JOB SPECIFICATION
OF
AIR COOLED DUMP CONDENSER

1.0 INTENT OF SPECIFICATION:

This Job specification covers the technical details of Air cooled dump condenser (ACDC) specific to the project.This Job specification and its Annexures shall be read in conjunction with Technical Purchase Specification PY-51379, and other annexures/ standards.

A typical P&ID of the system is also enclosed as annexure.

2.0 PROJECT DETAILS:

PROJECT	**CAPTIVE POWER PLANT PACKAGE FOR VRMP**
CUSTOMER	HPCL VIZAG
CONSULTANT	Engineers India Limited

3.0 METEOROLOGICAL DATA:

Sl. No.	Parameters	Unit	Min.	Normal	Max.	Design
1	Barometric Pressure	mmHg	735	750	760	760
2	Ambient Temperature	°C	12.5	36	45	45
3	Relative Humidity @ ambient temperature	%	60	80	95	95
4	Rainfall data for 1 hr period	mm		80	100	100
5	Rainfall data for 24 hrs period	mm			293	293
6	Wind Velocity **	Km/hr	1-5		185	185
7	Dry Bulb temperature	°C				42
8	Wet Bulb temperature	°C				29
9	Ambient temperature for MDMT	°C				12.5
10	Air temperature for air cooled exchangers	°C				42
11	Earthquake design factor (Code IS-1893 zone-III/ Site spectra whichever is governing)					As per site spectra
12	Elevation above mean sea level	M				5.56
13	Wind direction					Qtr-I – N & SW Qtr-II – SW Qtr-III- SW Qtr-IV – NE

4.0 SYSTEM DESCRIPTION

Air cooled dump condenser (ACDC) is envisaged to condense the excess LP steam in header during the CCPP plant upset operation conditions. Under these conditions after utilisation of LP steam by internal consumers of CCPP, the balance excess LP steam in the steam header will be routed to ACDC.

The LP steam header pressure is maintained by the Pressure control valve (upstream pressure control) in the steam line to ACDC. The pressure control valve will open and dump LP steam to ACDC whenever the LP steam header pressure reaches the set point of 6.0 kg/cm2(a). The pressure control valve after opening will maintain the header pressure at 4.75 kg/cm2(a) in upstream pressure control mode. The pressure downstream of the control valve will be based on the system resistance in the ACDC circuit based on the LP steam flow to ACDC. The parameters of the LP steam inlet to ACDC for the design case and other operating conditions are indicated in the Design Basis table mentioned below. For the design condition the pressure at the downstream of pressure control valve i.e ACDC inlet is indicated. Bidder to indicate the ACDC inlet pressure for the other conditions mentioned in the design basis in his offer.

The LP steam header, pressure control valve and steam piping upto inlet terminal point of ACDC are not in ACDC vendor scope.

The operation of the ACDC is highly intermittent. During normal operation of the plant, ACDC will not be in operation and hence the fans of the ACDC will not be in operation. Only when LP steam is diverted to dump condenser, fans of dump condenser will be operated. To facilitate auto start of ACDC, the fan motors and motor operated vent valves operation will be based on the opening of the pressure control valve i.e when the opening of the pressure control valve is more than 5% then the fans and vent valves of the ACDC will be operated.

ACDC shall be designed to take any amount of LP steam flow i.e. from 1.0 tph to maximum capacity of 25 tph.

To facilitate pressurization of ACDC during startup, the vent valves will be motor operated regulating type valves with inching facility.

The condensate from the ACDC will flow by gravity from the tube bundles to the condensate storage tank.

The parameters of LP steam to ACDC are mentioned under **d**esign **basis** in the **job specification attached with** this specification.

The P&ID of Air cooled dump condenser is enclosed as Annexure –VI for reference.

5.0 DESIGN BASIS

Air Cooled Dump Condenser shall be designed for the design condition indicated in the below table and it should operate satisfactorily for the other operating conditions also:

Parameters	**Design condition**	**Cond.1**	**Cond.2**	**Cond.3**	**Cond.4**	**Cond.5**	**Cond.6**
Steam pressure upstream of PCV in the inlet steam line to ACDC ($kg/cm^2(a)$)	5.5	4.5	4.5	4.5	4.5	4.5	4.5
Steam temperature upstream of PCV in the inlet steam line to ACDC ($kg/cm^2(a)$	175	150	150	150	150	150	150
ACDC operating steam pressure ($kg/cm^2(a)$)	3.5 (Refer note-1)	3.5	**	**	**	**	**
ACDC operating inlet steam temp. (^0C)	169	146.2	**	**	**	**	**
Outlet condensate temperature in (^oC)	133*	133*	**	**	**	**	**
Steam Flow (tph)	25	25	11.43	20	15	10	5
Mechanical design pressure in $kg/cm^2(a)$	4.2						
Mechanical design temperature in ^oC	190						

Note:

1. *During startup of the dump condenser, pressure at the inlet of Dump Condenser will not be 3.5 $kg/cm^2(a)$ as there is no backpressure. Hence, the backpressure of 3.5 $kg/cm^2(a)$ has to be created by ACDC during start up.*

2. **** Design of ACDC will involve a sub-cooling of 5°C for the design condition***.

3. ** Bidder to design the ACDC for the design condition indicated in the above table. Based on ACDC design, bidder to indicate the parameters for the other conditions indicated in the above table in his offer. In case of any observations on the above parameters, bidder may bring out during pre-bid stage for discussion and consideration accordingly.

4. The bidder shall demonstrate the design condition parameters as performance guarantee after successful erection and commissioning of ACDC.

6.0 Brief scope of Work:

Brief scope of work shall include design, engineering, manufacture, assembly, testing at manufacturer's works, delivery properly packed for transport, inland transportation up to site, unloading, storage at site, in-plant transportation, complete services of erection, testing (including performance test) and commissioning, complete with all accessories of the following:

- Air-cooled dump condenser (ACDC) package,
- One no. of Condensate storage tank (CST) - with 10 minutes of storage volume between normal level and low level which is 5 m^3 of volume.
- Interconnecting piping between ACDC, CST and upto terminal points.
- Motor operated vent valves of regulating type with inching facility.
- Necessary hook up on equipment / piping of ACDC for mounting of Instruments
- Vibration switches for fan.
- Local control panel with push button stations
- Commissioning and Erection spares (Bidder to furnish unit rates and quantities)
- Special tools and tackles
- Mandatory spares
- Complete lubrication requirements of the equipment for initial fill.

NOTES:

1. Items not specifically mentioned but deemed necessary to make the Air cooled dump condenser (ACDC) complete in all respects, as a self- contained package for reliable and efficient operation shall also be deemed to have included in scope of the bidder.
2. This Job specification and its Annexures shall be read in conjunction with Standard Technical specification, P&IDs, and other annexures/ standards.
3. It is not the intent to list all details herein; Scope of supply listed here is in brief.

   Please refer technical specification PY-51379 for detailed scope of Mechanical, Electrical and C&I of this package.

6.1 Supply of Condensate Storage tank (CST)

- All other technical requirements shall be as per specification PY51385. The same is attached as annexure.

6.2 Electricals:

a) For complete requirements of the motor refer EIL motor specification (Doc no. 6-51-0032) attached as annexure.

b) All Motors shall be provided with necessary canopies to protect from rain water or water accumulation for other sources.

c) Glands and lugs for power cables, control cables, signal cables and space heater cables (as applicable) shall be supplied by bidder along with the main equipment.

d) Glands shall be weather proof (as per equipment category) double compression type Nickel plated Brass (ET) shall be provided with back nut and PVC shroud.

e) Lugs shall be tinned copper heavy duty lug.

f) All power cables are in BHEL scope. Cable details shall be furnished during detailed engineering.

6.3 Instrumentation:

a) Vibration switches for fans included in the bidder scope. Vibration switches shall be flame proof.

b) Hook up material for mounting of instruments on equipment / piping of ACDC.

c) Any other instrumentation not specifically mentioned but required for safe operation of the complete system is included in vendor scope of work.

6.4 Mandatory Spares:

Following is the list of mandatory spares to be supplied along with the equipment. Supplier to quote separate price (item wise) as indicated in the price bid format of the specification

Sl. No.	Description	Quantity
	For Pressure Vessels (CST)	
1	Bolting for each nozzle with blind/ companion flange, for each pad nozzle	10% (Min. 4 sets)
2	Gaskets for each nozzle with blind/ companion flange, and for each pad nozzle	200%
3	Bolting for internal flanges	10 % (Min. 2 sets)
4	Gasket for each internal flange	200%
Spares for MV Induction motors (applicable only if the motor rating is 37 KW and above)		
5	Bearing set (DE & NDE)	1 set for each motor
6	Terminal studs / bushing assembly	1 set for each type

- When a particular item of spares is indicated as 'percentage', it shall be considered as percentage of total number of that item of spares in the single equipment/system, unless specified otherwise and the fraction shall be rounded-off to the next higher whole number.

