pressure.
1.16	ORIFICE PLATE	

SR. NO.	ITEM	DESCRIPTION
1.16.1	Application	Low fluid velocity flow measurement.
1.16.2	Design Standard	BS-1042, Part-I.
1.16.3	Number of Tapings	As required plus one additional pair of taps.
1.16.4	Diameter Ratio	Between 0.4 to 0.7.
1.16.5	Thickness	3 mm for main pipe diameter upto 250 mm, 6 mm for main pipe diameter above 250 mm and upto 500 mm and 10 mm for main pipe diameter of 500 mm and above.
1.16.6	Document	Beta ratio calculation, assembly drawing and Flow vs. DP curve.
1.16.7	Meter run pipe	Same as pipe material.
1.16.8	Accessories	Flanges, gaskets, nuts & bolts, root valves jack screw, meter run pipe, Drain & vent hole as per application etc.
1.17	FLOW NOZZLE	
1.17.1	Application	High fluid velocity flow measurement.
1.17.2	Design Standard	ASME PTC 19.5.
1.17.3	Number of Tapings	As required plus one additional pair of taps.
1.17.4	Diameter Ratio	Between 0.4 and 0.7.
1.17.5	Thickness	Suitable for the application.
1.17.6	Document	Beta ratio calculation, assembly

SR. NO.	ITEM	DESCRIPTION
		drawing and Flow vs. DP curve.
1.17.7	Meter run pipe	Same as pipe material.
1.17.8	Accessories	Meter run pipe, nipples and root valves (Inspection port assembly for nozzles used in plant performance purpose).
1.18	GAUGE GLASS	
1.18.1	Type	Reflex.
1.18.2	Glass	Toughened borosilicate Resistant to mechanical and thermal shocks.
1.18.3	Body material	Carbon steel / stainless steel - As per process requirements (Flanged Connection).
1.18.4	Pressure rating	Twice the maximum working pressure.
1.18.5	Temperature rating	As required.
1.18.6	Bolts and nuts	Rust proof alloy steel.
1.18.7	Accessories	Suitable ball check valves of SS-304 /316 body, gaskets, companion flange etc.
1.19	POWER CYLINDERS (PNEUMATIC)	
1.19.1	Mounting Type	(a) Fixed position mounting. (End mounting)
		(b) Trunnion mounting.
1.19.2	Control Signal	4-20 mA DC to SMART positioner with Superimposed HART protocol for

SR. NO.	ITEM	DESCRIPTION
		modulating purposes. 24V DC operated solenoid valve operating on pneumatic line for open & closing purpose of on & off drive.
1.19.3	Supply Air	7 Kg / cm^2.
1.19.4	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.
1.19.5	Casing	IP-65.
1.19.6	Accessories	(a) Air lock relay.
		(b) Hand wheel.
		(c) Air filter regulator with gauge.
		(d) Volume Booster.
		(e) Limit Switches.
		(f) Smart Positioner with Input and Output pressure gauges, local keypad & display.
		(g) Solenoid Valve.
		(h) Integral non contact type position Transmitter. (4-20 mA DC linear output)
		(i) Junction box with cable gland.
1.19.7	Fail-safe operation	For regulating duty- stay put against

SR. NO.	ITEM	DESCRIPTION
		power & air fail.
1.19.8	Repeatability	Better than 0.5% of full travel.
1.19.9	Hysteresis	Less than ±1% of full travel.
1.19.10	Operating Temp. limit	80 Deg. C (min.)
~~1.20~~	~~SMOKE DENSITY ANALYZER~~	
~~1.20.1~~	~~Type~~	~~Insitu dry visible light. (through LED)~~
~~1.20.2~~	~~Principle of measurement~~	~~Transmission & absorption. (Dual beam type)~~
~~1.20.3~~	~~Light source~~	~~Modulated high intensity LED.~~
~~1.20.4~~	~~Display~~	~~Back Lit LCD.~~
~~1.20.5~~	~~Measurement range~~	~~0-999 mg/m^3, 0-999 mg/Nm^3, 0-100% Opacity.~~
~~1.20.6~~	~~Measurement averaging~~	~~Selectable 10 sec to 60 minutes.~~
~~1.20.7~~	~~Accuracy~~	~~0.2% opacity.~~
~~1.20.8~~	~~Resolution~~	~~0.1% opacity.~~
~~1.20.9~~	~~Linearity~~	~~0.1% opacity.~~
~~1.20.10~~	~~Repeatability~~	~~0.1% opacity.~~
~~1.20.11~~	~~Flue gas temperature~~	~~350 ^{0}C (max 600 ^{0}C).~~
~~1.20.12~~	~~Ambient temperature~~	~~0 - 60 ^{0}C.~~
~~1.20.13~~	~~Operating temperature~~	~~Transmitter & receiver - 0-90^{0}C, Electronic unit - 70 ^{0}C.~~

SR. NO.	ITEM	DESCRIPTION
~~1.25.16~~	~~Enclosure~~	~~Flame Proof.~~
~~1.25.17~~	~~Accessories~~	~~Calibration gas, mounting accessories and others as required to be provided~~
~~1.25.18~~	~~Application~~	~~Generator Gas Purity.~~
1.26	RADAR TYPE LEVEL MEASUREMENT	
1.26.1	Type	Radar based on Time Domain Reflectometry.
1.26.2	Antenna	Co axial / single rod type guided wave or Horn type as required for the application.
1.26.3	Communication	Two wire 4-20mA DC, HART protocol.
1.26.4	Environmental temperature	0 – 50 °C.
1.26.5	Enclosure	Explosion proof/IP 65 as per application.
1.26.6	Cable Entry	½" NPT.
1.26.7	Calibration	Self calibration with internal reference.
		Zero & Span calibration.
1.26.8	Programming	Handheld programmer & Local keypad.
1.26.9	Process Connection	Flanged /screwed.
1.26.10	Electronic Housing	Epoxy painted Die-Cast aluminium alloy.

SR. NO.	ITEM	DESCRIPTION
1.26.11	Antenna / Flange assembly	316 SS or Hestalloy. (as required)
1.26.12	Output Indicator	Digital Integral Display.
1.26.13	Accuracy	5 mm or 0.1% of probe length.
1.26.14	Accessories	(a) Programming tool kit.
		(b) Gasket.
1.27	ULTRASONIC LEVEL TRANSMITTER	
1.27.1	Principle of operation	Detection of reflected ultrasonic pulse, HART Protocol
1.27.2	Measuring ranges	Up to 30 meters (typical)
1.27.3	Signal processing	Microprocessor Controlled Signal Processing
1.27.4	Operating frequency	10 KHz to 50 KHz (typical)
1.27.5	Display	Large alpha-numeric back lit LCD/ LED
1.27.6	Calibration & Configuration	Accessible from front of panel
1.27.7	Diagnosis	On-line
1.27.8	Status	For power, Hi/Lo/V. Hi/V. Lo - level indication, fault etc.
1.27.9	Construction	Plug-on board
1.27.10	Power supply	240 V AC 50 Hz / 24V DC
1.27.11	Signal Output	4-20 mA DC - 600 Ohm load.

SR. NO.	ITEM	DESCRIPTION
1.27.12	Hysteresis	Fully adjustable preferred
1.27.13	Output contacts	2 SPDT Potential free changeover contacts @ 240V, 5A AC/220V, 0.5A DC.
1.27.14	Accuracy & Repeatability	0.25% of span or better
1.27.15	Resolution	0.1% of span
1.27.16	Operating Temperature	Transmitter- 50 ^{0}C and Sensor – 80 ^{0}C
1.27.17	MOC Sensor	Body- PVC and Face – Polyurethane
1.27.18	Humidity	1% to 95% non condensing.
1.27.19	Enclosure	IP-65 Epoxy painted die cast aluminium or Polycarbonate housing.
1.27.20	Cable connection	3/4" ET
1.27.21	Mounting	2" for sensor and Transmitter on panel.
1.27.22	Accessories	Cable gland, prefab cable, mounting accessories.
1.28	CAPACITANCE TYPE LEVEL SWITCH	
1.28.1	Type	Capacitance type
1.28.2	Probe	(i) Rod or suspended electrode
		(ii) Rope type probes may be used only where required probe length is greater than 3 meters.
1.28.3	Probe Mounting	Stainless steel 1½" ANSI RF Flange / ¾" NPT (M)

SR. NO.	ITEM	DESCRIPTION
1.28.4	Material of construction	316 SS
1.28.5	Insulation	PTFE Part/ Full as per service.
1.28.6	Enclosure	Powder/Epoxy coated Die cast aluminium with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
1.28.7	Ambient temperature	0-60 °C.
1.28.8	Mounting	On Tap
1.28.9	Supply voltage	240V AC, 50Hz /24V DC
1.28.10	Relay output	2 SPDT
1.28.11	Contact rating	240V, 5A AC/220V, 0.5A DC.
1.28.12	Response time	100 mSec or better
1.28.13	Cable connection	¾" ET
1.28.14	Accessories	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.
1.29	TEMPERATURE SWITCH	
1.29.1	Type	Mercury filled-in.
1.29.2	Sensing Element Material	Bellow / Bourdon AISI SS-316.
1.29.3	Bulb Material	AISI SS-316.
1.29.4	Capillary	Stainless steel armoured.
1.29.5	Movement Material	AISI SS-304.
1.29.6	Case material	Epoxy coated steel plate or die-cast aluminium alloy with neoprene gasket

