BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

FOR

WASTE WATER TREATMENT SYSTEM

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1.0 SCOPE OF SUPPLY & SERVICES

The intent of this specification is to cover Design, Engineering, Manufacturing, shop testing, supply, Transportation**,** erection & commissioning ,performance guarantee test and handing over of **Waste water Treatment system** as mentioned below.

The scope shall fully cover the requirement of the Design Criteria and Technical requirement of this specification for treating the waste water of Plant. The scope of supply & services shall include but not limited to the following :

a. 2 x 100% Backwash waste water transfer pumps with motors & accessories
b. 1 x 100% flash mixer with agitator
c. 1 x 100% flocculator with agitator
d. 1 x 100% tube settler with all accessories
e. 2 x 100% sludge transfer pumps with motors & accessories
f. 1 x 100% agitator for sludge sump with motor & accessories
g. 1 x 100% centrifuge & all accessories
h. 3 x 50% Neutralising pit effluent transfer pumps with motors & accessories
i. 2 x 50% priming chambers for neutralizing pit effluent transfer pumps
j. 1 set of dosing systems each for Lime, PAC, Polymer & DW Polymer as applicable.
k. 1 Lot of piping system for interconnecting between backwash waste transfer pumps, tube settler, clarified water storage tank (Customer scope-BHEL), interconnecting pipes between tube settler, sludge sump, sludge transfer pumps, centrifuge unit, neutralizing pit, Neutralizing pit transfer pumps suction & discharge piping etc., as per tender P&ID.
l. 1 Lot of Valves for the scope of piping as indicated above in sl.no.k as per tender P&ID.
m. 1 Lot of miscellaneous items such as Foundation bolts for all the equipment , pumps, gaskets, fasteners, bellows etc.,
n. 1 set of Electricals, controls & instrumentation as per enclosed tender P&ID
o. 1 set of commissioning spares
p. 1 set of mandatory spares
q. 1 set of recommended spares for 2 years O & M (optional).
r. Erection, Commissioning, PG test & handing over

The scope for erection & commissioning and PG test requirements shall be as mentioned elsewhere in the specification.

Items though not mentioned but needed to make the system complete as stipulated under these specifications are also to be supplied unless otherwise specifically excluded.

1.1 It is not the intent to specify all the details of the design & manufacture. However, the equipment shall conform in all respects to high standard of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Engineer / Customer, who will

interpret the meaning of drawing & the specification and shall be entitled to reject any work or material, which is not in full accordance herewith.

1.2 In case of any deviation, the Bidder shall indicate the same, clause by clause in the deviation schedule. In the absence of the same it will be construed that the bid confirms strictly to the specification.

1.3 General terms & conditions, instructions to the bidder & other attachments referred to elsewhere are part of this specification.

1.4 The order of priority of this specification is as follows:
a. Technical requirement/Equipment Specification,
b. Drawings
c. General design requirements

Any contradiction either between various parts or contents of the specification shall be a matter for clarification to be obtained by the bidder. The Customer's decision shall be final. However, as a general guideline the details furnished in the equipment specification shall prevail.

1.5 The material shall be dispatched to site as per the bidder's shipping list approved by customer. The format for the shipping list & quality plan will be given by customer after order for the successful bidder.

2.0 PROJECT INFORMATION

2.1	Owner	:	ONGC Petro additions Ltd. (OPaL)
2.2	Project Title	:	OPaL Raw water treatment plant (Membrane filtration based)
2.3	Location	:	Dahej, Gujarat
2.4	Nearest Railway Station / Access Road	:	Dahej / Bharuch (Rly. Station)

3.0 TECHNICAL REQUIREMENT

3.1 WASTE WATER SYSTEM CAPACITY

No. of Streams	: 1W
Tube settler outlet capacity	: 350 m3/hr.
Centrifuge capacity	: 20 m3/hr. (min.)

3.2 FEED WATER QUALITY FOR DESIGN

Sl.No	Description	Unit	Water Quality Considered for design
	Physical Parameters		
1	Inlet TSS	ppm	20 - 400
2	pH		7.8 – 8.5

3.3 GUARANTEED OUTLET WATER QUALITY

The plant design should meet the outlet water quality at Tube settler outlet as indicated below.

Sl.No	Description	Unit	Water Quality Considered for design
	Physical Parameters		
1	pH		6.5-8.5
2	Outlet TSS	ppm	< 30
3	Turbidity	NTU	< 20

4.0 TECHNICAL SPECIFICATION - MECHANICAL

4.1 DESIGN CRITERIA

The UF backwash waste / reject is collected in backwash waste collection sump (Customer scope). The effluent from backwash waste sump shall be pumped through backwash waste transfer pumps (2 x100%) to a tube settler. The tube settler shall be provided with PAC, lime and polymer dosing to enhance the coagulation and for effective settling of solids. The clear liquid from the tube settler shall be routed to Clarified water storage tank (By customer).

The sludge settled from the tube settler shall be routed to a sludge management system comprising of centrifuge. DWPE dosing system shall be provided for sludge treatment system. The supernatant from the centrifuge along with chemical cleaning waste from the membrane skids and other miscellaneous chemical drains shall be routed to a Neutralization pit (Customer scope).

The neutralized effluent shall be further pumped through neutralized effluent transfer pumps (3 x 50%) to Storm water drain or utilized for Horticulture purpose. The neutralized effluent transfer pumps shall be provided with 2x 50% nos. of priming chambers.

4.2 TERMINAL POINTS AND SCOPE :

a. All the civil works are in the scope of Customer. The equipment foundations are ready.

b. UF Back wash waste will be made available in the backwash waste sump (below ground). Further suction piping, backwash waste transfer pumps (submersible pumps), discharge piping, instrumentation shall be in the scope of the bidder.

c. Clear water from the tube settler shall be terminated at the inlet nozzle of Clarified water storage tank located at the elevation of 5 m above finished floor level (FFL) by the bidder through pipeline. (MS-Tank by Customer).

d. Waste from the Tube settler system shall be terminated by the bidder at the inlet of Sludge sump (RCC sump by Customer).

e. The sludge transfer pumps suction piping, discharge piping, instrumentation (including sludge sump) shall be in the scope of the bidder.

f. The supernatant liquid from the sludge treatment system shall be terminated by the bidder at the inlet of neutralizing pit (RCC pit by customer). Further suction piping, discharge piping & instrumentation (including neutralizing pit) shall be in the scope of bidder.

g. Neutralizing pit pump discharge piping shall be terminated at one point at required pressure and flow (~ upto 5 m). The instrumentation on the discharge piping of neutralizing pit transfer pumps is also in the scope of bidder.

h. All the flanges drilling shall be as per ANSI B 16.5, 150 #.

i. All the sumps depths are as indicated in the tender layout.

j. The utility water will be terminated at one point near the dosing system area by the customer. Further piping upto the dosing tanks shall be in the scope of the bidder. The wash water piping will be terminated at one point by the customer. Further piping by bidder.

4.3 EQUIPMENT SPECIFICATION:

The technical requirement of the equipment is indicated below. In addition, the applicable P & ID drawing and Layout enclosed with this specification shall be referred.

4.3.1 Flash mixer:

1)	Quantity	: 1X100%
2)	Flow	: 350 m3/hr
3)	Tank MOC	: CS –Epoxy
4)	Retention time	: 90 seconds (Min.)
5)	Agitator MOC	: SS304
6)	Agitator Mechanism	: Motor driven With gearbox
7)	Agitator Motor rating (Max.)	: As per attached Annexure -C

4.3.2 Flocculator:

1)	Quantity	: 1X100%
2)	Flow	: 350 m3/hr
3)	Tank MOC	: CS –Epoxy
4)	Retention time	: 10 minutes (Min.)
5)	Agitator MOC	: SS304
6)	Mechanism	: Paddle wheel/ 4 RPM / Motor driven with gearbox
7)	Agitator Motor rating (Max.)	: As per attached Annexure -C

4.3.3 Tube settler:

1)	Quantity	: 1X100%
2)	Type	: Vertical up flow with tube module/ inclined plates
3)	Design	: As per CPHEEO manual on water supply and treatment.
4)	Tank MOC	: CS-Epoxy
5)	Capacity	: 350 m3/hr
6)	MOC of tube module	**:** FRP/PVC/SS

7) Shape of tubes : Circular / Square / Rectangular
8) Submergence of tube from top : 18" -30"
9) Angle of inclination of tubes : 60^0 (to the horizontal plane)
10) Slope in bottom : 1 in 12
11) Surface loading in tube settler (of the horizontal projected area) : 88-206 (120) m3/m2/day
12) Sludge removal mechanism : By gravity/ By screw conveyor/ By sludge rake
13) Water losses in de-sludging : 2% (maximum)

Flocculator paddles, tube packs, inlet, adjustable type overflow weir, launder (if applicable), telescopic monitoring device & sludge bleeding arrangement etc., all complete.

Note: A flushing line of 4" size shall be provided in the sludge dewatering line

4.3.4 Centrifuge:

Note: The dewatered sludge from Centrifuge unit should be in the form of cake and shall be disposed into tractor trolley.

4.3.4.1 Centrifuge:

1) Capacity : 20 m3/hr
2) MOC of Bowl/Shaft/Scroll/Casing : SS316
3) Wear Lining : Tungsten carbide
4) Motor : As per ROS-4079 enclosed.
5) Motor rating (Max.) : As per attached Annexure -C
6) Make : As per Mech.Vendor list in **Sec.4.8**

4.3.5 Backwash waste transfer pumps with motors & accessories:

1) No. of Pumps : 2 x 100%
2) Location : outdoor
3) Operation : Intermittent
4) Type : Submersible(Non-API)
5) MOC
   - Casing, Impeller& Stuffing Box : Carbon steel.
   - Shaft : SS 410
6) Make : As per Mech.Vendor list in **Sec.4.8**
7) Speed of the pump : not to exceed 3000 rpm
8) Design Flow /pump : 350 m3/hr
9) Design Head of pumps : As per system requirement + friction

	head for design flow of the pump (or) 15 mwc, (whichever is higher)
10) Bearing	: Anti-friction
11) Seal	: Mechanical seal
12) Lubrication	: bidder to specify
13) Operating range	: 30 – 120% of rated flow
14) Pump characteristic	: Non-overloading type & stable
15) Shut-off head	: About 15 % more than the rated head
16) MOC of All fasteners	: GI
17) Motor	: As per ROS-4079 enclosed.
18) Motor rating (Max.)	: As per attached Annexure -C
19) Accessories	: Guide pipe along with lifting chain Arrangement and other structural arrangements

4.3.6 Sludge transfer pumps with motors & accessories:

1) No. of Pumps	: 2 x 100%
2) Location	: Outdoor
3) Operation	: Intermittent
4) Type	: Screw type (Non API type)
5) MOC	
- Casing	: SS316.
- Impeller	: SS316
- Shaft	: SS 410
6) Make	: As per Mech.Vendor list in **Sec.4.8**
7) Speed of the pump	: not to exceed 3000 rpm
8) Design Flow /pump	: 20 m3/hr
9) Design Head of pumps	: As per system requirement + friction head for design flow of the pump (or) 30 mwc, (whichever is higher)
10) Bearing	: Anti-friction
11) Seal	: Packing
12) Lubrication	: bidder to specify
13) Operating range	: 30 – 120% of rated flow
14) Pump characteristic	: Non-overloading type & stable
15) Shut-off head	: About 15 % more than the rated head
16) MOC of All fasteners	: GI
17) Motor	: As per ROS-4079 enclosed.
18) Motor rating (Max.)	: As per attached Annexure -C

4.3.7 Neutralizing pit transfer pumps:

1)	No. of Pumps	: 3 x 50%
2)	Location	: Outdoor
3)	Operation	: Intermittent
4)	Type	: Horizontal(Non-API)
5)	MOC	
	- Casing,	: SS316L
	- Impeller	: SS316L
	- Shaft	: SS 410
6)	Make	: As per Mech.Vendor list in **Sec.4.8**
7)	Speed of the pump	: not to exceed 3000 rpm
8)	Design Flow /pump	: 50 m3/hr(min.)
9)	Design Head of pumps	: As per system requirement + friction head for design flow of the pump (or) 30 mwc, (whichever is higher)
10)	Bearing	: Anti-friction
11)	Seal	: Mechanical seal
12)	Lubrication	: bidder to specify
13)	Operating range	: 30 – 120% of rated flow
14)	Pump characteristic	: Non-overloading type & stable
15)	Shut-off head	: About 15 % more than the rated head
16)	MOC of All fasteners	: GI
17)	Motor	: As per ROS-4079 enclosed.
18)	Motor rating (Max.)	: As per attached Annexure -C

Note: The discharge piping of the pumps shall be terminated near plant boundary (upto 5 m). The piping shall be in bidder scope.

4.3.8 Dosing systems:

4.3.8.1 CHEMICAL DOSING PUMPS (For PAC, Polyelectrolyte, Lime & DWPE) :

1)	No. of Pumps	: 2 x 100% for each chemical
2)	Location	: Under shade/outdoor
3)	Type	: Electro Mechanical (Positive Displacement, diaphragm type-API pump)
4)	Minimum capacity	: As per tender P&ID
5)	Head	: 5 bar

6) Stroke adjustment : 10 – 100%

7) Power supply : 415V, 3 phase(by customer)

8) Motor Rating(Maximum) : As per attached Annexure -C

9) Make : As per Mech.Vendor list in **Sec.4.8**

10) MOC of Pump Components

- Diaphragm : Teflon
- Pump Head, Valve housing : PP/ PVDF
- External safety relief valve : Required

10) Seal /Packing : Glandless

11) Other accessories : Shall be as per attached P &ID.

Note: MOC of all components coming in direct contact with chemical shall be compatible to the respective chemical. All the dosing pumps shall be interlinked with PLC.

4.3.8.2 CHEMICAL DOSING TANKS (For PAC, Polyelectrolyte, Lime & DWPE):

1) Preparation cum dosing tank : 1 Tank for each PAC, Poly, DWPE chemicals
2 preparation cum dosing tanks for Lime dosing

2) Location : Under shade/outdoor

3) Type : Vertical , Cylindrical , atmospheric, with lid

4) Effective Capacity : 2 m3 (minimum effective chemical storage excluding the dead volume height of 0.2 m & free board of 0.3 m)

5) Required nozzles : Inlet, outlet, drain, air vent, overflow, instrumentation etc

6) MOC : FRP-Seamless (Bidder shall confirm the compatibility of FRP for the respective chemicals handled

7) Air Vent, drain and over flow : Required

8) Make : As per Mech.Vendor list in **Sec.4.8**

9) Tank thickness(min) : 8 mm

10) Internal protection : **2.0 mm** thick Vinyl Ester resin
(Balance thickness with isothalic resin)

The glass content of the inner layer shall be 25 to 30% weight and the glass content of filament wound structural layer shall be 55 to 70% weight.

11) Level indicator & level switch : Required, shall be interlocked with pump
12) Agitator with gear reducer : 1 no. each for all dosing tanks (2 nos for lime dosing tanks)
13) Agitator MOC for all dosing tanks : SS316L
14) Diameter of the agitator : 500 mm(minimum)
15) Dissolving Basket : To be provided wherever required
16) Fasteners MOC(cover/Flange) : SS316/ as per chemical compatibility
17) Necessary Electricals,C&I : To be provided wherever required

General:

Tanks shall be vertical, cylindrical, (tapered bottom wherever needed) with level indication. The top cover shall be flanged with suitable reinforcing and bracing. The top cover (One segment) shall have opening for chemical loading and this part shall be hinged type for preparation tank and where ever required. A perforated basket for chemical dissolution shall be provided, in the FRP tank, below this opening for chemical loading. Necessary structural platforms and ladder shall be provided by the bidder for dosing tanks.

DOSING TANK SIZING

Sl	System Description	Chemical used	Dosing rate (**mg/l)**	Feed Flow **m3/hr**	Prep. Soln concentration (max.)	Dosing Tank cap.(**Lts)**
1	**Coagulant**	**PAC**	**~10.0**	350.0	**10%**	2000 **FRP**
2	**Lime**	**Ca(OH)2**	**~10.0**	350.00	**5%**	2000+2000 (dosing cum preparation) FRP
3	**Poly Electrolyte**	**PE**	**~1.0**	350.0	**0.5%**	2000 FRP
		-				
4	**Dewatering Polymer**	**DWPE**	**~30.0**	20.0	**0.5%**	
	(for sludge treatment system)					2000 FRP

Note:

1. The values indicated in the above table are indicative only. Bidder to provide their values in the above format.

2. Bidder to provide the frequency of chemical preparation for each chemical.

4.3.9 Backwash waste holding sump (by BHEL)

1) Number : One No.

2) Capacity : 250 M^3

3) Material : RCC (Construction by Customer)

4) **Level transmitter** **: to be provided by bidder**

4.3.10 Sludge holding Sump (by BHEL)

1) Number : One No.

2) Capacity : 50 M^3

3) Material : RCC (Construction by Customer)

4) Sludge sump agitator : SS316L **(to be provided by bidder)**

5) Diameter of Agitator : 500 mm (minimum)

6) Agitator Motor rating (Max.) : As per attached Annexure -C

6) **Level transmitter** **: to be provided by bidder**

4.3.11 Neutralising pit (by BHEL)

1) Number : 1 No.

2) Material Of Construction : RCC (Construction by Customer)

3) Capacity : 200 M^3

4) **Level transmitter** **: to be provided by bidder**

4.3.11 PIPING & VALVES:

1) Piping : Refer section 4.5

2) Valves : Refer section 4.6

4.4 GENERAL DESIGN REQUIREMENTS

The common requirements for the system are stated in the general design requirements. However the requirements indicated in the technical specification for mechanical equipment section **4.3** shall be strictly complied with.

4.4.1 COMMON REQUIREMENTS:

1. Only latest revision of standards shall be used.
2. The tanks coming in contact with corrosive fluids should be compatible for the chemicals.
3. All the rotating equipment noise level shall be < 85dBA measured at 1 mtr distance from the equipment.
4. Sampling connections and air vent at the top most point of piping and vessels shall be provided at all stages of the Unit.
5. The size of the overflow pipes of all storage tanks shall be one size higher than inlet pipe sizes of these tanks.
6. All the piping & valves are to be located to facilitate easy accessibility and operation from the ground level.
7. All flange fasteners shall be GI MOC.
8. The fasteners shall be of stud type with spring washers & nuts.
9. The direction of Flow shall be indicated by an arrow at regular intervals on all pipelines.

4.4.2 CENTRIFUGAL PUMPS:

1. The critical speed of the pumps shall be well away from the operating speed and in no case less than 130% of the rated capacity.

2. The pumps shall have stable head Vs capacity characteristic continuous rising towards shut-off with an approximate shut-off head of 15% more than the design head for radial flow type pumps.

3. The characteristic curves of set of pumps shall match other for load sharing in case of parallel operation.

4. Pumps shall be provided with non-return valve & shut off valve on discharge side and shut-off valve on suction side.

5. Unfiltered vibration velocity for horizontal pumps upto 3000 rpm with antifriction bearing or sleeve bearings when measured at the bearing housing in horizontal or vertical direction shall not exceed 4 mm/sec RMS.

6. Tolerance in pump guaranteed efficiency and rated head for the rated flow shall be minus 2% to plus 3%.

7. Pressure gauges shall be provided on discharge side of all pumps.

8. Each pump suction and discharge shall be installed with an expansion bellow.

9. The pumps shall be designed for continuous operation at its best efficiency to satisfy the performance requirements.

10. The pumps shall be controlled from remote panel and locally.

4.5 PIPING

4.5.1 LINE SIZING

1. Sizes of pipelines shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow:
   - Pump Suction : <1.2 m/sec
   - Pump Delivery & header : ≤2.0 m/sec
   - Service water / Potable water : <1.5 m/sec
   - Compressed air : 15 m/s
   - Flash mixer to U/S of Tube settler zone : 1.0 m/s
   - Backwash waste water inlet to clarifier: 2.0 m/s.
   - Other gravity lines(m/s) : 0.8 m/s

2. All high points in piping system shall be provided with air vents along with valves. All low points shall be provided with drains along with valves.
3. Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic location in piping system.
4. Necessary thrust blocks shall be provided to minimize water hammer & vibration in piping & headers.

5. Supporting arrangement of piping system shall be rigid and properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation.
6. Sufficient upstream and downstream lengths shall be provided for flow measuring device, control valves and other specialities.
7. Test certificate / compliance certificate to be furnished by the bidder for all the components instruments & piping etc.

4.5.2 MATERIALS OF CONSTRUCTION:

SL. NO.	SERVICE	SIZE	PIPES	FITTINGS	FLANGES	GASKETS	LINE JOINT
1.0	**Low Pressure Application**						
1.1	**All piping**	**Upto DN 150**	**UPVC , PN10 as per latest DIN standard**	**UPVC , PN10 as per latest DIN standard**	**UPGF / PP Flange drilling should be ANSI B16.5, 150 Class**	**Neoprene rubber gasket**	**Solvent cemented / flanged**
		Above DN 150	****GRP, PN10 as per AWWA-C950-07 standard**	**GRP, PN10 as per AWWA-C950-07 standard**	**GRP**	**Viton rubber gasket**	**Flange/ insitu joint**
1.2	**Instrument Air & Plant Air line**	**All sizes**	**Galvanized as per IS 1239 , Heavy grade**	**Screwed fittings of Galvanized as per IS 1239 , Heavy grade**	**Not applicable. Screwed fitting shall be considered**	**Not applicable**	**Screwed connections**
1.3	**Chemical dosing lines**	**All sizes**	**CPVC, Sch.80 of ASTM**	**CPVC, Sch.80 of ASTM**	**UPGF / PP Flange drilling should be ANSI B16.5, 150 Class**	**Viton rubber gasket**	**Solvent cemented / flanged**

****GRP pipes shall be with the following requirements:**

1. Inner corrosion resistance layer of 1.5 mm thickness Vinyl Ester resin (Resin/mat-90:10 by weight)
2. Outer layer cross filament wound at 54.7 deg to horizontal and Resin isopthalic (Resin / mat-30:70 by weight)
3. Minimum Stiffness -2500 N/m2

4. Pressure Rating- PN10
5. Top most layer -resin rich, UV stabilizer, with pigment of 0.2 to 0.3 mm.
6. Tolerance on thickness, resin-filament ratio, etc., will be 5% (+/-).
7. Pipes shall have sufficient clearance at the flange ends for mounting butterfly valves, non-return valves, etc.

Notes:

1. Pipes & Fittings shall be tested for its material composition and certificate shall be enclosed for the same.
2. All piping & valves supports shall be of dismantling type for easy maintenance using suitable bolted connections.

4.6 VALVES

4.6.1 DESIGN AND CONSTRUCTION FEATURES

The following consideration shall be made during the design / selection of valves for the waste water treatment System.

1. For the waste water treatment system Butterfly valves shall be used for isolation / regulation purpose.
2. The material of construction for the valves shall be as per the table no 4.6.2 given below.
3. The end connection for the diaphragm valves shall be of flanged type as per **ANSI B16.5, 150 classes**.
4. Pressure rating of valves shall be of minimum PN10
5. Necessary pneumatic actuated valves shall be provided for auto operation, Backwashing & Chemical cleaning of the plant as per the P & I diagram.
6. The painting shall be as per the requirements indicated in the painting specification.
7. Bidder shall furnish the valves schedule in the attached format. (Annexure-4)
8. Cast steel valves shall be provided for compressed air system.

4.6.2 VALVE – MATERIALS

Sl. No.	Service	Valve Type	Size	BODY	Disc / Ball / Diaphragm	Stem / Shaft	Valve seat / Seat ring	Hinge Pin	Valve Ends
1	All lines	UPVC Ball Valve	≤50 NB	UPVC	UPVC	UPVC	PTFE	---	Solvent cement Socket End
		UPVC Ball Check Valve	≤50 NB	UPVC	UPVC	---	EPDM	---	Solvent cement Socket End
		Butterfly Valve	≥65NB	CS	DI with nylon coating	SS410	EPDM	---	Wafer type
		Check Valve	≥65NB	SS304	SS304	SS410	EPDM	---	Wafer type
2	Chemical dosing Lines(Acid, alkali, NaOCl etc.,)	CPVC Ball Valve (sch 80)	All size	CPVC	CPVC	CPVC	PTFE	---	Solvent cement Socket End
		CPVC Ball Check Valve (sch 80)	All size	CPVC	CPVC	---	EPDM	---	Solvent cement Socket End
3	Compressed air application	Ball Valve	≤50 NB	Galvanized cast carbon steel or Forged carbon steel	Stainless Steel / ANSI 420	Stainless Steel / ANSI 420	Nitrile Rubber / PTFE	---	Flanged End / Screwed

4.7 PAINTING

The painting specification is enclosed as **Annexure-B.**

4.8 VENDOR LIST FOR MECHANICAL ITEMS

The vendor list is enclosed with this specification as **Annexure-A.**

5.0 TECHNICAL SPECIFICATION FOR ELECTRICAL, CONTROLS & INSTRUMENTATION

Electrical, Controls & Instrumentation requirements for the waste water treatment system is attached separately as **ROS : 4084, Rev:00** along with this specification.

6.0 TECHNICAL DETAILS FOR CIVIL WORKS:

Construction of civil shed, foundation and flooring etc for the Waste water treatment system is not in bidder scope. However the foundation materials like grouting mix, foundation bolts & packing shims etc, are in bidder's scope. The bidder shall provide the equipment layout drawing along with bid. **The equipment foundations are ready and the final foundation drawings are enclosed with this specification. Bidder to provide the equipment so as to match the foundations (Foundation drawings no. -:1-WT-220-00482 Rev00, 1-WT-220-00483 Rev:00) without any modification.** However, Bidder to submit the construction drawing with foundation requirement like load details, foundation pockets etc, for all the skids, equipment, tanks, flooring requirements, trenches for pipe routing, cable routing & drains etc. for verification and scrutiny.

Any special requirement like handling arrangement, floor / trench protection etc. shall also be indicated in the drawings. All the plant drains & trenches are to be connected in a common trench and terminated near the system boundary. The approximate area & location are indicated in the enclosed lay out drawing. Bidder to accommodate the Waste water treatment system with in the stipulated area only as indicated in the typical layout drawing **(1-WT-220-00463, Rev 00)** attached along with this specification.

7.0 PERFORMANCE GUARANTEE

The system performance guarantees applicable are detailed in this section.

7.1 PERFORMANCE GUARANTEE

The bidder shall guarantee all equipment for workmanship, materials and satisfactory performance. The guarantee for performance will cover individual items and systems including electrical for their ratings / outputs as well as for the integrated operation of equipment and its auxiliaries as a whole. On completion of satisfactory commissioning, the supplier shall conduct performance / acceptance tests on the equipment and system as a whole for demonstrating the guaranteed performance parameters specified.

a. Waste water treatment outlet water quality as indicated in section 3.2
b. Power consumption for continuous operating equipment as per Annexure-2

c. Vibration and noise level of rotating equipment

7.1.1 Minimum 72 hrs performance test run shall be conducted for the guaranteed values of treated water quality, quantity and other performance parameters.

7.1.2 General

In addition to the guarantees mentioned above, the requirements of specifications on all guarantees as elaborated under relevant clauses of Technical Specifications should be met.

Any part which proves defective either in design, materials / and / or manufacture within the above guarantee period shall be replaced at free of cost to the owner at site and the provision of this clause shall apply to the portions of the plant so replaced or renewed until the expiration of the guarantee period or from the date of replacement which ever is later.

8.0 SPARES:

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8.1 Commissioning Spares:

The bidder should take care of this requirement for trouble free commissioning of the system since commissioning is under bidder's scope. The commissioning spares List and the individual price shall be indicated and included in the main supply. The bid price shall include these spares also. Any unutilized commissioning spares shall be handed over to the purchaser. The commissioning spares shall be delivered well in time before the start-up & commissioning of the plant.

8.2 Mandatory Spares:

The mandatory spares shall be delivered along with the main supply. The Cost of mandatory spares shall be indicated separately and the same is considered for Bid Evaluation.

The list of mandatory spares are given below:

8.2.1 Horizontal Pumps(wherever applicable):

SL. NO.	Name of Items	Qty	Remarks
1)	Mechanical seal	1 Sets	For each type

8.2.2 Agitators:

SL. NO.	Name of Items	Qty /tag no	Remarks
1)	Bearings for agitator	1 set	per tag no
2)	Gasket for agitator mounting nozzle, if any	200%	for each joint
3)	Bolting for agitator mounting nozzle, if any	10%	(min. 2 sets for each size)
4)	Oil seal for gear box	2 set.	

For the list of mandatory spares for E, C & I portion, please refer electrical specificationROS-4084 & 4079.

8.3 Recommended Spares:

The bidder shall provide the list of recommended O&M spares for the first two years of normal operation to be filled as per **Annexure-5**. Customer reserves the right to buy any of the recommended spares as considered necessary by him during later stage. The price of recommended spares will not be considered for bid evaluation.

9.0 ERECTION, COMMISSIONING, PG TEST & HANDING OVER:

Erection, commissioning, PG test & Handing over for the Waste water treatment system shall be as per the requirement mentioned elsewhere in the specification (ROS-9025).

10.0 DOCUMENTATION:

The documentation during bid and post order stage shall meet the following requirements.

1. All documents and drawing shall be submitted in English
2. Hard copies of all documents and drawings during bid stage to be submitted in duplicate.
3. Hard copies of all documents for approval shall be submitted in triplicate.
4. Hard copies of all final documents, drawings, Erection and O& M manual etc., shall be submitted in bound folder in 6 copies.
5. Soft copies of all final documents in MS word / MS office in the form of CD –1 set
6. Soft copies of all final calculations in MS excel/ MS office in the form of CD–1set

7. Soft copies of all final drawings in Auto Cad, latest version in the form of CD-1set

10.1 DOCUMENTS ALONG WITH BID:

The following drawings / documents are to be enclosed along with the bid for scrutiny.

1. Technical write-up giving details of equipment operation, interlocks / control requirement. (for Tube settler system & centrifuge unit)
2. P& I diagram along with instrument list
3. Equipment layout drawing
4. Filled up data sheets as called in the specification – **Annexure -1, 2 & 3**
5. Chemical consumption for tube settler & centrifuge unit
6. Utility requirements like instrument air, service air and service water
7. Pump performance curves with marked duty point.
8. Sub vendor list for mechanical, electrical and C&I items.
9. Preliminary civil requirements.
10. PLC I/O list(if applicable).
11. Tentative quantity of Power, Control and Screened cables to be supplied for the waste water treatment system by the Purchaser.
12. Deviation schedule duly filled, if any –**Annexure – 6.** Any deviation should have cost of withdrawal for our evaluation in the commercial bid.
13. Unpriced commercial offer including commissioning spares on the scope of supply
14. Unpriced commercial offer for the recommended spares list
15. Reference list of the plants with minimum one year in operation.

Note:

1. In case of any deviation, the Bidder shall indicate the deviation, clause by clause in the deviation format attached in **Annexure – 6.** If there is no deviation "NIL" statement shall be furnished. In the absence of the non attachment of this **Annexure-6,** it will be construed that the bid confirms strictly to the specification.

10.2 DOCUMENTS AFTER ORDER

10.2.1 The following documents/Drawings and data to be furnished for BHEL / customer approval.

Phase-I (for approval within 7 days from the date of ordering):

1. Technical Write-up and design basis (Tube settler system & centrifuge unit)
2. P&ID diagram including pipe sizes & terminal points.
3. Equipment layout showing Tube settler, treated effluent transfer pump etc.,
4. Sizing, process calculations for various equipment

5. Filled up datasheets for approval as per **Annexure – 1,2 & 3**
6. Quality Plan and field quality checks, stage inspection etc. for the above equipment & system
7. Performance curves for pumps & motors
    a. Flow Vs Head
    b. Flow Vs efficiency
    c. Flow Vs Power
    d. Flow Vs NPSH
8. Instrument schedule.
9. PLC I/O list.
10. Foundation Details indicating foundation design, load data, anchor bolt location, pocket details, floor & trenches etc.
11. Performance Test procedure
12. Activity / Bar chart

Phase-II (for information within 2 weeks from the date of LOI):

1. General arrangement drawings for all the equipment showing dimensions and details of materials
2. Piping and Valves schedule
3. Erection Manual indicating
    a. Erection/installation instructions of equipments.
    b. Log sheet containing stage check parameters & clearance
    c. Log sheets for alignment check of pump & motor
    d. Field quality checks
4. All the documents called in Electrical specification.

Phase-III (for information-before dispatch):

1. Shipping list for BHEL's approval in BHEL format

Phase-III (for review):

1. Pump performance test reports
2. Pump performance guarantee certificates
3. Operation and maintenance manual.
4. Maintenance instruction & assembly
5. Lubrication chart.

6. Electrical equipment layout, Cable trench layout, cable routing, cable schedules and cable termination details.
7. Cable interconnection diagram for cables up to junction box & cable schedule.

8. Test Certificates for all the supplied instruments.
9. List of alarm, interlock & trip set points
10. Installation drawings for instruments
11. Wiring drawings & GA drawings for Local Panels, junction boxes.
12. All other details called in Electrical specification.

Note: Bidder to confirm in their offer that these details called in 10.2 will be provided.

11.0 ATTACHMENTS

The following drawings enclosed are a part of the specification:

1. PID for Waste treatment system : 1-WT-220-00461 Rev: 00
2. Legend for P&ID : 1-WT-220-00462 Rev: 00
3. Waste water system layout : 1-WT-220-00463 Rev:00
4. GA for tube settler : 1-WT-220-00464 Rev:00
5. Foundation details for equipment : 1-WT-220-00482 Rev:00
6. Centrifuge foundation details : 1-WT-220-00483 Rev:00
7. Erection, commissioning, PG test & handing over specification no. ROS 9025, Rev 00
8. E, C & I specification no. ROS 4084, Rev 00
9. Electrical motor specification no. ROS 4079, Rev 00
10. Vendor list(Annexure-A)
11. Painting specification (Annexure-B)
12. Motor ratings (Annexure-C)

12.0 IMPORTANT POINTS TO BIDDERS

1. If the bidder has suggestions/requirements of any additional instruments/equipment over & above as shown in the P & ID drawing for the efficient functioning of the system, the same has to be clearly indicated and suitably covered in the commercial bid also separately.

2. The specification for the instruments/equipment available in the main specification has to be taken for such additional requirements (or) Customer should be contacted.

ANNEXURE-1

DATA SHEET

I WASTE WATER TREATMENT OUTLET WATER QUALITY

Sl.No	Description	Unit	Values
1	pH		
2	Total Suspended Solids	ppm	
3	Turbidity	NTU	

II CHEMICAL REQUIREMENT

Sl.No.	Description	Concentration (%)	Unit	Total per day
1	PAC (for Tube settler)		kg	
2	Polyelectrolyte(for Tube settler)		kg	
3	Lime (for Tube settler)		Kg	
4	DWPE(for Centrifuge unit)		Kg	

III FREQUENCY OF CHEMICAL PREPARATION

Sl.No.	Description	Duration/cycle (hrs)	No. of Cycles per day (24 hrs)
1	PAC (for Tube settler)		
2	Polyelectrolyte(for Tube settler)		
3	Lime (for Tube settler)		
4	DWPE(for Centrifuge unit)		

Annexure-2

ELECTRICAL POWER CONSUMPTION

Sl. No.	Equipment Description	Qty		Efficiency	Drive rating KW	Conn load. Load KW	Power consumption KW	Voltage, Phase
		W	SB					
A	FOR CONTINUOUS OPERATING EQPT.							
1								
2								
3								
4								
5								
6								
	Sub total of A							
B	FOR INTERMITTENT OPERATING EQPTS.							
1								
2								
3								
4								
5								
6								
	Grand Total							

Note: W – Working SB – Standby

Annexure- 3

Refer Annexure-3 enclosed with the specification.

Annexure - 4

VALVE SCHEDULE – DATA SHEET TO BE FILLED BY THE BIDDER

Sl. No.	Service	Valve Type	Size	BODY	Disc / Ball / Diaphragm	Stem / Shaft	Valve seat / Seat ring	Hinge Pin	Valve Ends
1	**Manual valves**								
2	**Pneumatic Valves(if any)**								
3	**Check Valves**								

Annexure-5

RECOMMENDED SPARES FOR 2 YEARS O&M WITH PRICE

Sl. No.	Description of the equipment	Description of spares	Quantity	Price

ANNEXURE -6

TECHNICAL DEVIATIONS

Sl. No	*Section no.*	*Clause No.*	*Page / No.*	*Specification*	*Statement of Deviations/variations*	*Reason for Deviation*	*cost of withdrawal*

BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

GENERAL SPECIFICATION

FOR

ERECTION, COMMISSIONING, PG TEST & HANDING OVER OF WASTE WATER TREATEMENT SYSTEM

1.0 SCOPE OF WORK ON SERVICES

The scope of Erection and Commissioning services covers erection, commissioning of waste water treatment system which comprises of collection of materials & equipment from site stores, transportation to erection spot, erection of complete system including site fabrication, stage clearance, testing, commissioning, Performance Guarantee Test , handing over of the system .

NOTE

I. Successful commissioning means, erection of entire system, trial run / trial operation till achieving the performance both in terms of Quality (including electrical power consumption) and Quantity to prove the agreed performance of the system and the system is ready for PG Test. Once this stage is reached, Vendor will inform to BHEL that they are ready for PG Test. If BHEL's & Customer's(M/s. OPaL) Engineer is satisfied in commissioning, PG test can be conducted within 30 days from the date of such notification by Vendor to BHEL and till such time the running of the system to be taken care of by the vendor. Conduct of PG Test shall be the responsibility of the Vendor. Necessary consumables and chemicals required for the trial run / trial operation till PG Test will be provided by BHEL at free of cost to Vendor. However, the requirement of consumables and chemicals details is to be provided well in advance (min. 4 months) before commissioning by the Vendor to BHEL. Further any testing chemicals for testing / calibration of instruments, consumables required for PG test shall also to be informed with minimum 4 months advance notice before commissioning, failing which the vendor has to take the responsibility of providing the same without any commercial implication.