- Whenever the item of spares has been indicated as `set' the same shall mean the supply for a single equipment/system. One set of spares for the particular equipment shall mean the total quantities of that particular spares for a single equipment e.g., `set' of bearings for a pump shall include the total number of bearings in a pump. The `set' shall however include all components required to replace that item of spares

6.5 Commissioning Spares, Tools and tackles:

- Certain quantity of commissioning spares are required during the erection and commissioning of the ACDC. These are mainly to accommodate any minor corrections/repairs (if needed) during erection and commissioning. All such commissioning spares are included in the scope of supply. Bidder to furnish the list of commissioning spares as pear annexure –iv of PY51379 atatched.

- Bidders to also include special tools & tackles (if any) required for carrying out minor maintenance (like annual maintenance etc.,) of the equipment.

- Commissioning spares and special tools shall form an integral part of the supply for the above package.

6.6 Recommended Spares (optional price only):

In addition to above, bidder to furnish the list of recommended spares for two (2) years operation separately and the same shall not form an integral part of the supply for the above package. If required to be ordered, requirement of 2 years operational spares shall be communicated explicitly.

7.0 TERMINAL POINTS

a) Inlet Steam Header -18": Flange joint of ACDC inlet with counter flange.

b) Outlet pipe from CST (6")

c) Recirculation line to CST (2") – near CST

A typical P&ID of the system is also enclosed as Annexure –A. Bidder to refer it for terminal points and quote accordingly. In case bidder is not able to offer in line with the P&ID, the same are to be discussed and settled during pre-bid stage only.

8.0 SCOPE MATRIX:

SUPPLY SCOPE FOR MAJOR ITEMS BETWEEN BHEL AND VENDOR				
Sl.No	**Items**	**vendor scope**	**BHEL scope**	**Remarks**
1.	Tube bundles	√		
2.	**Steel structures**			
2.1.	Complete Steel Structureincluding access stair and access ladder etc.	√		
2.2.	Fan Screens (if applicable)	√		
2.3.	Condensate tank Steel structure	√		
2.4.	Stair case	√		One on each side.
2.5.	Civil foundation (Concrete pedestals) below ground and upto maximum 300 mm above ground		√	
3.	**Fan Drive**			
3.1	Fan Stack/Bell	√		
3.2	Fan	√		
3.3	Gearbox/Belt drives (as applicable)	√		
3.4	Motor	√		
4.	**Piping and piping auxiliaries**			
4.1	From LP header to a single point near ACC battery limit.		√	
4.2	From ACC Condensate Collecting lines to Condensate tank	√		
4.3	All interconencting piping between ACDC & CST, Pressure Equalisation line between ACDC & CST, and miscellaneous piping (like drains, vents, etc) pertaining to ACC	√		
4.4	From Condensate Tank to Condensate Pumps		√	
5.	Condensate Tank	√		
6.	Painting of complete system (including pipes and structures)	√		Refer painting specification for details
7.	Complete material handling equipment for erection and commissioning of package	√		
8.	Motor operated vent valves	√		
9.	Stand pipe for mounting instruments of condensate storage tank.	√		
10.	**Spare Parts**			
10.1	Commissioning Spare Parts	√		
10.2	Mandatory spares	√		
11.	Foundation bolts assembly	√		

12.	Glands and lugs for power cables, control cables, signal cables and space heater cables (as applicable)	√		
13.	Electrical cables upto drives and signal cables upto instruments		√	
14.	Vibration switches	√		
15.	Oil level switch with indicator (if applicable)	√		
16.	ALL other instruments		√	
17.	Hook up for all instruments	√		Hook up is in vendor scope. If tube and tube fittings are used then the same shall be as per **swagelok/parker.**
18.	Local control panel with push buttons	√		

Note: The scope is not limited to above items and any items mentioned elsewhere in specification along with above mentioned items will be part of the supply for completeness of ACC package.

9.0 CHECK LIST

Bidder to note that Check List shall be completely filled and the data required in-line with Check List shall be submitted along with their Offer to enable Purchaser to evaluate the offer submitted.

S.No.	Description	Enclosed or [Yes/No]	Remarks/ Comments by Bidder
1	**Bidder to confirm compliance with** spec PY-AS-4-M104-8419-01 and its annexure without any deviations.		
2	Bidder has already raised pre-bid queries (if any) on Purchase specification.		
3	Bidder Shall submit completely filled following Annexures enclosed with Technical Purchase Specification PY-51379 along with their offer		
	Annexure-I: Key Information		
	Annexure-II: List of Recommended Spare Parts		
	Annexure-III: Special Tools and Tackles		
	Annexure-IV: List of commissioning spares		
	Annexure-V: Deviation from specification (Only those deviation indicated in this list will be considered during technical evaluation of offer. Bidder to indicate the deviations which are impractical.)		
4	All other requirements except the deviations brought out under deviation list, have been taken into consideration in the offer.		
5	Tentative Electrical Load List is enclosed with offer.		
6	Bidder has submitted unpriced “Price bid format” with “Quoted” mentioned against price for each line item of Price Bid Format		

10.0 PRICE BID FORMAT

SL NO.	DESCRIPTION	QTY.	UNIT PRICE (Rs)	TOTAL PRICE (Rs)
1	**Design, Engineering, Manufacture And Supply** of **Air cooled dump condenser package** with Complete Mechanical, Electrical and C&I equipment, erection and commissioning spares, Special tools and tackles as per BHEL specification PY-AS-4-M104-8419-01 and its enclosures.	1 lot		
2	**Design, Engineering, Manufacture And Supply** of **Condensate storage tank** including erection and commissioning spares, Special tools and tackles as per BHEL specification PY-AS-4-M104-8419-01 and its enclosures.	1 lot		
3	**Erection and commissioning** of Air cooled dump condenser, Condensate storage tank with complete Mechanical, Electrical and C&I equipment, including performance guarantee test as per BHEL specification PY-AS-4-M104-8419-01 and its enclosures	1 lot		
4	**Mandatory Spares** as per specification PY-AS-4-M104-8419-01	1 lot		
	Total (Sl. No. 1 + Sl. No. 2+ Sl. No. 3+ Sl. No 4)			
5.	**Optional Price**			
5.1	2 years recommended spares along with their quantities and unit rate for normal trouble free operation of Air cooled heat dump condenser based on bidders' experience. (List for recommended spares and it's unit rate to be furnished by bidder)	RO		

RO= Rate Only NA= Not Applicable

NOTES:-

A. Bidder to quote strictly as per BHEL's NIT requirements.

B. Bidder to note that this is a LUMP SUM Turn-Key Order. Any additional claim after placement of order will not be entertained under any circumstances.

C. **BHEL proposes to award the Contract on turnkey basis. i.e. evaluation shall be based on total price for Supply, Erection & commissioning and Mandatory spares)**
(i.e. Sl. No. 1 + Sl. No. 2+ Sl. No. 3+ Sl. No. 4) of price format).

D. Separate Purchase Orders will be issued for supply (including mandatory spares) and Erection and commissioning.

E. Bidder to quote the base rates only. All Applicable taxes and duties to be indicated shall be indicated separately for the Supply Portion, Erection & Commissioning Portion and Mandatory spares Portion as follows:

i. All Applicable Taxes and duties for Supply Portion
ii. All Applicable Taxes and duties for Erection & commissioning
iii. All Applicable Taxes and duties for Supply of Mandatory Spares

F. The above items shall be quoted as per tender specification PY-AS-4-M104-8419-01 & all its enclosures. Responsibility of ensuring correctness & completeness of scope of supply as per specification requirement solely lies with bidder.

G. Bidder to quote separately, in an identical format, 2 years operational spares with recommended quantity and unit rate. However ordering of the same shall be at the sole discretion of BHEL.

H. Bidder in their offer shall consider the price of E&C portion (Sl. No. 3) as minimum 20% of the Total Prices quoted by the bidder for Supply (Sl. No. 1+Sl. no.2) of price bid format.

BIDDER'S SIGNATURE

NAME:

DATE :

COMPANY SEAL

	RECORD OF REVISIONS				
Rev. No.	**Date**	**Revision Details**	**Prepared By**	**Revised By**	**Approved By**
00	07.07.18	First Issue	DSK	AKS	MSSN

TECHNICAL SPECIFICATION
OF
AIR COOLED DUMP CONDENSER

SECTION-I

1.0 INTENT OF SPECIFICATION

This specification is intended to cover the design, engineering, manufacture, fabrication, assembly, testing at manufacturer's works, delivery (properly packed for transport), inland transportation up to site, unloading, storage at site, in-plant transportation, complete services of erection, testing and commissioning, complete with all accessories as specified hereinafter and as required for safe and trouble free operation and maintenance of the Air cooled dump condenser.