SR. NO.	ITEM	DESCRIPTION
		and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
1.29.7	Scale	Black lettering on white background.
1.29.8	Over range Protection	120 %.
1.29.9	Instrument connection	Bottom.
1.29.10	Switch configuration	Two SPDT.
1.29.11	Switch rating	240V, 5A AC/220V, 0.5A DC.
1.29.12	Switch type	Snap acting, shock and vibration-proof.
1.29.13	Adjustability	Internal Set point adjustable over span range.
1.29.14	Cable connection	3/4" ET conduit connection or compression gland.
1.29.15	Compensation	(a) Capillary compensation with invar wire throughout the capillary length.
		(b) Case compensation.
1.29.16	Performance :	
(a)	Scale Accuracy	±1.0 % of full scale.
(b)	Repeatability	< 0.5 % of full range.
(c)	Response time	Less than 40 seconds with thermowell.
1.29.17	Capillary length	5 meters (minimum) for local mounting/15 meters for local panel mounting.

SR. NO.	ITEM	DESCRIPTION
1.29.18	Nameplate	Tag number, service engraved in stainless steel tag plate.
1.29.19	Accessories	Mounting accessories, 3/4"ETcable gland.
1.30	ROTAMETER	
1.30.1	Type	On-line up to 2". By-pass above 2".
1.30.2	Metering tube	Borosilicate glass.
1.30.3	Float	AISI 316-SS unless the process fluid demands some other material.
1.30.4	Body MOC	AISI 316-SS.
1.30.5	Scale	Graduated- Engraved black on white background.
1.30.6	Process connection	Flanged.
1.30.7	Accuracy	± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass type.
1.30.8	Nameplate	Tag number, service engraved in stainless steel tag plate.
1.30.9	Accessories	Slip-on orifice plate of 316-SS and taps of Stainless Steel as per application requirements. Applicable SS Isolation valves and SS Range Orifice - for bypass type rotameters.
1.31	TURBIDITY ANALYSER	
1.31.1	Type	Microprocessor based continuous

SR. NO.	ITEM	DESCRIPTION
		turbidity monitoring system
1.31.2	Wetted parts	Stainless Steel
1.31.3	Insulation Assembly	Yes
1.31.4	Range	As per service application
1.31.5	Accuracy	Better than ± 3 % of full scale
1.31.6	Sensitivity	Measures suspended solids from 0.001 to 10,000 NTU
1.31.7	Analyser output	4-20 mA DC – Two (2) numbers and contacts
1.31.8	Transmitter display	Digital
1.31.9	Type of Switch	Snap acting
1.31.10	Switch Rating	2 NO + 2NC, SPDT, Electrically isolated 240 V AC/5A,
1.31.11	Power supply	24V DC (for 2 wire type) & 240 V AC (for 4-wire type)
1.31.12	Calibration	Auto & Manual (from Remote)
1.31.13	Transmitter Housing	Die cast aluminium weather proof, dust tight & water proof conforming IP 65. For hazardous area, Explosion proof Enclosure as described in NEC article 500.
1.32	CHLORINE LEAK DETECTOR	
1.32.1	Sensor Type	Electro Chemical
1.32.2	Resolution	0.1 ppm

SR. NO.	ITEM	DESCRIPTION
1.32.3	Response Time	Less than 1 second
1.32.4	Display Type	7 Segment LED Display , Minimum 3 Digits with Decimal Point indications , Minimum Digit Height 12.5 mm
1.32.5	Alarm Type	Industrial Hooter
1.32.6	Power Supply	240 V , 50 Hz , AC, 1 Phase
1.32.7	Output	4 to 20 mA DC
1.32.8	Alarm Output	1NO + 1NC PF contact rated at 240V AC 5A
1.32.9	Enclosure	Epoxy painted die cast aluminium, IP 67.
1.32.10	Mounting	Wall Mounting with all mounting accessories
1.33	NUCLEONIC TYPE DENSITY METER	
1.33.1	Type	Nucleonic type
1.33.2	Measurement range	About 1.5 times normal density (min.)
1.33.3	Accuracy	± 0.1% of span.
1.33.4	Enclosure	IP 65
1.33.5	Power supply	24 V DC/ 230 V AC
1.33.6	Output	(i) 4 –20 mA DC
		(ii) 2 SPDT or 1 DPDT @ 5A, 30 VDC.

SR. NO.	ITEM	DESCRIPTION
1.33.7	Local indication	Required
1.33.8	Radioactive source	Radioactive source with regulatory approval for handling to be used.
1.33.9	Mounting	On vessel with suitable mounting accessories.
1.34	NON-NUCLEONIC TYPE DENSITY METER	
1.34.1	Type	Vibration of pendulum/ Rod
1.34.2	Range	To suit the process.
1.34.3	Temperature correction required	Yes/No
1.34.4	Accuracy	± 1%
1.34.5	Response time	Less than 1minute
1.34.6	Sensor material	SS 316
1.34.7	Housing material	Cast iron
1.34.8	Enclosure protection	NEMA-4X
1.34.9	Signal cable length	Minimum 5 meters
1.34.10	Ambient temperature	0 Deg.C to 80 Deg.C
1.34.11	Power supply	240 V AC + 10%, 50 Hz.
1.34.12	Load	Minimum 600 ohms
1.34.13	Electrical connection	¾" ET.
1.34.14	Transmitter Output	4-20 mA DC
1.34.15	Local Indication	LCD display Required.

SR. NO.	ITEM	DESCRIPTION
1.34.16	Flange material	ASTM 105
1.34.17	Accessories	Suitable gaskets, Nut- bolts etc.
1.35	I/P CONVERTER	
1.35.1	Type	Electro-pneumatic (Outdoor Type)
1.35.2	Input level	4-20 mA DC
1.35.3	Output range	0.2 to 1.0 Kg/Sq. cm With 'Fail Freeze' feature. (i.e in case of wire snapping the last good value of pneumatic signal out put will hold for at least six hours)
1.35.4	Split range	For typical application wherever required.
1.35.5	Control Action	Selectable air to close, air to open and fail freeze application.
1.35.6	Supply pressure	1.2 to 1.6 Kg/cm^2 (1.4 typical)
1.35.7	Max. supply pressure	7 Kg/ sq.cm.
1.35.8	Response Time	5 Seconds for 0 to 90% output pressure.
1.35.9	Housing	IP 55.
1.35.10	Repeatability	±0.1% of span.
1.35.11	Accuracy	± 0.25% of span.
1.35.12	Supply pressure effect	Less than 1%.
1.35.13	Span and Zero adjustments	Screw.
1.35.14	Pneumatic connection	¼" NPT.

SR. NO.	ITEM	DESCRIPTION
1.35.15	Stability	Less than 0.25% of Span / Zero for six months.
1.35.16	Cable connection	¾" ET.
1.35.17	Mounting	Field (pipe/wall mounting).
1.35.18	Accessories	Air filter regulator, mounting accessories, cable gland etc.
1.36	AIR FILTER REGULATOR	
1.36.1	Filter Element	Sintered Bronze.
1.36.2	Filter Size	5 microns.
1.36.3	Input Air	10.0 Kg/Sq. cm (maximum)
1.36.4	Output	Adjustable from 0-2.0 Kg / Sq. cm or 0-7.0 Kg/Sq. cm (continuous) as applicable for I/P converter, control drives and control valve.
1.36.5	Effect of Supply	Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm.
1.36.6	Bowl Material	Metallic cover around high temperature area/clear transparent polycarbonate with metallic cover for ordinary applications.
1.36.7	Accessories	2" dial size output pressure gauge.
1.36.8	Desirable Feature	No perceptible drop of pressure on opening the drain port.

SR. NO.	ITEM	DESCRIPTION
1.37	SOLENOID VALVE	
1.37.1	Operating Principle	Electromagnetic. (noiseless)
1.37.2	Coil voltage rating	240 V AC/220 V DC(as required. Any other voltage, if necessary, to be arranged by Bidder)
1.37.3	Ways	Generally 3-ways other depending on requirement
1.37.4	Port size	1/4" NPT all ports.
1.37.5	Body	SS bar stock.
1.37.6	Trim	SS-316.
1.37.7	Duty	Suitable for continuous energization.
1.37.8	Sealing	Airtight and leak proof.
1.37.9	Ambient Temperature	0 - 50 ^{O} C.
1.37.10	Fluid Temperature	0-150 ^{O} C (approx.)
1.37.11	Coil Enclosure	Stainless Steel.
1.37.12	Insulation	Class-H.
1.37.13	Coil Casing	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
1.37.14	Mounting	On pipe or on panel.
1.37.15	Cable Connection	3/4" ET.
1.37.16	Accessories	Mounting brackets, nuts and bolts.
1.37.17	Preferred feature	(a) Solenoid valve directly integral to actuator body shall have NAMOOR interface for uniformity.