II. The equipment after inspection at manufacturer's works shall be transported to BHEL site and shall be delivered to the BHEL stores as detailed in the supply specification and commercial terms of the tender. The applicable materials shall be drawn from BHEL stores as per the relevant procedure. The equipment shall be erected sequentially and shall be interconnected with the applicable piping and valve system. Necessary hydraulic testing of piping, valves etc. shall also be carried out as per supply specification. Necessary pump, blind-flanges, fasteners etc. required for the hydraulic testing are in vendor's scope.

The scope of major equipment covered for the erection & commissioning of the waste water treatment system at site is covered in Technical Specification clause 1 (scope of supply & services).

Apart from the scope mentioned in Technical specification, the foundation grouting materials including foundation fasteners, packing shims and final grouting shall be in the scope of bidder.

The quantity and the details given are only indicative. However the bidder shall supply required quantity to fully cater to the system requirement and carry out the erection of all the items to meet the system requirement as complete without any commercial implication to BHEL.

2.0 The Intent of this specification is to provide erection, commissioning & trial operation services for execution of projects according to most modern and proven techniques and codes. It is not the intent to specify completely herein, all aspects of the entire system. Nevertheless, the entire system shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation. The contract services towards installation of the Plant shall not relieve the contractor of the responsibility of providing such services, facilities to complete the project of portion of project awarded to him. The quoted rate shall deem to be inclusive of all such contingencies.

3.0 The Contractor shall carry out the work in accordance with instructions/ drawings/ specification/ standard practices supplied / approved by BHEL from time to time.

4.0 Modification / Rectification / repair / replacement of defective components if any shall be under bidder's scope within specified time.

5.0 Bidder to submit the erection schedule along with stage check data sheets. Each and every stage the bidder to get clearance from the BHEL Engineer / Consultant Engineer / Customer Engineer.

6.0 Establish the site co-ordination for identification of materials, withdrawal of material, storing and issue of materials, stage clearance for erection & commissioning.

7.0 Identification of consignment at BHEL stores, verification of the same in the presence BHEL official, taking delivery, co-ordination for the movement from store to erection work, safe custody, erection, commissioning and trial operation.

8.0 All the equipment and materials would be issued only at BHEL stores and it shall be the responsibility of the contractor to take delivery from BHEL stores, transport the same to site.

9.0 Necessary clearance for stage check, hydraulic test, leak check obtained from the customer engineer & pre – commissioning tests shall be carried out by the bidder.

10.0 Commissioning and putting into satisfactory operation of all the equipment at site including successful completion of trial operation and handing over of the system to the end user.

11.0 Finish coat (final coat) for all the equipment before hand over of the system to BHEL/Customer as per **Annexure-B** of the specification.

12.0 EXCLUSIONS

The following are excluded from the scope of supplier and will be arranged by BHEL

12.1 All civil works pertaining to waste water treatment System

12.2 Service water/construction water at one point near waste water treatment system

12.3 Construction power supply at one point near waste water treatment System

12.4 Supply of service / instrument air at one point

12.5 Chemicals for commissioning and trial operation is involved.

12.6 Receipt Storage of shipped items / container at BHEL store as of received condition

The requirement shall be specified by the bidder in their technical offer and the supply shall be limited to the specified quantities.

13.0 Specification, Standards & Codes:

All equipment shall be designed, tested and supplied as per the specification, relevant national / international standards & statutory codes.

14.0 Name plates, labels and directional marks:

Each equipment shall be provided with nameplate details designating the tag no., service of the item etc. Necessary directional arrow marks shall be provided.

15.0 Tools and Tackles:

All the Tools & tackles required for the complete erection of components shall be arranged by the contractor at his cost. The bidder shall have & own a complete set of special tools and tackles required erection, assembly, disassembly and maintenance. The bidder shall also supply any special tools and tackles that may be required additionally during commissioning. All tools & tackles shall be reputed make acceptable to the Purchaser and shall be handed over BHEL after the completion of erection & commissioning.

16.0 Commissioning Consumables / Spares:

The bidder shall supply all consumables like lubricating oil, Teflon tape, m-seal, cotton waste, tissue paper roll, sampling bottles, mugs, buckets etc required for commissioning the equipment shall be in bidder's scope.

The bidder shall consider sufficient quantity of the commissioning spares so that the commissioning of the system will not be delayed. The bidder shall also supply any spare components that may be required additionally during commissioning. These commissioning spares shall be included in the basic scope of supply.

17.0 Inspection & Testing:

All the stage checks & materials shall be offered to BHEL / Customer/ BHEL'S authorized representative for inspection. No material shall be dispatched without obtaining written clearance from BHEL. During inspection, the internal inspection reports shall be submitted to BHEL / customer for information.

18.0 Packing & Dispatch:

18.1 All equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site, till the time of erection. Each packing shall have necessary handling marks

18.2 Each packing shall contain a packing slip indicating the details of item like item description, quantity, weight etc.

18.3 Details of handling & Storage instruction shall also be provided in each packing.

18.4 All items shall be properly packed with adequate cushioning material to prevent damages due to rough handling and inland transport. The packing shall be in such a way so as to avoid seepage of water into the packing.

18.5 Special care shall be given to prevent damage to the fragile components.

19.0 Additional requirements

19.1 After completion of all erection and commissioning works, the left out items shall be handed over to BHEL site stores.

19.2 During commissioning at site some smaller equipment may get added or Logics may have to be changed. The bidder shall carryout these changes at site without any commercial implications to BHEL.

20.0 GENERAL INSTRUCTIONS TO THE BIDDER

20.1 Bidder shall quote for complete work specified in the document. Incomplete quotations for the part of the work will not be considered even if the quoted rates/price is lower.

20.2 Bidder shall contact BHEL and obtain additional details/data if any required to submit proper quotation.

20.3 The BHEL reserves the right to omit any one or more items of work at any time of the contact without assigning any reason what so ever.

20.4 The Bidder shall include all necessary commissioning spares in his basic scope of supply and the left out spares shall be handed over to BHEL after the completion of E & C.

20.5 Adequate lighting facilities such as low volt hand lamps shall be arranged by the contractor at the site of construction etc. at his cost.

20.6 All the lifting tackles including wire ropes, slings, shackles and electrically operated equipment shall be got approved by BHEL Engineer before they are actually put on use. Test certificates should be submitted before their usage. Test certificate obtained from the statutory authority should be submitted before their usage.

20.7 All equipment so used by contractor shall be of proven quality and safe in operation as approved by BHEL Site Engineers from time to time.

20.8 At periodic / intervals of work, complete and detailed account of the equipment so erected shall be submitted to the BHEL Engineer. The required format shall be submitted to BHEL Officials for approval.

20.9 All equipment shall be handled very carefully to prevent any damage and loss. No bare wire ropes, slings etc.., shall be used for unloading and / or handling for equipment without the specific written permission of the BHEL engineer. The equipment from the storage yard shall be moved to the actual site of erection / location at the appropriate time as per the direction of BHEL Engineer so as to avoid damage for such equipment at site.

20.10 The work covered under this scope of work is of highly sophisticated nature requiring best quality / precision workmanship engineering and construction management. Contractor should also ensure successful and timely commercial operation of equipment installed. The contractor must have adequate quantity of precision tools, construction aids in possession. Contractor must also have adequate trained qualified and experienced supervisory staff and skilled personnel.

20.11 All the necessary certificates, licenses statutory clearances required to carry out his scope of work are to be arranged by the contractor then and there at no extra cost.

20.12 When the work is temporarily suspended contractor shall protect all construction materials equipment and facilities from causing damage to existing property interfering with the operations of the station when it goes into services. The contractor shall comply with all applicable provisions of the safety regulations clean – up programme and other precautionary measures which the BHEL has in effect at the site .

20.13 It will be the responsibility of the contractor to ensure the safe lifting of the equipment taking due precautions to avoid any accidents and damage to other equipments and personnel.
All piping shall be adequately supported and protected to prevent damage during handling and erection.

20.14 Sometimes it may become necessary for the contractor to handle certain un-required components in order to take out the required materials. The contractor has to take this contingency also into account. No extra payment is payable for such contingencies.

20.15 It shall be contractor`s responsibility to arrange for required labour, brush, paint and other consumable like thinner, cotton waste, cloth etc., for carrying out preservative painting. The quoted rates shall be inclusive of above work.

20.16 Due to atmospheric conditions erected materials are likely to get rusted more frequently. It is the responsibility of the contractor to preserve the erection materials drawn from stores for erection till these are commissioned and handed

over to customer. The required paint, thinner all other consumables like painting brush, emery paper, cotton waste, cloth etc.., have to be arranged by the contractor at his cost. The contractor should ensure that the materials are not rusted on any account till they are handed over to customer. The decision of the BHEL Engineer is final with regard to adequacy of application of paint.

21.0 SITE CLEANLINESS AND SAFETY REQUIRMENTS:

21.1 Contractor shall strictly follow all safety regulations / conditions as per general conditions of contract booklet enclosed with this tender.

21.2 Non – conformity of safety rules and safety appliances will be viewed seriously and the BHEL has right to impose fines on the contractor as under.

21.3 Contractors shall ensure that the quality is maintained in all the works connected with this contract at all stages of the requirement of BHEL.

21.4 Contractor shall ensure that all Inspection, Measuring and Testing equipment that are used, whether owned by the contractor or used on loan, are calibrated by the authorized agencies and the valid calibration certificate will be available with them for verification by BHEL. A list of such instruments possessed by contractor at site with its calibration status is to be submitted to BHEL Engineer for control.

21.5 Contractors shall arrange for the inspection of the works at various stages as required by BHEL. Immediate corrective action shall be taken by the contractor for the non-conformances if any, observed and pointed out by BHEL.

22.0 PAYMENT TO CONTRACTORS

22.1 All payment due to the contractors shall be paid by “E-payment” only.

22.2 All recoveries due from the contractor shall be effected in full from his bills unless specific approval from the competent authorities is obtained otherwise.

22.3 The bill shall be prepared in the proforma prescribed for the purpose based on the certificate issued by BHEL Engineer that entire work as stipulated in the tender specification has been completed in all respects to the entire satisfaction of BHEL. Contactor shall give unqualified “No Due” and “No Demand” certificates. Quantities / Weight erected shall be prepared and paid as per agreed payment terms. The quantities and financial value shall be entered in Measurement Book and signed by both the parties to the contract.

23.0 PROVIDENT FUND & MINIMUM WAGES

23.1 The contractor is required to extend the benefit of provident fund to the labour employed by them in connection with this contract as per the Employees Provident Fund Act 1952. For due implementation of the same, the tenderer is hereby required to get themselves registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish us the code number allotted to them by the Provident Fund authorities with in one month from the date of issue of this letter of intent. In case any exemption from such remittance, an attested copy of authority for such exemption is to be furnished. Please note that in the event of failure to comply with the provisions of said Act, if recoveries there fore are enforced from payments due to us by the customer or paid to statutory authorities by us, such amount will be recovered from payments due to the contractor.

23.2 The contractor shall ensure the payment of minimum labour wages to the workmen under him as per the rules applicable from time to time in the state.

24.0 OTHER STATUATORY REQUIREMENTS:

24.1 The contractor shall submit a copy of labour licence obtained from the licencing Officer (Form VI) u/r 25 read with u/s 12 of contract labour (R&A) Act 1970 & rules and valid WC Insurance copy or ESI Code (if applicable) and PF code no along with the first running bill.

24.2 The contractor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) u/r 78 (1) (a) (1) of contract labour rules, copies of monthly return of PF contribution with remittance challans under EPF Act 1952 and copy of renewed WC insurance policy or copies of monthly return of ESI contribution with challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

24.3 The contractor should ensure compliance of Sec 21 of Contract Labour (R&A) act 1970 regarding responsibility of payment of wages. In case of “Non compliance of sec21 or non-payment of wages” to the workmen before the expiry of wage period by the contractor, BHEL will reserve its right to pay the workmen under the orders of appropriate authority at the risk and cost of the contractor.

25.0 TIME OF COMPLETION

25.1 The time schedule as prescribed in the contract is the essence of the contract. The time for completion shall always be reckoned from the date of commencement of work as certified by the BHEL Engineers.

25.2 The entire work shall be completed by the contractor with in the time schedule or within the such extended time as may be allowed under relevant clause.

26.0 ENGAGEMENT OF L ABOUR

26.1 The contractor will be directly responsible for provision of health and sanitary arrangements more particularly described in contract labour (regulations & Abolition) Act, safety precautions etc., as may be required for safe and satisfactory execution of the contract.

26.2 The contractor shall be responsible for proper accommodation including adequate medical facilities & transportation to the work spot and back for the personnel employed by him.

27.0 COMPLIANCES WITH LABOUR LAWS & RULES

27.1 The contractor shall comply with all state and central Laws, statutory rules, regulation etc.., relating to labour in respect of following acts and also as amended by the Government during the tenure of the contract and having in force or jurisdiction at site.

a. Payment of wages act, 1936
b. Minimum wages act, 1948
c. Workmen's Compensation act, 1923
d. Industrial dispute act, 1947
e. Employees Provident fund scheme, 1952
f. Payment of Bonus act, 1965
g. Payment of Gratuity act, 1972
h. Contract Labour (Regulation & Abollition) Act, 1970

28.0 TAXES & DUTIES, ETC.:

The contractor shall pay all taxes, VAT, licence fee, deposits, duties, royalty, commissions or other charges, other than such taxes specifically mentioned in the special conditions of contract, which may be leviable on account of any of his operations in executing the contract. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from the contractor either from his bills or other wise as deemed fit.

TECHNICAL SPECIFICATION FOR

ELECTRICAL, CONTROLS & INSTRUMENTATION

OPAL DAHEJ – WASTE TREATMENT SYSTEM

00	27.12.13	AT	VNS	SK	Fresh issue
Rev.No	Date	Prepared	Checked	Approved	Remarks

THIS DOCUMENT CONSISTS OF THE FOLLOWING SPECIFICATIONS:

0.0 REFERRED PUBLICATIONS

Design and terminology shall comply, as a minimum, with the latest edition prior to the date of purchaser's enquiry with following codes, standard practices and publications:-

AGA	American Gas Association
Report No.3 -	Orifice Metering of Natural Gas & other related hydrocarbon fluids
Report No.7 -	Measurement of Gas by Turbine Meters.
ANSI/ASME	American National Standards Institute/American Society of Mechanical Engineers.
B 1.20.1	Pipe Threads General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings
B 16.20	Metallic Gaskets for pipe Flanges, Ring Joint, Spiral wound and Jacketed.
ANSI/FCI	American National Standards Institute/Fluid Control Institute
70.2	Control valve seat leakage classification
API	American Petroleum Institute
API 520	Sizing, selection and installation of pressure relieving devices in refineries.
Part-I	Sizing and selection
Part-II	Installation
API 521	Guide for pressure relieving and depressurising systems.
API 526	Flanged steel Pressure Relief Valves.
API 527	Seat tightness of Pressure Relief Valves.
API MPMS	Manual of Petroleum measurement standards.
API RP 551	Process Measurement Instrumentation
Part I -	Process Control and Instrumentation
API 522	Transmission Systems.
S 1101	Measurement of Petroleum Liquid Hydrocarbon by Positive Displacement meter.
S 2000	Venting Atmospheric and low-pressure storage tank non-refrigerated and refrigerated.
S 2534	Measurement of liquid hydrocarbons by turbine meter systems
S 670	Vibration, Axial-Position and Bearing-Temperature Monitoring
ASME	American Society of Mechanical Engineers
ASME Sec-VIII	Boiler and Pressure Vessels Code rules for construction of pressure vessels
ASME Sec-I	Boiler and Pressure Vessels Code. Section-I 'Power Boilers'
ASTM	American Society for Testing and Materials.
BIS	Bureau of Indian Standards
BS	British Standards
BS-5308 Part-II :	Specification for PVC insulated cables.
BS-7244	Flame Arrestors.
DIN	German Standards
DIN-43760	Temperature Vs Resistance curves for RTDs.
DIN-19234	Electrical Distance Sensors; DC interface for Distance Sensor and Signal Converter.
EN-10204	Inspection Documents for Metallic Products
IBR	Indian Boiler Regulations

IEC	International Electro technical Commission
IEC 60079	Electrical Apparatus for Explosive Gas atmosphere
IEC 60085	Thermal Evaluation and Classification of Electrical Insulation.
IEC 60332	Test on bunched wires or cables.
Part III	Cat. A
IEC 60529	Degree of protection provided by enclosures.(IP code)
IEC 60534-2	Industrial Process Control Valves-Flow capacity.
IEC 60584-2	Thermocouple Tolerances
IEC 60751	Industrial Platinum Resistance Thermometer Sensors
IEC 61000-4	Electromagnetic compatibility for Industrial Process measurement and control equipment.
IEC 61158	Foundation Fieldbus Specifications
IS	Indian Standard
IS-5	Colours for ready mixed paints and enamels
IS-319	Specification for free cutting Brass bars, rods and sections
IS-1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS-1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
IS-1554	PVC insulated (heavy duty) electric cables working
Part I -	voltage up to and including 1100V
IS-2074	Ready mixed paints, air drying, red oxide - zinc chrome
IS-13947	Degree of Protection provided by Enclosures for Low Voltage Switchgears and Control gears. Part 1 General Rules.
IS-2148	Flame proof enclosures for electrical apparatus for Explosive Gas Atmospheres – Flameproof Enclosures ‘d’.
IS-3624	Specification for pressure and vacuum gauges
IS-5831	PVC insulation and sheath of electric cables.
IS-7358	Specifications for Thermocouples
IS-8784	Thermocouple compensating cables.
ISA	International Society of Automation
S-5.2	Binary logic diagrams for process operations.
S-7.3	Quality standard for instrument air
S-75.01	Flow equations for sizing control valves.
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits.
NACE	National Association of Corrosion Engineers
NEC	National Electric code
NEMA	National Electrical Manufacturer's Association
ICS-6	Enclosures for Industrial control and systems.
NFPA	National Fire Protection Association
NFPA-496	Purged and pressurized enclosures for electrical equipment.
OSHA	Occupational Safety and Health Authority.
SAMA	Scientific Apparatus Maker’s Association

1.0) GENERAL SPECIFICATION FOR ELECTRICAL, CONTROLS & INSTRUMENTATION:

a) ELECTRICAL, CONTROL & INSTRUMENTATION (E,C&I) scope of work by system vendor, scope of work between BHEL & VENDOR, Scope of supply for the system between BHEL and Vendor shall be as mentioned in this specification.

b) The system vendor should furnish a " Write up on Control Description" explaining the controls, interlocks etc., for the system which have to be arranged by the purchaser in the PLC system. Necessary Valve Sequence Charts ,Logic Diagram control philosophy, list of interlocks etc., have to be furnished during detailed engineering to facilitate implementation of the system controls & interlocks in the PLC system.

c) Based on the inputs furnished by system vendor, the PLC vendor will prepare the engineering software in the form of ladder diagrams for the system portion. The system vendor shall review and approve the ladder diagram for implementation. At this stage of checking & approval the system vendor should not call for any considerable number of additional I/Os over & above the I/O list given in his offer. Once the system requirements are implemented in the PLC system after vendor's review & approval, the responsibility for proper functioning of the entire system in Auto & Manual mode shall rest with the vendor.

d) Analytical instruments for pH / ORP / Conductivity / Silica / Turbidity / TOC / Dissolved Oxygen /ClO2 etc. as applicable shall consist of sensor & microprocessor based analyser which shall be located in the field. Only 4 - 20mA output signals from the analysers shall be brought to the PLC system where these parameters will be displayed on the PC screens using HMI software. Necessary calibration solutions / buffer powders / reagents etc. required for calibration & commissioning of analytical instruments at site shall be included by the vendor in his scope. The offer should include rates for such calibration solution / buffer powder / reagents and the periodicity and quantity requirement

e) All the instruments supplied by the vendor must meet BHEL's specification and will have to be procured from the approved vendors list only.

f) All electrical equipment shall be suitable for the power supplies, fault levels and other climatic conditions indicated in "Project Information" enclosed with the specification.

1.0.1 Additional requirements

a) During execution stage, the bidder shall assist BHEL for obtaining the approval for various drawings / data sheets / documents pertaining to this package by visiting customer's premises along with the buyer

b) All mounting accessories for various instruments shall be supplied as a part of basic scope of this package.

c) After award of contract of bidder should submit the quality plan for BHEL approval for all the items covered in this package. O& M manuals for all the Instruments should be submitted in Hard & soft copies. (After award of contract)

d) Erection hardware like root valves, impulse lines, 2 / 3 / 5 way manifold valves shall also be supplied as a part of basic scope of this package.

e) All Electrical equipments and instruments shall be provided with suitable earthing terminals as per relevant IS standard.

f) The specification for Instruments, cables, instrument accessories shall be as per enclosed specification.

g) Tag numbering philosophy would be uniform for the entire plant. There would a single, unique tag for a given equipment / signal.

h) After completion of all erection and commissioning works, the left out items/ spares / tools & tackles / calibration instruments etc. shall be handed over to BHEL site office.

i) All instruments shall be type-tested type. Only type tested instruments shall be supplied.

j) All instruments shall undergo all routine tests. Test certificates/calibration certificates for all supplies shall be furnished.

1.0.2 GENERAL INSTRUCTIONS TO THE TENDERER

a) Vendor shall quote for complete work specified in the document. Incomplete quotations for the part of the work will not be considered even if the quoted rates / price is lower.

b) The owner reserves the right to omit any one or more items of work at any time of the contact without assigning any reason what so ever.

c) The vendor shall include all necessary commissioning spares in his basic scope of supply.

d) Rate for erection, testing, commissioning and training shall be quoted separately, which shall be included in the basic scope.

1.1 ELECTRICAL AND C&I SYSTEM ACTIVITIES

SL. NO	ELECTRICAL, C&I SYSTEM ACTIVITY BY THE VENDOR
1	Design, Manufacture / procurement, testing at manfacturer's works, packing delivery of the instruments, Instrument cables, cable Trays & Junction Box to site for complete skid.
2	Obtaining approvals from end customer for the specification, makes, model numbers of the instruments, GA drawing,
3	Furnishing the Inputs required for LTMCC engineering such as Electrical Load list with KW rating, number of drives covering all dosing pumps, dosing mixers in BHEL Format.
4	Furnishing the Inputs required for PLC engineering such as Sequential Flow Chart, Control philosophy, Detailed IO list, Alarm list for the system
5	Furnishing the data sheets for Instruments in BHEL Format.
6	Furnishing the GA drawings & Termination details of Junction Boxes(JB's),
7	Furnishing the Interconnection drawing of Instrument to Junction Box(JB's) in BHEL format.
8	Preparation of Instrument Hook-up & installation drawings
9	Supply of LT motor along with cable glands & lugs
10	Supply of instruments as per enclosed PID (1_WT_220_00_369) along with support structures for the complete WASTE TREATMENT SYSTEM.
11	Supply of required Junction Boxes (JB's) along with support structures for all supplied instruments
12	Supply of Instrument Cables from instruments, POV's (limit switch, solenoids) to JB's
13	Supply of Cable Trays along with support structures (from Instruments to JB's and POV's to JB's)
14	Supply of Cable Glands, cable lugs for instruments, motors, Junction Boxes(JB's), including the cable glands & cable lugs for the incoming cables in BHEL scope.
15	Supply of Mandatory spares as per enclosed list.
16	Supply of Commissioning spares as per enclosed list.
17	Obtaining all necessary statutory clearance for the installation
18	Calibration of all instruments at site with standard calibration solutions & standard instruments
19	Supply of tools required for erection & commissioning of instrumentation system
20	Carrying out pre commissioning Checks & test at site
21	Commissioning and putting into satisfactory operation of all instruments at site including successful trial operation and handing over the system to end user (Customer)
22	Providing training to BHEL & End user (BHEL Customer) at site
23	After commissioning the instruments to the satisfaction of the end user (Customer) the successful bidder shall extend support to BHEL & Customer for a period of three months from the date of commissioning for the following.

	a) Recalibration of all instruments b) Rectification / Repair / Replacement of defective components
24	Submission of Operation & Maintenance manual in required number of copies (06 no hard copy & Soft copy).
25	Furnishing unit price of various components for addition / deletion purpose for all components of instruments, erection accessories.

1.2 ELECTRICAL AND C&I SCOPE OF SUPPLY

The list of items to be included in bidder scope includes but not limited to the following.

SL. NO	ELECTRICAL, C&I SYSTEM
1	Supply of LT motor along with cable glands & lugs
2	Supply of instruments as per enclosed PID (1_WT_220_00_369) along with support structures for the complete Waste treatment plant including dosing skids for the same .
5	Supply of required erection materials for Instruments impulse line (Root valves, 2 / 3 / 5 Way manifold for instruments, Drain valves, ½" SS316 SS Tube, SS Fittings, Perforated trays for impulse tube, supporting structure etc) covered in Sl.No 2

1.3 ELECTRICAL AND C&I SCOPE OF WORK BETWEEN BHEL & VENDOR

SL. NO	ELECTRICAL SYSTEM	ACTIVITY	AGENCY
1	SPECIAL CABLES(REFER NOTE 5)	SUPPLY ERECTION	VENDOR VENDOR
2	JUNCTION BOXES (Purchaser will furnish the JB drg. DDE)	SUPPLY ERECTION	VENDOR VENDOR
3	LAYING & TERMINATION OF DIGITAL / ANALOG INSTRUMENT CABLES / CONTROL CABLES BETWEEN EQUIPMENT & JUNCTION BOXES.	SUPPLY ERECTION CHECKING	VENDOR VENDOR VENDOR
4	CABLING MATERIAL BETWEEN EQUIPMENT & JUNCTION BOX (CABLE TRAYS & ACCESSORIES)	SUPPLY ERECTION	VENDOR VENDOR
5	CABLE SCHEDULE & CABLE INTERCONNECTION DRG.(UPTO JB)	PREPARATION VETTING	VENDOR BHEL
6	CONTROLS AND INSTRUMENTATION (As per P & ID enclosed)	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
	INSTRUMENT AIR LINE DISTRIBUTION	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
7	IMPULSE PIPING AND FITTINGS	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
8	LOCAL PANEL FOR INSTRUMENTS, TRANSMITTER RACKS ETC.(IF APPLICABLE)	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
9	CALIBRATION OF INSTRUMENTS		VENDOR

NOTES:

1. Necessary layout inputs shall be given for BHEL supplied equipments.
2. Cable gland & Lugs shall be provided by vendor for equipment supplied by vendor.
3. Cable glands shall be matching to cable sizes where cables are supplied by purchaser. Cable sizes shall be furnished to the vendor at detailed Engineering stage.
4. Necessary layout inputs shall be given for BHEL supplied equipments.
5. Cables other than Power, Control & Screened control cables are special cables (cable between sensor & analyser).
6. Erection of cables beyond junction boxes shall be in purchaser's scope.
7. Termination of cables at Vendor supplied equipments by vendor, upto Junction Box.
8. All field instruments and junction boxes shall be provided with prefabricated canopy made of GI sheet with bolted construction.

1.4 List of drawings / documents to be submitted along with offer.

The bidder shall submit the following documents along with the offer:

1. Signed conformation of BHEL specification in total for the subject enquiry.
2. Instrument Schedule indicating instrument type, location, Quantity, operating parameters, measuring range, Makes in BHEL Format
3. Vendor P & ID
4. I / O list with number of DI, DO, AI, AO required for entire package
5. Electrical Load List indicating KW rating and no. of drives shall be furnished along with offer
6. Unit price for addition / deletion purposes during detailed design commissioning at site (in a separate sealed cover).
7. Schedule of Technical Confirmations – Schedule-A
8. Schedule of Technical deviations(if any) – Schedule-B

1.5 List of drawings / data sheet to be submitted after placement of purchase order for the approval of the Purchaser, for all items under the scope of supply:

a. Data Sheet for Medium Voltage Squirrel Cage Induction Motor as per enclosed format 6987-017-16-50-DS-08 Rev. 0(2pages) in LT Motor spec No ROS-4079
b. Detailed I / O list
c. Data Sheet for Instrument signal Cables, Instrument power cables
d. Type and quantity of cable trays supplied
e. Erection manual or procedure for all the items in English
f. O&M manual 6 copies of all items (for information) English
g. Technical data sheet for all instruments supplied in BHEL Format
h. List of commissioning spares
i. List of Tools & tackles
j. List of calibration tools & Instruments
k. Dimensional drawings, mounting / installation drawings, materials of construction, Terminal Drawing for Junction Boxes supplied
l. Dimensional drawings, mounting / installation drawings, materials of construction, Terminal Drawing for Solenoid Valve Enclosure Boxes supplied

m. Test certificates for all supplied items including but not limited to Instruments, cables, Junction Boxes, Solenoid valve Enclosure Boxes, VFD panels(if applicable).
n. Instruments, POV's Installation ,Hook up drawings for all items

2.0 PROJECT INFORMATION:

Customer: ONGC Petro Additions Ltd
Consultant: Engineers India Ltd
Location: Dahej, Gujarat

Site conditions
Equipment design temperature (IS-9676) : 45°C
Minimum /Maximum Ambient Temperature : 5.6°C/ 47°C
Relative Humidity : 89%
Altitude above mean sea level : Less than 1000m above mean sea level
Seismic Zone :As per IS-1893-ZONE-III
Classification of Area : Non Hazardous Area
Atmosphere : Dusty, tropical and corrosive as found in hydrocarbon industry
Area Classification : All field Instrumentation including junction boxes shall be weatherproof and suitable for safe area.

3.0 Specification for LT Motors

The specification for LT motors shall be referred in enclosed specification **ROS 4079** and the referred customer specification enclosed therein as a minimum requirement.

3.1 Specification for Instruments

The specification shall be read along with enclosed customer specification and the vendor shall comply to these specifications as a minimum requirement.

All instruments and equipments shall be suitable for use in a hot, humid and tropical industrial climate in which corrosive gases and/or chemicals may be present. As a minimum, all instruments and enclosures in field shall be metallic type and dust proof and weatherproof to IP-55 as per IEC-60529/IS-13947 and secure against the ingress of fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive plant atmosphere.
In case of contradiction between licensor specifications and this Design Philosophy, licensor specifications shall prevail unless waiver to that specific requirement has been identified in the job specifications. In case, job specifications categorically identifies requirement, which is in contradiction to this, job specifications will prevail. All transmitters, instruments and instrument connections should generally be accessible from the ground or permanent platforms.

The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC 61000-4 'Electromagnetic compatibility for Industrial Process measurement and Control equipment'.

All transmitters shall be provided with canopy. Canopy wherever used shall be pre-fabricated. All terminals shall be screwless clamp type of Phoenix, Wago or Weidmuller make.

All online process analysers shall be supplied with built-in Auto calibration without operator intervention, complete with required calibration apparatus/ calibration gas cylinders etc. Each analyser shall be complete with fault and maintenance contacts to advise analyser status in the DCS.

Vendor to consider ¼" OD SS tubes and fittings such as male connectors etc. for ¼" OD size even though 6 mm OD is indicated in the tubing hookups attached.

Following units of measurement shall be applicable, unless indicated specifically otherwise;

Flow Liquid : m3/h
Gas and Vapour : Nm3/h
Pressure/Vacuum Gauge : kg/cm2g : mm of H2O
Temperature : deg C
Level : % ,mm
Analysis : % : ppm
Conductivity : µS (micro siemens)

Ranges for instruments shall be selected in general, such that in normal process operation the indication is between 40% to 60% of span for linear and 60% to 80% of span for square root inputs. The set range for field instruments shall be 1.1 times the maximum process value or 1.4 times the operating process value whichever is higher rounded to the nearest ten.

Ranges for process switches shall be selected, in general, such that the set point falls preferably in the middle 30% of full adjustable range i.e. the set point shall fall between 35% and 65% of adjustable range.
Unless specified otherwise, the instruments shall have an over-range protection of at least 130% of range or maximum/ design pressure, whichever is higher, as a minimum.

All field instruments and junction boxes shall be provided with prefabricated canopy made of GI sheet with bolted construction.
Following power supply voltage levels shall be used, unless otherwise specified:

- For Analyzers like pH,ORP,ClO2 etc : 110 V AC± 10%(UPS) 50Hz ±3Hz.

3.1.1 Field Transmitters/ Meter Electronics

Field transmitters for flow, pressure, differential pressure , level , ClO2 gas detector or density indicator transmitter shall be yoke mounted type unless specified otherwise. Meter electronics is used for flow measurement for inline meter, level measurement, analysers, etc. and shall include all the associated items like pre-amplifier, converter, transmitter, integrator, integral output meter etc.

Field transmitter shall be intrinsically safe and meter electronics shall be intrinsically safe, in general. In case, intrinsically safe is not available from the approved vendor list enclosed with this FEED, flameproof enclosure is acceptable. In case sensor/ pick up coil is intrinsically safe, suitable barrier shall be provided and installed in flameproof enclosure.

These transmitters shall be 2 wire system having 4 - 20 mA DC output with superimposed digital signal having simultaneous analog and digital communication with HART communication protocol, unless otherwise specified.

The transmitter shall be microprocessor based and it shall incorporate a non-volatile memory which shall store complete configuration data of transmitter and sensor charaterisation. All necessary signal conversions, including conversion to produce output with the required protocol shall be carried out in the transmitter electronics. The

configurationally data of the instruments shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, Vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.

Transmitter shall also run complete diagnostic subroutines and shall provide diagnostic alarm messages for sensor as well as transmitter healthiness. In the event of detection failure, the output shall be driven to a predefined value, which shall be field configurable.

Accuracy of transmitters, smart as well as field bus based, shall be as follows:

Type of Transmitter	Range of Transmitter	Accuracy
Direct	760 mm WC and above	Equal to or better than ±0.075%
Direct	Less than 760 mm WC	Equal to or better than ±0.15%
Diaphragm seal	500 mm WC and above	Equal to or better than ±0.25%
Diaphragm seal	Less than 500 mm WC	Equal to or better than ±0.5%

The accuracy is defined as the combined effect of repeatability, linearity and hysteresis.

The stability of the transmitters shall be equal to or better than ±0.1% of span for a period of minimum 6 months, as a minimum.

Transmitter shall update the output at least 8 times a second unless otherwise specified. Unless specified otherwise in purchaser's specification, transmitter response time shall be as follows:

a) For transmitter range of 760 mm WC and above, the response time shall be equal to or better than 500 milliseconds.

b) For transmitter range below 760mm WC, the response shall be equal to or better than 1 second. The response time of the transmitter shall be considered as the sum of dead time and 63.2% step response time of the transmitter. The response time of transmitters shall commensurate with process. It shall be equal or better than the half of the scan time of control loop specified elsewhere in the bid package.

Unless specified otherwise, the over-range/static pressure protection of the transmitter shall be as follows;

However if the Over range/ static pressure value specified above is less than the maximum/ design pressure of service conditions, offered instrument shall be suitable for the maximum/ design pressure.

In the transmitter, the 'WRITE' option shall be protected through password.

3.1.2 Pressure Instruments (Pressure Gauges)

a) Pressure gauges shall be weatherproof to IP 55 as per IEC 60529 / IS 13947, as a minimum, with dial size of 150 mm and shall have screwed bezels. Pressure gauge sensing element shall be an elastic element like bourdon tube, bellow, diaphragm etc. of SS316 and movement of Stainless steel, as a minimum. The design of pressure gauges shall confirm to IS-3624. Case material shall be SS304 and vapor-tight.

b) Dial markings and dial colour shall be as per IS 3624. The pointer stops shall be provided at both ends of the scale to restrict the pointer motion beyond 5% above the maximum of scale and less than 5% below the minimum of the scale. Pointers shall have external micrometer adjustment for gauge zero adjustment.

c) Unless otherwise specified, the accuracy including repeatability and hysteresis shall be ±1% of full scale for Direct pressure gauges, ±2% of full scale for Chemical seal type pressure gauges and for Differential pressure gauges.

d) Whenever the maximum pressure specified in the data sheet exceeds the over range protection pressure, over range protector shall be provided. In case of pressure gauges with diaphragm seal, same shall be installed between the seal and the gauge. Snubbers/pulsation dampners/gauge sever of SS304 shall be used for all pulsating services. These shall be floating pin type, externally mounted and externally adjustable.

Over range protector and Snubbers, whenever used, shall be same as socket material, as a minimum.

e) Where vibrations and pressure fluctuations are expected, Glycerin filled type shall be used. Incase of vibrating services like pump outlets, flexible armored hoses shall be used in place of impulse piping and gauges shall be mounted on separate stanchions.

f) Bourdon element shall be welded to socket and tip end shall be stress relieved.

g) Pressure gauges with range as 0 to 100kg/cm2g and above shall have safety type solid front case. Unless specified otherwise, the pressure gauges shall have an over-range protection of at least 130% of maximum working pressure, as a minimum.

h) Process connection shall normally be 1/2" NPTM bottom.

i) Sensing element for Draft gauges shall be suitable to measure the draft ranges such as capsule, bellows.

j) All pressure instruments shall be provided with 2- valve manifolds along with prefabricated hook ups made of SS316.

k) All Differential pressure gauges shall be provided with 3-way manifold of SS316. It shall be suitable for mounting on 2" pipe. Mounting accessories shall be provided with gauge.

l) All differential pressure gauges shall be of magnetic piston type. Alternatively DP transmitter with local indication shall be provided.

m) All gauges shall be provided with a blow out device i.e. blow out disc of aperture not less than 25mm for gauges with dial size 100mm and above, while 20mm for gauges with dial size less than 100mm.

n) Diaphragm seal pressure gauge with capillary shall be used for congealing and high viscous services or corrosive fluid, i.e where plugging of the element may occur or where suitable material is not available in highly corrosive service and where an element protection is necessary or where plugging of element may occur.. Size of the capillary shall be selected to ensure response time of the gauge better than 5 seconds.

For diaphragm seal pressure gauges with flanged ends, the diaphragm shall be rated for the maximum allowable pressure of the associated flange and spacer ring, isolationvalve and plugs shall be provided.

The process connection shall be 1½" flanged for all application except where line size is below 1", chemical seal type pressure gauges with ½"NPT connection are acceptable for 1" below line size..

o) Receiver pressure gauges for local transmitter output indication shall have 100 mm dial with stainless steel element and 1/4" NPTM instrument connection.

p) The dial cover shall be made out of shatter proof glass sheet of thickness 1.5 to 3mm for gauges with dial size less than 100mm while minimum 3.0mm for gauges with dial size 100mm or greater.

q) The gauge socket shall be in one piece without any capillary or tube in between for bourdon tube type element and for others tubing with minimum bore of 3 millimetres is acceptable. Socket shall be welded type only.