This specification shall be read in conjunction with its enclosures. In case of any discrepancy arising between Job specification & its enclosures, wherein more than one level (i.e. both less stringent level and more stringent levels) of same requirement have been indicated for a particular item, the most stringent of all shall be followed and shall relevantly over-ride others. Otherwise, the requirements indicated in this Job specification shall be considered as additional requirements to the ones indicated in the enclosures. Further, if a requirement in this specification or its enclosures, calls for decision of owner/BHEL, it shall be bidder's sole responsibility to clearly bring out the same before submitting his technical tender offer, so as to enable owner/BHEL to furnish their decision. If such a requirement is not duly addressed by bidder during tender stage and same comes out during order execution stage, it shall be binding on the bidder to comply with the decision furnished by owner/BHEL then, without any cost, delivery, or any other commercial implications. Bidder shall get all his technical queries/doubts clarified before technical bid submission.

Any additional equipment, material, etc., which are not specifically mentioned here, but are required to make the supplied equipment complete in all respect, in accordance with the intent of this technical specification, contractual agreement, statutory requirements, relevant/applicable codes/standards, good engineering practices, and for safe and trouble-free operation, shall be deemed to be covered under the scope of this specification.

2.0 GENERAL REQUIREMENTS:

2.1 The design, manufacture, inspection, erection, commissioning, testing and performance of the air cooled dump condenser and its accessories shall comply with latest edition of all currently applicable statutes, standards, regulations and safety codes. Nothing in this specification shall be construed to relieve the vendor of this responsibility.

2.2 All materials supplied under this contract shall be new and unused. All indigenous equipment/materials offered should be with ISI mark. All imported equipment/materials should have an approval of ASME / API / BS / LPC / FM / UL / BASEEFA / NEC / IEC / NFPA / AWWA /other-applicable-authority, as the case may be.

2.3 All equipment/items supplied shall conform to the provisions of statutory & other regulations in force in India and the State/Province where the project is executed, such as the Indian Factories Act, Indian Electricity (Supply) Act, Indian Electricity Act, Indian Electricity Rules, International Electric Technical Commission (IEC) Publication, Environmental Rules, etc.

2.4 Supplies shall be rendered in conformity with proven design principles. The purpose of this contract must be fulfilled in its entirety and the maximum of reliability and economy guaranteed.

2.5 All the components shall be so designed that repairs and overhauling is minimum and can be carried out easily in the shortest possible time.

2.6 ACHE design shall take into account operation at part load. Vendor shall carryout all necessary checks during the design stage.

2.7 All materials shall be procured from the approved project vendor list.

3.0 SCOPE OF SUPPLY:

The packaged Air Cooled Dump Condenser (ACDC) consists of Heat Exchanger with high fin tubes, plug / bolted type end covers, axial flow fans for cooling, condensate storage tank. Interconnecting piping between ACDC, CST and upto terminal points, pressure equalization line between ACDC and CST, Motor operated vent valves of regulating type with inching facility, Vibration switches for fan, Junction boxes, necessary hook up on equipment / piping of ACDC for mounting of Instruments, Local control panel with push button stations, Commissioning and Erection spares (Bidder to furnish unit rates and quantities), Special tools and tackles and Mandatory spares, Structure and Foundation bolting etc.

The package shall be mounted on a steel structure including foundation, bolting, electrical cabling, control cables etc. The whole package shall be suitable for out-door installation as per the site environment conditions mentioned in the specification.

4.0 REFERENCES

The air cooled dump condenser and its accessories shall comply with stipulations laid down in the latest editions of the following codes and their relevant specifications mentioned in the specifications.

4.1 Air Cooled Heat Exchangers shall comply with latest API - 661(ISO 13706).
4.2 American Society of Mechanical Engineers-Boiler and pressure Vessel Code – Section VIII, Div-1. – 2015.
4.3 American Institute of Steel Construction - Design, Fabrication and Erection of Structural Steel for Buildings.
4.4 Specification for degree of protection of Electrical apparatus IEC Standard.
4.5 National Electric Manufacturers Association (NEMA) Standard on motor power loads.

5.0 THERMAL DESIGN

Thermal design proposed by the Bidder will have to be in order as per either HTRI or HTFS software. This includes adequacy of heat transfer area and tube and airside pressure drops. If any modifications are required to be carried out by the Bidder in order to make the thermal design acceptable as per either HTRI or HTFS software, the same will be done without any cost and delivery implications.

ACHE design shall take into account operation at part load.

6.0 SPECIFICATION OF COMPONENTS :

6.1 Tube Bundle

a) Tube bundles shall be manufactured from straight round finned tubes of **KL-Type** with plug type box header at each end. Provision shall be made in the header for draining and venting with 1½" flanged connections with root valves and piping inclusive.

b) Tube material is Carbon steel SA179 and Fin material is Aluminium-SB 209 alloy no.1060.

c) Each Tube bundle shall be pressure tested with water at 1.5 times the design pressure.

d) Air seals shall be provided throughout the tube Bundles to minimise air leakage & bypassing.

e) There shall be practically no air gaps in bolted joints (plenum to beam, in between parts of plenum etc.). However, these gaps shall be limited to 0.5 mm (maximum).

f) The bundle side frame shall have minimum 5 mm thickness for tube lengths less than 6 m and bundle width up to 2 m and shall have 8 mm thickness (minimum) for greater tube lengths or bundle widths. Only one joint is permitted in the frame. The weld, if any, shall be full penetration weld, shall be ground flush from inside and DP tested.

g) Even number of passes are preferred for simplicity in piping layout. Process noizles shall be at the fixed header end to minimise thermal expansion stresses. Pass partition plates shall be provided with one 6mm diameter drain hole.

h) The ACDC is to be mounted horizontally for airflow in the vertical direction. The header shall be designed, fabricated, tested and inspected in full accordance with ASME Sec VIII Div 1. Radiography for headers shall be 100%.

i) The mechanical bond between tube and fin shall be tested by carrying out suitable pull-out test. 1% of the total number of tubes per size, fin diameter, fin pitch shall be tested at two locations along the tube length. Tubes, which pass the test, may be used after stitching of fin portions across the cut.

6.2 Gaskets:

a) Metal Jacketed (3 mm thick) gaskets shall be 13mm (minimum) wide all around. CAF (2 mm thick) gaskets shall be 19 mm (minimum) wide all round. Width of the gasket at pass partition shall be equal to the pass partition plate thickness.

b) For cover type header, the gasket shall be CAF or metal-jacketed type with the metal compatible with cover and flange material. CAF may be used only for water, air, steam (up to 150 °C) with ASME 150 Class. CAF shall be 2mm thick only. Asbestos is not permitted.

c) For plug headers, only solid soft metal gaskets are to be used.

6.3 Nozzles and other connections:

All connections at the terminal points shall be flanged irrespective of flange rating. Counter flanges, gaskets, fasteners are in bidder's scope of supply.

Slip on flanges and threaded connections shall not to be used.

6.4 Fans:

a) Fan Type: **Forced Draft** having manual adjustable pitch.

b) Two or more fans aligned in the direction of tube length shall be provided for each bay. All fans in a bay shall be arranged for independent operation.

c) Fan shall be capable of providing extra 10% over design flow with corresponding increase in pressure.

d) The characteristic fan performance curve shall relate static pressure, airflow, blade pitch, fan input, brake horsepower and efficiency for designed case. The operating point and brake horse power for the designed ambient temperature and minimum ambient temperature shall be shown separately. These shall be supplied along with bid.

e) The vendor shall indicate pitch angle.

f) The design of the fan shall be non-sparking type.

g) Vendor to confirm with data that the HP of the motor is adequate for driving the fan with rated capacity under continuous operation services.

h) Fan tip speed shall not exceed 60 m/sec. Noise limitation may require lower speeds.

i) Fan datasheet shall be forwarded to motor supplier and frame size shall be able to take all torque/ loads/ thrust imposed by fan. Bidder shall submit necessary calculation after order.

j) Vendor shall furnish with bid the GD^2 value, Torque Vs Speed curve for fan, speed torque characteristic, Efficiency Vs Load, Current Vs Time characteristic for motor & calculation for the acceleration time to reach full speed when coupled with fan.

k) If applicable, SS tubing (1/4" dia minimum) and fittings shall be provided for lubrication of fan shaft bearings and motor bearings. Provision shall be made from motor access platforms, without shutdown of the equipment or removal of the machinery guards. These connections shall be accessible from maintenance platform. Vendor to develop detailed connection drawing to connect the lubrication piping to one point.

l) Fan including explosion proof accelerometer type vibration switch shall be protected against foreign objects by means of non-sparking bolt-on screens constructed from square galvanised wire mesh.

m) **Fan Guards**: Removable galvanised steel fan guard shall be provided on each fan. A hinged door shall be provided on the fan guard of fan diameter greater than 2m, to attend to problems without removing entire fan guard.

n) **Fan blades:**

Fan blades shall be of aluminium alloy/ FRP. In case of aluminium alloy blades, the same is to be resistant to stress corrosion cracking. Copper content in aluminium blade should not exceed 0.4%.

Fan hub and blade material shall be non-sparking type.