SR. NO.	ITEM	DESCRIPTION
		(b) Local indication for power.
1.38	SIGHT GLASS	
1.38.1	Type	Flap-type.
1.38.2	End connection	Screwed / Flanged.
1.38.3	Material	
(a)	Body	CS/SS as per process medium.
(b)	Indicator	Stainless steel.
1.38.4	Sight Glass	Toughened Borosilicate.
1.38.5	Gasket	Neoprene.
1.38.6	Bolts & Nuts	High tensile steel.
1.38.7	Hydraulic Test Pressure	1.5 times maximum working pressure.
1.38.8	Accessories	As required.
1.39	LEVEL GAUGE (FLOAT & TAPE)	
1.39.1	Type	Float and Tape
1.39.2	Float & Tape MOC	AISI 316
1.39.3	Pulley material	Aluminium
1.39.4	Guide wire	SS 316 Stainless steel
1.39.5	Accuracy	± 2 mm
1.39.6	Indication	On circular or vertical dial
1.39.7	Rating	Twice the design pressure

SR. NO.	ITEM	DESCRIPTION
1.40	FLOW INDICATING SWITCH	
1.40.1	Type	On line metal tube Rotameter.
1.40.2	End connection	Flanged.
1.40.3	Material	
(a)	Body	CS/SS as per process medium.
(b)	Float	Stainless steel.
(c)	End fittings/flange	Stainless steel.
(d)	Other wetted part	Stainless steel.
(e)	Casing	Di cast Aluminium.
1.40.4	Accuracy	+/- 2.0% of FSR.
1.40.5	Rangeability	10:1.
1.40.6	Electrical connection	¾" ET.
1.40.7	Switch type	Snap acting hermitically sealed 2 nos. SPDT.
1.40.8	Contact rating	5A, 240V AC.
1.40.9	Protection class	IP-65.
1.40.10	Accessories	As required.
1.41	ZERO SPEED SWITCH	
1.41.1	Probe	
	(a) Type	Magnetic pick up (inductive type)
	(b) Size	As per requirement

SR. NO.	ITEM	DESCRIPTION
	(c) Protection class	NEMA 4 (IP 65)
	(d) Enclosure type	Robust cast aluminium
1.41.2	Electronic unit	
	(a) Supply voltage	240 V AC ± 10%, 50 Hz.
	(b) Speed range	As per process requirement
	(c) Speed setting accuracy	Within ± 5% of desired value.
	(d) Repeatability	Within ± 1%.
	(e) Differential	Within ± 5% of set value
	(f) Output contact type	2 NO + 2 NC
	(g) Contact rating	240V, 5A AC/ 220V, 0.5A DC.
	(h) Ambient Temperature	0-60 Deg. C.
	(i) Preferable features	(i) Red LED for "Supply On"
		(ii) Green LED for "Relay On"
		(iii) Display of present speed
		(iv) Alarm facility with indication
1.42	BELT SWAY SWITCH	
1.42.1	Type	Microprocessor based
1.42.2	Body	CI
1.42.3	Protection class	NEMA 4 (IP 65)
1.42.4	Enclosure type	Die cast aluminium; Flame proof
1.42.5	Output contacts	2 NO + 2 NC

SR. NO.	ITEM	DESCRIPTION
1.42.6	Contact Rating	240V, 5A AC/ 220V, 0.5A DC.
1.42.7	Reset facility	Auto reset
1.42.8	Contact roller support	Bearing with high relative lubrication & low Coefficient of friction.
1.42.9	Accessories	Canopy
1.43	PULL CHORD SWITCH	
1.43.1	Type	Microprocessor based
1.43.2	Body	CI
1.43.3	Protection class	NEMA 4 (IP 65)
1.43.4	Enclosure type	Die cast aluminium; Flame proof
1.43.5	Output contacts	2 NO + 2 NC
1.43.6	Contact Rating	240V, 5A AC/ 220V, 0.5A DC.
1.43.7	Reset facility	Manual reset
1.43.8	Local trip indication	Required
1.43.9	Operating handle	Fitted with spring steel rings at both ends
1.43.10	Accessories.	(i) Canopy over lever of pull cord switch.
		(ii) Linking of switches through a single cable for each section.
1.44	BELT WEIGHING SYSTEM	
1.44.1	General	
	The mechanical design and constructional features for belt weigher has been described under mechanical section, hence not repeated here. Similarly motor	

SR. NO.	ITEM	DESCRIPTION
	specifications for the same has been covered under electrical specification, hence not repeated here. (Bidder may also refer ANNEXURE-A, clause no. 5.0 of this section for additional features.)	
	The belt weighing system shall have its own local panel to be located in electrical equipment room. The Local panel shall include: (a) Local flow rate indication (b) Integrated flow indication (c) System alarm annunciation (d) Local calibration facility (e) Power On/ Off All these above displays shall be backlit LCD type with 12mm character height. Battery backup shall be provided for the measurement system. (a) Application : Bulk material, Powder material (b) Drive Protection : Reverse Polarity Communication failure	
1.44.2	Load sensing cell	
	(a) Type	Strain Gauge
	(b) Enclosure Protection	NEMA 4X (IP 66)
	(c) Load	
	(i) Nominal load	Bidder to specify in tabular form.

SR. NO.	ITEM	DESCRIPTION
	(ii) Rated Load	Bidder to specify in tabular form.
	(iii) Destructive Load	Bidder to specify in tabular form.
	(d) Supply Voltage	24VDC
	(e) Sensing	Resistance bridge.
	(f) Temp. effect on zero & span	± 0.015%/ 10K
	(g) Basic Resistance	Manufacture's standard
	(h) No. of load sensors	Single
	(i) Mounting type	Four idler
	(j) Accessories	Mounting plate kit, cable etc.
	(k) Accuracy	± 0.015% FSD
	(l) Speed sensor	Tacho/ Encoder.
	(m) Speed output	Pulse train to be distributed to -
		(i) Local panel for own use
		(ii) 4-20mA DC signal to PLC
	(n) Load sensor output	4-20mA DC isolated signal for PLC along with provision for serial communication link standard protocol
	(o) Computed flow rate	
	(i) Hardware	4-20mA DC isolated 2 numbers
	(ii) Serial Link	In compliance with standard protocol
	(p) Protection class for measuring cell	NEMA 4X (IP66)

SR. NO.	ITEM	DESCRIPTION
	(q) Accessories	Special cables, electronics, cabinets etc. as required to make the system complete, with bar/chain.
	(r) Range	Application dependent.
	(s) Range increment	0.1% of this selected range.
	(t) Operating temperature	0 -70 ^{0}C
	(u) Accuracy	± 0.5% FS range
~~2.0~~	~~CONTROL PANELS/DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES~~	
~~2.1~~	~~COUPLING RELAY~~	
~~2.1.1~~	~~Type~~	~~Octal base plug in type/ DIN rail Mounting.~~
~~2.1.2~~	~~Coil voltage~~	~~24 V D.C. in general / other as required.~~
~~2.1.3~~	~~Contact~~	~~2 NO & 2 NC (Minimum).~~
~~2.1.4~~	~~Contact rating~~	~~250 V/5A (A.C)/220V/2A (D.C).~~
~~2.1.5~~	~~Operating range~~	~~70 to 110% of rated voltage.~~
~~2.1.6~~	~~Insulation~~	~~2 kV for 1 minutes between terminal & earth.~~
~~2.1.7~~	~~Mechanical life~~	~~20 million operations.~~
~~2.1.8~~	~~Coil protection~~	~~Diode.~~
~~2.1.9~~	~~Indication~~	~~Coil on LED.~~

5.1 CONDUCTIVITY ANALYZER

5.1.1 Sensor

(a)	Type of Cell	:	Flow thru'.
(b)	Conductivity Range	:	As per instrument schedule
(c)	Cell Constant	:	0.01/0.1/1.0 depending upon range.
(d)	Temp. Compensation	:	Manual and Automatic (Integral) 0-100°C.
(e)	Process Connection	:	Screwed.
(f)	Wetted Parts	:	Electrodes-SS316L/ Insulators KYNAR/Viton.
(g)	Pressure Rating	:	10 kg/cm².
(h)	Accessories	:	Vessel (SS 316) with ½" NPT connection.
(i)	Cable	:	Upto transmitter in flexible conduct.