3.1.3 Level Instruments

Level standpipe philosophy

The usage of standpipe shall be considered for clean, non-viscous and non-crystallizing services. The size of standpipe shall be 2" NB minimum. Separate isolation valve to be considered for standpipe unless otherwise specified by licensor.

Standpipe shall be used if there are more than 4 nozzles required for level instruments.

Maximum number of nozzles on the standpipe shall be limited as follows:

i) to 8 with no displacer type/ guided wave radar type level instrument on it.

ii) To 6 with displacer type/ guided wave radar type level instrument on it.

Multiple level gauges shall be used for visible lengths more than 1470 mm.

Separate standpipe shall be used for boot interface level measurement in addition to standpipe for the horizontal vessel.

3.1.3.1 Level Gauges- Float & Board type

FUNCTION	INDICATE, LEVEL MEASUREMENT OF LIQUID
TYPE-CONSTRUCTION	GUIDED- DIRECT INDICATION
MEASURING RANGE	DDE
FLOAT	SS316
FLOAT WIRE ROPE	Ø1.6MM SS 316 (MULTISTRAND)
GUIDE WIRE ROPE	Ø1.6MM SS 316 (MULTISTRAND)
ANCHOR PLATE	SS316
NAME PLATE & TAG	SS
MOC OF ACCESSORIES FOR GAUGE	SUITABLE FOR SEASHORE ENVIRONMENT
PROCESS CONNECTION	3 Nos of 25 NB ANSI B 16.5 150# SOFF FLANGE, SS
LEAST COUNT	5 MM
CALIBRATED GAUGE BOARD	6" WIDE X AL WHITE POWDER COATING WITH BLACK GRADUATIONS & NUMERICALS
ACCESSORIES FOR GAUGE	SUITABLE FOR SEASHORE ENVIRONMENT
PROTECTION CONDUIT	STEEL PIPE (CAD.PLATED) 3/4" NB X 650mmL + 40mm (ADJ.)
SPRING TENSIONER ASSLY.	STEEL SPRING HOUSED IN STEEL ENCLOSURE (CAD.PLATED)

3.1.3.2 Level gauges -Tubular

Magnetic level gauges shall be used for in general. Only where the same is not suitable, gauge glasses shall be used. Gauge glasses shall generally be steel armoured reflex or transparent type.

a) All gauge glasses shall be steel armoured reflex or transparent type with body and cover material of forged carbon steel as a minimum and shall have toughened borosilicate glass with asbestos free gasket. Transparent type of gauges shall be provided with integral illuminators operating at 230 V 50 Hz single phase supply and suitable for electrical area classification specified. Multiple illuminators in gauge shall be wired internally using armoured cables and suitable glands. The incoming power terminals shall be suitable for cable connection upto 4.0 mm² size. All gauge glasses must have a rating equal to or more than the vessel design pressure and temperature.

b) Reflex type shall be used for clean and colourless liquids, for liquid level interface. For low temperature, low boiling point service, large chamber type will be used. Transparent type will be used on acid, caustic, dirty or viscous, coloured liquids and liquid interface. Transparent type with Mica or Kel-F shields shall be used for treated water, boiler and condensate services, and for corrosive liquids, which will attack glass.

They may be used for non-hazardous services at ambient temperature and low

pressures.

c) Large chamber gauges with anti-frost extension shall be provided for cold services below 0 deg C with extension material as Perspex or equivalent. Heating jacket shall be provided for viscous liquids.

d) In general, all gauges shall have top and bottom chamber connections, unless otherwise specified. In addition each gauge shall be provided with ball check valves and pipe union.

e) The visible range of level gauge shall be selected to cover the complete operating level as well as measuring range of the other level instruments provided for the same purpose. In general, the visible length of the level gauges shall be selected from the following:

Visible length, mm	Centre to Centre Length, mm
220	470
470	720
720	970
980	1230
1230	1480
1490	1740

In any case, the maximum visibility length shall not exceed 1500 mm for a single gauge. Multiple gauges with overlapping range shall be used for such cases.

f) Testing requirements - The gauge glasses shall be of heavy armour design and shall meet the following test pressures as a minimum: Gauge glasses (transparent type) in corrosive service shall be provided with glass protective shield/liners suitable for the process fluid being handled.

g) Gauge cocks shall be of the quick-closing, offset type with bolted bonnet, outside screw and with renewable seats. All moving and wetted internals like ball check seat, stem etc. shall be SS316, as a minimum.. Primary isolation valves are normally required in addition to the gauge glass cocks, except on vented tanks containing harmless liquids. Where the process fluid tends to foul the cocks internals and create plugging or where leakage is a problem, gauge valve may be eliminated. On low temperature service, with liquids having very high vapour pressure at ambient temperature, safety valve shall be provided at the vent connection of the gauge glass.

h) For level gauging in very viscous liquids, liquids with crystals, sour services and pressure above 600#, toxic services, float operated magnetic gauges with 2" flanged end connections shall be used. The float and chamber material shall be non-magnetic type with material of SS316L, as a minimum, and magnetic properties of the applicable parts shall not degrade under the influence of the design temperatures. For external mounted magnetic level instruments, the rolling magnet type of indication with red and yellow colour (with red colour indicating the level) or Ball-follower type of indicator shall be provided. Measuring scale shall be linear type.

Accuracy and scale resolution shall be better than ± 10 mm. C-C to distance shall be 2000 mm, maximum.

i) Bicolor type level gauges shall be used for steam drums.

j) Where side-side connections are specified, the gauge shall have two entries, 180 degrees apart at each end with one side plugged.

3.1.3.3 Level Transmitter

a)Generally Guided Wave Radar type instruments shall be used for level measurement upto 1219 mm. Differential pressure transmitter shall be used for level measurement above 1219 mm and for services requiring purge or where liquid might boil in external portion.Internal displacer type of level transmitters shall be avoided unless application necessitates its use.

b)Displacer type of level instruments shall be used for interface applications upto 1219mm, and where guided wave radar type level instruments are not suitable. All displacer type of level transmitters shall be of torque tube type with torque tube material of inconel, as a minimum.

c) Non-contact type level transmitters may be used on corrosive, congealing, slurry services or services with varying density where diaphragm seal type transmitter cannot be used.Only ultrasonic or radar type level instruments shall be used for all acid and alkali tanks. Radar Gauges used on tanks shall have inventory capabilities.

d) Differential pressure transmitter shall be used for level measurement above 1500 mm, for services requiring purge or where liquid might boil in external portion.

e) Differential Pressure transmitters for use on corrosive or fouling service shall generally be diaphragm wafer with extended filled capillary type. Flush or extended diaphragm type differential pressure transmitter shall be considered for special applications only. Diaphragm material shall normally be stainless steel or any other special alloy.

f) Magnetic Level instruments shall have Float failure indication and their accuracy and scale resolution shall be better than ± 10 mm.

3.1.3.4 Guided Wave Radar & Ultrasonic Level Instruments

a) Guided Wave Radar type Level Instrument shall be based on Time Domain Reflectometry (TDR) principle with type of wave guide i.e. coaxial/ twin rod/ single rod selected by the Vendor . External type instrument shall have external chamber/cage with 2" flanged end connections with ¾" flanged vent and drain connection provided with blind flange. Accuracy (inclusive of linearity, repeatability and hysteresis) shall be better than ±3 mm, repeatability shall be better than ±3.0 mm, Response time (i.e. 63.2% response) shall be better than 1 second.

b) Ultrasonic type level instrument shall have ultrasonic probe which shall be selected to ensure that distance between the probe and the maximum level of interest is more than the blocking distance of the probe. Accuracy inclusive of linearity, repeatability and hysterisis shall be better that ±0.25% of measuring range.

c) Radio-frequency type level instruments shall have rod or rope type probe. Accuracy inclusive of repeatability, linearity and hysterisis shall be ± 0.5% of the level measurement range.

General : All the above level instruments shall meet the following;

i) Sensor/ Probe shall be of flanged construction with 2" size. In case of welded flanged connection design, the weld joint shall be of radiography quality. Probe shall be of rugged construction without any mechanical moving part and shall not be affected by abrasion because of fluid turbulence. The probe design shall ensure that the deposits, dust, noise, foam or turbulence in the fluid, shall not affect the performance of the offered level instruments.

ii) Instrument electronics shall be shall be of microprocessor based capable of being configured locally, either using an integral keypad or through a hand held configurator and compatible with the associated level probe. It shall comprise of pre-amplifier, converter, transmitter, switching amplifier etc. as applicable for the specified application. Vendor shall ensure that the input/output signals and performance characteristics of individual item provided as a part of each special level instrument are compatible with each other. Instrument electronics shall be integral with the probe.

iii) Offered probe/ sensor shall also have compatible certification. Switching Amplifier unit shall have repeatability better than 1%.

3.1.3.5 Level Switch (wherever applicable)

a)Level switches shall generally be external float type with flanged head.Internal float/ displacer operated switches shall be used for viscous and underground tanks.

b) Level switches shall generally be external ball float type with flanged head. External displacer type level switches can be considered for lighter fluids where specific gravity is less than 0.5. Internal ball float/ displacer type (top or side mounted) level switches shall only be used if external ball float/displacer type is not possible, like in viscous services and in underground tanks/vessels. Mechanical stops shall be provided so as to prevent reset of contacts while the switch is still in alarm condition. Float/displacer material used shall be SS316 minimum. Repeatability shall be 2 mm or better.

c) Multi float / displacer level switches shall be avoided in process service.

d) Switch shall be sealed snap action micro type with contact rating suitable for the specific application. Level switches with Reed switch shall not be used.

e) For external cage type level switches, the switching point shall be 70 millimeters below the centre line of top connection for both high as well as low level application.

f) In case of tandem type level switch, high and low level actuation points shall be adjustable. All switches shall be provided with very low differential, unless otherwise stated. The Vendor shall indicate differential.

3.1.4 Flow Instruments

General:- Flow meter shall be of in-line mounting design with flow direction clearly marked on the flow meter body to ensure correct installation.

Flow meter design shall ensure that the location and / or orientation of installation of flow meter in the line shall not affect the calibration, accuracy and performance of the meter.

3.1.4.1 Variable area flow meter/Rotameter

Variable area flow meters shall be as per ISA-RP 16.1, 16.2,16.3,16.4,16.5 and 16.6 and shall be used for viscous or corrosive services or where rangeability in flow precludes the use of an orifice. In general, variable area flow meters shall be selected such that the meter end connections are same as the line size.

Flow meter design shall be such that it eliminates the stagnant areas. Flow meter shall have float stops at the top and bottom, which shall be easily removable.

Differential Pressure Valve : Differential pressure regulator shall be used to maintain constant flow rate irrespective of variation in the inlet / outlet operative pressure as per the application indicated. Vendor shall select a proper differential pressure regulator depending upon the line pressure and the flow requirement. The material of differential pressure valve/constant differential valve and needle valve including the interconnection piping shall be same as flow meter tube material, as a minimum. Performance Requirements : Unless otherwise specified, the variable area flow meter shall meet the following performance specifications;

Flow meter Transmitter Accuracy : better than ± 2% of full scale

Repeatability : better than ± 0.5% of full scale

3.1.4.2 Glass Tube Variable Area Flowmeters

Glass tube variable area flow meters shall be used for low pressure utility services for local indication and where line size is 1-1/2" or less. Glass tube variable area flow meters shall not be used if outlet line is connected to a line or vessel containing hazardous or toxic fluid unless a check valve is installed at the downstream side of variable area flow meters.Glass tube flow meters shall have their metering tube made of toughened borosilicate glass and shall be thick walled. Borosilicate glass tubes shall be used keeping in view the recommended safe working pressure for different meter sizes and operating temperatures as per clause 6.1 of ISA-RP16.1, 16.2 and 16.3.

All glass tube flow meters shall be adequately shielded with safety glass on the reading side and amply vented. The glass tube flow meters shall be considered in low flow

applications up to and including ANSI 300# rating only. Metal tube / Glass Tube flow meter Accuracy : better than ± 2% of full scale Repeatability : better than ± 0.5% of full scale

3.1.4.3 Metal Tube Variable Area Flow meters :

Metal tube variable area flow meters shall be used for all process fluids. The body rating of the meter shall at least be equal to the rating of the end connection. Metal tube meters shall have the motion of the float transmitted via a magnetic coupling for secondary functions like indication, transmission or alarm.

3.1.5. ANALYSERS

General

Vendor shall be responsible to supply all types of analysers required for the System. Vendor to note:

a) Vendor "s scope shall include supply of various analysers like TOC Analyser, Oil in Water Analyser, turbidity, Chlorine Dioxide, ORP, pH & Dissolved Oxygen Analysers etc. as applicable as per requirement of finally approved P&IDs & other process documents and as per specifications complete with sample system designed for the specific purpose. Vendor shall supply in-line Analysers with necessary transmitters mounted in the field. In-situ analysers shall be capable of withstanding line pressure and temperature conditions. Analysers shall be supplied as per the approved P&IDs with functional requirements as specified elsewhere. Where no specifications are available,
Vendor shall detail out the same in line with international codes and practices, specifications provided with this document and last but not the least as per good engineering practices followed by analyser industry.
In all such cases, Vendor in their own interest must get performance specification reviewed by Owner/Owner Representative before proceeding with further engineering & procurement.

b) All analysers shall be micro-processor based in general and shall be capable of providing detail diagnostic alarms, messages to help maintenance personnel. These system alarms shall be connected to the PLC system in Central Control Room. The configurational data of the analyser including set range shall be stored in a non-volatile memory. Vendor shall provide smart transmitters, in general, for all the analysers. However in case SMART transmitters are not available for any particular type from the approved vendors, Vendor may supply Non-Smart type.

c) The span of the analyser shall be adjustable from the analyser front without opening the analyser enclosure. In case separate device is required to make such a change, same shall be included.

d) The material of construction selected by Vendor must be in suitable for fluid being handled. Vendor must select SS316 as a minimum.

e) All components of the analysers shall be certified suitable for the hazardous area classification.

f) The design of sample system for all the above analysers shall ensure a clean representative and measurable sample for the selected analysers. System shall

include sample probe, pressure reducing station, filters, regulators, relief valves, sample cooler etc as required. The design shall include a sample flow switch, which will provide alarm and inhibit analysis whenever a low flow is sensed. Filters shall always be provided in dual configuration. It shall be possible to replace the filter without upsetting the operation of the analyser.
Vendor shall consider provision of fast loops and sample return to process as necessary to meet performance requirements. The sample return shall not be vented or routed to drain unless the return is a waste product.

g) The analyser cabinet for the analysers shall be mounted in the field with canopy. A glass cover shall be provided for the panel front mounted items. The analyser cabinet shall be certified suitable for hazardous area classification. Further all the items / components including analyser electronics to be mounted in the analyser cabinet shall also be site environmental condition or other wise Vendor shall provide industrial grade air conditioner of required rating in the cabinet to make all the components suitable for site environmental conditions.

h) The configurational data of the analyser including set range shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.

i) Vendor shall be fully responsible for and shall arrange for analyser sub-vendor assistance for commissioning of the analyser system.

j) All the analysers shall be supplied pre-assembled, pre-tubed and pre-wired condition complete with sample handling system. All the interconnecting wiring shall be colour coded/ numbered and terminal blocks shall be clearly identified.

3.1.5.1. pH Analysers:

Principle: flow through
Protection Class: IP65.
Overall accuracy: ±0.01 pH or better for pH analyser.
Output: two wire, 4-20 mA, isolated.
Temperature compensation: automatic, built-in.
Local indication: digital, LCD indicator.
Mounting: local on 2” pipe, mounting kit (bracket, clamp, nuts etc.) to be supplied.
Sensor: flow through with flow powered cleaner.
Measuring electrolyte: bUffer solution.
Pre-amplifier: built-in.
Power Supply: 110V AC ± 10% 50Hz ± 1%
Calibration: semi-automatic using pre-configured bUffer tables.
Span and Zero adjustment required.
pH analyser shall be installed in such a manner that wetted parts are protected from oily sludge & other impurities present in the water. Automatic timer actuated cleaning / purging system should be provided to enhance the life of electrode.

3.1.6 MISCELLANEOUS REQUIREMENTS

Proven Track Record (PTR)

The instrumentation selected for the units shall be rugged in design and must be well proven in the hydrocarbon industry. Prototype design or equipment of experimental nature or design undergoing testing etc. shall not be selected and supplied.

Following criteria must be applied before selecting a particular instrument item:

a) For Instrument Items (Other than Systems)
The instruments as being offered / supplied should have been operating satisfactorily in hydrocarbon industry like Refinery, Petrochemical and Gas Processing Plant under similar process conditions for at least 4000 hrs.

b) For System Oriented Item

i) The system (with all its sub-systems) as being offered / supplied should have been installed and operating satisfactorily in hydrocarbon industry like Refinery, Petrochemical or Gas Processing Plant for at least 4000 hrs (as collaborated by user certificate).

ii) The system should be supplied, engineered, integrated tested etc. from a factory from where the system / sub-systems as offered / supplied have already been supplied, engineered, integrated tested etc. and meet the criteria b(i) above.

iii) All the activities including engineering should be carried out by the agency, which have carried out the similar activity in the past and meets the criteria b(i) above.

iv) The system should be supplied by the manufacturer in the fully engineered condition or should be supplied by the manufacturers representative / subsidiary who have proper infrastructural facilities and meets the criteria b(i) above.

v) In any case, the manufacturer whose system is being offered / supplied should have a local representation / subsidiary which has the proper infrastructural facilities like engineering, installation, maintenance, testing, spare part support, system fault diagnosis and other related logistic support. Systems, which don"t have the local base, should be avoided.

c) The installation & hook up standards selected in cryogenic services shall be proven for application in similar services as per above provenness requirement.

3.2 Specification for Instrument Cables & Instrument Power cables

Multi cables between the field instruments and field junction box shall be as per following philosophy:

a) Signals (4-20 mA or switch contact): 2pair individually and over all shielded (screened) and armoured, twisted.
b) Instrument Power Supply(110V AC ± 10% 50Hz ± 1% UPS supply): 3C 2.5 sq.mm stranded copper, armoured

All power supply cables shall be as per IS-1554 Part I and shall have copper/aluminium conductors depending on conductor size. Minimum conductor size shall be 2.5 mm2 of copper conductor. For higher sizes, aluminium conductor can be considered. All these cables shall be PVC insulated and armoured.
Any other special cable required for instruments shall also be provided as per requirements. Contractor shall ensure that these cables are armoured type and shall meet all other requirements mentioned in this specification.
In general, 80% of pairs of multicables shall be used i.e connected to instruments.

Remaining pairs shall remain unused however same shall be suitably terminated at junction boxes/ Local control panels/ Marshalling racks etc.

3.2.0 General Specification

The cables and accessories shall also conform to the provisions of CEA Regulations and other statutory regulations, as applicable.

In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However, Owner's decision in this regard will be final and binding.

All cables shall have PVC insulated primary insulation of 85 C PVC as per IS-5831 Type C. Thickness of primary insulation shall be 0.5 mm as a minimum. For PE insulated cables, primary insulation shall be of 70 C Polyethylene. Inner and outer jacket (sheath) shall be made of extruded flame retardant 90 C PVC to IS-5831 Type ST-2 and meeting flame retardant requirements for bunched cables as per IS 10810 (Part 62) category AF or IEC 60332 category A. Minimum Oxygen index of PVC shall be 30% at 27 C ±2 C, temperature index shall be over 250 C, a rip cord shall be provided for inner sheath, Outer sheath shall be suitable for protecting the cable against rodent and termite attack.

All cables shall be fire retardant as per standard IEC 60332-3 Part 3 Cat.A.

The insulation grade shall be 600 V/1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirements as per BS-5308 Part-2.

All cables shall be armoured. Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 part I. Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS 3975 and IS 10810 (Part 40) respectively.

All the cores of single pair or multipair shall be twisted and numbers of twist shall not be less than 10 per meter.

The thickness of the sheath shall be as per IS 1554 part 1.

Tolerance in overall diameter of cable shall be within ± 2 mm over offered value.

Overall twist of all pair/triads shall be as per vendor's standard.

For signal and control cables, inner sheath colour shall be black.

Vendor shall ensure a minimum of 20% of quantity of each type of cables provided as spare including any special cable. And in each multipair cables 20% pairs shall be kept as spare.

Running length of the cable shall be printed at least at every 1-meter interval. For multipair/ multitriad cables, a pair identification shall be provided with numbers at interval of not more than 250mm as per vendor"s standard. The embossing /engraving shall be legible and indelible.

3.2.1 Instrument Signal Cables

The Type-I single pair/triad cables shall be 1.5mm2 conductor size made of annealed electrolytic copper conductor of 7 strands with each strand of 0.53 mm diameter.

Type-II Multipair/ Multi-triad cables with individual pair/ triad shield and overall shield with 1.5mm2 conductor size shall have 7 strands of annealed electrolytic grade copper conductor with each strand of 0.53 mm diameter.

Type-III (Multi-pair / Multi-triad cable with only overall shield) cable shall be same as type-II cable, except that the individual pair/ triad shall not have shielding.

Type-IV Multi-pair /Multi-triad cable (with individual pair shield and overall shield) with 1.5 mm2 conductor shall have 7 strand with each strand of 0.53 mm diameter.

Type-V Multi-pair / Multi-triad cable (with overall shield only) shall be same as type IV except that the individual pair/triad shall not have the shielding.

Each pair/triad shall be shielded. Shield shall be aluminium backed mylar/polyester tape bonded together with metallic side down helically applied with either side having 25% overlap on either side and 100% coverage. Minimum shield thickness shall be 0.05 mm in case of single pair/ triad and 0.075 mm in case of multipair/ triad cable.

Drain wire shall be provided for individual pair and overall shield which shall be 0.5 mm2 multi stranded bare tinned annealed copper conductor. The drain wire shall be in

continuous contact with aluminium side of the shield.

Maximum DC resistance of the conductor of the completed cable shall not exceed the following:-
a) 12.3 Ω/km at 200C for cables with 1.5 mm2 conductor.
b) 39.7 Ω/km at 200C for cables with 0.5 mm2 conductor.
The mutual capacitance of the pair/ triad or adjacent cores shall not exceed 250 pF/m at a frequency of 1 kHz and between the pairs/ triads for PE Insulated cables shall not exceed 100 pF / metre at a frequency of 1 KHz. The capacitance between any core and screen shall not exceed 400 pF/ m at a frequency of 1 kHz.
L/R ratio of adjacent cores shall not exceed 40 µH / Ω for cables with 1.5 mm2 conductor and 25 µH / Ω for cables with 0.5 mm2 conductor.
The drain wire resistance including shield shall not exceed 30 Ω/km. Electrostatic noise rejection ratio shall be over 76 dB.
Contractor shall ensure a minimum of 20% of quantity of each type of cables provided as spare including any special cable. And in each multipair cables 20% pairs shall be kept as spare.
Running length of the cable shall be printed at least at every 1-meter interval. For multipair/multitriad cables, a pair identification shall be provided with numbers at interval of not more than 250mm as per vendor"s standard. The embossing /engraving shall be legible and indelible.

3.2.2 ELECTRICAL FIELD WIRING

a) Instrument electronic signal (non FF) & alarm cables, single pair as well as multipair shall be 1.5 mm² twisted in pair individually and overall shielded with aluminium Mylar tape with drain wire and armoured.
b) Control wiring for actuating devices and solenoid valves of the interlock and shutdown system shall generally be 1.5 mm² armoured cable.
c) Multicore extension cables for Thermocouples, wherever applicable, shall be 20 AWG single conductor twisted pairs, armoured, individual pair and overall aluminium mylar shielded with over all drain wire. Single pair extension cables shall be armoured cable with 16 AWG single conductor wire.
d) Power supply cables to field instruments shall be minimum 2.5 mm² armoured.
e) All cable glands shall be of nickel-plated brass and they shall be of double compression type suitable for armoured cables.
f) Generally PVC insulated cables shall be used.
g) For longer distances conductor sizes shall be selected based on voltage drop.

3.2.3 INSPECTION, TESTING AND ACCEPTANCE

The cables shall be tested and inspected at the manufacturer's works. Manufacturer shall furnish all necessary information concerning the raw material supply to EIL/ Owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality. For HV cables, the vendor shall give at least 2 weeks advance notice to the purchaser, regarding the date of testing to enable him or his representative to witness the tests.

After completion of manufacture of cables and prior to despatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. The test reports for all cables shall be got approved from the Engineer before despatch of the cables.All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS: 1554 (Part-1) and IS: 7098 (Part-2) on PVC and XLPE insulated cables respectively.

The test requirements for PVC insulation and sheath of cables shall be as per latest revision of IS: 5831. Test for Resistance to Ultra Violet Radiation: This test shall be carried out as per DIN 53387 or ASTM-G-154 on outer sheath. The retention value of tensile strength and ultimate elongation after the test shall be minimum 60 % of tensile strength and ultimate elongation before the test. Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognised test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided outer
sheath remains same. Acceptance tests as per IS-1554 (Part-1) and IS-7098 (Part-2) and the following special tests to be performed on the cables as per sampling plan for all cables. However these tests are required to be witnessed by EIL/ Owner for HV cables.
a. Accelerated water absorption test for insulation as per NEMA-WC-70. (For PVC insulated cables) and as per NEMA-WC-53 (for XLPE/ EPR insulated cables). Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided type of insulation remains same.

Dielectric Retention Test: The dielectric strength of the cable insulation tested in accordance with NEMA-WC-70 at 75 ± 1° C shall not be less than 50 % of the original dielectric strength. (For PVC insulated cables). Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly and once for each order.

Oxygen Index Test: The test shall be carried out as per IS-10810 (Part 58). Sampling to be done for every offered lot/size as per sampling plan.

Flammability Test: The test shall be carried out on finished cable as per IS-10810 (Part 61 & 62). Sampling for these tests is to be done randomly once for each order, provided outer sheath remains same. The acceptance criteria for tests conducted shall be as under:
Part-61-The cable meets the requirement if there is no visible damage on the test specimen within 300 mm from its upper end
Part-62-The maximum extent of the charred portion measured on the test sample should not have reached a height exceeding 2.5 m above the bottom edge of the burner at the front of the ladder.

Test for rodent and termite repulsion property shall be done by analysing the property by chemical method.

Routine and acceptance tests as listed in relevant Indian standard and equipment specifications shall be conducted.
Type test if listed in Inspection and Test Plans and in the relevant data sheet shall be conducted. Type test, if specified, shall be conducted only on one of equipment of each type and rating. These tests shall be carried out by the Contractor/ vendor/ sub-vendor and shall be witnessed by Owner/ PMC or an agency authorized by Owner/ PMC.
The cable shall be inspected and tested based on the following documents.

1. Approved Quality Plan

2. BHEL Technical Specification
3. BHEL Purchase order
4. BHEL approved supplier's data sheet

3.2.4 PACKING AND DESPATCH

Cables shall be despatched in non-returnable wooden or steel drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage.The wood used for construction of the drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage. On the flange of the drum, necessary information such as project title, manufacturer's name, type, size, voltage grade of cable, length of cable in metres, drum no., cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.

3.3 Specification for Junction Boxes

The junction box shall be suitable for the type of signal and type of multicore cables used as indicated below. Unless otherwise specified, Vendor must use the following type of junction boxes:

Separate junction boxes shall be used for the following type of signals:

- Non Intrinsically Safe Analog Inputs/Outputs (4-20 mA)
- Non Intrinsically Safe contact Inputs.
- Non Intrinsically Safe contact Outputs.
- Electrical Junction Boxes for Analyser power supply ie 110 V AC

3.3.1 Junction Boxes and Wiring/ Termination blocks for Analog Outputs, Analog Inputs, Digital Inputs& Digital outputs.

a) Junction boxes shall be either Weather proof type or Weather proof and flameproof type. No other type of junction boxes shall be offered / provided unless specifically required.

b) Unless otherwise specified, the enclosure shall conform to the following standards:
Weatherproof housing : IP 55 to IEC-60529/IS-13947

c) Junction boxes with top entries shall not be offered. The size of cable entries shall be as per the cable sizes.

d) Each junction box shall have spare entries as follows:
i) Minimum of 2 Nos. for 6P/12C JB
ii) 4 numbers for 12P/24C JB.

3.3.2 Electrical Junction Boxes for Analyser power supply

i) The material of construction of electrical junction boxes shall be die-cast aluminium of minimum 5 mm thick (LM-6 alloy).

ii) Weather proof junction box shall have hinged type door with neoprene gasket, which shall be fixed to the box by plated countersunk screws.

iii) Power junction boxes (junction boxes for power supply cable / distribution) shall have either the warning cast or shall have warning plate with following marking and shall be suitable for incoming armoured power cable up to 150 sq.mm conductor size: "Isolate power supply elsewhere before opening".

iv) Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.

v) All terminals used in signal, alarm and control junction boxes shall be suitable for accepting minimum 2.5sq.mm copper conductor, in general.

vi) Terminal used in power junction boxes / power supply distribution box shall be suitable for accepting conductor size of 4 Sq. mm to upto 120 sq. mm. Exact

requirement shall be specified in job specification. Higher size of terminals shall be provided when indicated. Bus bar terminals shall be provided for conductor size of 50 sq. mm and above. Suitable size of lugs shall be provided to suit conductor size.

vii) Each junction shall have minimum of 30% spare terminal of those actually required to be utilised. Number of terminals for various types of junction boxes shall be as follows;

24 Nos. for 6 pair junction box.

48 Nos. for 12 pair junction box

viii) Terminals shall be identified as per the type of input signal e.g all terminals for intrinsically safe inputs shall be blue while others shall be grey in colour.

ix) Junction boxes shall be provided with external earthing lugs.

x) Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines;

- 50 to 60 mm gap between terminals and sides of box parallel to terminal strip for upto 50 terminals and additional 25 mm for each additional 25 terminals.
- 100 to 120 mm between two terminal strips for upto 50 terminals and additional 25 mm for each additional 25 terminals.
- Bottom/top of terminal shall not be less than 100 mm from bottom / top of the junction box.

Earthing bolts & nuts with lug shall be provided at opposite points on outside of the junction box with earth symbol.

3.3.3 Painting of Junction Boxes

i) Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

ii) Two coats of lead-free base primer and two final coats of lead free epoxy based paint shall be applied both for interior and exterior surfaces.

iii) All intrinsically safe junction boxes shall be Light blue and all others shall be of Light grey colour.

iv)No painting is required for SS Junction Boxes.

3.3.4 Packing of Junction Boxes

Each JB shall be fully wrapped in a polythene cover to avoid water entry and then packed separately in cardboard box. Finally all such boxes shall be packed in a wooden crate.

3.3.5 Drawing of Junction Boxes

JB Manufacturing drawings such as General Arrangement, Mounting Arrangement, Terminal Block Details in AUTO CAD/PDF shall be submitted for approval by BHEL, (prior to start of manufacture) within 10 days from the date of purchase order.

The junction boxes shall have cable entries suitable for the multi and single cables used. 20% additional cable entries must be provided. Unused entries shall be plugged. The junction boxes shall have terminals suitable for the cable wire size and shall preferably be of Phoenix or equivalent make.

The multi cable entry for 6 pair Junction Box (JB) shall be 1" NPTF and for 12 pair/ 8 triad junction box, it shall be 1 1/2" NPTF. Each junction box shall be provided with 2 multicable entries with one plugged with weatherproof, flameproof plug as required.

Multicable entries shall be from the bottom whereas 1 pair/triad from the side.

One junction box shall be connected to one multicable only. The other cable entry shall be plugged. The junction boxes in the field as well as local panels shall be provided with sUfficient number of terminals to terminate all the pairs of multi-cable (including spare pairs) and shields of individual pairs as applicable.

3.4 Specification for Cable Trays, cable glands, Fittings

a) Specification for Cable Trays

a) All cables on the main pipe rack shall be laid in cable duct fabricated out of GI sheets.

b) All branch cables shall be run on cable trays. The Perforated trays, Ladder trays and Angle trays shall be of Mild Steel hot dip galvanised. The Perforated trays shall be of 2.5 mm thickness.

c) Cable tray laying to take care of the necessary clearances for fire proofing of structures.

d)All branch cables/tubes shall run on cable trays. The cable trays shall be made out of Galvanised mild steel sheets of 2.5 mm thickness unless specified otherwise. Ladder trays shall be of mild structural steel and shall be hot dip galvanised. 50 mm x 50 mm angle shall be used as a minimum. The width shall be so selected that 50% of tray space is available for future use.) Suitable cable clamps shall be provided for binding the cables/tubes at every 500 mm. Continuous channel for support of overhead duct shall be provided and shall be suitable for load considering 100% filling of duct by cables. For cable trays supports shall be provided at a minimum interval of 1.5m.

b) Specification for Cable Glands

a) Vendor shall provide all cable glands required for glanding the above mentioned cables both at field instrument and local control panel side, junction boxes side and at control room side.

b) All cables glands shall be of nickel-plated brass and they shall be double compression type suitable for armoured cables.

c) Flame proof glands wherever required shall be provided with Exd certification.

d) Vendor shall provide a minimum of 20% of cable glands as spare.

e) All cable glands shall be weather proof to IP-55.

f) Cable glands shall be NPT for all field items and junction boxes where as ET thread with check nuts for control room end.

g) Cable glands shall be provided to suit the cable dimensions along with tolerances. Various components like rubber ring, metallic ring, metallic cone and the outer / inner nuts etc. shall be capable of adjusting to the tolerances of cable dimensions.

c) Specification for Instrument Valves, fittings and Manifolds

a) Vendor shall provide instrument valves (miniature type) and valve manifolds wherever required.

b) Vendor should refer hook up drawing (EIL) as ENCLOSED.

c) For all valves and manifolds with body material of carbon steel/stainless steel, the valve trim material shall be SS316, as a minimum. For any other body material, trim material should be same as body material as a minimum. Superior trim material shall be selected as required by process conditions. Packing material in general shall be of PTFE. The o-ring materials wherever used shall also be of PTFE.

d)

i. Instrument Valves (Miniature) shall be of globe pattern needle valves forged/ bar stock with inside screwed bonnet, with back-seated blow out proof system.

ii. Instrument Air Isolation Valves (Miniature) shall be full-bore ball type with forged body.

iii. Instrument Air Needle Valves (Miniature) shall be globe pattern-needle valves forged/ bar stock with inside screwed bonnet.

iv. For all these valves types, Body material shall be SS316.

v. End connection shall be ½"NPTF to ANSI B 1.20.1 for Instrument Valves (Miniature) and Instrument Air Isolation Valves (Miniature) and ¼" NPTF to ANSI B1.20.1 for Instrument Air Needle Valves (Miniature).

vi. For Instrument Valves (Miniature) and Instrument Air Needle Valves (Miniature), flow direction shall be marked on the body.

e) Vendor shall ensure that Qualification tests (hydrostatic proof and burst tests) as per MSS SP-99 are carried out by vendor for each design and size of valve to establish the cold working pressure (CWP) rating.

f) The finishing and tolerances of parts like stem, piston, stem threading etc. of the offered valves and manifolds shall be properly machined to avoid problems like galling. g) The hand wheel material for all valves and manifolds shall be zinc/nickel plated carbon steel. Any other material, if provided as per standard vendor design, shall also be acceptable.

d) 3-Valve manifold :

i. It shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54mm (2-1/8") center-to-center connections and 41.3mm (1-5/8") bolt-to-bolt distance.

ii. It shall contain two main line block valves and an equalizing bypass valve. The valves shall be needle type. They shall use self-aligning 316 Stainless Steel ball seats, unless otherwise specified.

iii. The flanges shall be integral part of manifold block.

iv. The process connection shall be ½"NPTF to ANSI B 1.20.1.

v. Manifolds for stanchion mounting shall be provided along with mounting accessories. The bolts and nuts shall be alloy steel as per ASTM A 193 Gr B7 and ASTM A194 Gr. 2H (Hot dip galvanised or zinc plated) respectively. Other accessories shall be zinc plated.

e) 3 way 2 valve manifold for pressure gauges :

i. It shall be designed for use with pressure gauges with block and bleed valves. The manifold body shall be either straight or angle type as required.

ii. The valve shall be a needle type.

iii. The inlet connection shall be ¾" plain ends with a minimum of 100mm nipple extension suitable for socket weld or butt weld as per B16.11/ B16.9. The gauge connection shall be with union nut and tail piece threaded to ½"NPTF and drain connection shall be ½"NPTF.

For all Valve manifolds material of construction shall be SS316.

5-Valve manifold shall be provided, if specified in the job specifications.

Vendor shall provide a minimum of 20% instrument valves and manifolds as spare.

f) Pneumatic Signal Tubes

a) Vendor shall provide ¼" OD x 1 mm thick SS316L for pneumatic signal tubes unless specified otherwise.

b) Vendor shall avoid use of intermediate connections and shall estimate single length for each instrument location.

c) Vendor shall provide a minimum of 20% length of these tubes as spares.

g) Instrument Air Lines Fittings and Valves

a) Instrument air lines and fittings shall be as per piping class unless specified otherwise.

b) Isolation valves on instrument air service shall be packless gland type full bore ball valves of SS.

c) Vendor shall provide a minimum of 20% of air pipe, fittings and valves as spare.

h) Stainless Steel Tube Fittings

a) Fittings shall be of flare less compression type having four-piece (for double compression type) construction consisting of two ferrules, nut and body or three piece (compression type) construction consisting of single ferrule, nut and body suitable for use on tubes of specified material for example stainless steel tubes conforming to ASTM A269 TP 316L with hardness in the range of HRB 70 to 79.

b) All parts of the tube fittings shall be of SS316.

c) Hardness of the ferrules shall be in the range of HRB 85-90 so as to ensure a hardness difference of the order of 5 to 10 between tube and fittings for better sealing.

d) Nuts and ferrules of a particular size shall be interchangeable for each type.

e) Specific techniques like silver plating shall be used over threading in order to avoid jamming and galling.
f) Ferrule finish and fitting finish shall be such that there is no abrasion/galling when the nut is tightened.