Fan shaft shall be to either SA 105 or EN 24 (hardened and tempered and UST). CS pipes may be used for shaft housing. Bearing housing shall be to SA 105.

6.5 HTD – Belts & Pulleys with tapered lock bush

a) Fans shall be driven by HTD – V belts, Pulleys & Electric motors. Belt design with four "V'"s per belt shall be considered. Belt tension adjustment feature shall be provided. The belts material shall be spark proof, anti-static, Oil resistant & shall have a service factor of 1.8. Pulleys shall be Taper lock bush type.

6.6 Main Structure

a) A bolted type steel structure shall be supplied to support Air Cooled Exchanger. The structure shall withstand wind speeds of 200 KMPH maximum, and seismic loads. Provisions for lifting of its components rated at 5G to be included. Structural sub-assemblies may be welded in shop and final assembly at site is by bolting to minimise erection time, except for cases where site welding is unavoidable. All foundation hardware materials including shims are to be supplied by vendor and shall be Hot Dip Galvanised.

b) STAAD analysis of structure shall be carried out by Vendor and submitted to BHEL for approval. STAAD analysis shall cover seismic and wind loadings.

c) Two ground cable connectors shall be placed on the opposite corners of the skid for connection with a grounding system.

d) Walking platforms required on all four sides of cooler (refer enclosed drawings). The platforms shall have anti-skid gratings & hand railings. Stairs on one side & ladders on the other side are to be provided. Walkways shall have toe-boards.

e) Lowest point of the Fan Motor assembly shall be at least **2.5** meters above the ground level.

f) Platform, ladder & Structure materials shall be hot-dip Galvanised.

g) Common inlet distribution manifold shall be included joining all inlet connections. End connection with counter flange, fasteners, (Reducers if required to match with subsequent pipelines) & gaskets shall be included.

h) Common outlet distribution manifold shall be included joining all outlet connections. End connection with counter flange, fasteners, (Reducers if required to match with subsequent pipelines) & gaskets shall be included.

i) Inlet an outlet distribution manifolds to be symmetrically installed

6.7 Electrical Devices:

a) Local control panel is in vendor scope. However, electrical cabling upto the drives is excluded from BIDDER'S scope of supply.

b) All electrical items shall have protection class IP-65 and Explosion proof. All field instruments & electrical items (transmitters, gauges, switches, I/Ps, SOVs, junction boxes, cable glands, detectors, probes etc.) shall be weather proof to IP 65.

c) The certification from statutory authorities like BASEEFA, FM, PTB, UL & CENELEC etc. for items of foreign origin and from CMRI / CCOE etc. for items of Indian origin are to be submitted wherever they are required.

d) Local push button stations for all motors shall be supplied by vendor, which are located on the local panel. They shall not be mounted on the module structural. Local Push Button stations shall have ON/OFF push buttons with key lock facility in off position.

e) A local panel is envisaged in vendor's scope. The local panel consists of Explosion proof push buttons, explosion proof junction boxes and status lamps

6.8 Instrumentations:

a) Vibration switches for fans:

Vibration switch shall be with the vibration range suitable for the offered fan. Set point shall be adjustable throughout the range i.e. 0 to 100%, and shall be adjustable externally without opening the switch housing. Switch shall have local as well as remote reset facility.

Unless specified otherwise, switch shall provide two independent contacts i.e. either by one DPDT or two SPDT type each rated for 240V AC, 5A and 11 OV DC, 0.5A.

Switch enclosure shall be weatherproof to IP65. Unless otherwise specified, the housing shall also be certified flameproof and explosion proof suitable for specified area classification (IEC Zone I, gas group-IIC). In addition to the certification from authorised agencies like CMRI, FM, UL etc., the switch shall have the valid approval from statutory authorities of place of installation, which is CCOE in case of Indian installations.

The switch assembly shall have two cable entries as a minimum, each of 1/2" NPT size. In case vendor standard model does not support two entries, the switch housing shall be supplied with integrally mounted 3-way junction box. The junction box shall be certified flameproof/ explosion proof meeting above requirements.

Vibration switch shall be located at motor suspension beams as close to the motor as possible. Switches shall be readily accessible for re-setting from maintenance platform without any interference.

b) Hook up material for mounting of instruments on equipment / piping of ACDC.

c) Any other instrumentation not specifically mentioned but required for safe operation of the complete system is included in vendor scope of work.

6.9 Spare parts, Special tools

a) Vendor shall supply the Erection and Commissioning spare items if require during erection and commissioning. Such spares shall be id entified, packed separately and noted in BOM (same are part of main equipment sup ply and so no separate price shall be quoted for these spares. List must be f urnished along with the offer).

b) Vendor shall furnish a list of O&M spares for two y ears trouble free operation (separate price shall be quoted for these spares.

c) Vendor shall supply a complete set of special tools that may be required for installation, normal maintenance and complete overh aul of the equipment's. Such items shall also be supplied as part of main scope of supply. Vendor shall indicate as "NIL – requirement" – if not applicable

7.0 PACKING & DISPATCH:

a) All loose items of structures shall be put in sealed and totally covered crates before dispatch. The vendor shall furnish list of crates and identification numbers of parts kept inside each crate. The crates shall be sequentially numbered in line with site erection sequence for easy retrieval and assembly.

b) All bundles shall be protected for damage before dispatch.

c) For complete requirements of packing refer specification "AA0490010" enclosed.

8.0 INSPECTION & TESTING:

a) At least one bay assembly of Air cooled Dump Condenser shall be tested carried out in manufacturer's works and following tests shall be conducted at works only. All items shall be match marked before dis-assembly and before dispatch to site. These tests shall be conducted for each equipment. Final assembly & testing will be witnessed by BHEL / Project Consultant / End user.

b) Stage wise inspection shall be carried out by BHEL / Project Consultant / End user

c) Vendor has to submit his Quality plan along with offer and take approval from End user/ Project Consultant / BHEL.

d) Acoustic Testing:
The sound level of the unit shall not exceed 85 dBA as measured 1 meter from the periphery of the equipment & at 1.5 meter above ground level.

e) Air flow test:
Bidder shall only measure the face velocity of air coming out of Tube Bundle to verify actual air flow across the tube bundle and static pressure drop across Tube Bundle with all the fans running.

f) Hydrostatic test:
Heat Exchangers & Header Piping shall be pressure tested as per code.

g) Vibration test:
Care shall be taken to have adequate stiffening belts connecting columns & beams of structures so as to ensure vibration limits are well within limits. Motors shall be assembled at Works for this test. Vendor to ensure availability of both these items at Works well in time to avoid shifting of testing dates or shifting of testing to site. Vibration will be measured at Drive Structure Beam.

h) Instrumentation Test:
Instrument tests shall be performed. Vibration Switches, pressure switches and other devices must be set in accordance with required setting. Calibration of gauges shall be verified. Functional operation of all switches shall be verified at the required settings. All control functions shall also be verified.

i) Test Procedure and Report:
For all the above tests a written test procedure including test data sheet outline, all test data to be taken and method of recording shall be submitted to BHEL for approval. A detailed test report shall include description of actual test and inspection performed, listing of all recorded data and recommendations and conclusions indicating compliance with design and test requirements and submitted to BHEL. The vendor shall provide a final report that evaluates the unit for compliance with the requirements of the specification and ordering sheet.

j) Quality Plan:

Quality Plan shall be submitted to BHEL for approval after award of contract. Quality plan will be reviewed during detailed Engineering stage with respect to Inspection and standard Engineering practices and various tests and stages of inspection. Inspection & Testing shall be by BHEL and/or BHEL's authorised inspection customer. Bidder shall concur accordingly in their bid.

9.0 ERECTION AND COMMISSIONING SERVICES:

The bidder scope includes the following:

a) Complete erection, testing and commissioning at site for the Mechanical, electrical, instrumentation equipment covered under scope of supply.

b) Surface preparation (Mechanical items & Electrical devices) & their painting.

c) The bidder shall arrange/take care of the following to complete the job:
   a. All labour
   b. All tools and related equipment
   c. All hoisting/material handling equipment
   d. All necessary scaffoldings
   e. All necessary transporting equipment
   f. Testing and commissioning responsibility

d) On completion of the work, the bidder shall remove and dispose off, all rubbish and other unsightly materials caused by his working and thereby leaving the premises and the package shall be in good, clean, safe and operable condition.

e) Owner or his authorized representative will have the right to inspect at any stage of manufacture and construction, all materials, components and workmanship and testing of material. The bidder shall provide all facilities for inspection and testing without any extra cost to the owner.

f) It shall be clearly understood that the bidder shall be responsible to complete and commission the entire work in all respects including the work not specifically mentioned in the scope of work or specifications or in drawings, but are necessary to achieve completions.

10.0 OTHER MISCELLANEOUS REQUIREMENTS:

The following miscellaneous services are also in the bidder scope of work.

a) Training of Owner's personnel in operation and maintenance of the complete system
b) Submission of all construction drawings for consultants review / approval.
c) Submission all interface data required for design and engineering of systems which are included in the scope of supply defined above
d) Preparation and submission of drawings / documents for approval / information to Purchaser / Consultant as per the drawings / documents submission schedule.
e) Quality plan, inspection and testing of equipment at works, submission of test certificates.
f) Submission of monthly progress report.