5.1.2 Transmitter

(a)	Type	:	Microprocessor based, Single stream
(b)	Mounting	:	Flush Panel.
(c)	Protection Class	:	IP-55 or better.
(d)	Output	:	4-20 mA DC (isolated).
(e)	Display	:	Digital Display in Engineering Unit, Alarm Status.
(f)	Zero/Span Adjustment	:	Front Panel Membrane type

				Keyboard.
	(g)	Temp. Compensation	:	Manual or Automatic.
	(h)	Diagnostic	:	Self diagnostic for electronics, electrode etc.
	(i)	Alarm	:	Dual set point, hysteresis and time delay adjustable.
	(j)	Enclosure	:	Die cast aluminium, epoxy coated.
	(k)	Cable Termination	:	Internal (cable entry through conduit).
	(l)	Accuracy	:	± 1.0 % of measured range.
	(m)	Response time	:	Less than 5 sec.
	(n)	Stability	:	± 1.0 % of output range / month non-cumulative.
	(o)	Accessories	:	For cation conductivity- Dual Ion-Exchange column, resin, etc. (minimum 12 months' requirements).
5.2	pH ANALYZER		:	
5.2.1	Sensor		:	
	(a)	Type of Cell	:	Flow thru'.
	(b)	Range	:	0-14 pH.
	(c)	Type of measurement	:	Combination electrode.
	(d)	Temp. Compensation	:	Manual and Automatic (Integral) 0-100 ^{0}C.

	(e)	Process Connection	:	Screwed.
	(f)	Measuring Electrode	:	Glass.
	(g)	Pressure Rating	:	10 kg/cm².
	(h)	Accessories	:	Vessel (SS 316) with ½" NPT connection.
	(i)	Cable	:	Upto transmitter in flexible conduct.
	(j)	Preamplifier	:	Integral or separate.
	(k)	Liquid Junction	:	Ceramic / Kyner or equivalent.
5.2.2	Transmitter		:	
	(a)	Type	:	Microprocessor based, Single stream
	(b)	Mounting	:	Flush Panel.
	(c)	Protection Class	:	IP-55 or better.
	(d)	Output	:	4-20 mA DC (isolated).
	(e)	Display	:	Digital Display in Engineering Unit, Alarm Status.
	(f)	Repeatability	:	± 1% or better.
	(g)	Temp. Compensation	:	Manual or Automatic.
	(h)	Diagnostic	:	Self diagnostic for "Calibration requried"/ "Calibration O.K.", electrode checking etc.
	(i)	Alarm	:	Dual set point, hysteresis and time delay adjustable.

(j)	Enclosure	:	Die cast aluminium, epoxy coated.
(k)	Cable Termination	:	Internal (cable entry through conduit).
(l)	Accuracy	:	± 0.2% of FSD or better.
(m)	Response time	:	Less than 5 sec.
(n)	Stability	:	± 0.001 pH / week.
(o)	Accessories	:	Ultrasonic Electrode Cleaner, Buffer solution tablets.

5.3 SILICA ANALYZER :

(a)	Type	:	Colorimetric monitor, gravity / pumped feed Microprocessor based.
(b)	Output	:	4-20 mA DC (isolated) into 600 ohms.
(c)	Readout	:	Digital Indicating meter for direct readout.
(d)	Accuracy	:	± 1% of F.S.D or better.
(e)	Reproducibility	:	± 2% of F.S.D. or better.
(f)	Calibration	:	Manual & automatic.
(g)	Cycle time	:	Less than 10 min or better.
(h)	Operating temperature	:	0-45 ^{0}C .
(i)	Mounting	:	Flush panel.
(j)	Life of light source	:	9,000 hours (approx.).

(k)	Alarm Facility	:	2 HI & 2 LO independently adj. over span.
(l)	Alarm for	:	Monitor mal-function.
		:	Monitor on standby.
		:	Monitor auto-zeroing.
		:	Concentration high.
		:	Loss of sample.
		:	Concentration low.
		:	Loss of reagent.
(m)	Accessories	:	Reagent cabinet.
		:	Sample strainer.
		:	Reagent Reservoir etc.
		:	Phenolic name plate.
		:	Reagents & consumables for 1 year.
		:	Special cables.

5.4 SODIUM ANALYZER ASSEMBLY :

(a)	Type of Cell	:	Flow Through ion-selection electrode.
(b)	Flow Chamber	:	Plexi Glass Body or equivalent.
(c)	Measuring Electrode	:	Sodium Selective Glass Electrode.
(d)	Output	:	4-20 mA DC (isolated) into 600

			ohms.
(e)	Temp. Compensation	:	Automatic upto 45 Deg.C.
(f)	Read Out	:	Digital Indicating meter.
(g)	Accuracy	:	< 5% of reading.
(h)	Response Time	:	2 minutes or better.
(i)	Mounting	:	Flush Panel.
(j)	Calibration	:	Automatic.
(k)	Alarm Facility	:	2 HI and 2 LO independently adj. over span.
(l)	Accessories (Preassembled, pre- wired and pre-tubed in enclosure)	:	Phenolic tag plate etc.
		:	Sample filter.
		:	Pressure regulator & flow meter.
		:	Automatic calibration kit.
		:	Reagents and consumables.
		:	Special cables.

5.5 HYDRAZINE ANALYZER :

(a)	Type	:	Electrochemical Type.
(b)	Output	:	4-20 mA DC linear.
(c)	Readout	:	Digital Indicating Meter, linear read-out.
(d)	Accuracy	:	±2% of FSD or better.
(e)	Reproducibility	:	2% of FSD or better.

(f)	Drift	:	2 ppb/month or better.
(g)	Temp. Compensation	:	Automatic up to 45 ^{o} C.
(h)	Response Time	:	1 minutes or better.
(i)	Mounting	:	Flush Panel.
(j)	Alarm Facility	:	2 HI and 2 LO independently adj. over span.
(k)	Preferred Feature	:	2 Hi and LO alarm LED visible from front.
		:	Power supply on/failure LED.
(l)	Accessories	:	Chemical reagents for 12 months.

5.6 DISSOLVED OXYGEN ANALYZER :

(a)	Type	:	Electro-chemical, Microprocessor based.
(b)	Range	:	As per approved instrument schedule
(c)	Type of Cell	:	Flow through sampling type (continuous).
(d)	Enclosure	:	IP-55 or better.
(e)	Output	:	4-20 mA DC isolated to a load of 600 Ohms (minimum).
(f)	Temp. Compensation	:	Automatic up to 45 Deg.C
(g)	Readout	:	Digital Indicating meter.
(h)	Accuracy	:	Better than ± 4% of full scale for Transmitter.

(i)	Sensor Response Time	:	90% in 30 seconds or better.
(j)	Mounting	:	Flush panel.
(k)	Alarm Facility	:	2 HI & 2 LO independently adj. over span.
(l)	Preferred Feature	:	HI & LO Alarm LED visible from front.
		:	Power supply on/failure LED.
		:	In-built calibration facility.
(m)	Accessories	:	Reagent Cabinet (if applicable).
		:	Reagent Reservoir (if applicable).

5.7 CHLORIDE ANALYZER :

(a)	T y p e	:	Electro-chemical, Microprocessor based.
(b)	Type of Cell	:	Chloride Ion Selective Electrode.
(c)	Enclosure	:	IP-55 or better.
(d)	Output	:	4-20 mA DC isolated to a load of 600 Ohms.
(e)	Temp.Compensation	:	Automatic with Pt 100.
(f)	Ambient Temp.	:	45 Deg. C
(g)	Readout	:	Digital Indicating meter.
(h)	Accuracy	:	± 2% or better.
(i)	Reproducibility	:	<3%.
(j)	Detection Limit	:	0.5 mg/l or better.

(k)	Analysis Time	:	5 minutes (max).
(l)	Cycle time	:	Adjustable.
(m)	Calibration	:	Manual and automatic.
(n)	Mounting	:	Flush panel.
(o)	Alarms	:	1 HI, 1 LO and 1 system alarm.
(p)	Control accessories	:	Sample level detector.
		:	Reagent level detector.
		:	Calibration solution level detector.
		:	Automatic sample, rinse and drain valve.
		:	Pump for reagent solution.
		:	Pump for calibration solution.
(q)	Accessories	:	Reagent solution tank.
		:	Calibration solution tank.

5.8 SAMPLE CONDITIONING SYSTEM

5.8.1 Sample conditioning system shall be designed and constructed to receive and condition all samples as required by the respective analyzers. This shall include all conditioning equipment mentioned herein:

(a) Sample filtering.

(b) Primary and final sample cooling and temperature control.

(c) Pressure reduction and control, as required.

(d) Flow rate control.