4.0 Mandatory Spares

Sl.No	PART DESCRIPTION	QUANTITY REQUIRED
1	Field Instruments such as Pressure Gauges, Temperature Gauges with Thermowell , Differential Pressure Gauges, ft Gauge, Field Indicators, RTD/ Thermocouple (with Thermowell), Thermowells, Skin Thermocouple Sets, Cool down Temperature Elements, speed probe and transmitters (Note-5)	10% subject to minimum 1 No. of each type
2	Smart Transmitters for Pressure, Level (excluding radar and displacer transmitters), Flow (DP type only), Temperature & Differential Pressure (complete transmitter) (Note-5)	10% subject to minimum 1 No. of each type
4	All type of Switches (in case given in place of transmitters as a special case because of statutory / special applications) (Note-5)	10% subject to minimum 1 No. of each type
6	Instrument valves and manifolds	20% minimum of each type
	SS Tubes for Instrument Impulse line & ¼" OD Pneumatic air tubing	20% minimum of each type

NOTES:

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material, accessories as applicable.
2. Wherever % age is identified, Vendor shall supply next higher rounded figure.
3. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
4. Commissioning spares are part of Vendor scope of supply. Mandatory spares as indicated above do not cover commissioning spares.
5. Spares for Instruments shall be supplied alongwith the applicable accessories as mandatory spares. No accessories shall be supplied separately as mandatory spare.
6. The above mandatory spares are to be supplied along with main system

5.0 Commissioning Spares

For successful pre-commissioning, commissioning and performance testing, requirements of spares are to be provided by the contractor within quoted lump sum price and are to be listed in the bid. Any additional spares used shall be to Contractor's account. Any kind of spares required for start-up and commissioning shall be provided.

6.0 Two years operational spares List (optional)

Unless otherwise specified in the job specifications, all spares for 2 years of normal operation like gaskets, O-rings, diaphragms etc. as required for all instruments for two years of trouble free operation shall be quoted separately.
Unit rate of all items instruments, instrument cables, instrument valves manifolds and hardware shall be indicated by Vendor for any future addition/deletion for system related items. This

price shall include all engineering charges, installation, software charges etc. related to the effected addition/deletion & will not be considered for bid evaluation.

7.0 COMMISSIONING

a. This activity shall be carried out in a systematic manner so as to avoid any accident to plant and operating personnel.

b. During the plant start up all the instruments calibration, controller alignment, trip point settings shall be trimmed so as to meet the operation requirements.

c. Prior to guarantee run of any unit, the vital instruments as required by Vendor have to be recalibrated and the results recorded.

d. As built drawings shall be prepared after installation and commissioning is over.

8.0 Customer Approved Vendor List

Vendor List for Instrumentation items is provided in the specification. Vendor shall consider the instrument supplier as identified in the Vendor List. Vendor list provided in the package is for the Make only, and not for any specific Model.

For any instrumentation item, the offered model for the same must meet the specification and proven track record (PTR) requirement. For all special Instruments and systems like On-off valves, field instruments, Analysers, PLC system, EIL(PMC) approved vendor List shall be followed. This is applicable for skid mounted instruments as well.

9.0 SCHEDULES

8.1) Schedule of Technical Confirmations – Schedule-A

(Please indicate Yes / No)

1.	All the items / equipments / instruments as per Enquiry / PID are included in the scope	
2.	All the items / equipments / instruments are manufactured and tested as per relevant codes and standards.	
3.	All the items / equipment / instruments meet Enquiry technical BHEL specification	
4.	Erection of all supplied instruments and equipment included in scope	
5.	Laying & termination of cables included in scope	
6.	Laying & termination of SS impulse line for instruments included in scope	
7.	Laying & termination of SS tube for POV's included in scope	
8.	Pre commissioning checks will be included in scope	
9.	Commissioning included in the scope	
10.	Training at vendor's works and at site included in scope	
11.	Makes of all instruments and equipment will be as per the BHEL specification	
12.	Site specific Programming assistance for purchaser's PLC included in scope	
13.	Calibration at manufacturer's works included in scope	
14.	Calibration at site included in scope	
15.	Supply of commissioning spares included in scope	
16.	Supply of Tools & tackles included in scope	
17.	Supply of hand held programmer kit / calibrator suitable for all instruments included in scope	

18.	Supply of VFD panels (if any) included in scope	
19.	Supply of all calibration liquid, powder as per the BHEL specification included in scope.	
20.	In the event of order all drawings datasheets and documents as per the BHEL specification will be submitted to BHEL for approval.	
21.	All instruments / JB's/ SVEB's will be provided with Double Compression type cable glands and Annealed Tinned copper lugs	
22.	Operation and maintenance manual in required numbers will be supplied for all items	
23.	Erection materials like Root valves, 3 way manifolds, impulse piping required for installing all instruments will be included in scope	
24.	Supply of cable trays, glands, lugs included in scope	
25.	Number of Digital inputs to be provided in PLC	Indicate quantity
26.	Number of Digital outputs to be provided in PLC	Indicate quantity
27.	Number of Analogue inputs to be provided in PLC	Indicate quantity
28.	Number of Analogue outputs to be provided in PLC	Indicate quantity
29.	Site support for auto operation through PLC as per Enquiry included in scope	
30.	Unit price for addition deletion as per Enquiry furnished in the Price Bid	

8.2 Schedule of Technical Deviations **SCHEDULE-B**

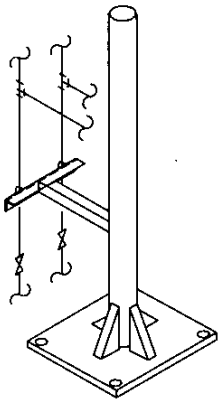
Specn. Clause no.	Specification requirement	Bidder's deviation statement

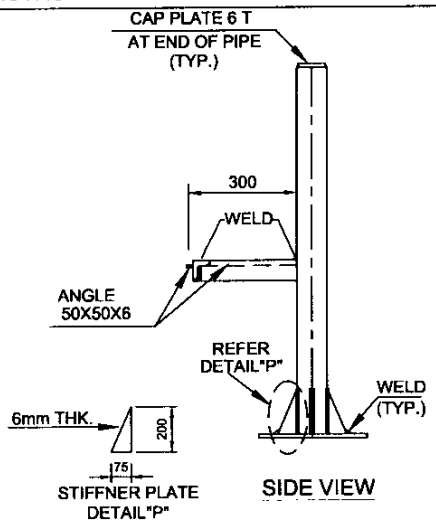
It is certified that except the deviation listed above, all other tender clauses are complied with.

Signature of the Bidder

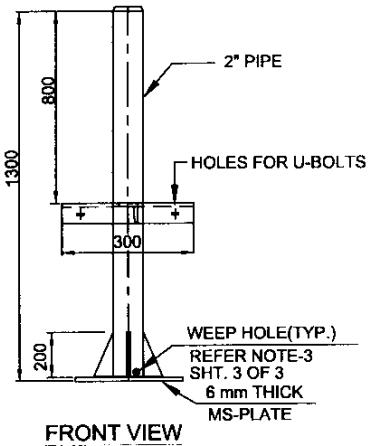
Date:

TYPE 11 — SINGLE INSTRUMENT SUPPORT - GENERAL ARRANGEMENT



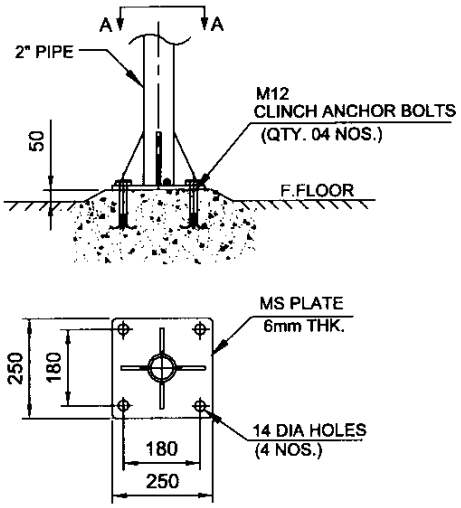


SIDE VIEW



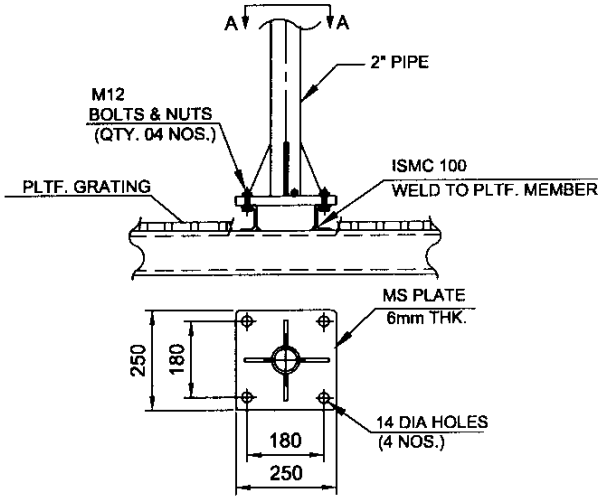
FRONT VIEW

TYPE 11-1



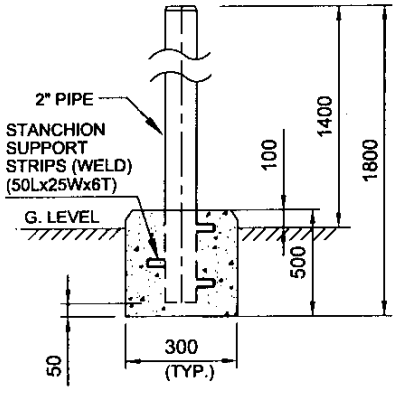
VIEW A-A
PAVED AREA MOUNTING

TYPE 11-2



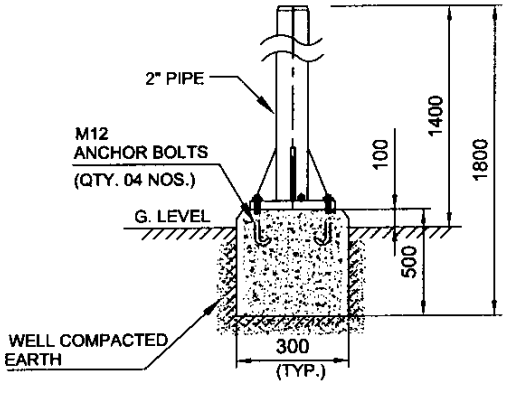
VIEW A-A
PLATFORM MOUNTING

TYPE 11-3



UNPAVED AREA MOUNTING
(WITH INTEGRAL CONC. BLOCK)

TYPE 11-4



UNPAVED AREA MOUNTING
(WITH SEPARATE CONC. BLOCK)

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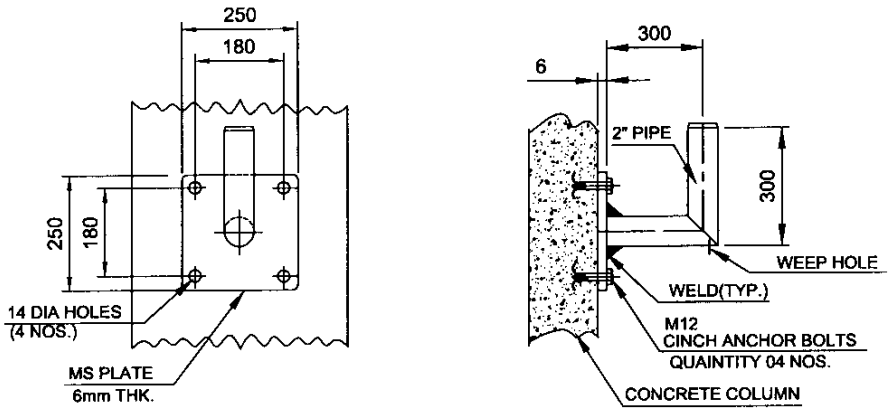
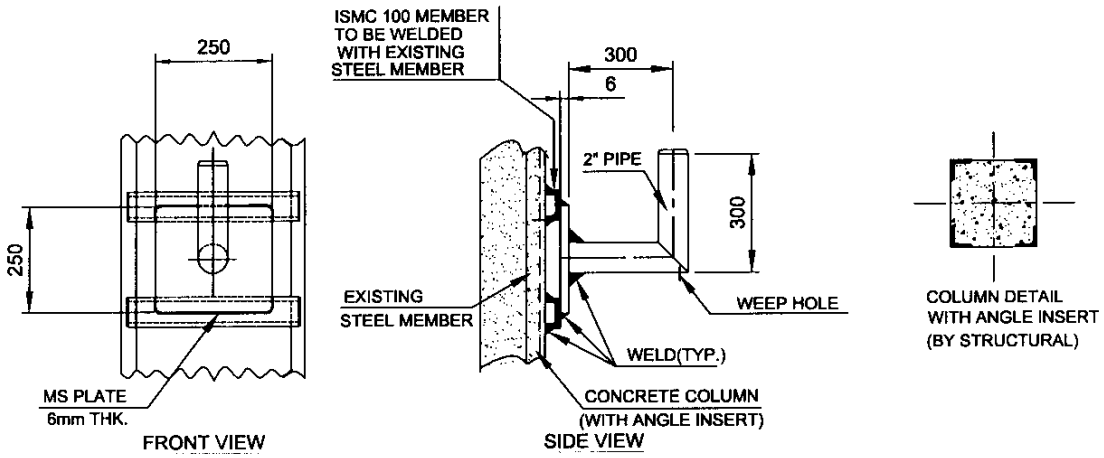
2	14-11-11	Revised & Reissued	Manoj	RG	RP/JMS	DM
1	01-09-06	Reaffirmed and Reissued	MN	TGM	PM	VC

TYPE 12 CONCRETE COLUMN MOUNTING



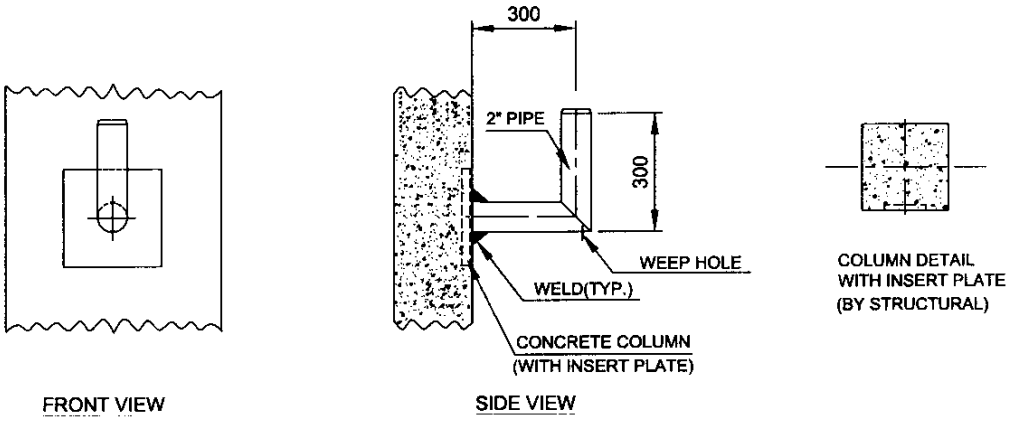
FRONT VIEW SIDE VIEW

TYPE 13 CONCRETE COLUMN (WITH ANGLE INSERT) MOUNTING



FRONT VIEW SIDE VIEW

TYPE-14 CONCRETE COLUMN (WITH INSERT PLATE) MOUNTING



FRONT VIEW SIDE VIEW

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
2	14-11-11	Revised & Reissued	Manoj	RG	RP/JMS	DM
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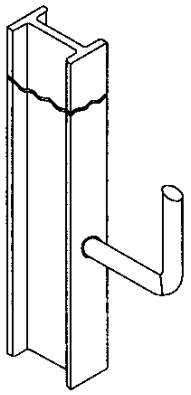
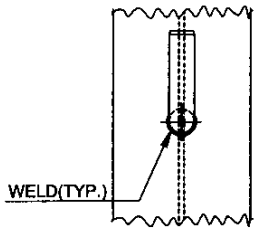
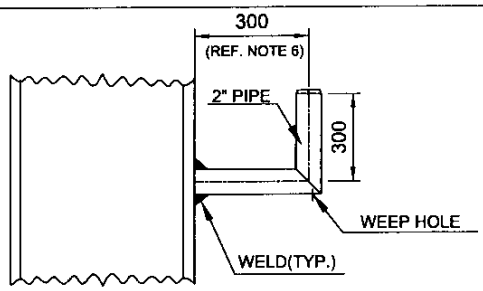
TYPE 15 STEEL COLUMN MOUNTING (FLANGE FACE)



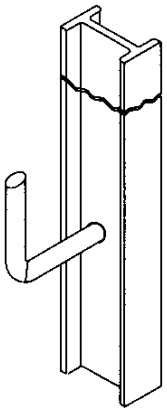


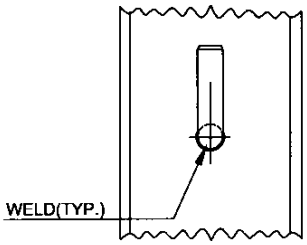
SIDE VIEW



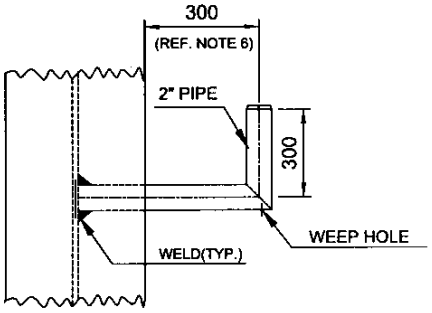
FRONT VIEW

TYPE 16 STEEL COLUMN MOUNTING (WEB FACE)





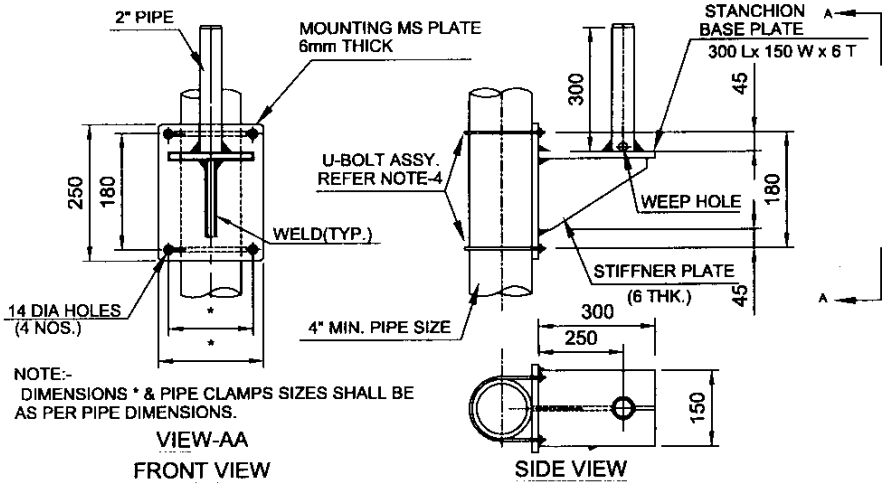
SIDE VIEW



FRONT VIEW

TYPE 17 PIPE BRACKET MOUNTING

TYPE 17.1 (VERTICAL PIPE)

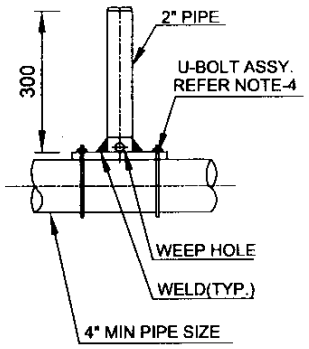


NOTE:-
DIMENSIONS * & PIPE CLAMPS SIZES SHALL BE AS PER PIPE DIMENSIONS.

VIEW-AA
FRONT VIEW

SIDE VIEW

TYPE 17.2 (HORIZONTAL PIPE)



(HORIZONTAL PIPE)

NOTES:-
1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. PIPE MATERIAL SHALL BE IS:1239 HEAVY GRADE AS A MINIMUM.
3. 6 mm DIA WEEP HOLE SHALL BE PROVIDED AT LOW POINT.
4. U-BOLT ASSEMBLY SHALL BE OF MINIMUM M12 SIZE WITH NUTS AND SPRING WASHERS.
5. ALL WELD SHALL BE 3mm FILLET WELD FULL STRENGTH.
6. ADD 50mm WHERE-EVER FIRE INSULATION IS PROVIDED.
7. BOLT SHALL BE TURNED FROM M.S. ROUNDS CONFIRMING TO IS : 432 GRADE 1.
8. NUTS AND WASHERS SHALL CONFIRM TO IS : 1363 AND IS : 3138.

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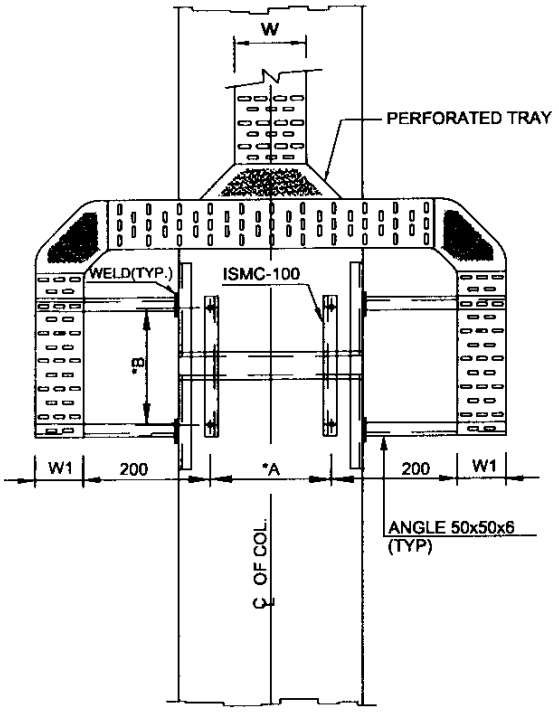
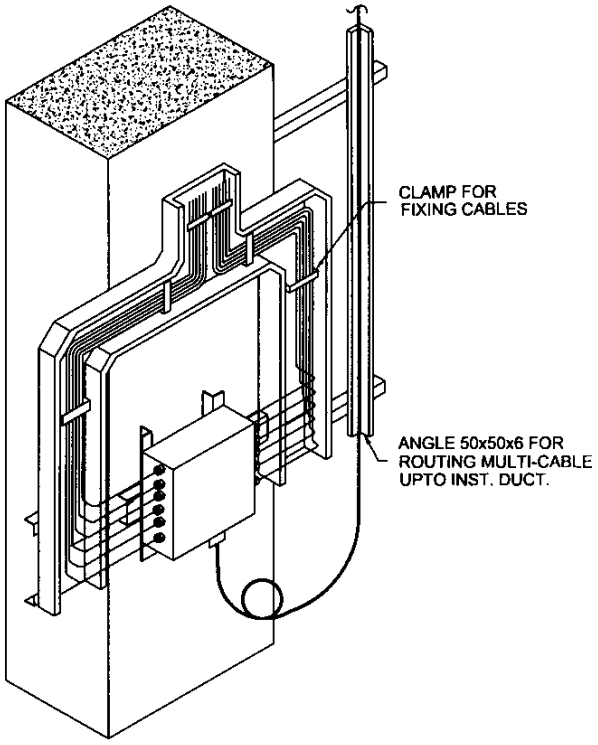
2	14-11-11	Revised & Reissued	Manoj	RG	RP/JMS	DM
1	01-09-06	Reaffirmed and Reissued	MN	TGM	PM	VC

Approved by

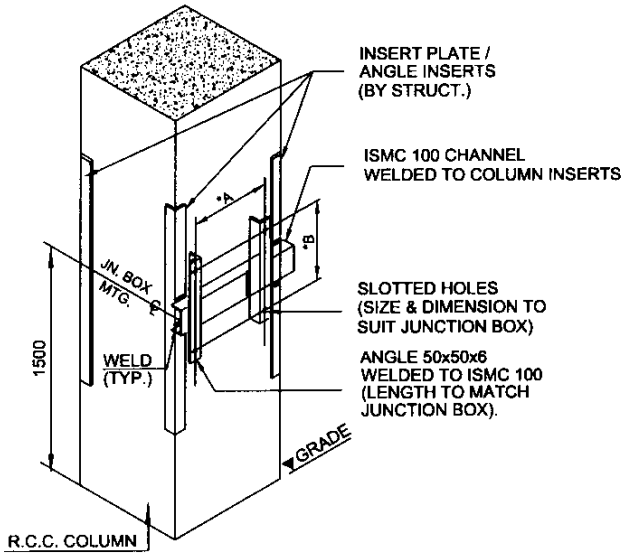
TRAY ARRANGEMENT FOR JUNCTION BOXES



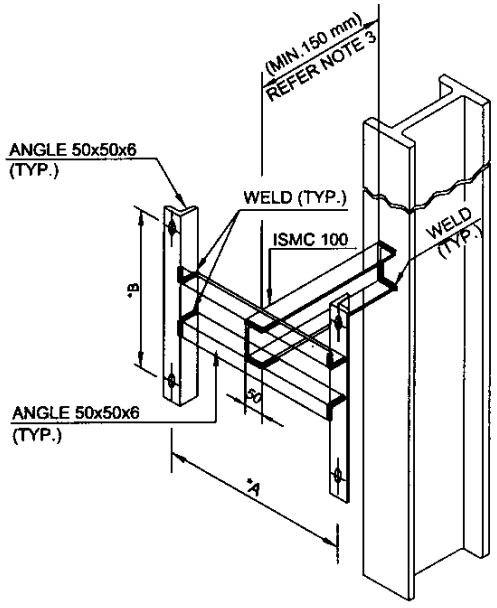
CABLE ROUTING FOR JUNCTION BOXES.



JN. BOX MOUNTING FRAME (R.C.C. COLUMN)



JN. BOX MOUNTING FRAME (STEEL COLUMN)



* DIMENSION `A and B' TO SUIT JUNCTION BOX.

NOTE:
1. ALL DIMENSIONS ARE IN mm.
2. CLAMP MULTICABLE ON ANGLE WITH 25mm WIDE PVC COVERED ALLUMINIUM STRIP.
3. ADD 50 mm WHERE-EVER FIRE INSULATION IS PROVIDED.

TRAY WIDTH

JN. BOX	W	W1
12 PAIR	300	150
8 TRIAD	300	150
6 PAIR	150	100
6 TRIAD	150	100

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1	01-09-06	Reaffirmed and Reissued	MN	TGM	PM	VC

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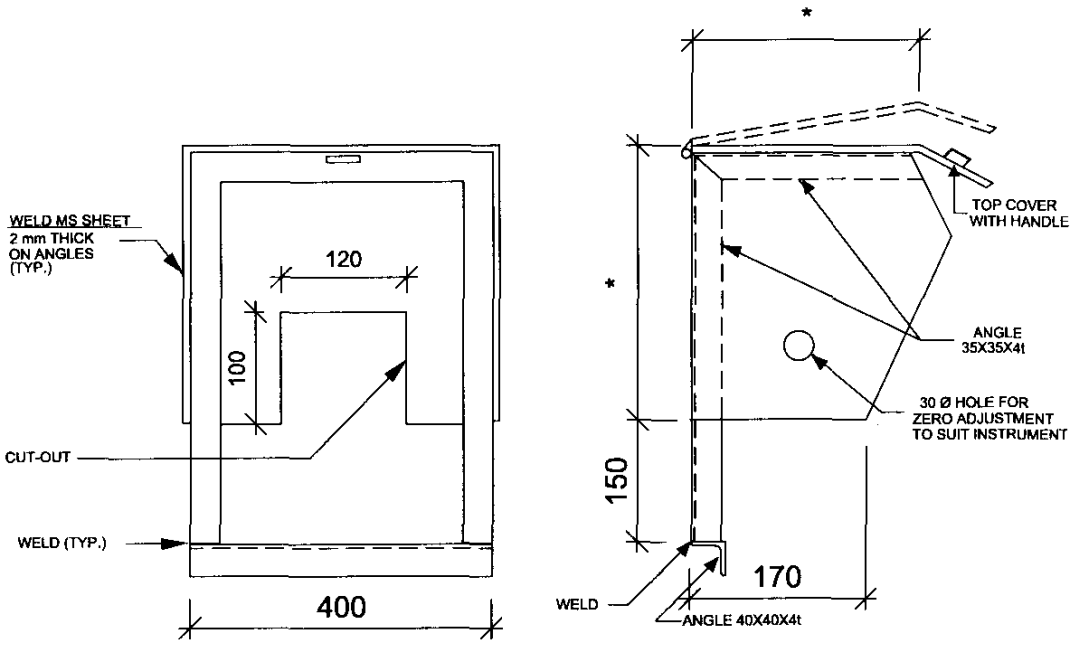

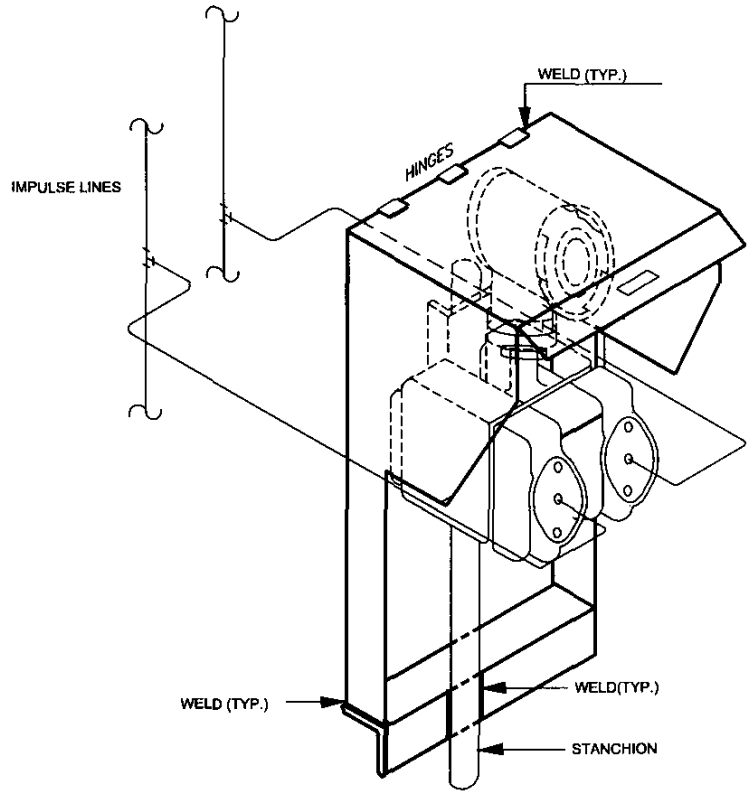

NOTES :

1. ALL DIMENSIONS ARE IN mm
2. * - TO SUIT INSTRUMENT DIMENSIONS
3. HINGES SHALL BE OF STAINLESS STEEL.
4. A MINIMUM OF TWO COATS PAINTING SHALL BE CARRIED OUT AFTER A MINIMUM OF ONE COAT OF RED OXIDE ZINC CHROMATE PRIMER. THE COLOUR OF THE PAINT SHALL BE AS PER IS-5.

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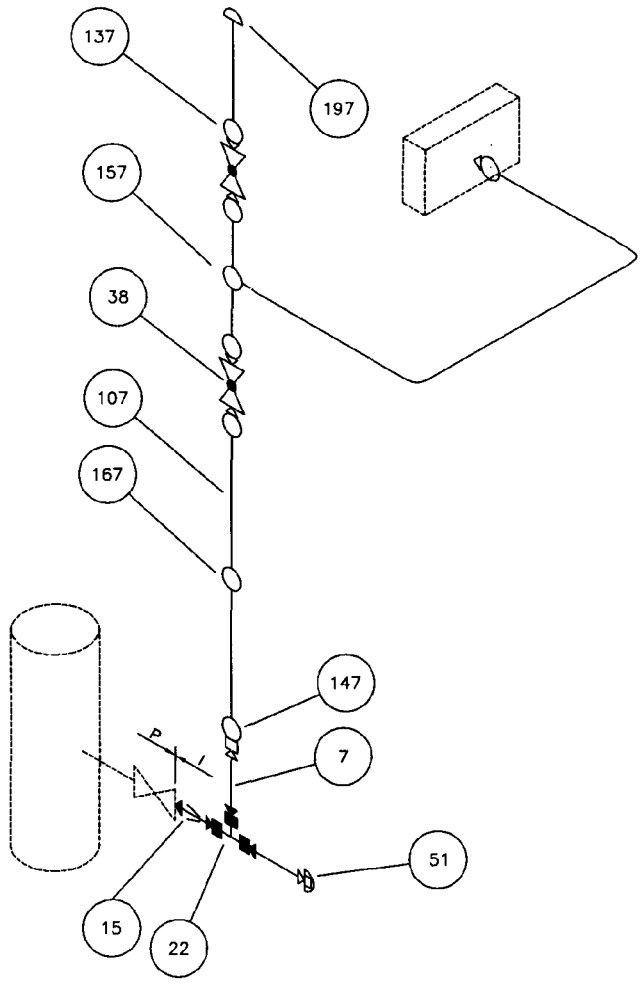
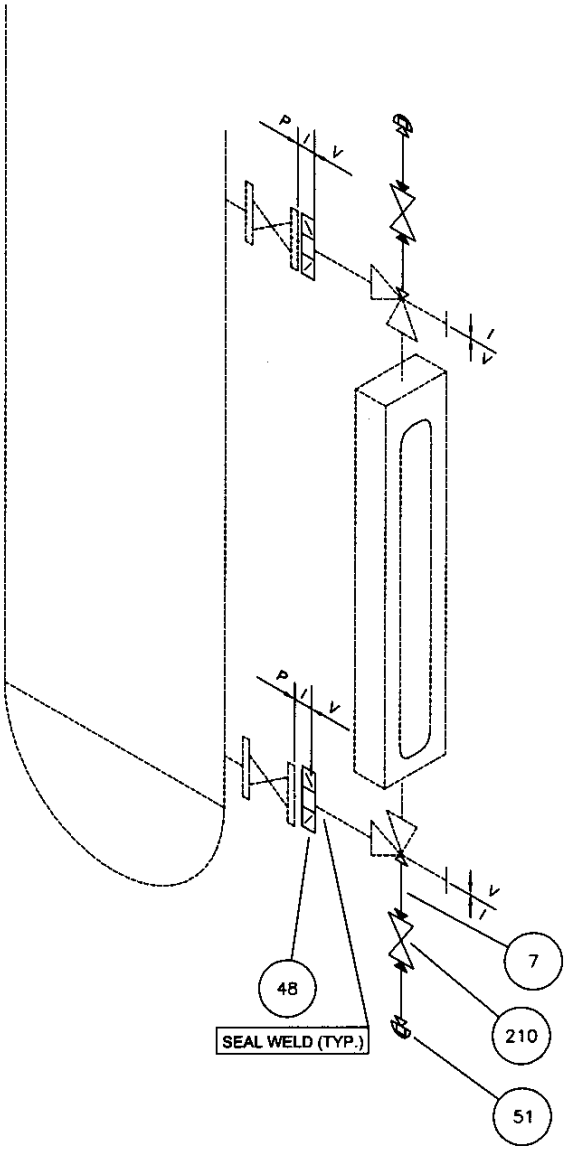


LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
7	NIPPLE	1/2"	TH X PL	2	Nø	107	TUBE	1/2"	OD	A/R	m
15	SWAGE NIPPLE	3/4" X 1/2"	PL X PL	1	Nø	137	MALE CONNECTOR	1/2" X 1/2"	TH X OD	5	Nø
22	EQUAL TEE	1/2"	SW	1	Nø	147	FEMALE CONNECTOR	1/2" X 1/2"	TH X OD	1	Nø
38	GLOBE VALVE	1/2"	TH	2	Nø	157	UNION TEE	1/2"	OD	1	Nø
51	CAP	1/2"	TH	1	Nø	167	TUBE UNION	1/2"	OD	1	Nø
						197	TUBING CAP	1/2"	OD	1	Nø

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	01-08-11	Revised & Reissued	Manoj	RG	RP/JMS	DM
3	07-08-06	Reaffirmed and Reissued	MN	TGM	PM	VJN

Approved by

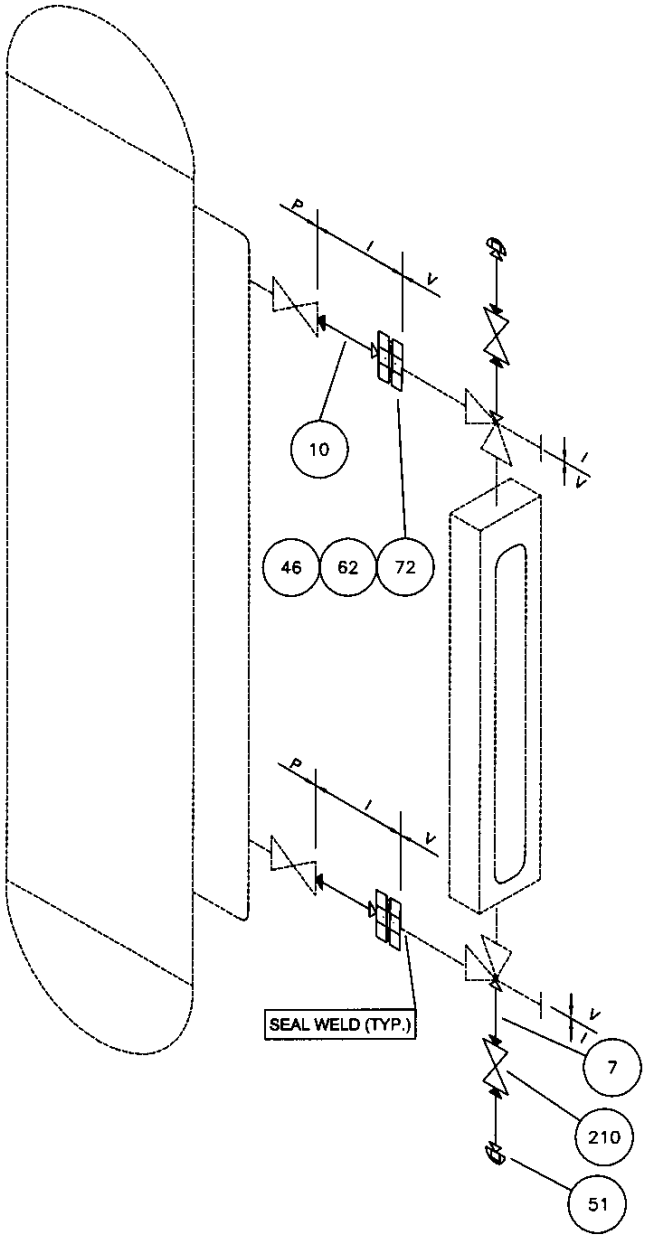


P - BY PIPING
I - BY INSTRUMENTATION
V - BY INSTRUMENT VENDOR

LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
7	NIPPLE	1/2"	TH X PL	4	Nø						
48	FLANGE	2" X 3/4"	FL X TH (Rod)	2	Nø						
51	CAP	1/2"	TH	2	Nø						
210	GATE VALVE	1/2"	SW	2	Nø						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
4	12-10-11	Revised and Reissued	Manoj	RG	RP/JMS	DM
3	07-08-06	Reaffirmed and Reissued	MN	TGM	PM	VJN