11.0 PERFORMANCE, GUARANTEE AND TESTS

a) The complete Air cooled dump condenser performance test shall be carried out by the bidder to demonstrate the design parameters specified under Design basis.
b) Bidder shall arrange all instruments, duly calibrated, required for performance testing without any extra cost.
c) The bidder shall assume full responsibility for proper design & operation of each & every component of the Air cooled dump condenser as well as the Air cooled dump condenser as a whole.
d) The bidder shall submit performance test procedure for approval in the event of order & conduct the test as per the approved procedure.
e) If the performance test shows a deficiency, the bidder shall rectify the defects without any additional cost and demonstrate the design parameters.
f) The power consumption for running the fan should not exceed the rated BHP.
g) Failing to meet the guaranteed parameters shall make ACDC liable for rejection.

12.0 SPECIAL CLEANING, PROTECTION & PAINTING

The Air Cooled Dump Condenser shall be of steel framed structure with surface protection by painting to protect against all ambient conditions.

Refer Project Specification for surface preparation and painting for complete requirements.

13.0 NAME PLATES & TAG PLATES:

a) Components whose identity is important for operation and maintenance of the plant shall be provided with permanently attached tag bearing the Purchaser's coding together with relevant text clearly inscribed.
b) A corrosion-resistant nameplate shall be attached to each unit in a clearly visible, easily accessible location. The nameplate shall be stamped with the following information:

- Manufacturer's name
- Manufacturer's model number
- Manufacturer's serial number
- Purchaser's equipment tag number (item No.)
- Service name
- Weight (kg)
- Hydrostatic test pressure, Bar. (g)
- Other design information of the flow media like flow rate, temperature, pressure etc.

Nameplates shall be 3 mm (0.12") thick engraved plate of sufficient rigidity with lettering of a minimum height of 4 mm (0.16"). The method of implementation and labelling will be informed for all components after award of contract

14.0 ORDER OF PRECEDENCE

This specification shall be read in conjunction with all other specifications and documents enclosed to it. Any conflict between referenced documents shall be identified and indicated. When resolving conflicts the following order of precedence shall govern.

(1) Job specifications of ACDC,
(2) Standard specifications –PY51379
(3) P&ID's referred
(4) Annexures
(5) Standards and codes as applicable

15.0 DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER

Bidder should read and comply with complete specification and all annexures and furnish the following:

- Duly signed and filled Engineering Check list
- Duly signed and filled in annexures I to V
- Unpriced price bid format.

16.0 VENDOR DOCUMENTATION PROCEDURE

Vendor shall confirm compliance in their offer for submission of documents as follows

Sl. No.	Document Name / Type	Document contents	Required With Offer	Required After P.O	
			Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
1	(a) Drgs, , Data Sheets , Catalogues. BOM etc. (b) PIDs , SLDs, Block-Schematics etc. (wherever applicable)	Adequate Information & essential for proper Technical Evaluation of the Offers. Other Information to be furnished as defined in the applicable Tech Specs.	2 (Addl. Copies Required -wherever Offer Docs. are subject to Review by Customer . See Spec. Requirement)	–	–
2	Terminal Point (s)	List of Scope Terminal Point (s) & Process Data etc. - wherever applicable.	2 (See also Sl-1 above)	–	–
3	Deviations if any	To be clearly listed, furnishing reasons for non-compliance	2 (See also Sl-1 above)	–	–
4	Master Document List (**MDL**)- (***Furnished during detail Engg.)***	**a)** List of all Documents & Drgs., Spares Items etc. which are applicable for the Project . They shall be group wise enlisted in MDL Doc.	-	3	16

Sl. No.	Document Name / Type	Document contents	Required With Offer	Required After P.O	
			Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
		b) Submission of Up-dated MDL Doc.is required at the time of each submission of Drgs./Doc or group of Drgs. / Docs..			
5	Project completion activity "Bar-chart" matching with BHEL Project Schedule	Required for packages & for contracts and also for projects where Erection & Commissioning activities are in vendor scope.	Compliance required to meet BHEL Delivery Sch.	3	16
6	(a) Drgs, , Data Sheets , Catalogues. BOM etc. (b) PIDs , SLDs, Block-Schematics etc. (wherever applicable)	While carrying out Detailed Engg. during Post-Ordering Stage.	-	10	16
7	Information Reg. "INITIAL - FILL" Items & Consumable Items – List - As Required (for each applicable systems) Various utilities required	**a**) Confirmation from Vendor Required. The Items shall be considered as Part of main scope of supply. **b**) A Separate Doc. to be furnished with Detail List & Quantity. (Applicable Items & Qty subject to Review during detail Engg.)	**a**) Supply Confirmation Required from Vendor **b**) Doc. to be Enlisted in MDL.	10	16
8	SPARES for Erection / Commissioning	**a**) Informative List required with Technical & Commercial bids. **a.1**) To consider as Part of main scope of Supply. **b**)Such Spares List is subject to Review during Detail Engg.	Vendor to Confirm Supply in their Offer.	6	16

Sl. No.	Document Name / Type	Document contents	Required With Offer	Required After P.O	
			Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
	"Operation and Maintenance Spares" / "Mandatory Spares" List	**a**)Recommended List by Vendor **b**) List with Other Data – if Specified in Tech. Spec.	**1**) To Enclose with Offer. **2**)To indicate price for the listed items in commercial offer & with extended validity	6	16
10	Vendor's "Bill of Material" Doc. (**BOM) – *Furnished during detail engg.)*** This Doc. shall be Enlisted in MDL Doc.	1) The Engg. Part of Information in this Doc. shall be approved by BHEL 2) Submission of this Document is essential during initial Submission stage of Engg. Docs. & the same be progressively Updated as the Detail Engg. progresses. 3) All Dispatchable Units shall be identified in this Doc with "Dispatch Tag-No." (5 Chr. BHEL Des. No. with 3 Chr. Running Item Sl No. - e.g. "Jxxxx / 001" , max. upto 999) . 4)The Despatch Tag no. shall be written on an 'Al- Strip' and tied to the dispatchable Unit or be prominently painted on each Item with washable paint. **PL. NOTE** – This Standard Unified System shall be followed being an essential part of Field Qualitry Assuannce Practices & for proper Identification of Items at Site.	-	6	16

Sl. No.	Document Name / Type	Document contents	Required With Offer	Required After P.O	
			Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
11	Quality Assurance Plan (QAP) & Factory Testing Procedure Documents	1) Approval from BHEL required. 2) Submission along with the Engg. Docs.	**A**) Submission -if already standardized with BHEL / Draft proposal & it may be finalized after Review. **B**) Submission compliance from Vendor required	6	4
12	FQAP (Field Quality Assurance Plan) & Site Erection, Testing & Commissioning Procedure documents	1) Approval from BHELsite required 2) Submission along with the Engg. Docs.	same as for Sl-11 above	6	4
13	<u>Erection Documents & Drawings:-</u>	1) To contain final MDL, BOM, Handling & Storage Instructions Doc., Initial-Fill & Consumables Items list, Erection & Commissioning Spares List , Operation & Maintenance spares list / Mandatory Spares List etc. 2) Submission minimum 6 – weeks before eqpt. schedule dispatch. 3) The drgs. shall be kept in plastic pouches and neatly arranged, submitted in an aesthetic, appropriate & durable folder(s). Documents filed appropriately in Folder in – seriatim of MDL.	-	-	16

Sl. No.	Document Name / Type	Document contents	Required With Offer	Required After P.O	
			Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
14	O&M Manual Document Folder(s)	1) Submission 1-month before schedule eqpt. dispatch (Draft copy shall be submitted beforehand for review by BHEL) 2) The manual shall be submitted in an aesthetic, appropriate & durable folder(s). Each vol. shall be marked with its Vol. No. 3)**<u>This Manual shall include</u> primarily following information: -** **i)** Operational & safety instructions. **ii)** Environmental Safety instructions & indicating compliances of the Regulations in-force. **iii**) Guidelines incorporating requirements for Operation of the Equipment in Hazardous Environment- wherever applicable. **iv)** Master document List (MDL) doc. **v)** Bill of material (BOM) doc. **vi)** Erection Instructions. vii) Sub-vendor O&M Manuals	-	Adv. Copy (2 sets)- for review by BHEL	Final Copies –(16 sets)

Sl. No.	Document Name / Type	Document contents	Required With Offer	Required After P.O	
			Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
		vii) Operational & Maintenance s / Items with adequate , etc., Catalogue information Model no. marked therein), viii) Lubrication Schedule **viii**) Initial-Fill Items List **ix**) Approved QAP's Shop Tests & Calibration Reports. **x**) Approved FQAP - along with related docs. , with site testing & commissioning Protocols etc.			
15	"As –Built" Drawings & Documents	Submission within three weeks - after commissioning at site	-	-	16
16	Compact Disc (CD)	1) MDL, All drawings, Documents, Data sheets – as Listed in Approved MDL Doc. , all applicable Catalogues (Scanned), BOM & all items covered in the O&M Manuals & the "As-built" Drgs. 2) To submit along with the submission of "As-built" drgs. & docs.	-	-	3

Notes:

16.1.1 Refer master document list attached as annexure for list of documents required to be furnished after the award of the order.