SR. NO.	ITEM	DESCRIPTION
	(k) Colour of letters	Black (for white windows)
	(l) Facia front cover	Hi-impact polystyrene
	(m) Facia rear plate	Translucent plastic
	(n) Colour of background	Milk white and red for critical / trip.
	(o) Fascia block plate	Cold rolled sheet steel epoxy painted.
	(p) Audible alarm	Cone type speaker
	(q) Tone generator	Electronic with adjustable tone, amplitude and frequency
	(r) Preferred sequence	(i) Ordinary Channel : ISA-S 18.1 1979 R
		(ii) First up channel : ISA-S 16.1 1979 F3M3

NOTE:

1. Instruments which are open to atmosphere should be covered with proper canopy.

3.0 CONTROL VALVES, ACTUATORS & ACCESSORIES

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

(a) Bidder shall exercise caution in selecting severe service control valves like BFP recirculation valves, HP & LP bypass valves, superheater & reheater attemperator valves, PRDS valves for Boiler & Turbine, Soot blower steam pressure control valve, control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control, condenser make up water control valve, separator level control and CEP minimum flow control valve. For such critical applications, Bidder shall offer valves which are proven

for similar application. Above valves shall have leakage class equal or better than class-V with metal-to-metal seating.

(b) Wherever, steam conditioning calls for Pressure reducing & desuperheating, combined PRDS type valves shall be offered.

(c) Bidder shall provide redundant control valves for Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum for high availability. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.

(d) Control valves shall be located near floor or platform for ease of access and with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream isolating valve, inching duty motorized bypass valve and manual drain valves. Each redundant control valve shall have its upstream motorized and down-stream manual isolating valves. Where quick shut off requirement is foreseen such as in case of SH & RH attemperation valves, upstream isolation valve shall be pneumatic type.

3.1 GENERAL

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

3.1.2 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.

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

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

3.2 VALVE BODY/END CONNECTIONS

3.2.1 Valve end to end dimension and connection shall be according to ANSI standard, straight through pattern. However, Bidder may offer angle body valve for high pressure drop applications. For high pressure drop applications, construction of the valve shall be such that the gland is not exposed to inlet pressure.

3.2.2 Control valves of 40 mm. size and above with line pressure up to 50 Kg/Sq. cm may have flanged or welded end connections.

3.2.3 Control valves, used in high pressure services shall have butt welded end connections for size 65mm and above and socket weld end connection for size 50 mm or below.

3.2.4 Control valve body shall be selected as per the ISA guideline. Generally control valve body shall be cast and machined for pressure rating up to 1500 lbs. Above 1500 lbs, valve body shall be of forged steel. For Demineralized Water application, valve body shall be Stainless Steel.

3.2.5 The direction of flow shall be clearly engraved on the body.

3.2.6 Valve Body Material

SR.NO.	SERVICE		MATERIAL
(a)	Non corrosive, non-flashing and non cavitating service for fluid temperature upto 275°C	:	Cast carbon steel ASTM A216 Gr. WCB
(b)	Non corrosive, non-flashing and non cavitating service for fluid temperature above 275°C	:	Cast alloy steel ASTM A217 Gr. WC9
(c)	Severe flashing / cavitating services	:	Cast alloy steel ASTM A217 Gr. WC9
(d)	Low flashing / cavitating services	:	Cast alloy steel ASTM A217 Gr. WC6

SR.NO.	SERVICE		MATERIAL
(e)	DM water application (condenser hotwell normal, emergency make up etc.)	:	Cast type 316 stainless steel ASTM A351 Gr. CF8M

3.3 VALVE SIZE

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

(a) The valves shall pass normal flow (MCR condition) with 60 to 70 percent opening for linear characterized valves and between 70 to 80 percent opening for equal percentage characterized valves.

(b) The valves shall have adequate rangeability to pass the minimum and maximum flows at 10% and 85% of the valve opening respectively. Valve stem travel range from minimum to maximum flow condition shall not be less than 50% of the total valve stem travel.

(c) Valve CV shall be selected in such a way that the valve shall be capable of handling at least 120% of required maximum flow.

(d) The valve selection shall be based on the highest size dictated by the above considerations unless noise, flashing or other factors dictate the final selection.

(e) Trim outlet velocity for the control valves shall be no more than 7 m/sec for water service and Mach number less than 1/3 for steam and air service application.

(f) The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.

3.4 VALVE TOP WORK

3.4.1 Top work shall be sized so that the valve shall operate properly when upstream pressure is 10 percent above maximum inlet pressure and downstream pressure is atmospheric.

3.4.2 Extended bonnet/Finned bonnet and high temperature packing shall be used for high temperature application.

3.4.3 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for lower temperature application (232°C maximum) and for high temperature application graphite asbestos glands are to be provided. For vacuum services, the glands shall be of dry seal type.

3.5 VALVE TRIM

3.5.1 Valve trim for applications up to leakage class-V shall be stainless steel 316 SS for pressure drop up to 7 Kg/Sq. cm. For pressure drops above 7 Kg/ Sq. cm hard trim (stelliting or equivalent) shall be used. Other alloys or treatment such as nitride shall be used if severe erosion is expected.

3.5.2 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators.

3.5.3 For flashing services and two stage mixtures, the trim material shall be 17-4 PH SS or equivalent.

3.5.4 If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trim valves. Trim of severe service valves shall be of multistage and multipath design with number of discrete pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.

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

3.5.6 Trim Material

SR. NO.	SERVICE		MATERIAL
(a)	Non corrosive, non-flashing and non cavitating service for fluid temperature upto 275°C.	:	SS 316 stellited
(b)	Non corrosive, non-flashing and non cavitating service for fluid	:	SS 316 stellited

SR. NO.	SERVICE		MATERIAL
	temperature above 275°C.		
(c)	Severe flashing /cavitating services	:	440 C
(d)	Low flashing /cavitating services	:	17-4 PH SS
(e)	DM water application (condenser hotwell normal, emergency make up etc.)	:	17-4 PH SS

3.6 NOISE LEVEL

The equivalent sound level measured at 1.5M above nearest floor level in elevation and 1 M horizontally from the control valve expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dB. If the calculated noise is more than the above limit, even with low noise trim design, diffusers shall be included. Diffusers shall be made of stainless steel and shall be integrally connected to the control valve with spool piece. The spool piece shall be in conformity with the main line piping specification.

3.7 VALVE ACTUATORS

Spring-diaphragm type actuators shall generally be used. Piston type actuators shall be offered in case of high shut-off pressure & quick response requirement.

3.7.1 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.

3.7.2 Diaphragms shall be designed for 200% maximum operating pressure.

3.7.3 Nylon reinforced neoprene is preferred as diaphragm material.

3.7.4 Valve actuators shall be capable of operating at 80°C ambient, continuously.

3.7.5 Entire actuator assembly shall be painted with corrosion inhibiting paint.

3.7.6 Air connection size shall be ¼" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be stainless steel.

3.7.7 Bidder shall indicate the stroking time of the valve assemblies with positioner and ensure that the stroke time shall meet the process and equipment dynamics and shall be better than 20 seconds.

3.7.8 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.

3.8 VALVE POSITIONERS

3.8.1 Regulating duty valves shall be offered with SMART Electro Pneumatic Positioners to ensure accuracy and repeatability of response.

3.8.2 Positioners shall have integral non contact type position transmitter, input and output gauges, local keypad & display.

3.8.3 Positioners shall be capable of functioning under hot, humid and vibrating conditions.

3.8.4 Positioner casings shall be dust tight, corrosion resistant and weatherproof.

3.8.5 In general, positioner shall operate at signal range 4 - 20 mA DC for the full travel of the valve. Remote calibration from control room shall be possible through HART management station for main plant positioners. However the calibration of positioner of off-site plants shall be carried out from hand held station.

3.9 VALVE ACCESSORIES

Accessories shall include side mounted hand wheels, limit switches, junction boxes, airlock relays etc.. Solenoid valve wherever required shall be furnished.

LOCAL CONTROL PANEL AND JB DETAILS

4.0 CONTROL DESK / PANELS / RACKS

(a) Convenient and logical approach to operational interfaces and aesthetics in the overall view of the panel /desk shall be considered.

(b) For items susceptible to vibration, suitable anti-vibration padding shall be provided to prevent damage or malfunction.

(c) All items inside the panels/cabinets shall be neatly arranged with easy access/maintenance approach.

(d) Incoming power supply feeders shall be duplicated . Alarm shall be provided for failure of a power supply feed.

(e) Desk/panel shall be provided with interior illumination, utility receptacles with plug and cooling fan.

(f) Panel/Desk shall have gland plate at cable entry to panel. Thickness of gland plate shall not be less than 3 mm.

(g) Wire shall be routed/laid through covered trough.

(h) Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

(i) Nameplate

(i) Nameplate shall be provided for instrument or device mounted on the panel.
(ii) Nameplates for panels shall be provided both in front and rear.

(j) All local control panels shall be housed in air condition environment.

4.1 CONTROL DESK

4.1.1 Devices mounted on the desk shall be flush type. Devices shall be so mounted that their removal and replacement can be accomplished without interruption of services to others.

4.1.2 Desk shall be ergonomically designed to suit working on a 24 X 7 basis. Aesthetics, ergonomics and illumination shall be considered while positioning of the desk, large video screen and panels in control room.