P - BY PIPING
I - BY INSTRUMENTATION
V - BY INSTRUMENT VENDOR

LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
7	NIPPLE	1/2"	TH X PL	4	Nø						
10	NIPPLE	3/4"	TH X PL	2	Nø						
46	FLANGE	3/4"	TH	4	Nø						
51	CAP	1/2"	TH	2	Nø						
62	GASKET	FOR 3/4" FL		2	Nø						
72	STUDS & NUTS	FOR 3/4" FL		2	Set						
210	GLOBE VALVE	1/2"	SW	2	Nø						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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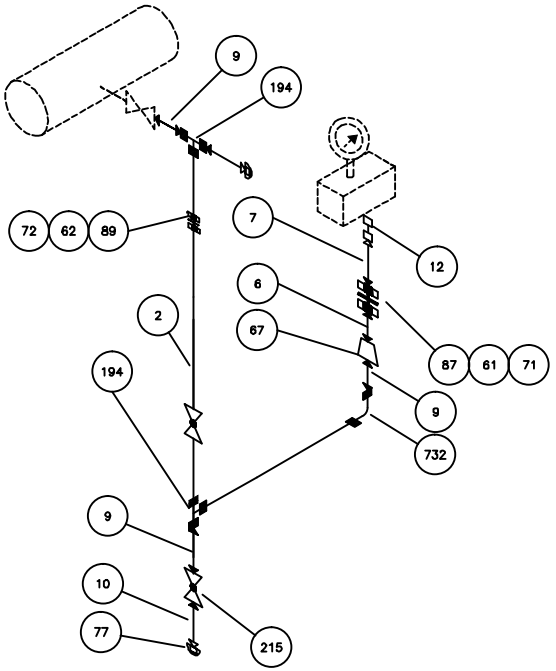
2	12-10-11	Revised and Reissued	Manoj	RG	RP/JMS	DM
1	07-08-06	Reaffirmed and Reissued	MN	TGM	PM	VJN

DAHEJ PETROCHEMICAL COMPLEX	REV.	DATE	REVISION	BY	CHECKED	APPD.	
CLIENT: M/S OPaL	0	01.07.09	ISSUED AS JOB STANDARD	Ravinder		RS	



LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
2	PIPE	3/4"	PL	A/R	m	61	GASKET	FOR 1/2" FL		1	Nø
6	NIPPLE	1/2"	PL X PL	1	Nø	71	STUDS & NUTS	FOR 1/2" FL		1	Set
7	NIPPLE	1/2"	PL X TH	1	Nø	89	FLANGE	3/4"	WN	2	Nø
9	NIPPLE	3/4"	PL X PL	3	Nø	62	GASKET	FOR 3/4" FL		1	Nø
10	NIPPLE	3/4"	TH X PL	2	Nø	72	STUDS & NUTS	FOR 3/4" FL		1	Set
12	COUPLING	1/2"	TH	1	Nø						
67	REDUCER	3/4" X 1/2"	BW	1	Nø						
194	EQUAL TEE	3/4"	BW	2	Nø						
732	ELBOW	3/4"	BW	1	Nø						
215	GLOBE VALVE	3/4"	BW	2	Nø						
87	FLANGE		WN	2	Nø						
77	CAP	3/4"	TH	2	Nø						

ENGINEERS INDIA LIMITED
NEW DELHI

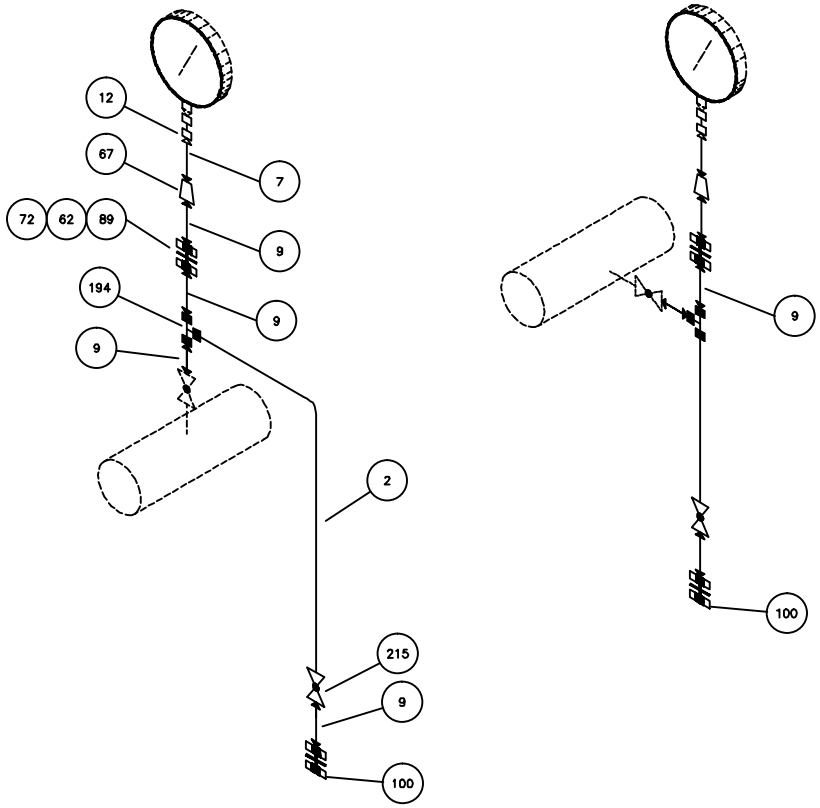
PRESSURE GAUGE ON PUMP DISCHARGE / REMOTE MOUNTED

DRAWING NO.	REV.
6987-017-16-51-IS-0013	0

SHT. 1 OF 1

1-1641-0504 REV.0 A4-210x297

DAHEJ PETROCHEMICAL COMPLEX CLIENT: - M/S OPaL	REV.	DATE	REVISION	BY	CHECKED	APPD.	
	0	01.07.09	ISSUED AS JOB STANDARD	Ravinder		RS	



LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
2	PIPE	3/4"	PL	A/R	m						
9	NIPPLE	3/4"	PL X PL	4	Nø						
7	NIPPLE	1/2"	TH X PL	1	Nø						
12	COUPLING	1/2"	TH	1	Nø						
67	REDUCER	3/4" X 1/2"	BW	1	Nø						
194	EQUAL TEE	3/4"	BW	1	Nø						
215	GLOBE VALVE	3/4"	BW	1	Nø						
89	FLANGE	3/4"	WN	3	Nø						
100	BLIND FLANGE	3/4"		1	Nø						
62	GASKET	FOR 3/4" FL		2	Nø						
72	STUDS & NUTS	FOR 3/4" FL		2	Set						

ENGINEERS INDIA LIMITED NEW DELHI	PRESSURE GAUGE LIQUID / GAS SERVICE	DRAWING NO.	REV.
		6987-017-16-51-IS-0014	0
		SHT. 1 OF 1	

1-1641-0504 REV.0 A4-210x297

INSTRUMENT CONNECTION ON VESSEL, STANDPIPES AND TANKS

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
0	10.07.09	ISSUED AS JOB STANDARD	AR	AA	RG

SR. NO	TYPE OF INSTRUMENTS	UNCLADD ED EQUIPMENTS		CLADDED EQUIPMENTS		INSTRUMENT CONNECTION
		EQUIPMENT/STANDPIPE	FIRST BLOCK VALVE	EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	
1.	EXTERNAL DISPLACER LEVEL INSTRUMENTS ON EQUIPMENT		2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
2.	EXTERNAL DISPLACER LEVEL INSTRUMENTS ON STANDPIPE		2" FLGD.		2" FLGD.	2" FLGD.
3.	EXTERNAL GUIDED WAVE LEVEL INSTRUMENT ON EQUIPMENT	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
4.	EXTERNAL GUIDED WAVE LEVEL INSTRUMENT ON STANDPIPE		2" FLGD.		2" FLGD.	2" FLGD.
5.	EXTERNAL MAGNETIC LEVEL INSTRUMENT ON EQUIPMENT		2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
6.	EXTERNAL MAGNETIC LEVEL INDICATOR ON STANDPIPE		2" FLGD.	2" FLGD.		2" FLGD.
7.	EXTERNAL BALL FLOAT LEVEL INSTRUMENTS ON VESSEL		2" FLGD.		3" FLGD.	1" SW
8.	EXTERNAL BALL FLOAT LEVEL INSTRUMENTS ON STANDPIPE	1" SW/BW/FLGD #	1" SW/BW/FLGD #	1" SW/BW/FLGD #	1" SW/BW/FLGD #	1" SW
9.	INTERNAL DISPLACER / FLOAT LEVEL INSTRUMENTS	4" FLGD	-	4" FLGD	-	4" FLGD.
10.	INTERNAL GUIDED WAVE LEVEL INSTRUMENT ON EQUIPMENT	4" FLGD.	-	4" FLGD.	-	4" FLGD.
11.	MAGNETIC LEVEL INDICATOR (INTERNAL - TOP MOUNTED)	4" FLGD.	-	4" FLGD.	-	4" FLGD.
12.	LEVEL GAUGE ON VESSEL		2" FLGD.		3" FLGD.	¾" SCRD.
13.	LEVEL GAUGE ON STANDPIPE	¾" SW/BW/ FLGD #	¾" SW/BW/ FLGD #	¾" SW/BW/ FLGD #	¾" SW/BW/ FLGD #	¾" SCRD.
14.	SPECIAL LEVEL INSTRUMENTS ON EQUIPMENT (CAPACITANCE PROBE/ULTRASONIC PROBE/R.F.PROBE)	2" FLGD.	-	3" FLGD.	-	2" FLGD.
15.	D.P. INSTRUMENTS ON VESSEL	2 " FLGD.	2 " SW/BW/FLGD #		3" FLGD.	½ " SCRD.
16.	D.P. INSTRUMENTS ON STANDPIPE	¾" SW/BW/ FLGD #	¾" SW/BW/ FLGD #	¾" SW/BW/ FLGD #	¾" SW/BW/ FLGD #	½ " SCRD.
17.	DIAPHRAGM SEAL D.P. INSTRUMENTS ON VESSEL		3" FLGD.		3" FLGD.	3" FLGD.
18.	EXTENDED DIAPHRAGM SEAL D.P. INSTRUMENTS ON VESSEL	4" FLGD. (NOTE-1)	-	4" FLGD. (NOTE-1)	-	4" FLGD.
19.	DIP TUBE LEVEL INSTRUMENTS	1½ " FLGD.	½ " SW (BY INST)	3" FLGD.	½ " SW (BY INST)	½ " SCRD

NO	TYPE OF INSTRUMENTS	UNCLADD ED EQUIPMENTS		CLADDED EQUIPMENTS		INSTRUMENT CONNECTION
		EQUIPMENT/STANDPIPE	FIRST BLOCK VALVE	EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	
20.	TANK LEVEL INSTRUMENTS (MECH)	1½ " FLGD	1½ " FLGD (BY INST)			½ " SCRD
21.	TANK LEVEL INSTRUMENTS (SERVO) ON ATMOSPHERIC TANKS	6" FLGD.	6" FLGD. (BY INST)			6" FLGD
22	TANK LEVEL INSTRUMENTS (SERVO) FOR PRESSURISED EQUIPMENTS	6" FLGD.	6" FLGD. (BY INST)	6" FLGD.	6" FLGD. (BY INST)	6" FLGD
23.	TANK LEVEL INSTRUMENTS (RADAR) ON ATMOSPHERIC TANK (CLEAN SERVICE)	8" FLGD.			-	8" FLGD.
24.	TANK LEVEL INSTRUMENTS (RADAR) ON ATMOSPHERIC TANK (VISCOUS SERVICE)	24" FLGD.			-	24" FLGD.
25.	TANK LEVEL INSTRUMENTS (RADAR) FOR PRESSURISED EQUIPMENTS	8" FLGD.	-	8" FLGD.	-	8" FLGD.
26.	TANK LEVEL INSTRUMENTS – CAPITANCE / ULTRASONIC/ RF TYPE ON ATMOSPHERIC TANKS/PRESSURISED EQUIPMENTS	2" FLGD.	-	3" FLGD.	-	2" FLGD.
27.	PRESSURE INSTRUMENTS ON VESSEL	2 " FLGD	2 "SW/BW/ FLGD #		3" FLGD.	½ " SCRD
28.	PRESSURE INSTRUMENTS ON STANDPIPE	¾" SW/BW/ FLGD #	¾" SW/BW/ FLGD #		¾" SW/BW/ FLGD #	½ " SCRD
29.	CHEMICAL SEAL PRESSURE INSTRUMENT/ GAUGE ON VESSEL	2 " FLGD	2 " FLGD		3" FLGD.	½ " SCRD
30.	DIAPHRAGM SEAL PRESSURE INSTRUMENT/ GAUGE ON VESSEL	2 " FLGD	2 " FLGD		3" FLGD.	2 "FLGD/ 3 " FLGD
31.	THERMOWELL ON EQUIPMENT	2 " FLGD	-	3" FLGD.	-	2 " FLGD/ 3" FLGD
32.	MULTI-POINT TEMPERATURE ELEMENTS FOR TANKS	3"FLGD.	-	3" FLGD.	-	3" FLGD
33.	STANDPIPE (RATING UP TO 600#)	2"FLGD.	-	3" FLGD.		
34.	STANDPIPE (RATING > 600#)	3"FLGD.	-	3" FLGD.		

NOTES: 1 NOZZLE I.D ON EQUIPMENT SHALL BE SELECTED TO SUIT O.D OF EXTENDED DIAPHRAGM OF INSTRUMENT.

2 ALL FLANGES/SW RATING SHALL BE AS PER PIPING SPECIFICATION.

3 IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED TYPE FIRST ISOLATION VALVE ARE PROVIDED, BOLTING AND GASKETS SHALL BE IN PIPING SCOPE.

4 INSTALLATION OF TANK LEVEL INSTRUMENTS (SERVO, MECHANICAL AND MULTIPOINT TEMPERATURE ELEMENT) ON TANKS ARE IN TANK VENDOR SCOPE.

5 FOR ANY OTHER INSTRUMENTS NOT REFERED ABOVE THE CONNECTION DETAILS SHALL BE AS PER INDIVIDUAL REQUIREMENT.

6 NOZZLE SIZES/ RATINGS AS SPECIFIED BY LICENSOR IN VESSEL DATA SHEETS SHALL HAVE PRECEDENCE OVER SIZES GIVEN IN THIS DOCUMENT.

\# AS PER PIPING SPECIFICATION.

INSTRUMENT CONNECTION ON PIPES

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
0	10.07.09	ISSUED AS JOB STANDARD	AR	AA	RG

(A) BARE PIPES

S. NO	TYPE OF INSTRUMENTS		WHERE PIPING CLASS RECOMMENDS SCRD CONNECTION			WHERE PIPING CLASS RECOMMENDS SW/BW # CONNECTION			WHERE PIPING CLASS RECOMMENDS FLGD CONNECTION		
			PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION
1	FLOW METER ORIFICE	≤ 600#	½" SCRD*	½" SCRD*	½" SCRD	½" SCRD*	½" SW/BW#	½" SCRD	½" SCRD*		½" SCRD
		> 600#			-	¾" SCRD**	¾" SW/BW#	½" SCRD	¾" SCRD**	¾" FLGD	½" SCRD
2	FLOWMETER VENTURI/NOZZLE	≤ 600#		½" FLGD	½" SCRD	½" FLGD		½" SCRD	½" FLGD		½" SCRD
		> 600#			-	¾" FLGD	¾" FLGD	½" SCRD		¾" FLGD	½" SCRD
3	FLOW METER ORIFICE (DIAPH.SEAL)	≤ 600#	½" SCRD*	½" SCRD*	3"FLGD	½" SCRD*	½" SW/BW#	3" FLGD	½" SCRD*	½" FLGD	3"FLGD
		> 600#			-	¾" SCRD**	¾" SW/BW#	3" FLGD	¾" SCRD**	¾" FLGD	3"FLGD
4	FLOW METER VENTURI/NOZZLE (DIAPH.SEAL)	≤ 600#		½" FLGD	3" FLGD	½" FLGD	½" FLGD	3" FLGD	½" FLGD	½" FLGD	3"FLGD
		> 600#			-	¾" FLGD	¾" FLGD	3" FLGD		¾" FLGD	3"FLGD
5	FLOW METER AVERAGE PITOT TUBE			3" FLGD (BY INST)	3" FLGD+		3" FLGD (BY INST)	3" FLGD	3" FLGD	3" FLGD (BY INST)	3" FLGD+
6	DIFFERENTIAL PRESSURE (DP) INSTRUMENTS		¾" SCRD*	¾" SCRD*	½" SCRD.		¾" SW/BW#	½" SCRD		¾" FLGD	½" SCRD
7	DIAPHGRAM SEAL D.P. INSTRUMENTS			3" FLGD.		3" FLGD.	3" FLGD.	3" FLGD	3" FLGD.	3" FLGD.	3" FLGD.
8	PRESSURE INSTRUMENTS <5>		¾" SCRD*	¾" SCRD*	½" SCRD.		¾" SW/BW#	½" SCRD		¾" FLGD	½" SCRD
9	DIAPH. (CHEMICAL) SEAL PRESSURE INSTRUMENT<5> (SCRD.)		¾" SCRD*	¾" SCRD*	½" SCRD.		¾" SW/BW#	½" SCRD		¾" FLGD	½" SCRD
10	DIAPHGRAM SEAL PRESSURE INSTRUMENTS (FLGD.)		1 ½ " FLGD.	1 ½ " FLGD.	1 ½ " FLGD.		1 ½ " FLGD.	1 ½ " FLGD.	1 ½ " FLGD.		1 ½ " FLGD.
11	THERMOWELL		1 ½ " FLGD.	-	1 ½ " FLGD	1 ½ " FLGD.	-	1 ½ " FLGD	1 ½ " FLGD.	-	1 ½ " FLGD

(B) CLADDED\CEMENTED\LINED PIPES

S. NO	TYPE OF INSTRUMENTS		WHERE PIPING CLASS SPECIFIES CLADDED PIPES			WHERE PIPING CLASS SPECIFIES CEMENT LINED PIPES			WHERE PIPING CLASS SPECIFIES RUBBER/TEFLON LINED PIPES		
			PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION
1	FLOW METER ORIFICE	≤ 600#	½" SCRD*	½" SCRD*	½" SCRD	½" SCRD*	½" SW/BW	½" SCRD		1" FLGD	½" SCRD
		> 600#	¾" SCRD**	¾" SW/BW	½" SCRD						
2	FLOW METER ORIFICE (DIAPHGRAM. SEAL)		½" SCRD*	½" SCRD*	3" FLGD	½" SCRD*	½" SW/BW	3" FLGD		1" FLGD	3" FLGD
			¾" SCRD**	¾" SCRD*	3" FLGD	-					-
3	FLOW METER AVERAGE PITOT TUBE		3" FLGD	3" FLGD (BY INST)	3" FLGD+	3" FLGD	3" FLGD (BY INST)	3" FLGD+	3" FLGD	3" FLGD (BY INST)	3" FLGD+
4	DP INSTRUMENTS			¾"SW/BW#	½" SCRD.	3" FLGD	¾" FLGD	½" SCRD	1½" FLGD	1 ½" FLGD	½" SCRD
5	DIAPHGRAM SEAL D.P. INSTRUMENTS		3 " FLGD.	3 " FLGD.		3" FLGD	3"FLGD		3" FLGD.	3" FLGD.	3" FLGD.
6	PRESSURE INSTRUMENTS		¾"SW/BW#	¾"SW/BW#	½" SCRD.	3" FLGD	¾"SW/BW	½" SCRD		1" FLGD	½" SCRD
7	DIAPHGRAM (CHEMICAL) SEAL PRESSURE INSTRUMENTS (SCRD.) <5>			¾"SW/BW#	½" SCRD.	3" FLGD	1 ½" SW/BW	½" SCRD		1" FLGD	½" SCRD
8	DIAPHGRAM SEAL PRESSURE INSTRUMENTS (FLGD) <5>			1 ½ " FLGD.	1 ½ " FLGD.	3" FLGD	1 ½"FLGD		1 ½" FLGD	1 ½" FLGD	1 ½" FLGD
9	THERMOWELL		1 ½ " FLGD.	-	1 ½ " FLGD	3" FLGD	-		3" FLGD	-	3" FLGD

NOTES:
1. FOR ANY OTHER INSTRUMENTS NOT REFERRED ABOVE THE CONNECTION DETAILS SHALL BE AS PER INDIVIDUAL REQUIREMENT.
2. ALL FLANGES/SW RATING SHALL BE AS PER PIPING SPECIFICATION.
3. IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED FIRST ISOLATION VALVE ARE PROVIDED, BOLTING AND GASKETS SHALL BE IN PIPING SCOPE.
4. INSTALLATION OF ALL IN LINE INSTRUMENTS SHALL BE IN PIPING SCOPE.
5. PRESSURE INSTRUMENTS INCLUDE PRESSURE TRANSMITTERS AND PRESSURE GAUGES.
6. INSTRUMENT CONNECTION SIZES/ RATINGS AS SPECIFIED BY LICENSOR SHALL HAVE PRECEDENCE OVER SIZES GIVEN IN THIS DOCUMENT.

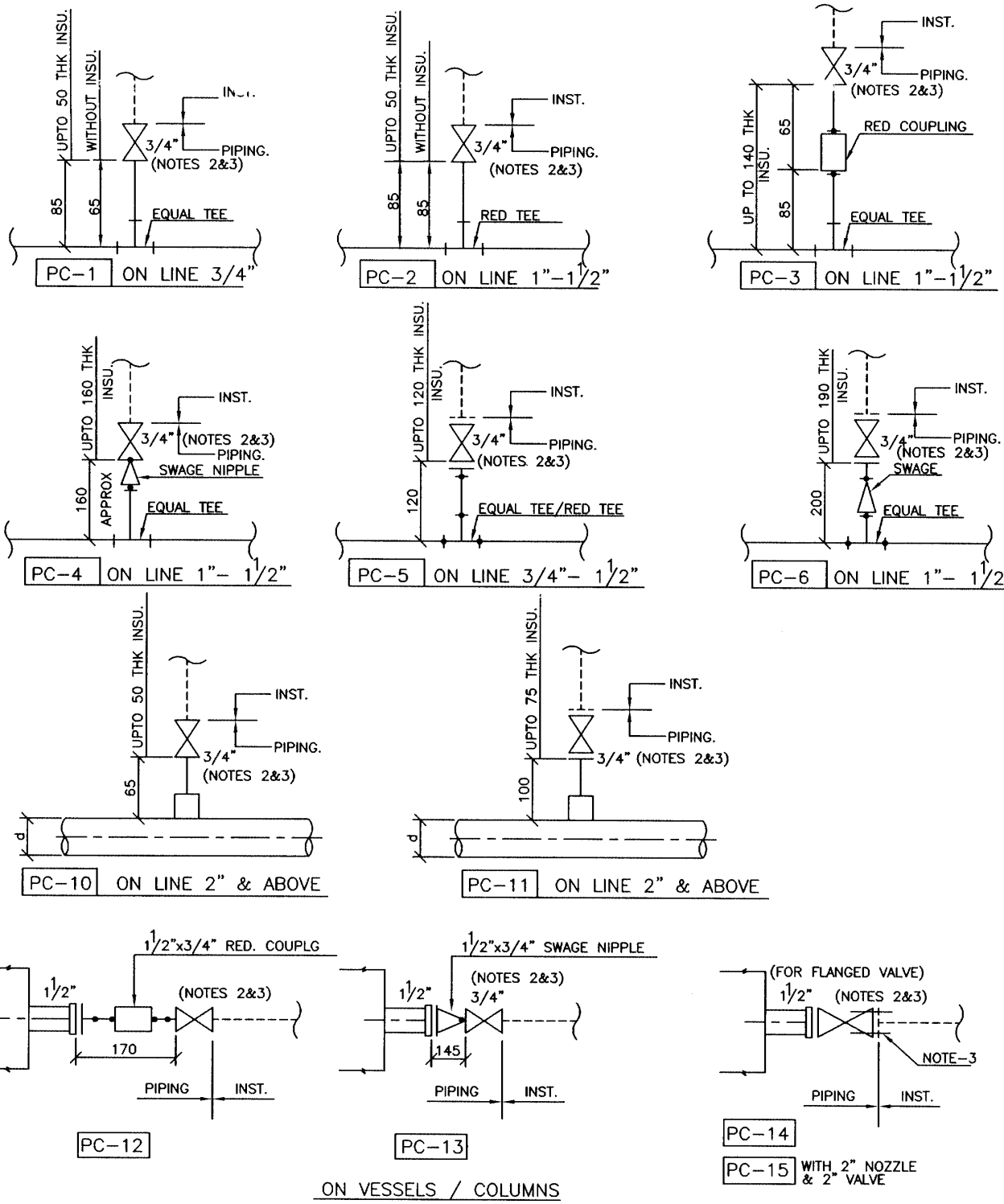
* SEAL WELDING REQUIRED. # AS PER PIPING SPECIFICATION.
** STRENGTH WELD + CONNECTIONS FOR D.P. INSTRUMENT ½" SCRD

S. NO.	TYPE OF INSTRUMENTS		HEATER/DUCT/LINE CONNECTION	FIRST BLOCK VALVE	INSTRUMENT CONNECTION
1	FLOW ELEMENT - AVG. PITOT TUBE	(F1)	3" FLANGED	-----	3" FLANGED (NOTE-4)
2	FLOW ELEMENT - VENTURI TUBE	(F2)	1/2" FLANGED	1/2" FLANGED	1/2" NPT (F)
3	FLOW ELEMENT - THERMAL MASS	(F3)	1 1/2" FLANGED	-----	1 1/2" FLANGED
4	PRESSURE INSTRUMENT	(P1)	1 1/2" FLANGED	1 1/2" FLANGED	1/2" NPT (F)
5	PRESSURE INSTRUMENT (COIL)	(P2/P4)	1 1/2" FLANGED	11/2" FLANGED	1/2" NPT (F)
6	DRAFT GAUGE	(P3)	1 1/2" FLANGED	-----	1/2" NPT (F)
7	TEMPERATURE INSTRUMENT	(T1)	1 1/2" FLANGED	-----	1 1/2" FLANGED
8	TEMPERATURE INSTRUMENT (COIL)	(T2)	1 1/2" FLANGED	-----	1 1/2" FLANGED
9	SKIN THERMOCOUPLE	(T3)	1" PIPE	-----	-----
10	FLUE GAS ANALYSER (SOx, NOx, O2, HC,CO)	(A1/A2/A4)	4" FLANGED	-----	4" FLANGED
11	FLUE GAS ANALYSER (SPM)	(A3)	6" FLANGED	-----	6" FLANGED

NOTES :-

1. PRESSURE RATING OF FLANGE CONNECTION SHALL BE 150# FOR INSTS MOUNTED DIRECTLY ON HEATER.
2. PRESSURE RATING OF FLANGE CONNECTION ON TUBE SIDE SHALL BE AS PER PIPING CLASS.
3. FOR IDENTIFICATION (F1), (P1) ETC. REFER TO STANDARDS 7-52-0011, 0012, 0013, 0014.
4. TRANSMITTER CONNECTION SHALL BE 1/2" NPT(F).

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	09-03-12	REVISED & REISSUED	Manoj	RG	RP/JMS	DM
2	12-03-07	REVISED & REISSUED	MN	TGM	HCJ	VC



NOTES :

1. THE INDICATED DIMENSIONS ARE MINIMUM WHICH ALSO COVER INSULATION TO THE EXTENT SHOWN ABOVE. IN CASE OF HIGHER THICKNESS OF INSULATION THAN INDICATED THE DIFFERENCE SHALL BE ADDED IN THE DIMENSIONS SHOWN ABOVE.
2. PRESSURE TAPPING SHALL BE PROVIDED WITH VALVE SIMILAR TO LINE ISOLATION VALVE (GATE, BALL OR PLUG VALVE ETC., WITH FLGD, S.W. OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS, TEE(EQUAL OR REDUCING)/HALF COUPLING(S.W. OR SCR'D)/STUB IN/SOCKOLET/WELDOLET SHALL BE AS PER PIPING MATERIAL SPECS.
3. IN CASE OF FLGD VALVES BOLTING & GASKET ON BOTH SIDES OF VALVE SHALL BE IN PIPING SCOPE
4. IN CASE OF TAPPING PROVIDED OTHER THAN INDICATED IN THIS STD FOR LAYOUT REASONS DETAILED DIMENSIONS WILL BE CALLED OUT.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
3	29.06.09	REAFFIRMED & ISSUED AS STANDARD	PK	RN	SC	ND
2	15.07.04	REVISED & ISSUED AS STANDARD	RN	SC	MRC	SKG

Approved by

VENDOR LIST FOR WASTE TREATMENT SYSTEM		
1	HART Communicator	FLUKE CORPORATION/USA
		HONEYWELL INC/PHILADELPHIA
		MERIAM PROCESS TECHNOLOGIES/CLEVELAND, OH 44102
		ABB UTILITY GMBH/GERMANY
		FISCHER ROSEMOUNT ASIA PACIFIC/SINGAPORE
		YOKOGAWA ELECTRIC CORPORATION/TOKYO 180
		FUJI ELECTRIC SYSTEMS CO. , LTD./OSAKI 1-CHOME, SHINAGAWA-KU, TOKYO
		YOKOGAWA INDIA LIMITED/BANGALORE
		EMERSON PROCESS MANAGEMENT/KUMARAPARK(WEST), BANGALORE
		CHEMTROLS INDUSTRIES LIMITED/POWAI, MUMBAI
		HONEYWELL AUTOMATION INDIA LTD/PUNE
		GE INDIA INDUSTRIAL PVT. LTD./PUNE
2	Rotameter	
		INSTRUMENTATION ENGINEERS PVT LTD/JEEDIMATLA
		PLACKA INSTRUMENTS INDIA PVT LTD/CHENNAI
		FLUIDYNE INSTRUMENTS PVT. LTD./CHEMBUR, MUMBAI
		EUREKA INDLEQUIPMENT PVT., LTD.,/PUNE
3	CABLES - MEDIUM VOLTAGE-POWER-PVC	ASSOCIATED FLEXIBLES AND WIRES [P] LTD INDIA
		CABLE CORPORATION OF INDIA LIMITED INDIA
		FINOLEX CABLES LTD. INDIA
		GEMSCAB INDUSTRIES LTD INDIA
		HAVELL'S INDIA LTD INDIA
		K E I INDUSTRIES LIMITED INDIA
		NICCO CORPORATION LTD INDIA
		POLYCAB WIRES PVT LTD INDIA
		RADIANT CORPORATION PVT LTD INDIA
		RAVIN CABLES LTD INDIA
		RPG CABLES LTD INDIA
		TORRENT CABLES LTD INDIA
		UNIVERSAL CABLES LTD INDIA
4	MOTOR - INDUCTION - MV (INDUSTRIAL TYPE SAFEAREA)	ABB LTD - BANGALORE / FARIDABAD INDIA
		BHARAT BIJLEE LIMITED INDIA
		CROMPTON GREAVES LTD. INDIA
		JYOTI LIMITED INDIA
		KIRLOSKAR ELECTRIC CO LTD INDIA
		LAXMI HYDRAULICS PVT LTD INDIA
		MARATHON ELECTRIC MOTOR I LTD INDIA
		SIEMENS LIMITED INDIA
5	ACTUATOR MOV	AUMA INDIA PRIVATE LTD INDIA
		AUMA RIESTER GMBH & CO. KG GERMANY
		BIFFI ITALIA S.R.L ITALY
		EIM CONTROLS UK LTD UK
		FLO - TORK INC USA
		FLOWSERVE LIMITORQUE INDIA
		LIMITORQUE INDIA LIMITED INDIA
		MARSH ENGINEERS INDIA
		ROTORK CONTROLS (INDIA) LTD INDIA
6	AIR FILTER REGULATORS	IMI NORGREN HERION (P) LTD/NOIDA
		ABB LTD (FARIDABAD) INDIA
		DIVYA CONTROL ELEMENTS PVT LTD INDIA
		JANATICS INDIA PVT LTD INDIA
		MARSH BELLOFRAM INDIA / USA
		PLACKA INSTRUMENTS INDIA P LTD INDIA
		SCHRADER DUNCAN LIMITED INDIA
		SHAH PNEUMATICS INDIA
		SHAVO NORGREN (I) PVT LTD INDIA
		THOMPSON VALVES LTD UK
		VELJAN HYDRAIR PVT LTD INDIA
		ASSOCIATED CABLES PVT LTD INDIA
		ASSOCIATED FLEXIBLES AND WIRES [P] LTD INDIA
		CMI LIMITED INDIA
		CORDS CABLE INDUSTRIES LTD INDIA
		DELTON CABLES LIMITED INDIA
		ELKAY TELELINKS LTD. INDIA
		FINE CORE CABLES PVT LTD INDIA
		GOYOLENE FIBRES (INDIA) PVT LTD INDIA
		K E I INDUSTRIES LIMITED INDIA

7	**SIGNAL CABLES**	NICCO CORPORATION LTD INDIA
		PARAMOUNT COMMUNICATIONS LIMITED INDIA
		POLYCAB WIRES PVT LTD INDIA
		RADIANT CORPORATION PVT LTD INDIA
		SUYOG ELECTRICALS LTD INDIA
		THERMO CABLES LTD INDIA
		KEC INTERNATIONAL LTD./MUMBAI
		TORRENT CABLES LTD. AHMEDABAD
		ADVANCE CABLE TECHNOLOGIES (P) LTD/BENGALURU
		IMT CABLES PVT LTD/NEW DELHI
		GUPTA POWER INFRASTRUCTURE LTD/BHUBANESHWAR
		SPECIAL CABLES PVT LTD/NEW DELHI
		TC COMMUNICATION PVT LTD/ GHAZIABAD
8	**ORIFICE PLATES & FLANGES**	BALIGA LIGHTING EQUIPMENTS (P) LIMITED INDIA
		DANIEL MEASURMNT & CONTROL ASIA PACIFIC INDIA / SINGAPORE /
		USA
		EUREKA INDUSTRIAL EQUIPMENTS (P) LTD. INDIA
		FMC MEASUREMENT SOLUTIONS-UK SINGAPORE / USA /
		UK
		GENERAL INSTRUMENTS CONSORTIUM INDIA
		GURU NANAK ENGG WORKS INDIA
		INSTRUMENTATION LTD. (PALGHAT) INDIA
		JRU CONTTROL PVT LTD INDIA
		MICRO PRECISION PRODUCTS PVT LTD INDIA
		PETROL VALVES SRL ITALY
		PIETRO FIORENTINI SPA ITALY
		STAR-MECH CONTROLS (INDIA) PVT LTD INDIA
		TM TECNOMATIC SPA ITALY
9	**TEMP. ELEMENTS, THERMOWELLS**	ABB AUTOMATION LTD INDIA / GERMANY
		BAUMER BOURDON HAENNI S.A.S. INDIA / FRANCE
		DAILY THERMETRICS USA
		DETRIV INSTRUMENTATION & ELECTRONICS LTD INDIA
		GAYESCO LLC USA
		GENERAL INSTRUMENTS CONSORTIUM INDIA
		INVENSYS SOFTWARE SYSTEMS (S) PTE LTD INDIA / SINGAPORE
		JAPAN THERMOWELL CO LTD JAPAN
		PYRO-ELECTRIC INSTRUMENTS GOA PVT LTD INDIA
		TEMP-TECH INDIA
		TEMPSEN INSTRUMENT INDIA LTD INDIA
		THERMO ELECTRIC CO. INC. USA
		THERMO-COUPLE PRODUCTS CO INDIA / USA
		THERMO-ELECTRA B.V NETHERLANDS
		TM TECNOMATIC SPA ITALY
		WIKA ALEXANDER WIEGAND & CO GMBH GERMANY
10	**PRESSURE GAUGES**	AN INSTRUMENTS PVT LTD INDIA
		ASHCROFT INDIA PVT LTD INDIA
		BADOTHERM PROCESS INSTRUMENTS B.V. NETHERLANDS
		BAUMER BOURDON HAENNI S.A.S. INDIA / FRANCE
		BRITISH ROTOTHERM CO.LTD UK
		BUDENBERG GAUGE CO. LTD UK
		DRESSER INC. USA
		FORBES MARSHALL (HYD) PVT. LTD INDIA
		GENERAL INSTRUMENTS CONSORTIUM INDIA
		GLUCK (INDIA) MFG.CO INDIA
		H GURU INSTRUMENTS(SOUTH INDIA)PVT. LTD INDIA
		H.GURU INDUSTRIES INDIA
		MANOMETER (INDIA) PVT. LTD. INDIA
		NAGANO KEIKI SEISAKUSHO LTD JAPAN
		WAAREE INSTRUMENTS LIMITED INDIA
		WALCHANDNAGAR INDUSTRIES LTD(TIWAC DIVN) INDIA
		WIKA ALEXANDER WIEGAND & CO GMBH GERMANY
		WIKA INSTRUMENTS INDIA PVT LTD INDIA
		BELLS CONTROL LTD/KOLKATA
		BELLS CONTROL LTD/CHENNAI
		PREMIER INSTRUMENTS PVT LTD/COIMBATORE
		PYRO ELECTRIC INSTRUMENTS PVT LTD/GOA
		NEW SCIENTIFIC REPAIRS 7 TRADING CO/KOLKATA
		GOA INSTRUMENTS INDUSTRIES PVT LTD/GOA
		ASIAN ENGG & SERVICES/CHENNAI
		LEHRY INSTRUMENTATION & VALVES PVT LTD/ CHENNAI
		KARLO TRADERS/CHENNAI
		VENS HYDROLUFT(P) LTD CHENNAI