16.1.2 For first submission of documents: Vendor to submit the documents as per the schedule mentioned in the MDL. BHEL will furnish their approvals / comments within 15 days after first submission of drawings/ documents.

16.1.3 For revised submissions, vendor shall submit the revised drawings/documents incorporating all the comments within 7 working days of receipt of comments from BHEL. BHEL shall also revert with comments or approval (as applicable) within 7-10 working days from date of submission of the document. However, Bidder is responsible to submit the documents/ drawings correctly in line with tender specification.

16.1.4 The O&M manuals shall contain the following details as minimum in addition to those indicated in the above table:-

- Identification details of the equipment like BHEL PO NO., Vendor's Sl. No., Vendors contact address with tel., fax details.
- Description of the equipment.
- Final Data sheets and Drawings of the equipment as per the list mentioned in this specification.
- O&M Manuals of the equipment.
- Recommended 2 years operational spares.
- Test reports.

16.1.5 The erection documentation shall consist of

- All drawings/documents,
- O&M instructions of pump, motor, instruments, etc.
- All such drawings/documents, not submitted for review, but essential for erection/commissioning, e.g. cooling plan, flushing plan, assembly drawings, etc.
- Master document list
- Site dispatchable B.O.M.
- Any special safety/erection/commissioning requirements, vendor would like to specify.

16.1.6 Vendor Documents Review (By BHEL / BHEL's Customer)

Review / approval of vendor documents / permission to proceed with manufacturing does not constitute acceptance or approval of design detail, calculations, analysis, test methods are materials developed or selected by vendor and does not relieve the vendor from their responsibilities for compliance with the applicable codes, standards, specifications, good engineering practices and contractual obligations.

16.1.7 Vendors should obtain manufacturing clearance on all documents from BHEL for proceeding with manufacturing , only then their equipment can be offered by the vendor for inspection to BHEL / BHEL's customer**.**

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ANNEXURE – I

Bidder to fill and furnish the following informatio n in the indicated format:

KEY INFORMATION

1.	Name of the Bidding Company	:	
2.	Registered in (mention the name of the Country)	:	
3.	Name, designation, telex & telephone number and postal address of responsible officer of Bidder to whom all reference shall be made for expeditious coordination.	:	
4.	Name, designation, telex & telephone number and postal address of responsible officer of Indian Agent.	:	
5.	Bidder's proposal number	:	
6.	Bidder's proposal date	:	
7.	Validity of offer, counted from the date of opening of bid	:	
8.	Guaranteed completion period, counted from date of issuance of LOI/TOI	:	
9.	Confirm that Scope of supply and services are exactly as per specification requirement.	:	Yes/No
10.	Confirm technical compliance with specification	:	Yes/No
11.	Confirm that List of Recommended Spares has been furnished as per Annexure-II	:	Yes/No
12.	Confirm that Special Tools & Tackles are as per Annexure-III	:	Yes/No
13.	Confirm that deviations ,if applicable, have been furnished as per Annexure-IV	:	Yes/No

Signature of Bidder's
Authorized representative with date.....
Date .....

ANNEXURE – II

LIST OF RECOMMENDED SPARES (FOR 2 YEARS)

Bidder shall tabulate in the proforma below list of all spare parts as recommended by the respective manufacturer for regular, reliable operation for a period of 2years. In case the Bidder has to add any other relevant information, the same shall be indicated herein. Continuation sheets of like size and format may be used as per Bidder's requirements.

Sl. No	Description	Quantity	Unit	Total Price	Delivery Period	Remarks

ANNEXURE – III

SPECIAL TOOLS AND TACKLES

Bidder shall supply the following tools and tackles for operation, maintenance and replacement of equipment and component, supplied under the specification.

Sl.No.	Description	Quantity	Model No./Type	

ANNEXURE – IV

LIST OF COMMISSIONING SPARES

Bidder shall tabulate, in the proforma below, list of all spare coasparts required for commissioning. In case the Bidder has to add any other relevant information, the same shall be indicated herein. Continuation sheets of like size and format may be used as per Bidder's requirements.

Sl.No.	Description	Quantity	Unit Price	Total Price	Delivery Period	Remarks

ANNEXURE – V

DEVIATION FROM SPECIFICATION

If the proposal submitted has got any deviation from the technical stipulations in the bidding document, the Bidder shall tabulate below the full particulars of such deviations and shall sign below. Additional sheets may be enclosed, if necessary. Deviation is to be furnished with mention of specific clause numbers. Technical and commercial deviations to scope of supply and services, shall be indicated separately.

Sl.No.	CLAUSE NO.	DESCRIPTION AS PER SPECIFICATION	DEVIATION BY BIDDER

We confirm that all the deviations/exceptions to the Job specification and enclosures including reference documents attached are listed in this format only. No other deviations or exceptions even if mentioned elsewhere shall be considered for any technical/ commercial evaluation or for ordering.

Signature of Bidder's
Authorized representative with date.....
Date.....

Variant Table:

Sl. No.	Description	Material code
00	Supply Of Air Cooled Dump Condenser	PY9751379008
01	E&C Of Air Cooled Dump Condenser	PY9851379018
02	Mandatory Spares	PY9751379024

	RECORD OF REVISIONS				
Rev. No.	**Date**	**Revision Details**	**Prepared By**	**Revised By**	**Approved By**
00	07.07.18	First Issue	CHP	AKS	MSSN

PROJECT ENGINEERING & SYSTEMS DIVISION
HYDERABAD

TECHNICAL SPECIFICATION
OF
CONDENSATE STORAGE TANK

Revisions: Refer to record of revisions	Prepared by :	Checked by :	Approved by :	Date :
	Pradeepa	AKS	MSSN	10.07.18

1.0 INTENT OF SPECIFICATION:

This specification covers the requirement of Condensate storage tank.

This specification is intended to cover the design, manufacturer, testing at manufacturer's works, and delivery at site, properly packed and forwarded with all accessories as specified in the scope of work and as required for the safe and trouble-free operation of the equipment to be installed at site.

2.0 SCOPE OF SUPPLY :

(i) One no. Condensate storage tank- Dished ends with horizontal constrction
(As per attached P & ID).

The scope of supply of each Condensate storage tank shall be strictly as per enclosed P&ID [**Annexure-1]** wherein, the Condensate storage tank boundaries are clearly marked. The system shall be provided with all interface connections, supporting lugs, manhole, flanges, counter/blind flanges, foundation bolts, etc., as detailed in various clauses of this specification.

3.0 TECHNICAL SPECIFICATION:

3.1.1 The pressurized Condensate storage tank shall be designed as a pressure vessel as per ASME Section VIII Div.1.

3.1.2 Refer Job specification for design basis.

4.0 GENERAL REQUIREMENTS:

4.1.1 The structural like legs, supports, etc., shall be of IS-2062 material.

4.1.2 **Vendor to provide necessary insulation cleats suitable for 50 mm thick insulation for Condensate storage tank.** ***Insulation is in BHEL scope only.***

4.1.3 Condensate storage tank shall be provided with legs.

4.1.4 All nozzles on the vessels shall be #300 Rating.

4.1.5 All bolts/studs/nuts shall be galvanized.

4.1.6 All Counter/blind flanges shall be provided with necessary gaskets, studs and nuts.

4.1.7 Wherever required, nozzles shall be provided with reinforcements as per code requirements, Vendor to also check for nozzle distances, and nozzle to weld distances as per code requirements, and adhere to the same while designing the vessels.

4.1.8 Piping shall be as per the PMS (piping material specification), the same is attached as annexure.

4.1.9 As the Condensate storage tank is designed as pressure vessel, all the openings on the tank including manhole shall be of circular type only.

4.1.10 The Condensate storage tank shall be designed as a pressure vessel and the thickness of shell plate & dished ends shall be as per code.

4.1.11 Suitable drain and vent connections to be provided on the tank at appropriate location.

4.1.12 Platforms, ladders & foundation bolts are included in vendor's scope of supply. All necessary supports, access stair ways (for accessing instruments, etc.) shall be provided

5.0 DESIGN BASIS FOR PRESSURE VESSELS:

PARAMETERS:

	Pressure (kg/cm2(a))	Temp. (Deg. C)
Normal	3.5	170
Minimum	1.0	130
Maximum	3.5	170
Mechanical Design	4.2	190
Medium	Steam and condensate	

5.1 Materials:

The following table gives guideline for material selection for various pressure Parts / Non pressure parts of the equipment.