4.1.3 Control desk shall be free standing floor mounting type of table-top design with compartments for locating the hardware. Desk shall be constructed from aluminum extrusion with high pressure laminate MDF board for work surface of approved colour. Aluminium structure shall be anodized or powder coated paint finish. Thickness of sheet shall not be less than 3 mm.

4.1.4 Monitors with retractable keyboard, emergency push buttons shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.

4.1.5 Desk shall be of modular, scalable and industrially ruggedized design and shall have Telephones and Intercom connections.

4.1.6 Desk shall have concealed cable trays for wire dressing.

4.1.7 Design shall include Earthing bolts.

4.1.8 Back installed items shall be suitably concealed from front view.

4.2 BACK UP PANEL

4.2.1 Construction shall be from sheet steel of thickness not less than 3 mm.

4.2.2 Electrical upright Panel construction & design shall be similar to back up panel. Control switches, meters, indicators, synchronizer, excitation control switch, annunciation window etc. along with associated mimic diagram, as recommended, shall be provided for manual synchronization of generator.

4.2.3	Cabinets/Enclosure/Panels		
(a)	Material of construction	:	Cold rolled steel sheet.
(b)	Thickness of Sheet	:	(i) 2.0 mm for faces supporting instruments / terminals.
(c)	Construction	:	Welded throughout as per approved National Standards.
(d)	Panel height	:	2300 mm. (approx)
(e)	(i) Corners	:	7 mm inner radius.
	(ii) Dimensional	:	a. In height & length - 3 mm.
	(iii) Tolerances	:	b. In height between adjacent sections - 2 mm.
		:	c. Total for a group - 6 mm.
(f)	Doors	:	Double, recessed, turned back edges.
	(i) Thickness of Sheet	:	2 mm.
	(ii) Hinges	:	Stainless steel.
	(iii) Door latches	:	Three point type.
	(iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure.
	(v) Opening of the doors	:	Outward.
	(vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof.
(g)	Color of interior	:	Brilliant white.
(h)	Colour external	:	RAL 7032.

(i)	Painting	:	Epoxy powder coated or better.
(j)	Gland plates	:	Removable 3 mm thick. (bottom)
(k)	Cable entry	:	Bottom.
(l)	Hardware	:	(i) Anti vibration pad- 15 mm.
		:	(ii) Predrilled base channel ISMC - 10 or equivalent for all sides.
		:	(iii) Stainless steel buff- finished 2 mm thick kick plate for all sides.
		:	(iv) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws.
		:	(v) Rubber strips to ensure air tightness between kick plate and finished floor.
		:	(vi) Lifting hook / Eye bolt.
		:	(vii) Drawing pocket.
		:	(viii) Door switch, lamps, thermostat, heaters and fans.
(m)	Enclosure Protection	:	As per environment condition of the area of installation. Refer section-1 of this vol.

4.3 LOCAL INSTRUMENT RACKS & ENCLOSURE

4.3.1 General Requirements

(a) Devices located in the field shall be grouped and installed in the enclosure (Closed Rack) in outdoor areas such as Boiler area etc. and in Open Type Rack in covered areas such as TG Building.

(b) Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc,.

(c) No more than six instruments shall be grouped in a single rack/ enclosure.

(d) Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.

(e) Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air/gas piping.

(f) Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.

(g) Instrument piping and tubing shall be hydrostatically tested at one and one-half times the maximum system pressure except for low pressure and vacuum measurement for which the test pressure will be as per piping standard.

(h) Service air connection shall be provided for continuous and intermittent purging of impulse pipe in dusty medium. Continuous purging shall be adopted for differential pressure measurement such as flue gas and coal air mixture application. Pressure measurement shall have only intermittent purging whenever required. In case of continuous purging, an air header shall be formed which shall receive service air through isolation valve and air filter regulator. Air shall be fed from the air header to both the impulse pipes near to take off points through isolation valves and flow regulators. Air header shall be constructed from stainless steel. Impulse pipe for such applications shall have a four-way valve. One port of the valve shall have an adaptor to connect flexible stainless steel braided nylon hose to the service air. Rating of the hose shall not be less than 10 Kg/sq.cm. Four way valve shall have two position operations. One position for service and other one for purging. Required pressure gauges shall be provided for monitoring of air pressure. Complete purging arrangement shall be integral to the enclosure and racks.

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

(j) Drawing No. PE-189-IN-SK-8004/P0 (Sheets 10) shall be referred for typical arrangement of Local instrument enclosure and rack.

4.3.2 Closed Instrument Rack

(a) Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load-bearing posts shall be suitably supported by gusset plates or moment members.

(b) Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black color finish.

(c) 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any member, which would reduce access, shall be avoided.

(d) Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.

(e) Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box.

(f) Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket Impulse lines within the enclosures shall be properly clamped.

(g) All internal wirings between the instruments and junction box shall run through flexible conduits.

(h) Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Header shall be of 2" NB ASTM A 106, Sch-80 Gr. C installed at a slope of 1:25 and extended beyond the rack for connection to plant drain header.

(i) Each rack shall be provided with one receptacle, light fixtures each at instrument & Junction box compartments with wire guard.

4.3.3 Open Instrument Rack

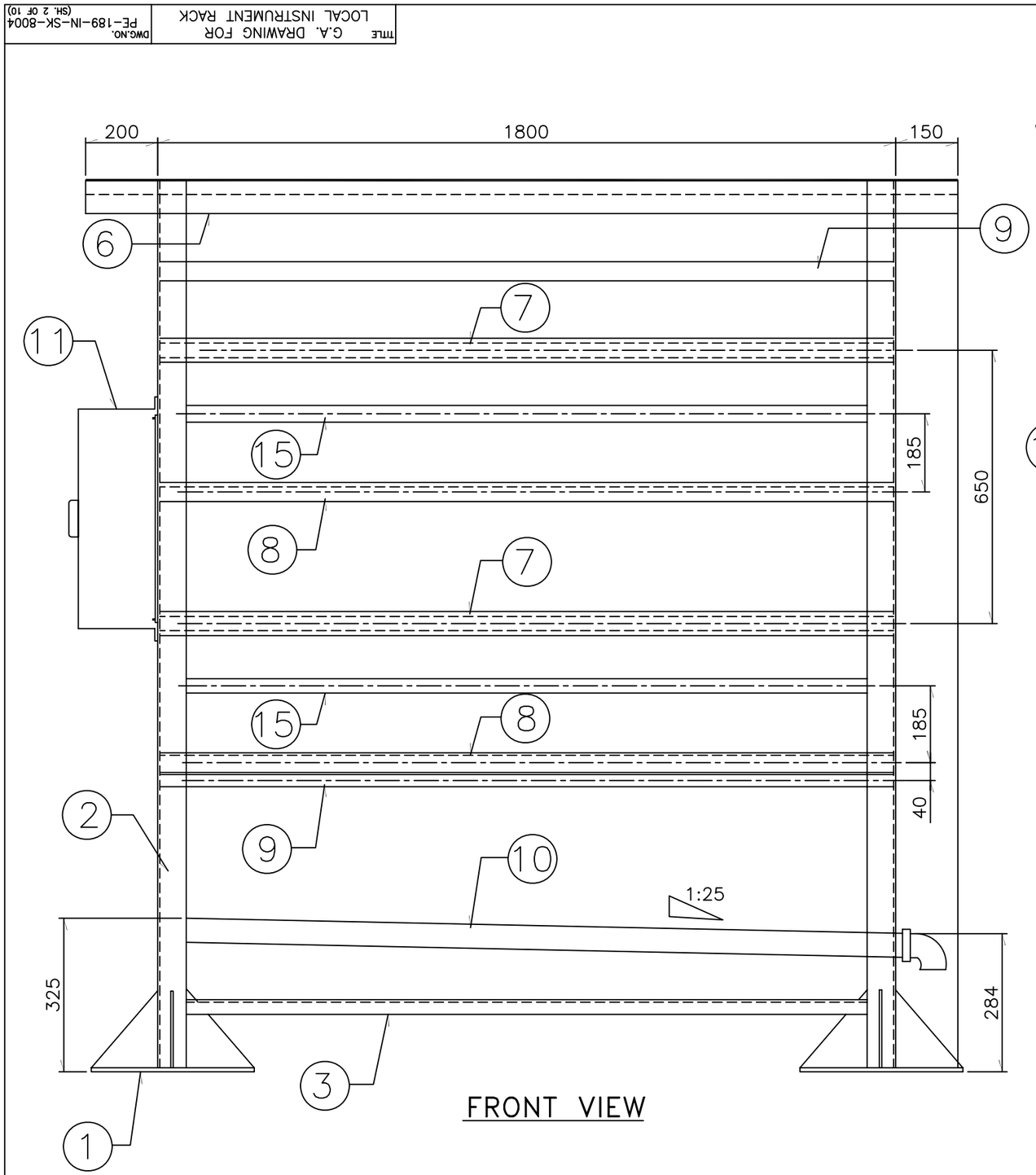
(a) Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or falling objects and shall be epoxy painted. Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable protective grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project. Canopy shall be of CRCA steel sheet of at least 3 mm thickness. Center posts or any member, which would reduce access, shall be avoided.