11	**TEMP. GAUGES (BI METALLIC , FILLED SYSTEM)**	AN INSTRUMENTS PVT LTD INDIA
		ASHCROFT INDIA PVT LTD INDIA
		BADOTHERM PROCESS INSTRUMENTS B.V. NETHERLANDS
		BAUMER BOURDON HAENNI S.A.S. INDIA / FRANCE
		DRESSER INC. USA
		GENERAL INSTRUMENTS CONSORTIUM INDIA
		H GURU INSTRUMENTS(SOUTH INDIA)PVT. LTD INDIA
		H.GURU INDUSTRIES INDIA
		NAGANO KEIKI SEISAKUSHO LTD JAPAN
		PYRO-ELECTRIC INSTRUMENTS GOA PVT LTD INDIA
		SOLARTRON ISA UK
		WALCHANDNAGAR INDUSTRIES LTD(TIWAC DIVN) INDIA
		WIKA ALEXANDER WIEGAND & CO GMBH GERMANY
		WIKA INSTRUMENTS INDIA PVT LTD INDIA
		FORBES MARSHALL (HYD) PVT. LTD INDIA
12	**VARIABLE AREA FLOW METERS (I, T)**	ABB AUTOMATION LTD INDIA / UK
		ALFLOW GLASS EQUIPMENTS INDIA
		ASA SPA ITALY
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /
		USA
		EUREKA INDUSTRIAL EQUIPMENTS (P) LTD. INDIA
		HEINRICHS MESSTECHNIK GMBH GERMANY
		INSTRUMENTATION ENGINEERS PVT. LTD. INDIA
		KROHNE MARSHALL PVT. LTD INDIA
		KROHNE MESSTECHNIK GMBH & CO KG GERMANY
		PLACKA INSTRUMENTS INDIA P LTD INDIA
		ROTA YOKOGAWA GMBH & CO. INDIA / GERMANY
		TOKYO KEISO CO LTD JAPAN
		TRANSDUCERS AND CONTROLS PVT LTD INDIA
13	**TANK LEVEL IND. (FLOAT OPERATED)**	ENDRESS+HAUSER JAPAN CO. LTD INDIA / JAPAN
		ENRAF B.V INDIA / NETHERLAND
		L & J TECHNOLOGIES SINGAPORE / USA
		NIVO CONTROLS PVT LTD INDIA
		SBEM PVT LTD INDIA
		SIGMA INSTRUMENTS CO INDIA
		TOKYO KEISO CO LTD JAPAN
		BAUMER TECHNOLIGIES INDIA PVT LTD/CHENNAI
		PUNE TECHTROL PVT LTD/CHENNAI
		V AUTOMAT AND INSTRUMENTS LTD/CHENNAI
14	**TRANSDUCERS (I/P , P/I)**	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /
		USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		FAIRCHILD INDUSTRIAL PRODUCTS CO. INDIA / USA
		IMI WATSON SMITH LTD UK
		MOORE CONTROLS LTD INDIA
		MTL INDIA INDIA
		SHREYAS INSTRUMENTS PVT LTD INDIA
		THERMO BRANDT INSTRUMENTS USA
15	**SOLENOID VALVES**	ALCON ALEXANDER CONTROLS LIMITED UK
		ASCO (INDIA) LIMITED INDIA
		ASCO JOUCOMATIC LTD INDIA / UK
		ASCO JOUCOMATIC SA FRANCE
		AVCON CONTROLS PVT. LTD. INDIA
		HERION WERKE GERMANY
		PRECISION INSTRUMENT COMPANY INDIA
		ROTEX AUTOMATION LTD. INDIA
		SCHRADER DUNCAN LIMITED INDIA
		THOMPSON VALVES LTD UK
		VERSA BV NETHERLANDS
16	**WATER QUALITY ANALYSER - PH**	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /
		USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		ENDRESS+HAUSER (I) PVT. LTD. INDIA
		FORBES POLYMETRON PVT LTD. INDIA
		HONEYWELL AUTOMATION INDIA LTD INDIA
		HONEYWELL INC. INDIA / USA

		INVENSYS INDIA PRIVATE LIMITED INDIA
		INVENSYS SOFTWARE SYSTEMS (S) PTE LTD INDIA / SINGAPORE /USA
		SERES ENVIRONMENT (FORM. SERES) FRANCE
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
17	**WATER QUALITY ANALYSER - CONDUCTIVITY**	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /
		USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		ENDRESS+HAUSER (I) PVT. LTD. INDIA
		FORBES POLYMETRON PVT LTD. INDIA
		HONEYWELL AUTOMATION INDIA LTD INDIA
		HONEYWELL INC. INDIA / USA
		INVENSYS INDIA PRIVATE LIMITED INDIA
		INVENSYS SOFTWARE SYSTEMS (S) PTE LTD INDIA / SINGAPORE /
		USA
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
18	**SPL. LEVEL INSTRUMENTS - GUIDED WAVE RADAR**	EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		K-TEK CORPORATION INDIA / USA
		KROHNE MESSTECHNIK GMBH & CO KG GERMANY
		L & J TECHNOLOGIES SINGAPORE / USA
		MAGNETROL INTERNATIONAL N.V INDIA / BELGIUM
		TOKYO KEISO CO LTD JAPAN
19	**TANK LEVEL INSTRUMENT (RADAR , ULTRASONIC)**	AMETEK DREXELBROOK USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA / SINGAPORE /
		USA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		ENRAF B.V INDIA / NETHERLAND
		HAWK MEASUREMENT SYSTEM PTY LTD AUSTRALIA
		KROHNE MESSTECHNIK GMBH & CO KG GERMANY
		L & J TECHNOLOGIES SINGAPORE / USA
		MAGNETROL INTERNATIONAL N.V INDIA / BELGIUM
		MOBREY LTD INDIA / UK
		ROSEMOUNT TANK RADAR AB SWEDEN
		SIEMENS AG INDIA / GERMANY
		VEGA GRIESHABER KG GMBH GERMANY
20	**DIFFERENTIAL PRESSURE GAUGES**	AN INSTRUMENTS PVT LTD INDIA
		FORBES MARSHALL (HYD) PVT. LTD INDIA
		GENERAL INSTRUMENTS CONSORTIUM INDIA
		HIRLEKAR PRECISION ENGINEERING PVT LTD INDIA
		SAMSON CONTROLS PVT LTD INDIA
		SWITZER INSTRUMENT LTD INDIA
		WAAREE INSTRUMENTS LIMITED INDIA
		WIKA INSTRUMENTS INDIA PVT LTD INDIA
21	**FIELD INSTRUMENTS (P,DP,F,L,T,TD)**	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /
		USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		FUJI ELECTRIC SYSTEMS CO. LTD INDIA / JAPAN
		HONEYWELL AUTOMATION INDIA LTD INDIA
		HONEYWELL INC. INDIA / USA
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
22	**TUBE FITTINGS**	ARYA CRAFTS & ENGINEERING PVT LTD INDIA
		ASTEC VALVES & FITTINGS PVT. LTD. INDIA
		AURA INC. INDIA
		AUTOCLAVE ENGINERS FLUID COMPONENTS USA
		BADOTHERM PROCESS INSTRUMENTS B.V. NETHERLANDS
		CIRCOR INSTRUMENTATION LTD UK
		EXCEL HYDRO PNEUMATICS PVT LTD INDIA
		EXCELSIOR ENGG. WORKS INDIA
		FLUID CONTROLS PVT LTD INDIA
		HAM-LET (ISRAEL-CANADA) LTD. ISRAEL
		JRU CONTTROL PVT LTD INDIA
		MULTIMETAL INDUSTRIES INDIA

		PANAM ENGINEERS INDIA
		PARKER HANNIFIN CORPORATION INDIA / UK / USA
		PRECISION ENGINEERING INDUSTRIES INDIA
		PRIME ENGINEERS INDIA
		RELIANCE ENGINEERING & ELECTRICALS CORPN INDIA
		SWAGELOK CO. INDIA / USA
		SWASTIK ENGINEERING WORKS INDIA
23	**INSTRUMENT TUBING**	HEAVY METALS & TUBES LIMITED(MEHSANA) INDIA
		JINDAL SAW LTD (NASHIK WORKS) INDIA
		NUCLEAR FUEL COMPLEX INDIA
		RAJENDRA MECH INDUSTRIES LTD INDIA
		RATNAMANI METALS AND TUBES LTD INDIA
		SANDVIK ASIA LIMITED (AHMEDABAD) INDIA
24	**LEVEL SWITCHES (DISPLACER /FLOAT)**	BLISS ANAND PVT LTD INDIA
		CHEMTROLS INDUSTRIES LTD INDIA
		DAG PROCESS INSTRUMENTS PVT LTD INDIA
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /USA
		ENDRESS+HAUSER JAPAN CO. LTD INDIA / JAPAN
		JRU CONTTROL PVT LTD INDIA
		KROHNE MESSTECHNIK GMBH & CO KG GERMANY
		KSR KUEBLER NIVEAUMESS-TECHNIK AG GERMANY
		LEVCON INSTRUMENTS PVT LTD INDIA
		MAGNETROL INTERNATIONAL N.V INDIA / BELGIUM
		MOBREY LTD INDIA / UK
		SBEM PVT LTD INDIA
		SIGMA INSTRUMENTS CO INDIA
		SOR INC. USA
		TOKYO KEISO CO LTD JAPAN
		TRANSDUCERS AND CONTROLS PVT LTD INDIA
		V AUTOMAT & INSTRUMENTS PVT LTD INDIA
25	**PRESSURE SWITCHES**	ASCO JOUCOMATIC LTD INDIA / UK
		BAUMER BOURDON HAENNI S.A.S. INDIA / FRANCE
		BETA BV NETHERLANDS
		DAG PROCESS INSTRUMENTS PVT LTD INDIA
		DELTA CONTROLS LTD UK
		DRESSER INC. USA
		GENERAL INSTRUMENTS CONSORTIUM INDIA
		INDFOS INDUSTRIES LIMITED INDIA
		NAGANO KEIKI SEISAKUSHO LTD JAPAN
		PYROPRESS ENGG CO LTD UK
		REGULATEURS GEORGIN S.A FRANCE
		ROBERTSHAW CONTROLS CO USA
		SIRCO CONTROLS LIMITED UK
		SOR INC. USA
		SWITZER INSTRUMENT LTD INDIA
		UNITED ELECTRIC CONTROLS CO USA
26	**ANALYSER SYSTEM**	ABB AUTOMATION LTD INDIA / UK
		ABB LTD-BANGALORE INDIA
		CHEMTROLS INDUSTRIES LTD INDIA
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		HAMILTON SUNDSTRAND CORPORATION USA
		SERVOMEX PLC INDIA / UK
		SIEMENS AG INDIA / GERMANY
		TELEDYNE ANALYTICAL INSTRUMENTS USA
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
27	**INSTRUMENT VALVES& MANIFOLDS**	ANDERSON GREENWOOD CROSBY INDIA / USA
		ARYA CRAFTS & ENGINEERING PVT LTD INDIA
		ASTEC VALVES & FITTINGS PVT. LTD. INDIA
		AURA INC. INDIA
		AUTOCLAVE ENGINERS FLUID COMPONENTS USA
		CHEMTROLS INDUSTRIES LTD INDIA
		CIRCOR INSTRUMENTATION LTD UK
		EXCEL HYDRO PNEUMATICS PVT LTD INDIA
		EXCELSIOR ENGG. WORKS INDIA
		HAM-LET (ISRAEL-CANADA) LTD. ISRAEL
		HYD-AIR ENGG. WORKS LONAVLA INDIA
		MICRO PRECISION PRODUCTS PVT LTD INDIA
		PANAM ENGINEERS INDIA
		PARKER HANNIFIN CORPORATION INDIA / UK / USA

		PRECISION ENGINEERING INDUSTRIES INDIA
		PRIME ENGINEERS INDIA
		SWAGELOK CO. INDIA / USA
		SWASTIK ENGINEERING WORKS INDIA
		TECNOMATIC INDIA PVT LTD INDIA
28	WATER QUALITY ANALYSER-DISSOLVED OXYGEN	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		FORBES POLYMETRON PVT LTD INDIA
		HONEYWELL AUTOMATION INDIA LTD INDIA
		HONEYWELL INC. INDIA / USA
		INVENSYS SOFTWARE SYSTEMS (S) PTE LTD INDIA / SINGAPORE /USA
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
29	WATER QUALITY ANALYSER SYSTEMS	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		FORBES POLYMETRON PVT LTD. INDIA
		HONEYWELL AUTOMATION INDIA LTD INDIA
		HONEYWELL INC INDIA / USA
		SERES ENVIRONMENT (FORM. SERES) FRANCE
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
30	WATER QUALITY ANALYSERS (TURBIDITY)	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		FORBES POLYMETRON PVT LTD. INDIA
		SERES ENVIRONMENT (FORM. SERES) FRANCE
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
31	WATER QUALITY ANALYSERS(CHLORINE)	ABB LTD (FARIDABAD) INDIA
		ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		SERES ENVIRONMENT (FORM. SERES) FRANCE
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
32	MAGNETIC FLOW METERS	ABB AUTOMATION LTD INDIA / UK
		EMERSON PROCES MGMT ASIA PACIFIC PTE LTD INDIA / SINGAPORE /USA
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD INDIA
		ENDRESS + HAUSER INSTRUMNTS INTL. AG INDIA / GERMANY
		ENDRESS+HAUSER (I) PVT. LTD. INDIA
		HEINRICHS MESSTECHNIK GMBH GERMANY
		INSTRUMENTATION ENGINEERS PVT. LTD. INDIA
		INVENSYS SOFTWARE SYSTEMS (S) PTE LTD INDIA / SINGAPORE /USA
		KROHNE MARSHALL PVT. LTD INDIA
		KROHNE MESSTECHNIK GMBH & CO KG GERMANY
		TOKYO KEISO CO LTD JAPAN
		YAMATAKE CORPORATION LTD JAPAN
		YOKOGAWA ELECTRIC CORPORATION INDIA / JAPAN
		YOKOGAWA INDIA LIMITED INDIA
33	A.C. (MV) VARIABLE SPEED DRIVE	ABB LTD (BANGALORE) INDIA
		ASEA BROWN BOVERY LIMITED SWITZERLAND
		BALDOR ELECTRIC COMPANY INDIA / USA
		BHEL (BANGALORE) INDIA
		DANFOSS INDUSTRIES PVT LTD INDIA
		EUROTHERM DEL INDIA LIMITED INDIA
		FUJI ELECTRIC CO LTD JAPAN
		HITACHI LTD INDIA / JAPAN
		KIRLOSKAR ELECTRIC CO LTD INDIA
		LARSEN & TOUBRO LTD INDIA
		MEIDENSHA CORP JAPAN
		ROCKWELL AUTOMATION INDIA LTD INDIA

		SCHNEIDER ELECTRIC INDIA PVT LTD INDIA
		SIEMENS AG INDIA / GERMANY
		SIEMENS LIMITED INDIA
		SIEMENS-ALLIS ENERGY PRODUCTS INDIA / GERMANY
		TOSHIBA CORPORATION INDIA / JAPAN
		VACON OYJ INDIA / FINLAND
34	**CABLE TRAYS (LADDER TYPE) & WITH COVER &PERFRATD**	CAUVERY ENGINEERING WORKS/PUDUKKOTTAI
		M METAPRINT INDUSTRIES/CHENNAI
		PATNY SYSTEMS (P) LTD.,/SECUNDERABAD
		PRAMMEN INDUSTRIES/PUDUKOTTAI
		AM-TECH ENGINEERING SERVICES/PUNE
		JAMNA METAL COMPANY/DELHI
		JAMUNA METAL COMPANY/SONEPAT (DT)
		KANADE ANAND UDYOG PVT. LTD/MUMBAI
		INAR PROFILES PVT. LIMITED/ANAKAPALLE
		INDUSTRIAL PERFORATION (INDIA) PVT. LTD/KOLKATA
		PREMIER POWER PRODUCTS (CALCUTTA) PVT. LTD/KOLKATA
		PARMAR METALS PVT LTD/RAJKOT
		RATAN PROJECTS & ENGINEERING CO PVT. LTD/KOLKATA
		RUKMANI ELECTRICAL & COMPONENTS PRIVATE LTD/KOLKATA
		SILVERLINE POWER INFRASTRUCTURE PVT LTD/VADODARA
35	**JUNCTION BOX FOR POWER & INSTRUMENTS**	TECH-UP ENGINEERING PVT. LTD/TIRUCHIRAPPALLI
		SHIBSHA INSTRUMENT INDIA P LTD/CHENNAI
		WIN POWER/KOLKATA
		CHEMIN CONTROLS AND INSTRUMENTATION PVT. LTD/PONIDICHERRY
		PYROTECH ELECTRONICS PVT LTD/UDAIPUR
		SAHYADRI ELECTRO CONTROLS (INDIA) PRIVATE LTD.,/BENGALURU
		SRI VISHNU INDUSTRIES/HOSUR
		KEAS CONTROL SYSTEMS INDIA PRIVATE LIMITED/COIMBATORE
		BALAJI ELECTROCONTROLS PVT. LTD.,/BENGALURU
		HAROLD INDUSTRIES PVT LTD.,/CHENNAI
		K.S.INSTRUMENTS PVT. LTD.,/BENGALURU
		AXON TECHNOLOGIES/KANCHEPURAM DIST
		MAIKA METALS PVT LTD/CHENNAI
		PRAMMEN INDUSTRIES/PUDUKOTTAI
		SAJAS ELECTRICALS/TIRUCHIRAPPALLI
36	**PADDLE WHEEL FLOW TRANSMITTER**	BURKERT CONTROMATIC PVT LTD/CHENNAI
		GEORG FISCHER PIPING SYSTEMS PVT LTD/CHENNAI

BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

For

LT MOTORS (AC)

00	07.12.13	RPS/MKV	VNS	SK	Fresh issue
Rev.No	Date	Prepared	Checked	Approved	Remarks

SCOPE OF SUPPLY:

Supply of LT Motors as per enclosed **EIL specification**: **6-51-0032- Rev 04**(14 pages). Vendors to meet applicable clauses of this specification in toto for the subject enquiry.

SITE DATA:

Ambient Temperature	:	50 Deg.C
Humidity	:	89% RH at 45 Dec.C
Location	:	Outdoor / Indoor, Non-Air Conditioned
Atmospheric condition	:	Dusty & Polluted
Classification of Area	:	Non Hazardous Area
Seismic zone	:	Zone III (As per IS 1893)

SPARES:

1. COMMISSIONING SPARES:

Vendor to include the required commissioning spares with the motor main supply.

2. MANDATORY SPARES:

1. 1 NO OF EACH TYPE OF BEARINGS SET FOR DE & NDE
2. 1 SET FOR EACH TYPE OF STUD / BUSHING ASSEMBLY.

3. RECOMMENDED SPARES;

Vendor to furnish a list of recommended spares for two years operation along with item wise price.

DATA SHEET:

Vendor shall submit the Motor data sheet as per enclosed data sheet format vide ref: 6987-017-16-50-DS-08 Rev.0(2 pages)

VENDOR LIST:

1. ABB LIMITED
2. BHARAT BIJLEE LIMITED
3. CROMPTON GREAVES LIMITED
4. JYOTI LIMITED
5. KIRLOSKAR ELECTRIC CO LTD
6. LAXMI HYDRAULICS PVT LTD
7. MARATHON ELECTRIC MOTOR I LTD
8. SIEMENS LIMITED.

****

मध्यम वोल्टेज इंडक्शन मोटरों के लिए विनिर्देश

SPECIFICATION FOR MEDIUM VOLTAGE INDUCTION MOTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	26.09.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	SD	BRB	JMS	VC
3	09.04.02	REVISED AND RE-ISSUED	UG	AAN	VPS	SKG
2	01.02.97	REVISED AND ISSUED AS STANDARD SPECIFICATION	AAN	VPS	SG	AS
1	26.07.84	ISSUED AS STANDARD SPECIFICATION	CSM	VPS	GNT	-
0	03.03.81	ISSUED AS STANDARD SPECIFICATION	-	-	GNT	-

Abbreviations:

BIS	Bureau of Indian Standard
BS	British Standards
CIMFR	Central Institute of Mines and Fuel Research
CT	Current Transformer
EIL	Engineers India Limited
FM	Factory Mutual
FRP	Fiber Reinforced Polyester
IEEE	Institute of Electrical & Electronics Engineers
IS	Indian Standard
LCIE	Laboratoire Central des Industries Electriques
NEMA	National Electrical Manufacturers Association
PO	Purchase Order
PVC	Poly Vinyl Chloride
RPM	Revolutions per Minute
UL	Underwriter's Laboratories
VDE	Verband Deutscher Elektrotechniker

Electrical Standards Committee

Convenor: Mr. J. M. Singh
Members: Mr. R. C. Sachdeva
Mr. U. A. Patro
Mr. S. K. Gupta
Mr. Niraj Sethi
Mr. Rajnish Mahajan
Mr. S. K. Kaul
Mr. C. R. Mandal / Mr. Ashok Choudhury

CONTENTS

1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of three phase medium voltage squirrel cage induction motors.

2.0 CODES AND STANDARDS

2.1 The squirrel cage induction motors and their components shall comply with the latest editions of following standards issued by BIS (Bureau of Indian Standards) unless otherwise specified:

IS - 5	Colours for ready mixed paints and enamels.
IS - 325	Three phase induction motors.
IS - 1076	Preferred numbers.
IS - 1231	Dimensions of three phase foot mounted induction motors.
IS - 1271	Thermal evaluation and classification of electrical insulation.
IS - 2148	Flame proof enclosures of electrical apparatus.
IS - 2223	Dimensions of flange mounted AC Induction motors.
IS - 2253	Designation for type of construction and mounting arrangement of rotating electrical machines.
IS - 2254	Dimensions of vertical shaft motors for pumps.
IS - 2968	Dimensions of slide rails for electric motors.
IS - 4029	Guide for testing three phase induction motors.
IS - 4691	Degrees of protection provided by enclosure for rotating electrical machinery.
IS - 4722	Rotating electrical machines.
IS - 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS - 4889	Method of determination of efficiency of rotating electrical machines.
IS - 6362	Designation of methods of cooling of rotating electrical machines.
IS - 6381	Construction and testing of electric apparatus with type of protection `e'.
IS - 7389	Pressurized enclosure of electrical equipment for use in hazardous area.
IS - 7816	Guide for testing insulation resistance of rotating machines.
IS - 8223	Dimensions and output series for rotating electrical machines.
IS - 8289	Electrical equipment with type of protection `n'.
IS - 8789	Values of performance characteristics for three phase induction motors.
IS - 9283	Motors for submersible pump sets.
IS - 9628	Three phase induction motors with type of protection `n'.
IS - 12065	Permissible limits of noise level for rotating electrical machines.
IS - 12075	Mechanical vibration of rotating Electrical Machines with shaft heights 56 mm and higher - measurement, evaluation and limits of vibration severity.
IS - 12802	Temperature rise measurement of rotating electrical machines.
IS - 12824	Type of duty and classes of rating assigned to rotating electrical machines.
IS - 13529	Guide on effects of unbalanced voltages on the performance of three phase cage induction motors.
IS - 13555	Guide for selection and application of three phase induction motors for different types of driven equipment.
IS - 14568	Dimensions and output series for rotating electrical machines, frame numbers 355 to 1000 and flange numbers 1180 to 2360.

2.2 In case of imported motors, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian Standards.

2.3 The motors shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.4 In case Indian Standards are not available, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any contradiction between various referred standards/ specifications/ data sheets and statutory regulations, the following order of priority shall govern:

- Statutory regulations
- Data sheets
- Job specifications
- This specification
- Codes and standards

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of the art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to ensure the end user for placement of order for spares and services.

4.0 OPERATING CONDITIONS

4.1 Ambient Conditions

Motors shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in refineries, petrochemical, fertilizer and metallurgical plants. Service conditions shall be as specified in the motor data sheet. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration.

4.2 Frequency and Voltage Variations

Unless otherwise agreed, motors shall be designed for continuous operation at rated output under the following conditions:

a) The terminal voltage differing from its rated value by not more than ± 6 % or
b) The frequency differing from its rated value by not more the ± 3 % or
c) Any combination of (a) and (b)

4.3 Starting

a) Unless otherwise specified, motors shall be designed for direct-on-line starting.
b) Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
c) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. The starting time of the motor shall be less than the hot thermal withstand time (time t_E in case of increased safety i.e. Ex-e motors) to permit application of conventional bimetal relays or thermal release against locked rotor and overload conditions.
d) Unless otherwise specified, all motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the motor terminals.

e) Motors shall be designed to allow the minimum number of consecutive starts indicated in Table below:

Starts	Minimum no. of consecutive starts
No. of consecutive start-ups with initial temp. of the motor at ambient level (cold)	3
No. of consecutive start-ups with initial temp. of the motor at full load operating level (hot).	2

4.4 Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. Directional arrow should be manufactured from corrosion resistant material. When a motor is provided with bi-directional fans, a double-headed arrow should be provided.

Normally, clockwise rotation is desired as observed from the driving (coupling) end, when the terminals ABC are connected to a power supply giving a terminal phase sequence in the order ABC. Counter-clockwise rotation of the motor shall be obtained by connecting the power supply to terminals so that the phase sequence corresponds to the reversed alphabetical sequence of the terminal letters. Ample space shall be provided at the terminal box for interchanging any two external leads for obtaining the reverse phase sequence.

5.0 PERFORMANCE

5.1 Motors shall be rated for continuous duty (S_1), unless otherwise specified.

5.2 Unless otherwise specified, the starting current (as % rated current) shall not exceed 600% subject to tolerance.

5.3 In particular cases, when the starting current is to be limited, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification.

5.4 In particular cases, when the starting with reduced voltage is specified, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification.

5.5 Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of the driven equipment under specified starting and operating conditions.

For heavy duty drives such as blowers, crushers etc. high starting torque motors shall be provided.

In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 110% of rated value for motors up to 75 kW and shall be 90% of rated value for motors above 75 kW.

5.6 The pull out torque at the rated voltage shall be not less than 175 percent of the rated load torque with no negative tolerance. Unless otherwise agreed, the pull out torque shall not exceed 300 percent of the rated load torque.

In case of motors driving equipment with pulsating loads (e.g. reciprocating compressors) the minimum value of pull out torque at 75 percent of the rated voltage shall be more than the peak value of pulsating torque and the current pulsation shall be limited to 40%.

5.7 The minimum values for performance characteristics of motors rated up to and including 37 kW shall be as per IS-8789 TABLE-1to TABLE-8.

The minimum value for product of efficiency and power factors of 2 pole, 4-pole, and 6-pole motors rated above 37 kW shall be as given in Table below.

Rated output	**Product of efficiency & power factor at rated load (minimum)**		
	2-Pole	**4- Pole**	**6-Pole**
45 kW	0.82	0.80	0.79
55 kW	0.82	0.80	0.79
75 kW	0.82	0.80	0.80
90 kW	0.82	0.80	0.80
110 kW	0.86	0.80	0.80
125 kW	0.86	0.80	0.80
160 kW	0.86	0.81	0.80
180 kW	0.86	0.83	0.80
200 kW	0.86	0.83	0.80

Efficiency and power-factor figures for motors having synchronous speeds of 750 RPM and below, shall be as agreed between the purchaser and the manufacturer.

6.0 CONSTRUCTIONAL DETAILS

6.1 Windings

6.1.1 Unless otherwise specified in the motor data sheet, motors shall be provided with class 'B' insulation as a minimum. In case of motors with class 'F' insulation, the permissible temperature rise above the specified ambient temperature shall be limited to those specified in the applicable Indian standards for class 'B' insulation.

6.1.2 The winding shall be tropicalised. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.

6.1.3 Windings shall be adequately braced to prevent any relative movement during operation. In this respect, particular care shall be taken for the stator windings for direct-on-line starting squirrel cage motors. Insulation shall be provided between coils of different phases that lie together. Core laminations must be capable of withstanding burnout for rewind at 400°C without damage or loosening.

6.1.4 In case of motors driving equipment with pulsating loads, special care shall be taken for the joints of rotor bars and end rings to avoid premature failures due to induced fatigue stresses.

6.1.5 The windings shall be connected in delta. However, for motors rated 2.2 kW and below, star connection may be accepted.

In case of motors with star-delta starting, the motor windings shall be fully insulated for delta connection.

6.1.6 The ends of the windings shall be brought out into a terminal box. These shall be terminated by means of terminals mounted on an insulating base made of non-hygroscopic and non-flammable material.

6.1.7 All motors shall be with six terminals and suitable links to connect them in star or in delta except for motors rated up to and including 2.2 kW which may be accepted with three terminals.

6.1.8 All terminals shall be thoroughly insulated from the frame with material resistant to tracking.

6.1.9 Anti-loosening, anti-vibration type of terminals shall be provided in case of increased safety (Type Ex e) and non-sparking (Type Ex n) motors.

6.2 Terminal Box and Cable Entries

6.2.1 Unless otherwise agreed, the terminal box shall be located on the right hand side as viewed from the driving (coupling) end. However, as a special case, terminal box located on top may also be accepted, particularly for hazardous area motors, in case manufacturer has only TOP mounted terminal box design which is duly tested/certified by CIMFR and approved by PESO/CCE for installation in hazardous area.. The terminal box design shall allow rotation in steps of 90° to facilitate cable entry from any direction.

6.2.2 The terminal box shall be of robust construction and large enough to facilitate easy connection of the cables. The terminal box shall be with necessary clearances, creepage distances between live parts and between live parts to earth considering air insulation and without any compound filling. Terminal box cover shall be provided with handles to facilitate easy removal. However, for terminal box covers weighing less than 5 kg., terminal box covers without handles can be accepted.

6.2.3 An adequately sized earth terminal shall be provided in the motor terminal box for termination of the fourth core of specified cables.

6.2.4 The terminal box shall be provided entries for suitable cable glands corresponding to the size of the specified cable. Crimp type tinned Cu lugs and nickel-plated brass (or aluminum if specifically required), double compression type cable glands shall be supplied along with the motors for the specified cable sizes for power and space heater cables.

6.2.5 Equipment and accessories provided shall conform to the hazardous area classification and the environmental conditions as specified in the motor data sheet.

6.2.6 Unless otherwise specified, the terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the cables sizes as specified below in Table for 2 pole, 4 pole or 6 pole motors :

Motor rating up to and including	Size of phase conductor (mm^2)
2.2 kW and below	4 Al./ 2.5 cu
3.7 kW	6 Al./ 4 cu
5.5 kW	10 Al./ 6 cu
7.5 kW	16 Al./ 6 cu
9.3 kW	25 Al./ 10 cu
11.0 kW	25 Al./ 16 cu
15.0 kW	35 Al.
18.5 kW	50 Al

22.0 kW	50 Al
30.0 kW	70 Al
37.0 kW	95 Al
45.0 kW	95 Al
55.0 kW	120 Al
75.0 kW	185 Al
90.0 kW	2x95 Al
110.0 kW	2x120 Al
125.0 kW/132 kW	2x150 Al
150.0 kW	2x185 Al
160.0 kW	2x185 Al
180.0 kW	2x240 Al
200.0 kW	2x300 Al

6.2.7 Cable sizes for motors having synchronous speeds 750 RPM and below shall be as agreed between the purchaser and manufacturer.

6.2.8 Cables used are of 650/1100 V grade aluminum conductor, PVC insulated, PVC extruded inner sheath, armoured with overall PVC sheath. However for cables up to & including 16 mm^2 cross-section, cables used may be with copper or aluminum conductor as indicated in the motor data sheet.

6.2.9 The terminal box shall be capable of withstanding internal short circuit conditions without danger to personnel or plant from the emission of hot gases or flame or due to excessive distortion or damage to the terminal enclosure.

6.2.10 Appropriate phase markings as per IS shall be provided inside the terminal box. The marking shall be non-removable and indelible.

6.3 Motor Casing and Type of Enclosure

6.3.1 Motors for use in safe areas shall be industrial type meeting the specified ambient conditions, starting and operating requirements.

6.3.2 Motors for use in hazardous areas (Zone-1 or Zone-2) shall have type of protection Ex d or Ex e or Ex n as specified in the motor data sheet and shall meet the requirements of applicable Indian standards.

6.3.3 The minimum degree of motor enclosures including terminal boxes and bearing housing shall be IP-55 as per IS.

6.3.4 Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. Motor casing shall be provided with a suitable drain for removal of condensed moisture except in case of flameproof motors (Type Ex d).

6.3.5 Vertical motors with downward shaft shall be provided with suitable canopies covering the motor fully. Vertical motors with upward shaft e.g. on fin-fan coolers, shall be adequately protected, (such as cowls/canopies) against ingress of water into the enclosure or the bearing housing even when standing still for long periods of time. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the non-driving end.

6.3.6 All internal and external metallic parts, which may come into contact with cooling air, shall be of corrosion resistant material or appropriately treated to resist the corrosive agents, which

may be present in the atmosphere. Screws and bolts shall be of rust proof material or protected against corrosion.

Unless otherwise agreed, motors shall have standard frame sizes for various output ratings as stipulated in IS.

6.4 Bearing and Lubrication

6.4.1 Motors shall have grease lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum L-10 rating life of 5 years, (40, 000 hours) at rated operating conditions
(The L-10 rating life is the number of hours at constant speed that 90% of a group of identical bearings will complete or exceed before the first evidence of failure).

6.4.2 Unless otherwise specified, the bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion.

6.4.3 Vertical motors shall be provided with thrust bearings suitable for the load imposed by the driven equipment.

6.4.4 In cases such as pumps for hot liquids where the driven equipment operates at high temperatures, bearings shall be cooled by a shaft-mounted fan. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven equipment by conduction or convection.

6.4.5 Bearings shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust / moisture e.g. labyrinth seal. Where grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices, which ensure passage of grease through the bearings.

6.4.6 Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 to 5 years of trouble-free service without the necessity of re-lubrication.

6.5 Cooling System

All motors shall be self ventilated, fan cooled. Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motor rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor.

For motors operating in hazardous area, the fans shall be of an anti-static non-sparking material.

6.6 Rotor

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life for the bearings. The accepted values of peak to peak vibration amplitudes for a motor at rated voltage and speed on a machined surface bedplate with the motor leveled and with a half-key or coupling fitted shall not exceed those given in IS. Die cast aluminum rotors for motors in hazardous areas may be accepted provided the same are type tested and approved by competent authorities.

6.7 Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

6.8 Lifting Hooks

All motors weighing more than 30 kg. shall be provided with lifting hooks of adequate capacity.

6.9 Earth Terminals

Two earth terminals located preferably on diametrically opposite sides shall be provided for each motor. The size of each earth stud shall be as given below in Table:

Motor Rating	Stud size
Up to and including 7.5 kW	6 mm
11 kW to 30 kW	10 mm
Above 37 kW	12 mm

Necessary nuts and spring washers shall be provided for earth connection.

An additional earth terminal shall be provided inside the terminal box as stated in 6.2.3.

7.0 MISCELLANEOUS ACCESSORIES

7.1 Anti-Condensation Heaters

Unless otherwise stated, all motors rated above 22 kW shall be provided with 240 V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shutdown periods. The heaters shall permanently remain `ON' when the motor is not in service and as such shall not cause damage to the windings.

For motors installed in hazardous atmospheres (Zone - 1 or Zone - 2), such heaters shall conform to the provisions of applicable Indian Standards and temperature classification specified in the motor data sheet.

The heater leads shall be brought out, preferably, to a separate terminal box which shall be of the same specification and grade of protection as the main terminal box.

A warning label with indelible red inscription shall be provided on the motor to indicate that the heater supply shall be isolated before carrying out any work on the motor.

7.2 Name Plates

A stainless steel name plate manufactured from series 300 stainless steel and having information as per IS shall be provided on each motor.

In addition to the motor rating plate, a separate number plate for motor tag number shall be fixed in a readily visible position. This number shall be as per the motor data sheets.

Additional information as stipulated in applicable standards shall be included in the nameplate for motors meant for use in hazardous atmospheres.

8.0 NOISE LEVEL

The permissible noise level shall not exceed the stipulations laid down in IS, unless otherwise specified in the motor data sheet.

9.0 MOTOR VIBRATIONS

Motor vibrations shall be with-in the limits of IS, unless otherwise specified for the driven equipment.

10.0 CRITICAL SPEEDS

The first actual critical speed of stiff rotors shall not be lower than 125 % of the synchronous speed. For flexible rotors this shall be between 60 % and 80 % of the synchronous speed; the second actual critical speed shall be above 125 % of the synchronous speed.

11.0 PAINTING

Internal and external parts of the casing and all metal parts including the canopy likely to come in contact with the surrounding air shall be protected with anti-acid paint that will resist the specified environment conditions.

All external surfaces of the motor and its canopy shall be given a coat of epoxy-based paint.

Paint shade shall be 632 as per Indian Standard-IS-5.

12.0 INSPECTION AND TESTING

12.1 During manufacturing of motors, the motors shall be subject to inspection by EIL/ Owner's Inspector or by an agency authorised by the Owner. The manufacturer shall provide all necessary information concerning the supply to EIL/Owner's Inspector.

12.2 Type tests, if specified, all the routine tests and other acceptance tests shall be witnessed by the EIL / Owner's Inspector. The manufacturer shall give prior notice of minimum 4 weeks to the Inspector for witnessing the tests.

Witness of acceptance test shall be applicable for motors rated above 11 kW. In case of motors rated up to 11 kW, routine test records shall be provided as part of final documentation.

12.3 All tests shall be carried out at manufacturer's shop under his care and expense.

12.4 Tests certificates duly signed by the EIL / Owner's Inspector shall be a part of final documentation.

12.5 The manufacturer shall submit all internal test records of the tests carried out by him on the bought-out items, motor sub-assembly and complete motor assembly to the Inspector before offering the motors for final inspection and testing.