	Pressure Parts				**Non-Pressure Parts**		
Design Temp, Deg. C	**Plate**	**Pipe** (see Note-1)	**Forging**	**Bolts/Studs /Nuts (External)**	**Structural attachment welded to pressure parts**	**Internal pipes/ plates**	**Bolts/Studs/Nuts (Internal)**
Above 0 to 343 Deg. C	SA 516 (all grades)	SA 106 Gr. B	SA 105 SA 266	SA 193 Gr. B7 / SA 194 Gr. 2 H	1. IS 2062 (Plates) Up to 300 ºC 2. Same as pressure parts For Up to 300 ºC	SA 106 Gr. B/ Same as pressure parts	SA 193 Gr. B8/ SA 194 Gr. 4

5.2 Minimum Wall thickness:

For Carbon steel:

The Minimum wall thickness shall be calculated as per code. However same shall be cross checked as follows :

Minimum wall thickness – 6 mm (including corrosion allowance), but not less than calculated as follows:

1. For DIA less than 2400 mm

   Wall thk = (Dia /1000) + 1.5 + Corrosion allowance
   All dimensions are in mm.

2. For DIA 2400 mm and above

   Wall thk = (Dia /1000) +2 .5 + Corrosion allowance

All dimensions are in mm.

5.3 Corrosion Allowance:

(i) Minimum corrosion allowance shall be 3 mm, unless otherwise specified.

5.4 Allowable stresses:

(i) Basic allowable stresses for shell, heads and other components etc, shall be the values specified in the design code.

(ii) The allowable stresses for structural members and anchor bolts shall be as specified in Indian Standard IS:800.

5.5 Wind and Seismic Loads

(i) Wind load shall be calculated as per Indian Standard IS 875 site specific wind data if attached with the bid package.

(ii) Earthquake forces shall he calculated in accordance with Indian Standard IS: 1193 or it shall be based on meteorological and seismic data of the site, if attached with the bid package.

5.6 Specification of Plate Materials:

(i) Carbon Steel Plates:

a. Plates used shall conform to latest issue of SA-20 with additional requirements mentioned herein.

b. Only normalized plates free from injurious defects with workmanlike finish shall be used. Reconditioning / repair of plates by welding shall not be permitted.

c. One product analysis of each heat shall be carried out and reported. Chemical analysis shall be as per applicable specification with carbon content not exceeding 0.23%.

d. Additionally, any of the following requirements for carbon equivalents (Ceq.) based on heat analysis shall be satisfied:

$Ceq = C + Mn/6 \leq 0.42$ - (1)

$Ceq = C + MN/6 + (CR+Mo+V)/5 + (Cu + Ni)/15 \leq 0.43$ (2)

Eq. 1 shall be used when applicable material specify C and Mn only.

Eq. 2 is applicable for restricted chemistry requirements or for supplementary requirements of S19 & S21of specification SA-20.

5.7 Heads:

All carbon steel dished heads and toricones up to 16 mm thickness (nominal) shall be stress relieved and more than 16 mm thickness shall be normalized if cold pressed or formed. However, in case hot forming is carried out in the normalizing range, no stress relieving is necessary.

5.8 Manholes, Hand holes and nozzles:

a. Manholes shall be minimum 600 mm NB unless otherwise specified. If the dimension of vessel does not permit, the manhole shall be minimum of 450 mm.

b. Manhole cover shall be provided with a davit or hinge.

c. Small vessels shall be provided with two pad type inspection openings of 150 NB. If it is not possible for small vessels (up to 300 mm diameter vessel) a suitable spool pipe shall be provided in the piping for inspection.

d. For vessels with diameter less than 900 mm and having removable internals, shell flanges shall be provided.

e. The reinforcement for the nozzle opening shall be integral type when required by the applicable code/standards or when the thickness of vessel wall exceeds 50 mm. Self-reinforcement type nozzles 80 NB and above shall be set-in type.

f. All vessel nozzles shall be welded to the vessel. Screwed connections into the vessel are not acceptable.

5.9 Pipes, Fittings, Flanges And Valves:

Complete pipes, fitting, flanges and valves shall be as per the project PMS (Piping material specification) enclosed as an annexure.

5.10 Ultrasonic Examinations of Plates

a. Plates having thickness 16 turn to 50 mm (both inclusive) shall be examined ultrasonically as per specification SA435.
b. For thickness above 50 mm. ultrasonic examinations shall be carried out as per Specification SA-578 and shall have acceptance standard of level-B.
c. For quenched and tempered steel plates, ultrasonic examination shall be envied out after the specified heat treatment.

5.11 Simulated Heat Treatment of Test Coupons:

-	For Plates above 16 mm thickness intended for hot rolling/forming.	One normalising* + one stress reliving as per UCS-56 of ASME Code. Sec. VIII Div.1
*	Recommended Normalising Cycle :	
(i)	Soaking Temperature	900° C To 1000° C
(ii)	Holding time one hour per 25 mm thickness but not less than half an hour	
(iii)	Cooling in still air	

- Charpy V-notch impact testing as per S5 if specification SA-20 to be carried out at design temperature for low temperature services.

5.12 Post Weld Heat Treatment:

Vessels shall be heat-treated whenever it is required due to service requirement or due to code requirements. Vessels shall be post weld-heat treated as a complete unit and no welding shalt be permitted once post weld heat treatment is performed.

6.0 Welding Process, Procedures and Qualifications:

(a) Full penetration weld shall be employed for joining pressure parts. Where both sides are not accessible for welding, root run by tungsten inert gas process or backing strip may be used to ensure full penetration. Backing strip, if used, is to be removed after welding, wherever possible.

(b) All root runs / TIG Welding shall carry out Single pass welds.

(c) Skip and/or stitch welding on all exterior structural welds are not permitted.

Welding processes: The welding processes as defined by section IX of the ASME Boiler and Pressure Vessel (B&PV) code are acceptable.

Welding Procedure specifications: Each manufacturer shall prepare or obtain detailed written welding procedure specifications (WPS) outlining all essential, nonessential and supplementary essential variables as required by section IX of the ASME B&PV code. Materials used in welding that are not classified under the ASME P-number base material grouping shall be qualified in accordance with the methods specified in section IX. It is the responsibility of the manufacturer to justify any base material and / or filler metal grouping that are not classified in section IX.

Welding Procedure Qualifications: Each manufacturer shall qualify the procedures he intends to use in production, by producing weldments and having mechanical tests performed as required by section IX of the ASME B&PV code. Where NACE MR-01- 75, the maximum hardness of the base materials, requires controlled hardness the weld metal, and the heat-affected zone may be determined on the procedure Qualification. The results of all tests shall be recorded and certified on Procedure Qualification Records (PQR) by the manufacturer to support each WPS. Qualification by one manufacturer shall not qualify a WPS for any other manufacturer.

Welder Qualifications: Each manufacturer shall qualify all welders and welding operators employed in welding in accordance with the requirements of section IX of the ASME B&PV code. The results of all tests shall be recorded and certified on welder performance qualification (WPQ) by the manufacturer for each welder and welding operator. Qualification of individuals employed by one manufacturer shall not qualify them for employment by any other manufacturer without re-qualification.

7.0 PRESSURE TESTING:

(a) Condensate storage tank shall be hydrostatically tested at a test pressure of 1.5 times the design pressure as per the code. In order to safeguard against the risk of brittle fracture during hydrostatic test, temperature of test fluid shall meet the requirements of ASME Sec. VIII Div.1.

8.0 RADIOGRAPHY / NON DESTRUCTIVE TESTING:

(i) The radiographic examination shall not be less than that specified in the code. However, spot radiography is the minimum requirement for all vessels.

(ii) When spot radiography is specified, the following requirement shall supplement the requirement specified in ASME section VIII Division 1:

1. All 'T' –joint shall be radio graphed.
2. Minimum 5% of total weld length excluding 'T" - joint shall be radio graphed.

3. Evaluation, tests and repair shall be as per applicable code.

(iii) All nozzles fabricated from plate, irrespective of thickness, shall be 100% radio graphed.

(iv) Weld seams of formed ends shall be 100% radio graphed after forming and heat treatment, if any.

(v) The technique employed and the weld quality achieved shall meet the requirements of the code.

(vi) All nozzles to shell welds (Root and Final run) shall be examined by magnetic particle/Dye penetrate test.

9.0 CLEANING:

Vessels shall be cleaned internally to remove scale, rust, dirt, and foreign material by wire brushing.

10.0 GENERAL:

a) Dimensions of flanges including shell flanges, blind head cover flanges, nozzle flanges and blind flanges shall be as per ASME B16.5. Larger flanges shall be as per ASME B16.7.

b) Nozzles up to 50 mm NB size shall be stiffened with 2 number of 40 mm wide X 6

mm thick stiffeners welded at 90 degrees apart to avoid damage due to vibration during transportation.

11.0 SURFACE PREPARATION AND PAINTING:

Please refer the project painting and surface preparation annexure attached for details.