(b) 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

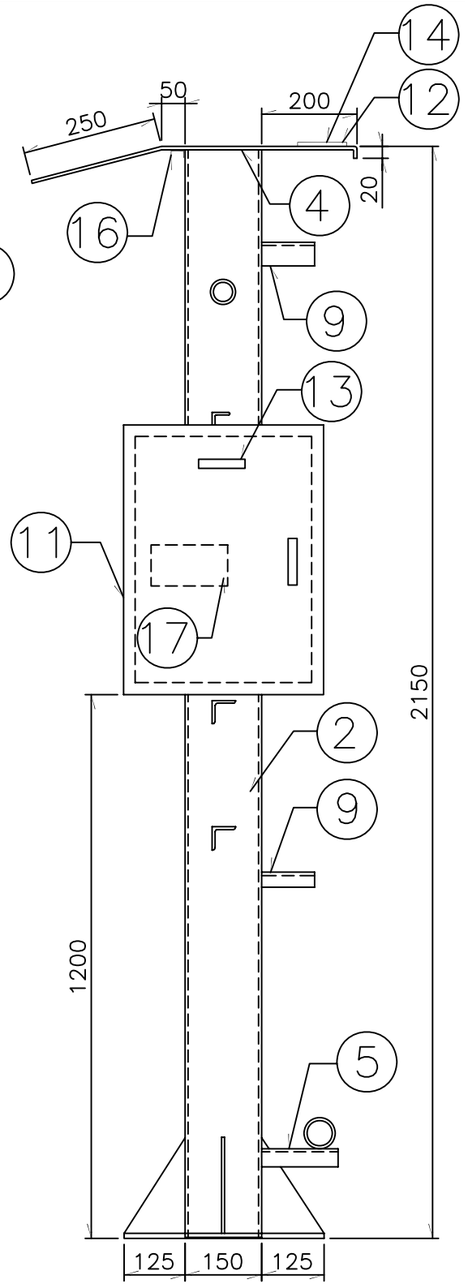
(c) All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

(d) All racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Header

TITLE	DWG.NO.
G.A. DRAWING FOR LOCAL INSTRUMENT RACK	PE-189-IN-SK-8004 (SH. 2 OF 10)



FRONT VIEW



RH SIDE VIEW

LEGEND:

ITEM NO.	DESCRIPTION
1.	M.S. PLATE 400 x 400 x 10
2.	ISMC 150 x 75 x 6
3.	ISMC 75 x 40 x 5
4.	CANOPY MOUNTING PLATE 5mm THICK.
5.	BRACKET FOR DRAIN PIPE.
6.	CANOPY ASSEMBLY 3.0mm THICK CRCA SHEET.
7.	GI PIPE 2" NB CLASS B FOR TRANSMITTER MOUNTING.
8.	M.S. ANGLE 40 x 40 x 5
9.	BRACKET FOR IMPULSE PIPE SUPPORT.
10.	DRAIN PIPE MATERIAL ASTM A106 GR. 'C' SIZE 2'' NB SCH 80.
11.	JUNCTION BOX SIZE: 480(H) x 360(W) x 180(D).
12.	BULKHEAD M.S. PLATE 5mm THICK.
13.	COMPACT FLUORESCENT LAMP FOR RACK ILLUMINATION.
14.	XLPE GASKET IN BETWEEN BULKHEAD PLATE & CANOPY MOUNTING PLATE.
15.	PVC CABLE TRAY/ FLEXIBLE CONDUIT FOR CABLE
16.	C' CHANNEL FOR LIGHT FITTING.
17.	TAG PLATE.

NOTES:

1. POWER SOCKET & TB SHALL BE PROVIDED IN JB.
2. COLOR: RAL 7032. OVERALL THICKNESS > 100 MICRONS.
3. TAG PLATE SHALL BE PROVIDED FOR EACH INSTRUMENT.
4. 20% TERMINALS SHALL BE PROVIDED AS SPARE.
5. ANTIVIBRATION PAD & FOUNDATION BOLTS SHALL BE PROVIDED.
6. DIMENSIONS SHOWN ARE TENTATIVE AND SHALL BE FINALIZED AT DETAILING.
7. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.

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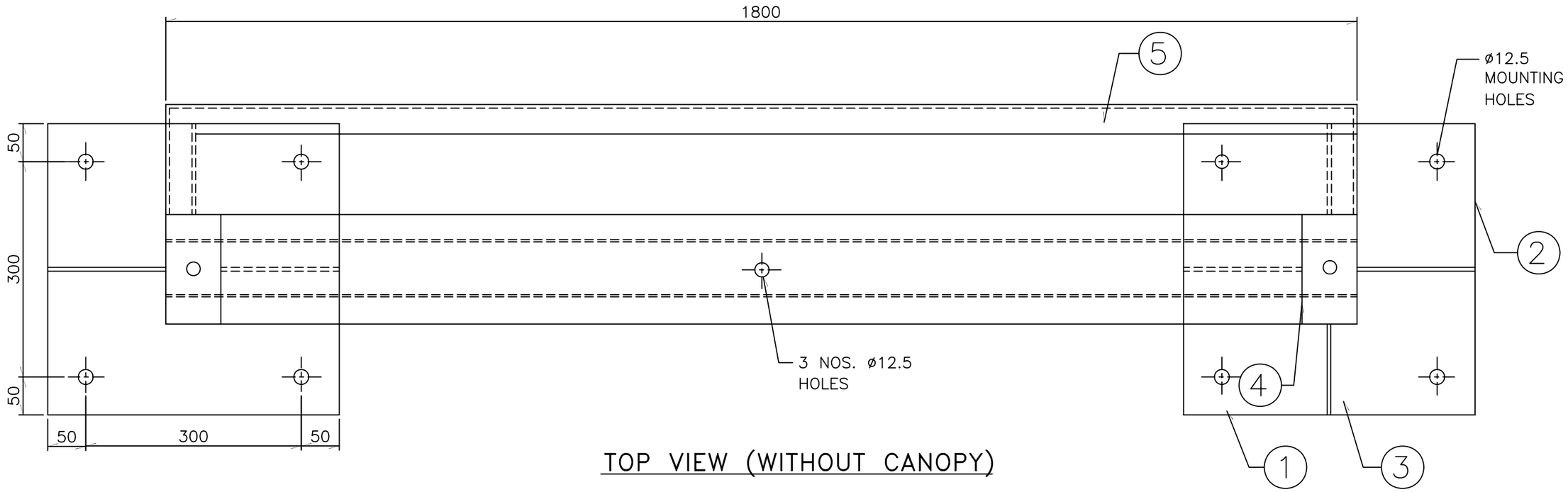
MAHARASHTRA STATE POWER GENERATION CO.LTD.

BHUSAWAL T.P.S. UNIT-6 : 1 X 660 MW PROJECT

G.A. DRAWING FOR LOCAL INSTRUMENT RACK

TECHNICAL SPECIFICATION FOR DM PLANT
1X660MW BHUSAWAL TPS-UNIT:6
MAHARASHTRA, INDIA.

TITLE	DWG.NO.
VIEW OF LOCAL INSTRUMENT RACK W/O CANOPY	PE-189-IN-SK-8004 (SH. 3 OF 10)



TOP VIEW (WITHOUT CANOPY)

NOTES:

1. M.S. PLATE 400 x 400 x 10.
2. RIB M.S. PLATE 162.5 x 170 x 5 THICK.
3. RIB M.S. PLATE 125 x 170 x 5 THICK.
4. RIB M.S. PLATE 134 x 165 x 5 THICK. (CANOPY MOUNTING PLATE SUPPORT)
5. BRACKET FOR IMPULSE PIPE SUPPORT.
6. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.