12.6 The manufacturer shall periodically carry out the following type tests as per applicable Indian Standards for all the frame sizes and ratings of motors :

a) Full load test and measurement of voltage, current, power & slip
b) Measurement of starting torque, starting current, full load torque and pull out torque
c) Measurement of efficiency and p.f. at 100%, 75% and 50% load
d) Temperature rise test

e) Momentary overload test
f) Measurement of vibration
g) Measurement of noise level
h) Over speed test

The above tests must be witnessed and approved by reputed inspection agencies. The manufacturer shall maintain test records and submit to the EIL/Owner's Inspector at the time of final inspection & testing. In no case, the test records shall be more than 5 year old.

In special cases where the type tests are asked to be carried out, EIL/Owner's Inspector shall witness these.

12.7 The manufacturer shall carry out routine tests as per applicable Indian Standards on all the motors. Routine tests not limited to the following shall form part of acceptance testing :

a) General visual checks, nameplate details, mounting, terminal box location and cable gland sizes
b) Measurement of shaft center height dimensions
c) Measurement of clearances in the terminal box
d) Verification of type of terminals (for Ex-e & Ex-n motors)
e) Verification of direction of rotation
f) Measurement of winding resistance
g) Insulation resistance test (before & after high voltage test)
h) High voltage test
I) No load test and measurement of voltage, speed, current & power input
j) Locked rotor test at reduced voltage and measurement of voltage, current & power input
k) Reduced voltage starting & running
l) Tests on the Ex d enclosures as per IS

12.8 The manufacturer shall submit the following certificates for verification by the EIL/Owner's Inspector:

a) Test certificate for degree of protection of enclosure
b) Test certificates issued by the recognised independent test house for hazardous area motors
c) Approval certificates issued by Statutory Authorities for hazardous area motors
d) BIS license and marking as required by Statutory Authorities for Ex d motors

12.9 Though the motors shall be accepted on the basis of the satisfactory result of the testing at the shop, it shall not absolve the Vendor from liability regarding the proper functioning of the motors coupled to the driven equipment at site.

13.0 CERTIFICATION

The hazardous area motors and associated equipment shall have test certificates issued by recognised independent test house (CIMFR/Bassefa/LCIE/UL/FM or equivalent). All indigenous motors shall conform to Indian Standards and shall be certified by Indian testing agencies. All motors (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous flameproof motors shall have valid BIS license & marking as required by statutory authorities.

Ex n motors shall be supplied with manufacturer's c ertificate of conformity to IS 9628 or equivalent international standard and Indian statutory approval.

14.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/cases to prevent damage to the finish. Crates/cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO Nos.' etc. shall be clearly marked on the package together with other details as per purchaser order.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature, unless otherwise agreed.

Data Sheet for Medium Voltage Squirrel Cage Induction Motor
ELECTRICAL DESIGN DATA

1	Motor tag no.:	*			
2	Voltage(V):	415V±6%	Phase: **3**	Frequency(Hz.):	50Hz ± 3%
3	Fault level (KA):	50kA	Duty: Continuous		
4	Method of starting:	Direct On Line *@			
5	Phase: THREE		Connection: DELTA	No. of terminals:	SIX
6	Design Ambient temp (°C)	45°C	Temp. rise(°C):	65°C for Ex(e) , 75°C for Ex(d), Ex(n)	
7	Cable size(mm^2): *		Type *		
8	Enclosure type	*@	Cooling: *@		
9	Insulation class	Class "F" with Temp. rise limited to Class "B"			
10	Haz. Area classification/Gas Group: *@				
11	Type of explosion protection: Ex(e) / Ex(d)/ Ex(n)		Applicable Standards: IEC / IS, 6-51-0032		

Technical particulars from Driven equipment manufacturer

12	Suggested Motor Rating in kW / Manufacturer:	*/*
13	Shaft kW / kW at end of curve:	*/*
14	Speed/rotation of equipment from Coupling End:	*/*
15	Starting/max. Torque required (m-kg):	*/*
16	WK^2 of equipment Including/excluding flywheel (kg-m^2):	*/*
17	Thrust up/down (kg):	*/*
18	Equipment/coupling type:	*/*
19	Starting Condition -On no load/Under loaded Condition:	*

Technical particulars from Motor Manufacturer

20	Manufacturer:			
21	kW Rating:	*	No. of poles:	*
22	Frame designation:	*	Mounting:	*
23	Full load speed (rpm):	*	Full load Torque (m-kg):	*
24	Starting torque as %of full load torque:	*		
25	Full load current (A):	*		
26	Starting current at 100% Voltage (A):	*		
27	Break down or pull out torque%:	*		
28	Rotation viewed from motor NDE: *	(Compatible with direction of rotation of driven equipment)		
29	Starting time at 75%V (sec.):	*	Starting time at 100%V (sec):	*
30	Time (Te) for increased safety motors at 100% Voltage (secs.): *			
31	Locked rotor with stand time cold/hot at 75% V (sec):	*/*	At 100% V (sec): * / *	
32	WK^2 of motor (kg-m^2):	*		
33	Power factor at 100%load:	*	Power Factor at 75% load: *	
34	Efficiency at 100% load:	*	Efficiency at 75% load:	*
35	Space heater watts/volts:	*/240V AC (for 30 KW and above)		
36	Bearing type/no. DE:	*/*	Bearing type/no. NDE:	*/*
37	Type of Lubrication:	*		
38	Weight of motor (kg):	*		
39	Canopy Required/Not required:	Required (FRP type)		

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	19.06.2013	ISSUED WITH BID PACKAGE	SNN	ANPS	PG

NOTES:

1. Motor Terminal Box must be suitable for the cable size specified.
2. Vendor shall submit duly filled-in motor data sheet for each motor.
3. Vendor shall submit approval certificates from Indian Statutory Authority: - CCOE, towards equipment suitability for hazardous area application.
4. Testing of MV motors (in motor manufact nform to EIL spec 6-51-0032.
5. Recommended list of maintenance spares for two years operation shall include the following as minimum:
   a) Bearing DE/NDE one set
   b) Terminal box cover with screws
   c) Fan
   d) Terminal block
6. Starting Time calculations shall be based on Operating conditions specified in bid document eg. Open valve conditions/ Closed valve Conditions, at No Load/ under load, as applicable.

***To be decided by Contractor in line with Engineering Design Basis/ Bid Document**

@ As per Engineering Design Basis/ Bid Document/ SLD.

4.8 VENDOR LIST FOR MECHANICAL ITEMS

Bidder to provide the bidder list for all major bought-out items along with the bid. However the following makes must be considered for items indicated below.

1. HORIZONTAL CENTRIFUGAL PUMPS :

ARAI PUMP MANUFACTURING COMPANY LTD, JAPAN
BHARAT PUMPS & COMPRESSORS LTD INDIA
CLYDE UNION LIMITED INDIA / UK
DMW CORPORATION JAPAN
EBARA CORPORATION (JAPAN) JAPAN
FLOWSERVE CORPORATION INDIA
FLOWSERVE INDIA CONTROLS PVT LTD INDIA
FLOWSERVE (THOMPSONS KELLY&LEWIS PTY LTD) INDIA / AUSTRALIA
GOULDS PUMPS INC INDIA / USA
KIRLOSKAR BROTHERS LTD INDIA
KIRLOSKAR EBARA PUMPS LTD INDIA
KSB AKTIENGESSELSCHAFT GERMANY
KSB PUMPS LTD (POONA) INDIA
NUOVO PIGNONE SPA (ITALY) (GE OILCO.) INDIA / ITALY
RUHRPUMPEN GMBH(FORMERLY THYSSEN) GERMANY
SANWA HYDROTECH CORPORATION JAPAN
SHIN NIPPON MACHINERY CO LTD JAPAN
STERLING FLUID SYSTEMS LIMITED UK
SU MOTORS PVT LTD INDIA
SULZER PUMPS (US) INC INDIA / USA
SULZER PUMPEN DEUTSCHLAND GMBH INDIA / GERMANY
SULZER PUMPS INDIA LIMITED INDIA
WEIR GABBIONETA ITALY
MATHER & PLATT
FLOWMORE LIMITED
WPIL LTD

2. PUMP MECH. SEAL : JOHN CRANE / EAGLE BURGMANN / FLOWSERVE SANMAR / LEAKPROOF ENGG (I) PVT. LTD.

3. PUMP BEARING : SKF / FAG

4. ROTARY SCREW PUMP

ALEKTON ENGG INDUSTRIES PVT. LTD / INDIA
ALLWEILER AG / GERMANY
BORNEMANN PUMPEN / GERMANY
FLOWSERVE CORPORATION /INDIA

IMO AB. / SWEDEN
IMO INDUSTRIES INC (USA)/ USA
LEISTRITZ AG / GERMANY
PLENTY MIRRLESS PUMPS/ SINGAPORE
POMPE VERGANI SPA / ITALY
ROTO PUMPS LTD / INDIA
TUSHACO PUMPS PVT. LTD / INDIA
UT PUMPS & SYSTEMS PVT. LTD. (BORNEMAN) / INDIA
WARREN PUMPS INC / USA

5. AIR BLOWER : WELLWIN ASSOCIATES (EVEREST BLOWERS) / RKR / HICK HARGREAVES.

6. UPVC/CPVC PIPING & VALVES : GEORGE FISCHER / ASTRAL

7. DOSING SYSTEMS : MILTON ROY / GRUNDFOS / PSI ENGG

8. DOSING PUMPS : MILTON ROY / GRUNDFOS / PSI ENGG / POSITIVE METERING

9. GRP TANKS : PURE WATER SYSTEMS PVT LTD.,
COSMO PLAST
MODERN ENGG PLASTICS PVT LTD
DAKLE REINFORCED PLASTICS PVT LTD
SHRIRAM SEPL COMPOSITE (P) LTD
CREATIVE COMPOSITES
BALAJI FIBERS REINFORCE PVT LTD
EPP COMPOSITE PVT LTD
REINHOLD POLYGLASS
CHEMICAL PROCESS PIPING PVT LTD

10. GRP PIPING : CHEMICAL PROCESS PIPING PVT LTD(CPP)
EPP COMPOSITE PVT LTD
SHRIRAM SEPL COMPOSITE (P) LTD
BALAJI FIBERS REINFORCE PVT LTD
REINHOLD POLYGLASS
MODERN ENGG PLASTICS PVT LTD

11. CENTRIFUGE : PENWALT, INDIA
ALFA-LAVAL, INDIA
HUMBOLDT, INDIA

12. THICKENER : HINDUSTAN DORR OLIVER, INDIA
GEO-MILLER, INDIA
EIMCO KCP, INDIA

PARAMOUNT, INDIA
NAVBHARAT ENVIROTECH, INDIA
KEC, INDIA
TRIVENI ENGG
VOLTAS

13. BELT FILTER PRESS : TECHNOFUNGI
DEWA Co.
EMO
ANDRITZ
TRIVENI
KROFTA

14. **VALVES – BUTTERFLY** :

FOREIGN SUPPLIERS:

BATLEY VALVE CO LTD, THE UK
CHARLES WINN (VALVES) LTD. UK
COOPER CAMERON (SINGAPORE) PTE LTD. SINGAPORE
CRANE AUSTRALIA PTY LTD AUSTRALIA
FLOWSERVE PTE (MFR. SERCK) UK
FLOWSERVE PTE LTD INDIA / SINGAPORE
FRIEDRICH KROMBACH GMBH & CO.KG INDIA / GERMANY
GUICHON VALVES FRANCE
HATTERSLEY NEWMAN HENDER LTD UK
LANZA S.P.A. ITALY
MCCANNA VALVES INC USA
METSO AUTOMATION PTE LTD(FORMERLY NELES INDIA / FINLAND
NAKAKITA SEISAKUSHO CO LTD JAPAN
ORTON S.R.L ITALY
PCC WOUTER WITZEL NETHERLANDS
PIETRO FIORENTINI SPA ITALY
SASAKURA ENGINEERING CO LTD JAPAN
SPX VALVES & CONTROLS (FORMERLY DEZURIK) INDIA / USA
TYCO VALVES & CONTROLS INDIA / USA
TYCO VALVES & CONTROLS ITALIA SPA INDIA / ITALY
WESTAD INDUSTRI A S NORWAY

INDIGENOUS SUPPLIERS:

ADVANCE VALVES PVT LTD INDIA
BDK ENGINEERING INDUSTRIES LTD INDIA

CRANE PROCESS FLOW TECHNOLOGIES IND. LTD INDIA
FOURESS ENGG.(INDIA) LTD.(BLR.WORK) INDIA
INSTRUMENTATION LTD. (PALGHAT) INDIA
INTERVALVE (INDIA) LTD. INDIA
LARSEN & TOUBRO LTD INDIA
LEADER VALVES LTD INDIA
MASCOT VALVES PVT LIMITED (FMLY VALFLO) INDIA
STAFFORD CONTROLS LIMITED INDIA
TYCO VALVES & CONTROLS INDIA PVT LTD INDIA

15. **VALVES – CHECK** :

FOREIGN SUPPLIERS:

ALCO ITALIA SPA ITLAY
AMPO, S.COOP (POYAM VALVES) INDIA / SPAIN
BABCOCK POWER ESPANA SA SPAIN
BFE SPA ITALY
CONVAL INC USA
CRANE AUSTRALIA PTY LTD AUSTRALIA
DANIEL MEASURMNT & CONTROL ASIA PACIFIC INDIA / SINGAPORE / USA
DOUGLAS CHERO SPA ITALY
ENTECH DEUTSCHLAND GMBH ITALY
FLOWSERVE PTE(MFR. EDWARD) USA
FRIEDRICH KROMBACH GMBH & CO.KG INDIA / GERMANY
FRIULCO SPA INDIA / ITALY
GESTRA AG GERMANY
GUICHON VALVES FRANCE
ISHIDA VALVE MFG CO. LTD JAPAN
JC FABRICA DE VALVULAS S.A. UAE / SPAIN
JIANGSU Jiulong Valve Manufacture Co.Ltd CHINA
LARSEN & TOUBRO LTD(JIANGSU)VALVE CO.LTD INDIA / CHINA
LAZARO ITUARTE S.A. SPAIN
LVF SPA ITLAY
MALBRANQUE S.A FRANCE
MOKVELD VALVES BV MALAYSIA
MSA A.S. CZECH
NEWMANS INC. USA
OMB VALVES ITALY
PETROL VALVES SRL ITALY
RING-O VALVE OPERATIONS ITALY
SEMPELL AG GERMANY
SITINDUSTRIE EQUIPMENT S.R.L. ITALY
STAHL ARMATUREN PERSTA GMBH GERMANY
SUFA LTD UAE
TAKAMISAWA VALVE CO LTD(ENQ TO MEC CORPN JAPAN

TH. JANSEN-ARMATUREN GMBH GERMANY
TOM WHEATLEY VALVE OPERATIONS USA
TRUFLO RONA S.A. BELGIUM
TYCO VALVES AND CONTROLS ITALIA S.R.L INDIA / ITALY
VALVINOX SRL ITALY
VALVOSIDER ITALY
VELAN INC CANADA
VITAS - DIVISION OF VALVITALIA S.P.A ITALY
WHEATLEY GASO INC USA
YONEKI VALVE CO LTD JAPAN
Z & J TECHNOLOGIES GMBH GERMANY

INDIGENOUS SUPPLIERS:

ADVANCE VALVES PVT LTD INDIA
BDK ENGINEERING INDUSTRIES LTD INDIA
BHEL (TRICHY) INDIA
ECONO VALVES PVT. LTD(NSSL LTD GROUP CO) INDIA
FOURESS ENGG (I) LTD. (AURANGABAD) INDIA
KSB PUMPS LTD (COIMBATTORE) INDIA
LARSEN & TOUBRO LTD INDIA
LEADER VALVES LTD INDIA
NANDINA IRON & STEELS LTD INDIA
NITON VALVE INDUSTRIES PRIVATE LTD INDIA
NSSL LTD. (NECO SCHUBERT & SALZER LTD) INDIA
OSWAL INDUSTRIES LTD INDIA
PANCHVATI VALVES & FLANGES PVT LTD INDIA
PETROCHEMICAL ENGG. ENT. (FOURESS GROUP) INDIA
SAKHI ENGINEERS PVT. LTD. INDIA
SHALIMAR VALVES PVT LTD INDIA
STEEL STRONG VALVES INDIA PVT LTD INDIA

Note: Any other makes proposed by the bidder shall be considered, subject to the approval of Customer (BHEL). For the E,C & I vendor list, please refer to specification no: ROS 4084

PAINTING SPECIFICATION

ANNEXURE-B FOR ROS 6109 (41 pages)

1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the provisions of various codes of practice, standard specifications etc. It is understood that contractor shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to the following.

2.1.1 This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services, MS Chimney without Refractory lining and Flare lines etc. The items listed in the heading of tables of paint systems is indicative only, however, the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

2.2 Extent of Work

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

a. All uninsulated C.S. & A.S. equipment like columns, vessels, drums, storage tanks(both external & internal surfaces), heat exchangers, pumps, compressors, electrical panels and motors etc.

b. All uninsulated carbon and low alloy piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.

c. All items contained in a package unit as necessary.

d. All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.

e. Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining.

f. Identification colour bands on all piping as required including insulated aluminium clad, galvanised, SS and nonferrous piping.

g. Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminium clad, galvanized, SS and non-ferrous piping

h. Marking / identification signs on painted surfaces of equipment/piping including hazardous service.

i. Supply of all primers, paints and all other materials required for painting (other than Owner supplied materials)

j. Over insulation surface of equipments and pipes wherever required.

k. Painting under insulation for carbon steel, alloy steel and stainless steel as specified.

l. Painting of pre-erection/fabrication and Shop primer.

m. Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.

n. All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in **ETP plant.**

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the owner, the same shall be painted as per the relevant specifications:

a. Uninsulated austenitic stainless steel.

b. Plastic and/or plastic coated materials

c. Non-ferrous materials like aluminum.

2.3 **Documents**

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for execution of work.

a. Bill of quantities for piping, equipment, machinery and structures etc.

b. Piping Line List.

c. Painting specifications including special civil defence requirements.

2.4 Unless otherwise instructed, final painting on pre-erection/ shop primed pipes and equipments shall be painted in the field, only after the mechanical completion, testing on systems are completed as well as after completion of steam purging wherever required.

2.5 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to EIL for deviation permit.

3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered by this contract.

IS-5	:	Colour coding.
RAL DUTCH	:	International Standard for colour shade (Dutch Standard)
IS-101	:	Methods of test for ready mixed paints and enamels.
IS-2379	:	Indian Standard for Pipe line identification-colour code.
ASTM-Vol 6.01 & 6.03:		American standard test methods for Paints and Coatings.
ASA A 13.1-1981:		Scheme for identification of piping systems: American National Standards Institution.

3.2 **Surface Preparation Standards**

The latest editions of any of the following standards shall be followed for surface preparation:

3.2.1 ISO 8501-1 / SIS-05 59 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

3.2.2 Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC-SP).

3.2.3 National Association of Corrosion Engineers, U.S.A., (NACE).

3.2.4 Various International Standards equivalent to Swedish Standard for surface preparations are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

3.4 The paint manufacturer's instructions shall be followed as far as practicable at all times for best results. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparation prior to painting shall be followed as per Table 8.0 to 16.0 of this standard shall be followed.

c. Mixing and thinning.

d. Application of paints and recommended limit on time intervals in between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipments, scaffolding materials, shot & grit blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity. The manufacturer's test certificates / data sheets for all the above items shall be reviewed by Engineer-in-charge at site before start of work.

4.2 Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

5.0 SURFACE PREPARATION, SHOP PRIMER COATING APPLICATION & REPAIR AND DOCUMENTATION

5.1 General

5.1.1 In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by Engineer-In-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

a. Manual or hand tool cleaning.

b. Mechanical or power tool cleaning.

c. Blast cleaning.

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification The minimum acceptable standard in case of manual or hand tool cleaning shall be St. 2 or equivalent, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent, in case of blast cleaning it shall be Sa 2-1/2 as per Swedish Standard SIS-055900(latest edition) or SSPC-SP or ISO 8501-01.Blast cleaning shall be Sa 3 as per Swedish Standard in case of highly corrosive environment.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%. Incase of internal coating of storage tanks, De-humidifiers shall be used to control the humidity levels during

rainy season, if painting is to be carried out during the no rain days in case of exigency of project schedule with prior permission of Engineer-in-charge of OWNER/EIL

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray if recommended by the paint manufacturer on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.5 The external surface of R.C.C. chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCL solution for about 15 minutes shall be carried and surface must be thoroughly washed with water to remove acid & loose particles and then dried completely before application of paint.

5.2 **Procedure of Surface Preparation** :

5.2.1 Air Blast Cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives like copper slag, $A1_2O_3$ particles, chilled cast iron or malleable iron and steel at pressure of 7kg/cm^2 at a appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size with appropriate size of G42 grade (maximum) and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak or specified profile in case of steel and malleable iron . The combination of steel grits and shots shall be normally in the ratio of 3 : 1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to ¾". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer/first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.2 Mechanical or Power Tool Cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and /or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

5.2.3 Manual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and hence does not appear in the tables of paint systems.

Hand tool cleaning normally consists of the following:

a. Hand de-scaling and/or hammering

b. Hand scraping

c. Hand wire brushing

Rust, mill scale spatters, old coatings and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose material shall be removed from the surface by clean rags and the surface shall be bushed, swept, dusted and blow off with compressed air/steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 Non-Compatible shop coat primer

The paint system followed for Shop coating of structures/equipments etc., shall be mentioned in IRN. The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc Rich epoxy, inorganic zinc silicate etc. as shop coat, the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in-Charge.

5.4 Shop coated (coated with Primer & finishing coat) equipment should not be repainted unless paint is damaged. Repair shall be carried out as per Table 7.2 of paint systems depending upon compatibility of paint.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before application of selected paint system for particular environment.

5.6 For Package units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

5.7 **Coating Procedure and Application**

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than $5^{o}F$ above dew point when the relative humidity is greater than 85% or when the temperature is below $40^{o}F$ and when the ambient/substrate temp is below the paint manufacturer's recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20KM per hour.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter coat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.

c. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

d. The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for changes in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by over spray

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film.

Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited

uniformly. During application, the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.

h. Areas inaccessible to the spray gun shall be painted by brush; if not accessible by brush, daubers or sheepskins shall be used.

i. All nameplates, manufacturer's identification tags, machined surfaces, instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating deposition. If these surfaces are coated, the component shall be cleaned and resorted to its original condition.

j. Edges of structural shapes and irregular coated surfaces shall be coated first and an extra pass made later.

k. If spray gun shows choking, immediately de-choking procedure shall be followed.

5.7.7 Airless spray application shall be in accordance with the following procedure: as per stesl structure paint Manual Vol.1 & Vol.2 by SSPC, USA, Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is sued to operate a pump to produce pressures of 1000 to 6000 psi. paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in automization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of in built strainer. Usually very small quantity of thinning is required before spray. In case of high build epoxy coating (two pack). 30:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8" ID and not longer than 50 ft to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

5.7.8 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint.

b. Round or oval brushes are most suitable for rivets, bolts, irregular surface, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paint shall be applied into all corners.

d. Any runs or sags shall be brushed out.

e. There shall be a minimum of brush marks left in the applied paint.

f. Surfaces not accessible to brushes shall be painted by spray, doubers, or sheepkin.

5.7.9 Manual application by sling (where 6 O' clock position of pipe is not approachable)

A canvas strip (alternatively a tinplate strip) about 450 mm wide and 1.5m long is hold under the pipe by two men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is obtained all round the bottom. This work shall be done very carefully and by experienced personnel. There shall not be any formation of "Whiskers" and holes in the coating. The coating film shall be inspected by mirror.

5.7.10 For each coat the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of coated surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or maxing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause checking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to a paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

5.9 Repair of damaged paint surface

5.9.1 Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-erection / fabrication and Shop primer shall be done as given below and as per the Table 7.2 of this specification.

5.9.2 Repair of damaged inorganic zinc silicate primer after erection / welding in the design temperature of -90^{o}C to 550^{o}C.

Surface Preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface over the intact adjacent surface surrounding the damaged area by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damaged was observed on pre-erection pre fabrication / shop primer of inorganic zinc silicate coating (F-9). F-9 shall not be applied if damaged area is not more than 5x5 cm.

5.10 Paint Application

5.10.1 Shop priming/pre-erection priming with F9 or F12 shall be done only on blasted surface (SSPC-SP-10)

5.10.2 Shop priming/ pre-erection priming with F9 or F12 shall be done only with airless spray.

5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.

5.10.4 Assessment of painting requirement

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the environment from area classification details and chose the appropriate table.

- Identify the design temperature from the technical documents

- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.

- Identify the shop priming requirement from Table 7.1 based on compatibility of the above paint system.

- Identify the need of repair of shop primer and execute as per Table 7.2.

5.11 Documentation

5.11.1 A written quality plan with procedure for qualification trials and for the actual work.

5.11.2 Daily progress report with details of weather conditions, particular of applications, no of coats and type of materials applied, anomalies, progress of work versus program.

5.11.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

5.11.4 Particulars of surface preparation and paint application during trials and during the work.

5.11.5 Details of non-compliance, rejects and repairs.

5.11.6 Type of testing equipments and calibration.

5.11.7 Code and batch numbers of paint materials used.

5 In case of Paint systems as per Sl Nos 8.5 and 8.6, the colour bands shall be applied over the Aluminum paint as per the Colour coding requirement for specific service of piping given in Clause 18.0.

TABLE 9.0 **PAINT SYSTEM FOR CORROSIVE ENVIRONMENT-UNIT AREAS** for external surfaces of Un-insulated Structures, Piping, Equipments, Columns, Towers, Vessels, Pumps, Compressors, Blowers etc(Note1); (For Carbon Steel, LTCS & Low Alloy Steel)

Sl. No.	Design Temperature in °C	Surface Preparation & Pre-erection/Shop Primer	Paint system (Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
9.1	-90 to -15	SSPC-SP-10; 1coat of F-9 @65-75µDFT/coat	None	None	65-75	No over-coating to be done on
9.2	-14 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @ 40µ DFT/ coat	1 coat of F-6A @ 100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (100+40=140)	245-255	F-9 as it will lead to mud cracking.
9.3	81 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat (2x20=40) or 1 coat of F-16 @50 µ DFT/coat.	105-115 or 115-125	F-12 shall be ambient temperature curing type
9.4	401 to 550	SSPC-SP-10; 1coat of F-12 @ 20µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat (2x20=40)	60	

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2.

3. In case of paint systems as per Sl Nos 9.3 and 9.4, the colour bands shall be applied over the Aluminum paint as per the Colour coding requirement for specific service of piping given in clause 18.0.

TABLE-1 (FOR CLAUSE 5.0)

SURFACE PREPARATION STANDARDS

SL. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
1	Manual or hand tool cleaning Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen	ST.2	SSPC-SP-2	--	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2	Mechanical or power tool cleaning Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	ST.3	SSPC-SP-3	--	
3	Dry abrasive Blast cleaning There are four common grades of blast cleaning				
3.1	White metal Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	SA 3	SSPC-SP-5	NACE#1	Where extremely clean surface can be expected for prolong life of paint system.
3.2	Near white metal Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is	SA 2½	SSPC-SP-10	NACE#2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based

SL. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
	free of all visible residues with desired surface profile.				and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	Commercial Blast Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	SA 2	SSPC-SP-6	NO.3	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.
3.4	Brush-off Blast Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so important	SA 1	SSPC-SP-7	NO.4	

6.0 PAINT MATERIALS

Paint manufacturers shall furnish the characteristics of all paints materials on original printed literature, alongwith the test certificate for all specified characteristics given in this specification. All the paint materials shall be of first quality and conform to the following general characteristics as per the tables 6.1, 6.2, 6.3 and 6.4.

PAINT MATERIALS

TABLE No. 6.1 PRIMERS

Sl. No.	DESCRIPTION	P-2	P-4	P-6	P-7
1	Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/wash primer	Epoxy zinc phosphate primer	ZINGA synthetic zinc primer
2	Type and composition	Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticizer, pigmented with zinc phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack Synthetic Resin based zinc primer containing 96% of electrolytic zinc dust of 99.995% purity.
3	Volume Solids (minimum)	40%.	7-8%	40%	37%
4	DFT (Dry Film thickness) per coat (minimum)	30-40µ	8-10µ	40-50µ	40-50µ
5	Theoritical covering capacity in M^2/coat/ litre (minimum)	8-10	8-10	8-10	4m^2/kg
6	Weight per litre in kgs/litre (minimum)	1.3	1.2	1.4	2.67 kg at 15°C
7	Touch dry at 30°C (minimum)	30 minutes	2 hrs.	After 30 min.	10 minutes
8	Hard dry at 30°C (maximum.)	24 hrs.	24 hrs.	24 hrs.	24 hrs.
9	Overcoating interval	Min.: 8 hrs	Min: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
10	Pot life at 30°C for two component paints (minimum)	Not Applicable	Not applicable	6 - 8 hrs.	Unlimited
11	Temperature (Resistance (minimum)	60 °C	NA	80°C	100°C.

PAINT MATERIALS

TABLE No. 6.2 FINISH PAINTS

Sl. No	DESCRIPTION	F-2	F-3	F-6A/B	F-7
1	Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build finish paint.	High build coaltar epoxy coating.
2	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint.	Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.	F6A: Two-pack polyamine cured epoxy resin medium suitably pigmented. F6B: polyamide cured epoxy resin medium suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
3	Volume Solids (minimum.)	40%.	40%	62%	65%
4	DFT (Dry Film thickness) per coat (minimum)	30-40µ	30-40µ	100-125µ	100-125µ
5	Theoritical covering capacity in M^2/coat/litre (minimum)	10-13	8-10	5-6	5.2-6.5
6	Weight per liter in kgs/litre(minimum)	1.3	1.2	1.4	1.5
7	Touch dry at 30°C	1 hr.	30 minutes.	3 hrs.	4 hrs.
8	Hard dry at 30°C (max) Full cure at 30°C (for immersion/ high temperature service)	16 hrs 5 days	8 hrs NA	16 hrs 5 days	48 hrs. 5 days
9	Over-coating interval at 30 °C	Min.: 12 hrs.	Min.: Overnight	Min.: Overnight Max.: 5 days	Min.: 24 hrs Max.: 5 days.
10	Pot life (approx.) at 30°C for two component paints (minimum)	6-8 hrs.	Not applicable	4-6 hrs	4-6 hrs.
11	Temperature Resistance (minimum)	80 °C	60 °C	80°C	125°C.

PAINT MATERIALS

TABLE No. 6.3 FINISH PAINTS

Sl. No	DESCRIPTION	F-8	F-9	F-11	F-12
1	Technical name	Self priming type surface tolerant high build epoxy coating (complete rust control coating).	Inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C dry temp.	Heat resistant silicone Aluminium paint suitable upto 500°C dry temp.
2	Type & composition	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two pack air drying self curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test.	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C.	Single pack silicone resin based medium with Aluminium flakes.
3	Volume Solids (minimum)	72%.	60%	25%	20%
4	DFT (Dry Film thickness) per coat (minimum)	100-125µ	65-75µ	20-25µ	20-25µ
5	Theoritical covering capacity in M^2/coat/ litre (minimum)	6.0-7.2	8-9	10-12	8-10
6	Weight per liter in kgs/litre (minimum)	1.4	2.3	1.2	1.1
7	Touch dry at 30°C (maximum)	3 hrs.	30 minutes.	3 hrs.	30 minutes.
8	Hard dry at 30°C (maximum) Full cure 30°C (for immersion /high temperature service)	24 hrs 5days	24 hrs NA	24 hrs NA	24 hrs NA
9	Over-coating interval	Min.: 10 hrs	Min.: 12 hrs.at 20°C & 50% RH	Min.: 24 hrs	Min.: 24 hrs
10	Pot life at 30°C for two component paints (minimum.)	90 minutes.	4-6 hrs.	Not applicable	Not applicable
11	Temperature Resistance (min)	80 °C	400 °C	250°C	500°C.

PAINT MATERIALS
TABLE No. 6.4 FINISH PAINTS

Sl. No	DESCRIPTION	F-14	F-15	F-16	F-17
1	Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint)	Ambient temperature curing Poly Siloxane coating/High build cold applied inorganic copolymer based aluminium coating suitable for under insulation coating of CS and SS piping for high temperature service.	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
2	Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS/SS piping	Amercoat 738 from Ameron Products, USA/ Berger 938 from Berger Paints Ltd., or Intertherm 751 CSA from Akzo Nobel coating. Note: 6	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
3	Volume Solids (minimum)	70%	65%	60%	98-100 %
4	DFT (Dry Film thickness) per coat (minimum)	125 µm	75-100 µm	75-100 µm	125- 150 µm
5	Theoritical covering capacity in M^2/coat/ litre (minimum)	5.5	6.5- 8.5	6.0- 8.0	6.5 - 8
6	Weight per liter in kgs/litre (mix paint) (minimum)	1.5	1.7	1.3	1.7
7	Touch dry at 30°C (maximum)	4 hrs	2 hrs	1 hr	2 hrs
8	Hard dry at 30°C (maximum) Full cure 30°C (for immersion /high temp. service)	24 hrs 168 hrs (7 days)	24 hrs 168 hrs (7 days)	16 hrs -	24 hrs 168 hrs (7 days)
9	Over-coating interval	Min. 6 hrs Max.5 days	Min. 36 hrs Max.21 days	Min.16 hrs Max. Not applicable	Min. 16 hrs Max.21 days
10	Pot life at 30°C for two component	4 hrs	1.5 hrs	1 hr	1 hr

	paints (minimum.)				
11	Temperature Resistance (min)	-45°C to 125°C under insulation	-45°C to 150°C under insulation (Note: 5)	Up to 400 deg. C for CS & SS surfaces under insulation	-45°C to 150°C for immersion service

NOTES (for tables 6.1 to 6.4):

1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the losses during application, min specified DFT should be maintained.

2. All primers and finish coats should be cold cured and air drying unless otherwise specified.

3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. In case of conflict between this specification and manufacturer's recommendation, the same shall be clarified through SMMS.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

5. F-15: Two-component Epoxy phenolic coating cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint) suitable upto 225ºC (Intertherm 228 from M/s Akzo Nobel Coatings & Sealants, Bangalore). For all other companies, the temperature resistance shall be a maximum of 150ºC.

6. F-16: Ambient temperature curing epoxy poly siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating.

   'Amercoat 738' from Ameron Products USA/Kansai Nerolac Paints Ltd. Mumbai, suitable upto 400°C for CS surfaces and 600°C for SS surfaces.

   'Berger 938' from Berger Paints Ltd Kolkata, suitable upto 400°C for CS & SS surfaces.

   'Intertherm 751' from Akzo Nobel Coatings and Sealants Pvt Ltd, Bangalore, Inorganic co-polymer cold applied Aluminium spray coating suitable upto 400°C of CS & SS surfaces.

6.5 List of recommended Manufactures

The paints shall conform to the specifications given above and best quality in their products range of manufacturers listed in Annexure-I.

TABLE 7.1: LIST OF PRIMERS & FINISH COATS COVERED IN TABLE NOS. 8.0 - 16.0

PRIMERS	
P-2	Chlorinated rubber zinc Phosphate Primer
P-4	Etch Primer/Wash Primer
P-6	Two component Epoxy Zinc Phosphate Primer cured with polyamine hardner
P-7	Single pack, synthetic resin based `ZINGA' zinc primer containing 96% of electrolytic zinc dust in dry film.
FINISH COATS/PAINTS	
F-2	Two component Acrylic – Polyurethane finish paint
F-3	Chlorinated Rubber finish paint
F-6A	High Build Epoxy finish coating cured with **polyamine** hardner
F-6B	High Build Epoxy finish coating cured with **polyamide** hardner
F-7	High build Coal Tar epoxy coating cured with **polyamine** hardner
F-8	Self priming surface Tolerant High Build epoxy coating. cured with **polyamine** hardner
F-9	Two component Inorganic Zinc Silicate coating
F-11	Heat resistant synthetic medium based Aluminium paint
F-12	Two component Heat resistant Silicone Aluminium paint.
F-14	Specially formulated coaltar epoxy coating. cured with **polyamine** hardner
F-15	Two component Epoxy phenolic coating cured with Polyamine adduct hardner system
F-16	Engineered Epoxy poly Siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating
F-17	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system

TABLE 7.2 REPAIR OF PRE-ERECTION/PRE-FABRICATION & SHOP PRIMING AFTER ERECTION/WELDING for all insulated and un-insulated CS, LTCS & low allow steel items in all environments. (refer clauses 5.4, 5.5 & 5.9)

Sl. No.	Design Temp. in ^{o}C	Surface Preparation	Paint System	Total DFT in Microns (min.)	Remarks
7.1	-40 to 150 for structures, hand rails and Gratings only	SSPC-SP-3	1 coat of F-9 or 2 coats of P-7 @ 40µ DFT/coat	65-75 (F-9) or 80 (P-7)	For few isolated damaged areas of more than 5x5 CM
7.2	-90 to 400	SSPC-SP-3	1 coat of F-9	65-75	-DO-
7.3	401 to 550	SSPC-SP-3	1 coat of F-12	20	-DO-

NOTES:

1 The application and repair of pre-erection/pre-fabrication & Shop Priming given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread on large areas, the Engineer-in-Charge may decide to advise re-blasting and priming again if required.

2 The pre-fabrication primer P-7, 'ZINGA' primer is recommended as alternative repair primer to F-9 for Structures, Hand Rails and Gratings only. F-9 shall be used for all other areas.

17.0 STORAGE

17.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE – NO NAKED LIGHT – HIGHLY INFLAMABLE" shall be clearly displayed outside. Manufacturer's recommendation shall be followed for storage of paint materials.

18.0 PIPING COLOUR CODE:

The following colour coding system has been made based on international standards like ASME/ ANSI, BS and Indian Standard.

18.1 IDENTIFICATION

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines ground colour shall be provided as per specified length and interval to identify the basic nature of service and secondary colour bands to be painted on these specified length to identify the particular service. Above colour code is applicable for both unit and offsite pipelines.

18.1.1 The following ground colour designation for identification of basic classification of various important services shall be followed:

Post Office Red	-	Fire protection materials
Off White/Aluminium	-	Steam (all pressures)
Canary Yellow	-	Chemicals and dangerous materials
Dark Admiralty Grey	-	Crude oil, lube oil
Orange	-	Volatile petroleum products (motor spirit and lighter)
Oxide red	-	Non-volatile petroleum products (kerosene and heavier, including waxy distillates and diesel, gas oil)
Black	-	Residual oils, still bottoms, slop oils and asphalts, fuel oil
Sky blue	-	Water (all purities and temperatures)
Sea green	-	Air and its components and Freon

18.1.2 Secondary colours: The narrow bands presenting the secondary colour which identifies the specific service, may be applied by painting or preferably by use of adhesive plastic tapes of the specific colour.

18.2 COLOUR BANDS AND IDENTIFICATION LETTERING

18.2.1 The following specifications of colour bands shall be followed for identifying the piping contents, size and location of bands & letters. The bandwidth and size of letters in legends will depend to some extent upon the pipe diameter. Either white or black letters are selected to provide maximum contrast to the band colour. Bands usually are 50 mm wide and regardless of band width, are spaced 25 mm apart when two bands are employed

Table 1.0: Colour bands and size of lettering for piping:

Outside diameter of pipe or covering in mm	Width of colour bands in mm	Size of legend letters in mm
19 to 32	200	13
38 to 51	200	19
64 to 150	300	32
200 to 250	600	64
Over 250	800	89

In addition, ground colour as per specified length should be provided on insulated piping for easy identification of nature of fluid, on which the colour bands should be painted for identification of each service. The length of the ground colour should be 3 times the width of normal band or 2 meters, whichever is suitable depending on the length of the pipe.

Size of letters stenciled/ written for equipment shall be as given below:

Column and vessel : 150 mm (Height)
Pump, compressor and other machinery : 50 mm (Height)

In addition, the contents of the pipe and/or direction of flow may be further indicated by arrows and legend. If a hazard is involved it must be identified clearly by legend.

18.2.2 Colour bands: The location and size of bands, as recommended, when used, shall be applied to the pipe:

- On both sides of the valves, tees and other fittings of importance.
- Where the pipe enters and emerges from walls and where it emerges from road & walkway overpasses, unit battery limits.
- At uniform intervals along long sections of the pipe.
- Adjacent to tanks, vessels, and pumps.

18.2.3 For piping, writing of name of service and direction of flow for all the lines shall be done at following locations:

18.2.4 The letters will be in black on pipes painted with light shade colours and white on pipes painted with dark shade colours to give good contrast.

18.2.5 Only writing of service name shall be done on stainless steel lines. Precautions_should be taken while painting by using low chloride content painting to avoid any damage to the

stainless steel pipes. It is preferable to use adhesive plastic tapes to protect stainless steel pipes.

18.2.6 Colour band specification:

a) Unit Area: Bands at intervals of 6.0 meters.
Offsite Area: Bands at intervals of 10.0 meters.

b) Each pipe segment will have minimum one band indication, irrespective of length.

c) The bands shall also be displayed near walkways, both sides of culverts, tanks dykes, tanks, vessels, suction and discharge of pumps/ compressors, unit battery limit, near valves of line, etc.

18.3 For alloy steel/ stainless steel pipes and fittings in stores/ fabrication yard, color band (Minimum ½" wide) should be applied along the complete length of pipe, bends/ tees, side-curved surface (on thickness) of flanges as well as valves as per the metallurgy.

18.4 In case of camouflaging requirements of civil defence or any other location requirements, the same shall be followed accordingly.

18.5 The specification for application of the complete Piping identification colour code, including base and bands colours, are presented in the following table confirming to RAL colour shades of Dutch Standard:

RECOMMENDED RAL COLOUR CODE FOR PAINTING OF PIPING AND EQUIPMENT

SR. No.	SERVICE	RECOMMNDED COLOR FOR PAINT SYSTEM	RAL COLOR CODE	
			BASE COLOR	BAND COLOR
HYDROCARBON LINES (UNINSULATED)				
1	CRUDE SOUR	Dark Admiralty grey with 1 orange band	7012	2011
2	CRUDE SWEET	Dark Admiralty grey with 1 red band	7012	3001
3	LUBE OILS	Dark Admiralty grey with 1 green band	7012	6010
4	FLARE LINES	Heat Resistant Aluminium	9006	
	LPG	Orange with 1 oxide red band	2011	3009
6	PROPYLENE	Orange with 2 blue bands	2011	5013
7	NAPTHA	Orange with 1 green band	2011	6010
8	M.S.	Orange with 1 dark admiralty grey band	2011	7012
9	AV.GASOLINE (96 RON)	Orange with 1 band each of green, white and red bands	2011 / 6010	9010 / 3001
	GASOLINE (regular, leaded)	Orange with 1 black band	2011	9005
11	GASOLINE (premium, leaded)	Orange with 1 blue band	2011	5013

12	GASOLINE (white)	Orange with 1 white band	2011	9010
13	GASOLINE (Aviation 100/130)	Orange with 1 red band	2011	3001
14	GASOLINE (Aviation 115/145)	Orange with 1 purple band	2011	4006
	N-PENTANE	Orange with 2 blue bands	2011	5013
16	DIESEL OIL (White)	Oxide red with 1 white band	3009	9010
17	DIESEL OIL (Black)	Oxide red with 1 yellow band	3009	1023
18	KEROSENE	Oxide red with 1 green band	3009	6010
19	HY.KEROSENE	Oxide red with 2 green bands	3009	6010
	DISUFIDE OIL (EX-MEROX)	Oxide red with 1 black band	3009	9005
21	M.T.O	Oxide red with 3 green bands	3009	6010
22	DHPPA	Oxide red with 2 white bands	3009	9010
23	FLUSHING OIL	Oxide red with 2 black bands	3009	9005
24	LAB FS	Oxide red with 2 dark admiralty grey bands	3009	7012
	LAB RS	Oxide red with 3 dark admiralty grey bands	3009	7012
26	LAB (Off. Spec)	Oxide red with 1 light grey band	3009	7035
27	N-PARAFFIN	Oxide red with 1-blue band	3009	5013
28	HEAVY ALKYLATE	Oxide red with red band	3009	3001

29	BLOW DOWN, VAPOR LINE	Off white / Aluminum with 1-Brown band	9006	8004
30	BLOWDOWN	Off white / Aluminum with 2 brown bands	9006	8004
31	A.T.F.	Leaf brown with 1 white band	8003	9010
32	TOULENE	Leaf brown with 1 yellow band	8003	1023
33	BENZENE	Leaf brown with 1 green band	8003	6010
34	LAB PRODUCT	Leaf brown with 1 blue band	8003	5013
35	FUEL OIL	Black with 1 yellow band	9005	1023
36	FULE OIL (Aromatic rich)	Black with 2 yellow bands	9005	1023
37	ASPHALT	Black with 1 white band	9005	9010

38	SLOP AND WASTE OILS	Black with 1 orange band	9005	2011
39	SLOP AROMATICS	Black with 2 orange bands	9005	2011
CHEMICAL LINES				
40	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	1012	5000
41	CAUSTIC SODA	Canary yellow with 1 black band	1012	9005
42	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
43	AMMONIA	Canary yellow with 1 blue band	1012	5013
44	CORROSION INHIBITOR	Canary yellow with 1 Aluminum band	1012	9006
45	HEXAMETA PHOSPHATE	Canary yellow with 2 black bands	1012	9005

46	ACID LINES	Golden Yellow with 1 red band	1004	3001
47	RICH AMINE	Canary yellow with 2 blue bands	1012	5013
48	LEAN AMINE	Canary yellow with 3 blue bands	1012	5013
49	SOLVENT	Canary yellow with 1 green band	1012	6010
50	LCS	Canary yellow with 1 smoke grey	1012	7031
WATER LINES				
51	RAW WATER	Sky blue with 1 black band	5015	9005
52	INDUSTRIAL WATER	Sky blue with 2 signal red band	5015	3001
53	TREATED WATER	Sky blue with 1 oxide red band	5015	3009
54	DRINKING WATER	Sky blue with 1 green band	5015	6010
55	COOLING WATER	Sky blue with 1 light brown band	5015	1011
56	SERVICE WATER	Sky blue with 1 signal red brown	5015	3001
57	TEMPERED WATER	Sky blue with 2 green bands	5015	6010
58	DM WATER	Sky blue with 1 aluminum band	5015	9006
59	DM WATER ABOVE 150°F	Sky blue with 2 black bands	5015	9005
60	SOUR WATER	Sky blue with 2 pearl white bands	5015	1013
61	STRIPPED WATER	Sky blue with 2 blue bands	5015	5013
62	ETP TREATED WATER	Sky blue with 2 oxide red bands	5015	3009
FIRE PROTECTION SYSTEM (ABOVE GROUND)				
63	FIRE WATER FOAM & EXTINGUISHERS	Post office red	3002	
AIR & OTHER GAS LINES (UNINSULATED)				
64	SERVICE AIR	Yellow green with 1 signal red band	6018	3001
65	INSTRUMENT AIR	Yellow green with 1 black band	6018	9005
66	NITROGEN	Yellow green with 1 orange band	6018	2011
67	FREON	Yellow green with 1 yellow band	6018	1023
68	CHLORINE	Canary yellow with 1 oxide band	1012	3009
69	SO_2	Canary yellow with 2 white bands	1012	9010
70	H_2S	Orange with 2 red oxide bands	2011	3009
71	GAS (Fuel)	Orange with 1 aluminum band	2011	9006
72	GAS (Sour)	Orange with 2 aluminum bands	2011	9006
73	GAS (Sweet)	Orange with 2 signal red band	2011	3001
74	HYDROGEN	Orange with 1 light green band	2011	6021
STEAM AND CONDENSATE LINES (UNINSULATED)				

75	HP STEAM	Off white / Aluminum with 1 yellow band	9006	1023
76	MP STEAM	Off white / Aluminum with 1 red band	9006	3001
77	MLP STEAM	Off white / Aluminum with 1 orange band	9006	2011
78	LP STEAM	Off white / Aluminum with 1 light green band	9006	6021
79	CONDENSATE	Sky blue with 1 white band	5015	9010
80	CONDENSATE ABOVE 150°F	Sky blue with 3 oxide red band	5015	3009
81	BFW	Sky blue with 2 red bands	5015	3001
Note: For all insulated steam lines, the colour coding shall be follow as given for un-insulated lines with the specified length of color bands.				
INSULATED HYDROCARBON PIPING				
82	IFO SUPPLY	1Black ground colour with 1 yellow band in centre	9005	1023
83	IFO RETURN	Black ground colour with 1 green band in centre	9005	6010
84	HPS	Black ground colour with 1 red band in centre	9005	3001
85	BITUMEN	Black ground colour with 2 red bands in centre	9005	3001
86	CLO	Black ground colour with 1 brown band in centre	9005	8004
87	VB TAR	Black ground colour with 2 brown bands in centre	9005	8004
88	VR AM (BITUMEN / VBU FEED)	1 Black ground colour with 1 blue band in centre	9005	5013
89	VR BH	1 Black ground colour with 2 blue bands in centre	9005	5013
90	VAC. SLOP	1 Black ground colour with 1 white band in centre	9005	9010
91	SLOP	1 Black ground colour with 1 orange band in centre	9005	2011
92	CRUDE SWEET	1 Dark admiralty grey ground colour with 1 red band in centre	7012	3001
93	CRUDE OUR	1 Dark admiralty grey ground colour with 1 orange band in centre	7012	2011
94	VGO / HCU	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
95	OHCU BOTOM / FCCU FEED	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011

UNINSULATED EQUIPMENTS, TANKS AND STRUCTURES

96	HEATER STRUCTURE	Steel grey	7011
97	HEATER CASING	Heat resistant aluminium	9006
98	VESSELS & COLUMNS	Aluminium	9006
99	HYDROGEN BULLETS	Pink	3014
100	LPG VESSELS	Oxide red	3009
101	SO_2 VESSEL	Canary yellow	1012
102	HEAT EXCHANGER	Heat resistant aluminium	9006
103	FO TANK AND HOT TANKS	Black	9005
104	ALL OTHER TANKS	Aluminum / Off white	9006
105	CAUSTIC / AMINE / ACID TANKS	Golden yellow	1004
106	SOUR WATER	Sky Blue	5015
107	OUTER SURFACE IN BOILER HOUSE	Heat resistant aluminum	9006
108	COMPRESSORS AND BLOWERS	Dark admiralty grey	7012
109	PUMPS	Navy blue	5014
110	Electrical Equipment – Indore	Pebbel grey	7032
111	Electrical Equipment - Outdoor	Blue grey	7031
112	HAND RAILING	Fluorescent yellow	1026
113	STAIRCASE, LADDER AND WALKWAYS	Black	9005
114	LOAD LIFTING EQUIPMENT AND MONORAILS ETC	Leaf brown	8003

115	GENERAL STRUCTURE	Dark grey	7031
116	LOCAL PANEL FACE	Opaline green	6026
117	PANEL REAR SURFACE, FRAME WORK & MOUNTING PLATES	Pale cream	9001
118	MONORAIL	Signal red	3001
PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE			
119	IBR	Signal red	3001
120	9Cr-1Mo	Verdigris green	6021
121	5Cr-0.5Mo	Satin blue	5012
1 22	$2_{1/4}$Cr-1 Mo	Aircraft yellow	1026
123	$1_{1/4}$Cr-½ Mo	Traffic Yellow	1023
124	SS-304	Dark blue grey	5008
125	SS-316	Dark violet	4005
126	SS-321	Navy blue	5014
SAFETY COLOUR SCHEMES			
127	DANGEROUS OBSTRUCTION	Black and alert orange band	9005 / 2008
128	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	2008

RAL COLOR CODING FOR PETROCHEMICAL COMPLEX

Sr. No.	SERVICE	RECOMMENDED COLOR FOR PAINT SYSTEM	RAL COLOR CODE	
			BASE COLOR	BAND COLOR
REFINERY PRODUCTS				
1	NATURAL GAS	Orange with 3 Oxide red bands	2011	3009
2	PROPANE	Orange with 3 Blue band	2011	5013
3	METHANE	Orange with 1 Brown band	2011	8004
4	CYCLOHEXANE	Orange with 1 Pearl night blue band	2011	5026
5	n-HEXANE	Orange with 1 Pearl green bend	2011	6035
6	ETHANE	Orange with 4 Blue bands	2011	5013
7	BLENDED FUEL OIL	Black with 3 Yellow bands	9005	1023
8	ETHYLENE OXIDE	Orange with 3 Green bands	2011	6010
9	POLYMER PELLETS & SLURRY	Brown beige with 1 white bands	1011	9010
10	HDPE PELLETS	Brown beige with 2 white bands	1011	9010
11	WAX	Oxide Red with 1 Pastel Green Band	3009	6019
12	GLYCOL	Canary yellow with 1 Pearl gentian blue	1012	5025
13	BUTADIENE < 15%	Orange with 1 band Pastel Green band	2011	6019
14	BUTADIENE 5 -95%	Orange with 2 Pastel Green bands	2011	6019
15	BUTADIENE > 95%	Orange with 3 Pastel Green bands	2011	6019
16	ALDEHYDE SOLUTION	Sky blue with 1 orange band	5015	2011
17	OCTENE-1	Orange with 1 Blue, 1 Black and 1 Blue band	2011 5013	9005 5013
18	ETHYLENE	Orange with 2 Blue bands + 1 Black band	2011	5013 9005
19	PROPYLENE	Orange with 2 Oxford blue bands	2011	5013
20	BUTENE -1	Orange with 2 Red band	2011	3001
21	HEXANE	Orange with 2 White bands	2011	9010
22	MEG	Canary yellow with 1 Blue lilac band	1012	4005
23	DEG	Canary yellow with 2 Blue lilac band	1012	4005
24	TEG	Canary yellow with 3 Blue lilac band	1012	4005
25	POLYGLYCOL	Canary yellow with 3 Green band	1012	6010
26	GLYCOL / WATER SOLUTION	Canary yellow with 1 Sky blue band	1023	5015

27	DTA	Canary yellow with 2 Green band	1012	6010
28	OXYGEN	Yellow green with 1 Blue band	6018	5013
29	CYCLE GAS SYSTEM	Oxide red with 2 Purple band	3009	4006
CHEMICALS				
29	ISOPRENYL ALUMINUM	Canary yellow with 1 copper brown bands	1012	8004
30	MAGNESIUM ETHYLATE	Canary yellow with 2 copper brown bands	1012	8004
31	TITANIUM TETRA CHLORIDE	Canary yellow with 1 chocolate brown band	1012	8017
32	SULPHURIC ACID	Golden Yellow with 3 red bands	1004	3001
33	CALCIUM HYDROXIDE	Canary yellow with 3 black bands	1012	9005
34	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
35	FERRIC CHLORIDE	Canary Yellow with 3 red oxide bands	1012	3009
36	SODIUM BI SULFIDE	Canary yellow with 3 white bands	1012	9010

37	CHLORINE DIOXIDE	Canary yellow with 1 orange band	1012	2011
38	HYDRAZINE	Canary yellow with 3 blue bands	1012	5013
39	CARBON DIOXIDE	Orange with 4 Aluminum bands	2011	9006
40	CARBON MONOXIDE	Orange with 3 Aluminum bands	2011	9006
41	TEAL	Dark admiralty grey with 2 white bands	7012	9010
42	LIQUID PEROXIDE	Canary yellow with 1 red and 1 blue band	1023 3001	5013
43	CATALYST LINE	Canary yellow with 2 Red band	1023	3001
44	CO-CATALYST LINE	Canary yellow with 3 Red band	1023	3001
45	EO / WATER SOLUTION	Sky blue with 3 Green bands	5015	6010

46	BCWS / BCSWR	Sky blue with 1 Brown Biege band	5015	1011
WATER				
47	CYCLE WATER- LEAN	Sky blue with 2 blue lilac bands	5015	4005
48	CYCLE WATER- RICH	Sky blue with 3 blue lilac bands	5015	4005
49	JACKET WATER	Sky blue with 3 black bands	5015	9005
50	JACKET WATER-BIOCIDE	Sky blue with 2 aluminum bands	5015	9006
51	JACKET WATER-CORROSION INHIBITOR	Sky blue with 3 aluminum bands	5015	9006
52	CHLORINATED WATER	Sky blue with 1 green band	5015	6010
53	BACK FLUSH WATER	Sky blue with 3 signal red bands	5015	3001
54	CUTTING WATER	Sky blue with 1 orange band	5015	2011
55	REFRIGERATED WATER	Sky blue with 2 violet blue bands	5015	5000

56	WASTE WATER	Sky blue with 2 Signal red bands	5015	3001
INTERMEDIATES				
57	MOTHER LIQUOR SOLUTION	Orange with 3 pebble grey bands	2011	7032
58	ADDITIVES SOLUTION	Pearl green with 2 white band	6035	9010
59	DEACTIVATORS	Pearl green with 2 orange band	6035	2011
60	OFF GAS	Pearl green with 2 yellow band	6035	1023
61	OFF GAS PLUS POLYMER	Pearl green with 2 Aluminum bands	6035	9006
62	RA SOLUTION	Pearl green with 2 oxide red bands	6035	3009
63	DONOR	Pearl green with 2 black bands	6035	9005
STEAM				
64	VHP	Offwhite / Aluminium with 2 yellow band	9006	1023
65	MHP STEAM (20 KG / CM_2 G)	Off white / Aluminium with 3 yellow bands	9006	1023
66	OTHER PROCESS LINES e.g. PROCESS STEAM, PROCESS CONDENSATE, PROCESS VENTS.	Light grey with 1Trafffic yellow band	7035	1023
67	DECOKING AIR	Yellow Green with 1 Terrabrown band	6018	8028
68	RPG	Orange with 1 Yellow Green band	2011	6018
69	C6-C8 CUT	Orange with 1 terrabrown band	2011	8028
70	C4 MIX	Orange with 1 peral black berry band	2011	4012
71	C9+ CUT / FLUX OIL	Orange with 2 grey Beige band	2011	1019
72	C4 PURGE / C4 MIX	Orange with 2 peral black berry	2011	4012
73	C9 CUT	Orange with 1 grey beige	2011	1019
74	C7-C8 CUT	Orange with 2 terra Brown band	2011	8028
75	C3	Orange with 1 Sky blue band	2011	5015
76	PP RECYCLE	Orange with 1 water blue	2011	5021
77	PLANT AIR	Yellow green with 1 peral light grey	6018	9022
78	AROMATIC	Black with 1 water blue	9005	5021
79	LIGHT DISTILLATION	Orange with 1 Solman pink band	2011	3022
80	C9+	Orange with 3 grey beige	2011	1019
81	OWS-OIL WATER SEWER	Sky blue with 1 band of salmon orange	5015	2012
82	CRWS-CONTAMINATED RAIN WATER SEWER	Sky blue with 2 bands of salmon orange	5015	2012
83	CRYOGENIC TANK (RCC)	Orange	2011	

19.0 IDENTIFICATION OF VESSELS, PIPING ETC.

19.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipe lines of more than one location as directed by Engineer-In-Charge, Size of letter printed shall be as below :

Column & Vessels	-	150mm (high)
Pump, compressor & other machinery	-	50mm (high)
Piping	-	40-150 mm

19.2 **Identification of storage tanks:**

The storage tanks shall be marked as detailed in the drawing.

20.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

20.1 Following items shall be painted for camouflaging if required by the client.

a. All Columns
b. All tanks in Offsites
c. Large Vessels
d. Spheres

20.2 Two coats of selected finishing paint as per defence requirement shall be applied in a particular pattern as per 20.3 and as per the instructions of Engineer-In-Charge.

20.3 **Method of Camouflaging**

20.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matt finish).

Dark Green	Light Green	Dark Medium Brown
5:	3:	2

20.3.2 The patches should be asymmetrical and irregular.

20.3.3 The patches should be inclined at 30º to 60º to the horizontal.

20.3.3 The patches should be continuous where two surfaces meet at an angle.

20.3.4 The patches should not coincide with corners.

20.3.5 Slits and holes shall be painted in dark shades.

20.3.6 Width of patches should be 1 to 2 meters.

21.0 INSPECTION AND TESTING

21.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be

accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.

21.2 Engineer-In-Charge at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch-wise test of wet paints for physical & chemical analysis as per clause 24.4 of relevant ASTM test method. All costs there shall be borne by the contractor.

The contractor shall produce test reports from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right to test wet samples of paint at random for quality of same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

21.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

(a) Surface preparation
(b) Primer application
(c) Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (D F T)) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra coat should have prior approval of Engineer-in-charge.

21.4 **Primer Application**

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge.

21.5 The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In-Charge before application of successive coats.

21.6 The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detector and protector whenever required for checking in case of immersion conditions.

21.7 Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on M.S.test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elkometer'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

21.8 At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

21.9 Final inspection shall include measurement of paint dry film thickness, Adhesion, Holiday detection check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by Engineer-In-Charge and shall be within + 10% of the dry film thickness, specified in the specifications.

21.10 The contractor shall arrange for spot checking of paint materials for Sp.gr., glow time (ford cup) and spreading rate.

22.0 GUARANTEE

22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

23.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR/SUB-CONTRACTOR

Painting contractor who is awarded any job for EIL, Projects under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor mush have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

24.0 PROCEDURE FOR APPROVAL OF NEW COATING MATERIALS AND MANUFACTURERS

Following procedure is recommended to be followed for approval of new manufacturers.

24.1 The manufacturer should arrange testing of the coating materials as per the list of tests given in para 24.4 below from one of the reputed Government laboratories.

24.2 Samples of coating materials should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer’s testing laboratory. The sampling shall be certified and sealed by a certifying agency.

24.3 All test panels should be prepared by Govt. testing agency coloured photographs of test panels should be taken before and after the test and should be enclosed alongwith test report.

Sample batch no. and manufacturer's test certificate should be enclosed alongwith the report. Test report must contain details of observation and rusting if any, as per the testing code. Suggested Government laboratories are:

IICT, Hyderabad
HBTI, Kanpur
DMSRDE, Kanpur
IIT, Mumbai
BIS Laboratories
UICT, Matunga, Mumbai
RITES, Kolkata
PDIL, Sindri
NTH, Kolkata

24.4 Manufacturers should intimate the company, details of sample submitted for testing, name of Govt. testing agency, date, contact personnel of the govt. testing agency. At the end of the test the manufacturer should submit the test reports to the company for approval. The manufacturer(s) shall be qualified based on the results of these tests and other assessment and the company's decision in this regard shall be final and binding on the manufacturer.

Test required for evaluation of acceptance of coating materials for onshore application.

Test	ASTM Test Method
Density	D 1475
Dipping properties	D 823
Film characteristics	
Drying time	D 1640
Flexibility	D 1737/D 522
Hardness	D 3363
Adhesion	D 2197
Abrasion resistance	D 968/ D 1044
DFT/coat	AS PER SSPC GUIDELINES
Storage Stability	D 1849
Resistance to	
Humidity for 2000 hrs.	D 2247
Salt spray 2000 hrs	B 117
Accelerated Weathering	D 822
% Zn in Dry film for Inorganic Zinc Silicate primer	G 53

24.5 Coating systems for panel test shall be decided after discussion with EIL.

24.6 Clause No. 24.0 is for approval prior to award of the contract. In case any agency proposes for any fresh approval after award of work, the same shall have no time implications upon the contract.

ANNEXURE-I

LIST OF RECOMMENDED MANUFACTURERS

Indian Vendors

1. Asian Paints (I) Ltd., Mumbai
2. Berger paints Ltd., Kolkata
3. Kansai Nerolac Paints Ltd., Mumbai (including Ameron, USA Products).
4. Chugoku Marine Paints Pvt. Ltd., Mumbai
5. Shalimar Paints Ltd., Kolkata
6. Sigma Kalon Marine and Protective Coatings(India) Pvt Ltd, Mumbai.
7. CDC Carboline Ltd., Chennai
8. Premier products Ltd., Mumbai
9. Coromandel Paints & Chemicals Ltd., Visakhapatnam
10. Anupam Enterprises, Kolkata
11. Grand Polycoats, Vadodata
12. Bombay Paints Ltd., Mumbai
13. Akzo Nobel Coatings and Sealants Pvt. Ltd., Bangalore
14. Cipy Polyurethanes Pvt. Ltd., Pune
15. Gunjan Paints Ltd., Ahmedabad
16. Advance Paints Ltd., Mumbai
17. VCM Polyurethane Paints (for polyurethane paints only)
18. Jotun Paints India Pvt Ltd, Chennai(Singapore)
19. Paladin Paints and Chemicals , Mumbai
20. Chembond Chemicals Pvt Ltd , Navi Mumbai
21. Aashish Coating Technologies Pvt. Ltd, Vadodara/Mumbai

Foreign Vendors

1. Sigma Kalon Protective Coatings, Singapore
2. Ameron, USA
3. Kansai Paints, Japan
4. Hempel Paints, USA
5. Valspar Corporation, USA
6. Akzo Nobel/International Coatings, UK
7. Jotun Paints, Singapore

The following are approved for specific materials only.

1.0 Mark-chem Incorporated, Mumbai (for phosphating chemicals only).

2.0 ChemTreat India Ltd.(for Phosphating Chemical and glass flake filled coatings of M/s Atlas Chemicals Corporation, USA).

3.0 Carolina equipment and supply Co., USA.

4.0 Zinga Metall(Rozenstraat 4-Industrial Zone)-9810 EKE-Belgium, Indian Agent-Newkem, Mumbai-14 (for cold spray zinc coating)

ANNEXURE-II
LIST OF RECOMMENDED MANUFACTURERS' PRODUCTS

Sl. No	Manufacturers Name	P2 Chlorinated Rubber Zinc Ph Primer	P4 Etch Primer/ Wash Primer	P6 Epoxy Zinc Ph. Primer	F9 Inorganic Zinc Silicate Primer/ Coating
1	ASIAN PAINTS (I) LTD.	ASIOCHLOR HB.ZN.PH.PRIMER RO PC 168	APCONYL WP636 (PC335)	APCODUR HB.ZP. PC433	APCOSIL 605
2	BERGER PAINTS LTD.	LINOSOL HIGH BUILD ZP PRIMER	BISON WASH PRIMER	EPILUX 610 HB PRIMER	ZINC ANODE 304 MZS
3	AMERON PRODUCTS	-	AMERCOAT 178	AMERCOAT 71/ 385P	DIMETCOTE-9FT
4	CHEMBOND CHEMICALS	KEMCHLOR 201	KEMGALVA GRIP A1	KEMOXY 301	KEMGUARD 501
5	SHALIMAR PAINTS LTD	CHLOROKOTE ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ETCH PRIMER	EPIGUARD ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ZILIKATE
6	SIGMA KALON INDIA PVT LTD,	SIGMA NUCOL UNICOAT 7321	SIGMA ETCH PRIMER (7185)	SIGMA COVER 256 (7412)	SIGMAZINC- 158
7	CDC CARBOLINE LTD.	-	-	CARBOLINE 893	CARBOZINC 11
8	PREMIER PRODUCTS LTD.	-	-	P-15/3A U-16/92	U17/92 ETHYL SILICATE INORGANIC ZINC
9	CORAMANDEL PAINTS & CHEMICALS LTD.	COROCLORE CR HB.ZN.PH PRIMER	CPC WASH PRIMER	COROPEX EPOXY ZN.PH. HIGH BILD PRIMER	CPC INORGANIC ZINC SILICATE PRIMER
10	ANUPAM ENTERPRISES	ANUCHLOR ZP PRIMER	ANUPRIME-291	ANUPAM ANLICOR A-EZP-500	ANUZINC 2001 TP
11	GRAND POLYCOATS	GP CHLOROPRIME 601	GP PRIME 401	-	GP PRIME 402
12	BOMBAY PAINTS LTD.	PENTA CHLOR HB PRIMER 8632	PENTOLITE WASH PRIMER 8520	PENTADUR PRIMER 8530	ZINC-O-SIL 75
13	HEMPEL MARINE PAINTS	HEMPA TEX HIGHBUILD 4633	-	HEMPEL'S SHOP PRIMER E1530	GALVASOL 1570
14	AASHISH COATING TECH-NOLOGIES				
15	AKZO NOBEL PAINTS	-	-	INTERGARD 251	INTERZINC 12/22
16	PALADIN PAINTS	VEGCHLOR HB PRIMER 1143	VEGWASH PRIMER 1181	VEGPOX 1241ZP	THERMOSIL1362 ZINC
17	VCM POLYURETHANE PAINTS				
18	JOTUN PAINTS		JOTA ETCH TWO PACK WASH PRIMER	EPOXY CQ SPECIAL ZINC PHOSPHATE PRIMER	RESIST-86
19	KCC PRODUCTS (KOREA)				EZ 180(N)
20.	CHUGOKU MARINE	-	-	CAMIDECK	GALBONS HB

	PAINTS PVT. LTD.			PRIMER	
21.	KANSAI NEROLAC PAINTS LTD.	NEROLAC HB CR ZINC PHOSPHATE PRIMER	NEROLAC ETCH PRIMER	NEROLAC EPOXY ZINC PHOSPHATE PRIMER	NEROSIL 118

LIST OF RECOMMENDED MANUFACTURERS PRODUCTS (Cont. …)

Sl. No	Manufacturers Name	F2 Acrylic-Polyurethane Finish Paint	F3 Chlorinated Rubber Finish Paint	F6A/B High Build Epoxy Finish Paint	F7 High Build Coal Tar Epoxy Coating
1	ASIAN PAINTS (I) LTD.	APCOTHANE CF676 (PC 1109)	ASIOCHLOR CF 621 (PC 319)	APCODUR HB COATING PC 1262	APCODUR CF 651/655(PC 131/471)
2	BERGER PAINTS LTD.	BERGER ACRYLIC PU FINISH	LINOSOL CHLORINATED RUBBER HB COATING	EPLIUX 04 AND 78 HB EPOXY COATING	EPILUX 555
3	AMERON	AMERCOAT 450GL	AMERCOAT 515	AMERCOAT 383 HS	AMERCOAT 78HB
4	CHEMBOND CHEMCIALS	KEMTHANE 411	KEMCHLOR 211	KEMOXY 324	KEMOXY 314
5	SHALIMAR PAINTS LTD	SHALITHANE FINISH	CHLORKOTE HB FINISH	EPIGARD TL FINISH POLYAMINE/ POLYAMIDE	BIPIGARD CTE ZL BLACK HB COAL TAR EPOXY COATING
6	SIGMA COATINGS.	SIGMADUR GLOSS (7528)	SIGMA NUCOL FINISH 7308	SIGMA GUARD 720	SIGMACOVER 300 (7472)
7	CDC CARBOLINE LTD.	CARBOLINE 132	-	CARBOLINE 191	CARBO-MASTIC-14
8	PREMIER PRODUCTS LTD.	U3/92 POLYURETHANE	CR-71, CR FINISH PAINT	42B/4A HIGH BUILD EPOXY	350/3A, COAL TAR EPOXY COATING
9	CORAMANDEL PAINTS & CHEMICALS LTD.	COROTHANE SUPER PU FINISH	COROCLORE CR FINISHING	COROPEX EPOXY HB COATING	COROPEX EPOXY COAL TAR COATING
10	ANUPAM ENTERPRISES	ANUTHANE ENAMEL	ANUCHLOR HB ENAMEL	DURACOAT-6000	COROGUARD
11	GRAND POLYCOATS	GP BOND 141	GP CHLOROGAURD 631	GP GUARD HP234	POLYGUARD CE
12	BOMBAY PAINTS LTD.	PENTATHANE FP 4510	PENTACHLOR FB 4635	PENTADUR HB 5540/5520	PENTADUR COALTAR EPOXY 8518/6518
13.	HEMPEL MARINE PAINTS	-	HEMPATEX HIBUILD 4633	HEMPADUR HIGH BUILD 5520	HEMPADUR 1510
14.	AASHISH COATING TECH	GA 1110 PU-UB		GA701 HB	
15	AKZO NOBEL COAITNGS	INTERTHANE 990	-	INTERGARD 966 / 410	INTERTUF 262 (TAR FREE TYPE)
16	PALADIN PAINTS	VEGTHANE (ALIPHATIC)	VEGCHLOR FP3140	VEGEPOX 3245/3562	VEGEPOX 4265
17	VCM POLYURETHANE PAINTS	PIPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT			
18	JOTUN PAINTS	HARDTOP XP		PENGUARD HB	JOTAGUARD 85
19	KCC PRODUCTS (KOREA)			KOEPOX TOPCOAT HB ET 5740	EH 173
20.	CHUKOGU MARINE PAINTS PVT LTD.	UNY MARINE	-	EPICON MARINE FINISH HB	BISCON HB 2001/ACHB
21.	KANSAI NEROLAC PAINTS	NEROTHANE ENAMEL	NEROLAC HB CHLORINATED RUBBER ENAMEL	NEROPOXY HB 262/6061	NEROLAC EPOXY COAL TAR POLYAMINE/POLY AMIDE CURED.

LIST OF RECOMMENDED MANUFACTURERS PRODUCTS (cont. …)

Sl. No.	Manufacturers Name	F8 Epoxy Mastic Coating Surface Tolerant	F-11 Heat Resistant Synthetic Medium Aluminium Paint	F-12 Heat Resistant Silicone Aluminium Paint	F-15 Two Pack Ambient Temperature Curing Epoxy Phenolic Coating
1	ASIAN PAINTS (I) LTD.	APCODOR CF 640	ASIAN HR ALUMINIUM PAINT (PC 300)	HR SILICONE ALUMINIUM PAINT (PC 189)	
2	BERGER PAINTS LTD.	PROTECTO MASTIC	FERROTOL HR ALUMINIUM PAINT	LUMEROS HR SILICONE AL. PAINT(HR/143)	BERGER EPOXY PHENOLIC COATING
3	AMERON	AMERLOCK 400		AMERCOAT 878	
4	CHEMBOND CHEMICALS	KEMGUARD 555	KEMGUARD 250HR	-	-
5	SHALIMAR PAINTS LTD	EPIPLUS 556	HEAT RESISTING LUSTROL ALUMINIUM	LUSTOTHERM HS SILICONE ALUMINIUM	EPIGARD TL 543 HS FINISH
6	SIGMA COATINGS.	SIGMA COVER 630 (7428)	HIGH TEMPERATURE RESISTANT EPOXY SYSTEM UPTO 200^{O}C	SIGMATHERM 540/SUPER THERMOVIT 600	SIGMA PHENGUARD 930 SYSTEM
7	CDC CARBOLINE LTD.	CARBO MASTIC-15	CARBOLINE 1248	CARBOLINE 4674	
8	PREMIER PRODUCTS LTD.	BH EPOXY MASTIC 150B/150A			
9	CORAMANDEL PAINTS & CHEMICALS LTD.	-	SILVOTOL HR ALUMINIUM PAINT	CPC SILICONE HR ALUMINIUM PAINT	
10	ANUPAM ENTERPRISES	ANU-MASTIC-102	-	ANUPAM HEAT GUARD.	
11	GRAND POLYCOATS	GP PRIME GUARD 235	-	-	
12	BOMBAY PAINTS LTD.	PENTADUR MASTIC 5515	KANGAROO HHR ALUMINIUM 4950	PENTHOLITE HRR ALUMINIUM 4951	
13.	HEMPEL MARINE PAINTS	HEMPDUR 1708			
14	AASHISH COATING TECH	GA700SPE	-	-	-
15	AKZO NOBEL COATINGS	INTERSEAL 670HS	INTERTHERM 891	INTERTHERM 50	INTERTHERM 228
16	PALADIN PAINTS	VEGEPOX MASTIC 2285	VEG HR AL PAINT	VEG HHR AL PAINT 600 DEG C	
17	VCM POLYURETHANE PAINTS	-	-	-	-
18	JOTUN PAINTS	PRIMASTIC UNIVERSAL	JOTUN AL PAINT HR 250 DEG.C	SOLVELITT AL SILICONE PAINT	TANKGUARD STORAGE
19	KCC PRODUCTS (KOREA)	EH 4158H		QT 606	
20.	CHUKOGU J&N LTD.	UMEGUARD MT/SX			
21.	KANSAI NEROLAC	NEROMASTIC 400	NEROTHERM 250	NEROTHERM 538	

	PAINTS LTD.				

Note : This list is subject to revision based on fresh approval/ re-approval/ deletion.