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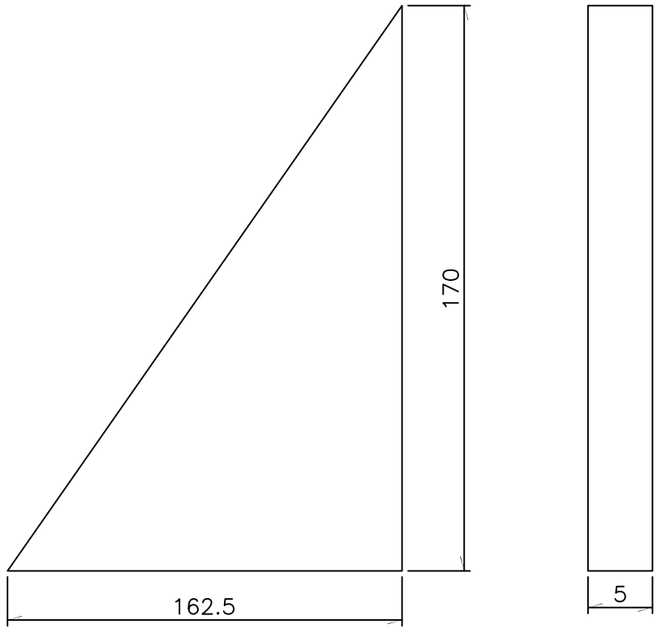
BHUSAWAL T.P.S. UNIT-6 : 1 X 660 MW PROJECT

VIEW OF
LOCAL INSTRUMENT RACK W/O CANOPY

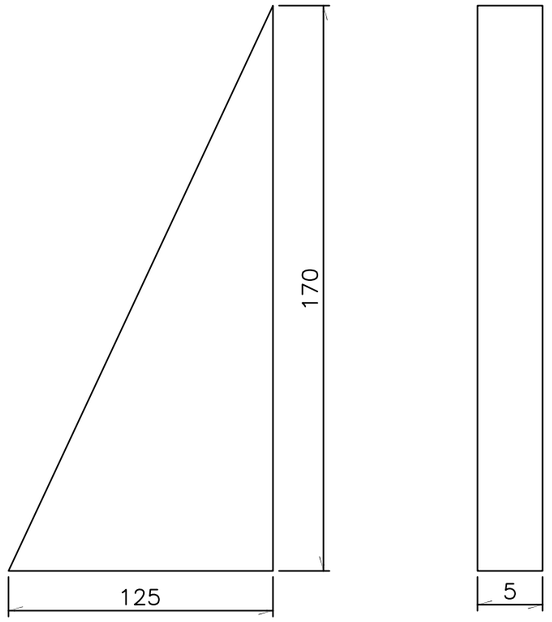
TECHNICAL SPECIFICATION FOR
DM PLANT
1X660MW BHUSAWAL TPS-UNIT:6
MAHARASHTRA, INDIA.

SH. D.W.G. NO. PE-189-IN-SK-8004(SH. 3 OF 10) REV. P0

TITLE	DWG.NO.
G.A. DRAWING OF CLEATS FOR LOCAL INSTRUMENT RACK	PE-189-IN-SK-8004 (SH. 4 OF 10)



DETAIL OF-1



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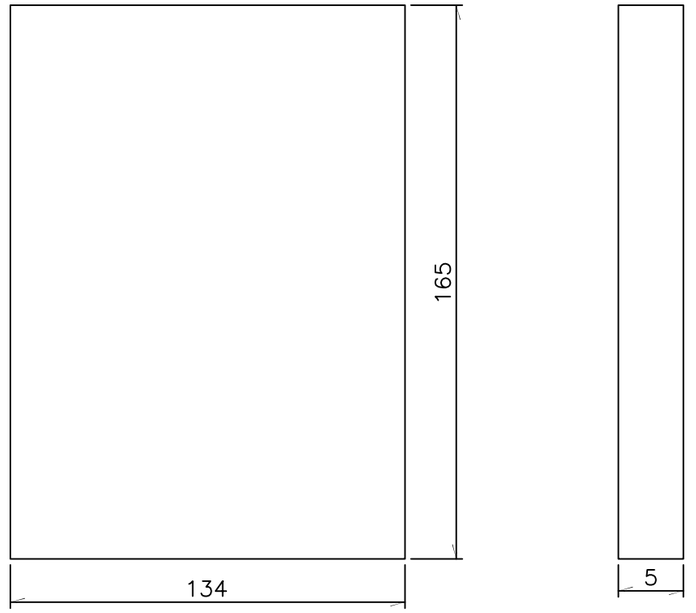

DETAIL OF-3

NOTES:

1. RIB M.S. PLATE 162.5 x 170 x 5 THICK.
2. RIB M.S. PLATE 125 x 170 x 5 HICK.
3. RIB M.S. PLATE 134 x 165 x 5 THICK.
4. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.

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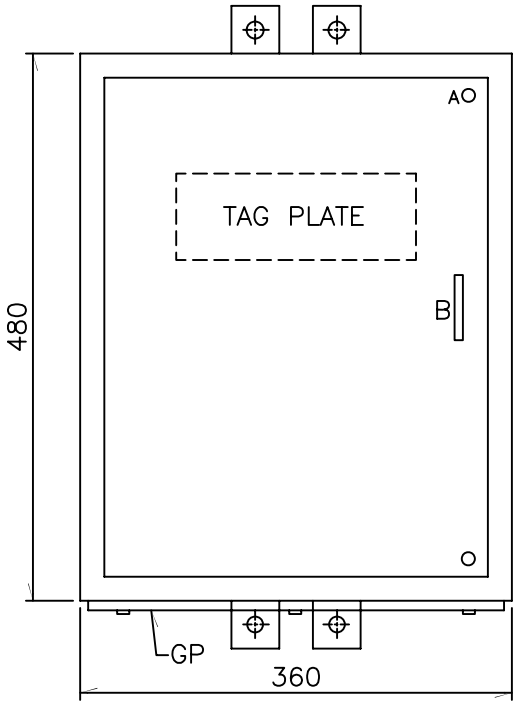
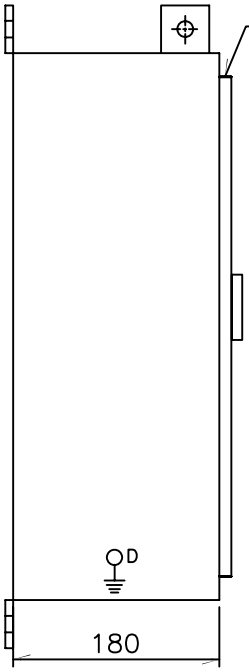
BHUSAWAL T.P.S. UNIT-6 : 1 X 660 MW PROJECT

G.A. DRAWING OF CLEATS FOR LOCAL INSTRUMENT RACK

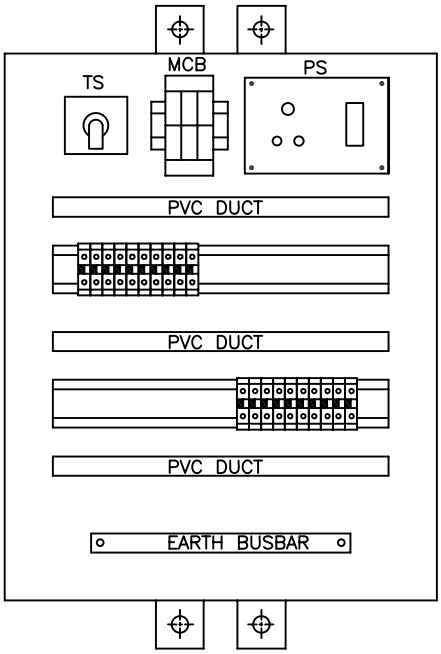
TECHNICAL SPECIFICATION FOR DM PLANT
1X660MW BHUSAWAL TPS-UNIT:6
MAHARASHTRA, INDIA.



FRONT VIEW



SIDE VIEW



INTERNAL FRONT VIEW

LEGEND:

A – DOOR LOCK
B – DOOR HANDLE
C – HINGES
D – EARTH STUD
GP – GLAND PLATE
PS – POWER SOCKET
TS – TOGGLE SWITCH
TBS – TERMINAL BLOCKS

NOTES:

1. JB WILL BE MADE OUT OF 2.0 mm CRCA SHEET.
2. PROTECTION CLASS IP–65.
3. COLOR: EXT.–RAL 7032, INT.–BRILLIANT WHITE.
4. NUTS FOR MOUNTING THE JUNCTION BOX SHALL BE PROVIDED.
5. 3 mm THICK CRCA GLAND PLATE (GP) AT BOTTOM SHALL BE PROVIDED.
6. SCREWLESS CAGE CLAMP TERMINALS SHALL BE USED.
7. EARTH BUS BAR SHALL BE OF 25x6 TINNED COPPER.
8. INSTRUMENT TAG VIS–A–VIS SERVICE AND TERMINAL DETAILS SHALL BE PRINTED ON PHENOLIC BOARD MOUNTED ON BACK SIDE OF DOOR.
9. COLOR CODE FOR POWER SUPPLY: PHASE–RED, NEUTRAL–BLACK & EARTH – GREEN.
10. CABLE FOR PANEL LIGHTING SHALL BE 1.5 SQ.mm, 1100V GRADE.
11. SIGNAL WIRING SHALL BE 4Px0.5 SQ.mm TINNED COPPER, TWISTED PAIR, OVERALL SHIELDED 500V GRADE, FRLS PVC.
12. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.

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TECHNICAL SPECIFICATION FOR DM PLANT 1X660MW BHUSAWAL TPS-UNIT:6 MAHARASHTRA, INDIA.

DO NOT SCALE | DATE : 23–08–2011

G.A. OF JB LOCAL INSTRUMENT RACK

SCALE ~ | APPROVED

DIV INST.
DR P.N.Z.
CH D.J.P.

DWG.NO.PE–189–IN–SK–8004 (SH. 5 OF 10) | P0