12.0 INSPECTION AND TESTING :

All vessels shall be offered for stage-wise as well as for final inspection in line with approved QAP.

All equipment covered under these specifications shall be subject to inspection and tests by the Purchaser/his authorized representative or third party during manufacture erection and commission. The approval of the Purchaser or passing of such inspection of test will not, however, prejudice the right of Purchaser to reject the equipment if it does not comply with specifications when erected or does not give complete satisfaction in service. The cost of all such tests as well as third party inspectors shall be borne by the Vendor.

All materials, castings and forging shall be of tested quality and certificates made available. If mill certificates are not available, the Vendor shall arrange for physical and chemical testing at his own cost.

In addition to the above, all major components shall be subjected to various material, in-process, dimensional, hydrostatic and NDT tests. Necessary test certificates to this effect shall be furnished to the Purchaser.

All welding shall be performed in accordance the Code for Power Piping B31.1.

Pipe butt welds shall be examined by liquid penetrant for the root and final passes. Fillet welds shall also be similarly examined. The tests shall be carried out as per ASME sec V. Acceptance criteria shall be ANSI B31.1.

Reports of all shop test including Radiography where ever necessary shall be submitted to the Purchaser prior to despatch for review and approval.

13.0 PACKING:

- Internal piping system cleanliness to be assured by flushing or equivalent method and means provided to clean condition.
- All material shall be delivered in a clean and usable condition. Openings shall be securely covered against entry of foreign material where appropriate.
- The vendor shall make shipment using the minimum number of shipping containers consistent with requirement of safe transit.
- For complete requirements of packing refer specification “AA0490010” enclosed.

14.0 Data sheet to be furnished by bidder:

ANNEXURE - II

DATA SHEET FOR PRESSURE VESSEL
(To be filled in by the Vendor)

PROJECT:	CLIENT;
UNIT:	JOB NO.:
ITEM NO.:	PACKAGE:
EQUIPMENT :	MR. NO.:
CODE FOR DESIGN AND CONSTRUCTION	
DESIGN CONDITION	OPERATING CONDITIONS
PRESSURE (Kg/cm^2g)	PRESSURE (Kg/cm^2g)
TEMPERATURE (°c)	TEMPERATURE (°c)
CORROSION ALLOWANCE	
SERVICE	H_2S [ ] LETHAL [ ] OTHERS [ ]
LIQUID LEVEL(mm)	
SPECIAL SURFACE FINISH INSIDE VESSEL	REQD. [ ] NOT REQD. [ ]
TYPE OF VESSEL	HORIZONTAL [ ] VERTICAL [ ]
DIAMETER (mm)	SKIRT /LEG HEIGHT
HEIGHT TL-TL (mm)	
JOINT EFFICIENCY	SHELL HEAD
RADIOGRAPHY	SHELL HEAD
POST WELD HEAT TREATMENT	
MATERIALS OF CONSTRUCTION	
SHELL, REINFORCEMENT PADS	
HEADS/CONES	NOZZLE NECK
SHELL FLANGES	MAN-WAY NECK
NOZZLE FLANGES	PIPE FITTINGS
INTERNAL PARTS	GASKETS(EXTERNAL)
EXTERNAL STUDS/NUTS	GASKETS(INTERNAL)
INTERNAL BOLTS/NUTS	SKIRT/LEG SUPPORT
CLIP ATTACHMENTS (EXTERNAL)	
ANY OTHER GENERAL REQUIREMENT	
NOTE : VENDOR SHALL SUBMIT COMPLETED DATA SHEET ALONG WITH OFFER WHEREVER ENGG. DRAWING IS NOT ATTACHED FOR THE VESSEL.	

	RECORD OF REVISIONS				
Rev. No.	**Date**	**Revision Details**	**Prepared By**	**Revised By**	**Approved By**
00	10.07.18	First Issue	CHP	AKS	MSSN

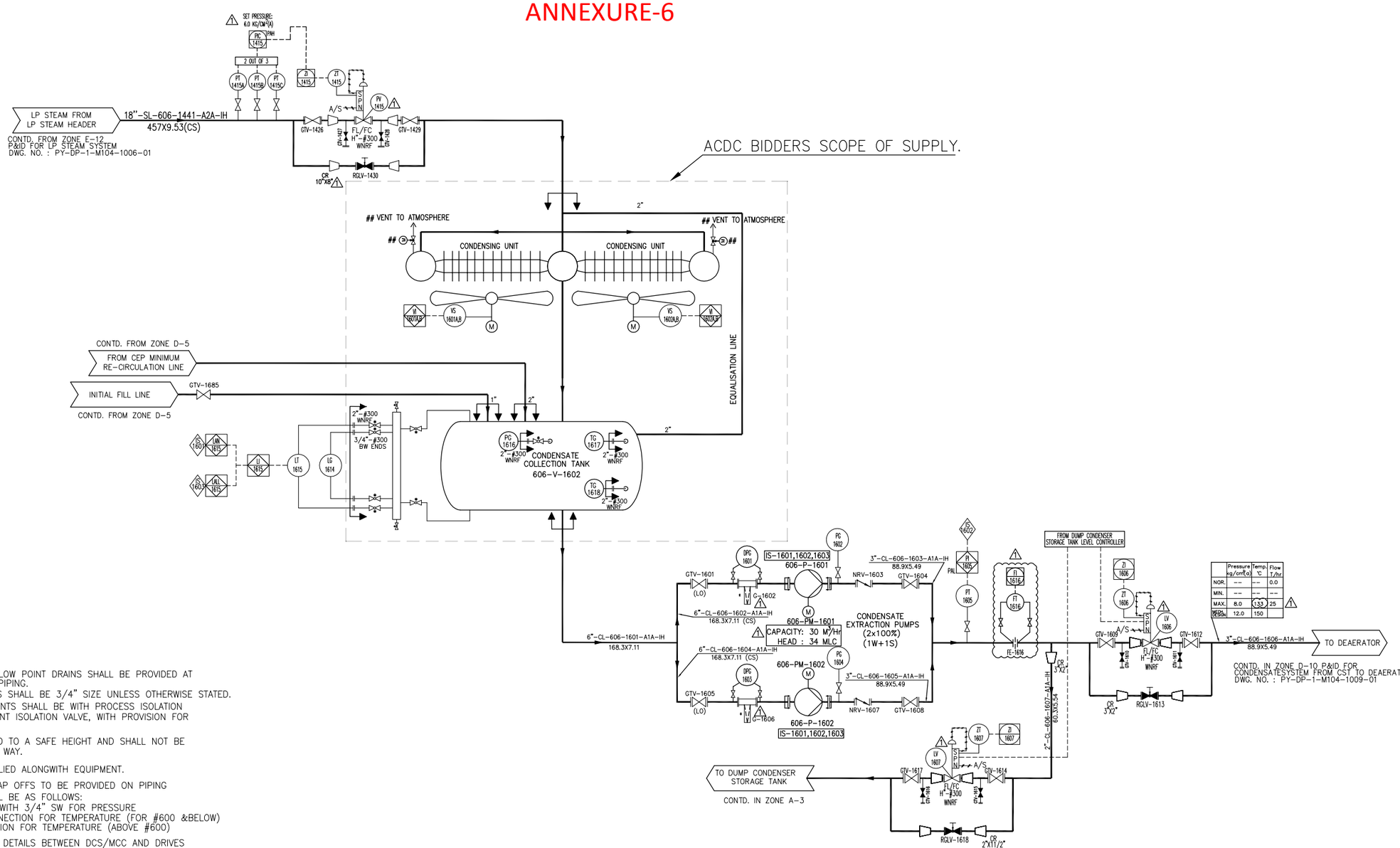
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. PY-DP-1-M104-1008-01

SHT. 01 OF 01

ANNEXURE-6



	Pressure kg/cm²(a)	Temp. °C	Flow T/hr.
NOR.	---	---	0.0
MIN.	---	---	---
MAX.	8.0	133	25
DESIGN	12.0	150	

NOTES:–

1. HIGH POINT VENTS AND LOW POINT DRAINS SHALL BE PROVIDED AT SUITABLE LOCATIONS IN PIPING.
2. ALL DRAIN & VENT LINES SHALL BE 3/4" SIZE UNLESS OTHERWISE STATED.
3. ALL PRESSURE INSTRUMENTS SHALL BE WITH PROCESS ISOLATION VALVE AND AN INSTRUMENT ISOLATION VALVE, WITH PROVISION FOR VENT AND DRAIN.
4. ALL VENTS SHALL BE LED TO A SAFE HEIGHT AND SHALL NOT BE DIRECTED TOWARDS PATH WAY.
5. '*' INDICATES ITEMS SUPPLIED ALONGWITH EQUIPMENT.
6. END CONNECTIONS FOR TAP OFFS TO BE PROVIDED ON PIPING
   FOR INSTRUMENTS SHALL BE AS FOLLOWS:
   i) ROOT VALVE ENDING WITH 3/4" SW FOR PRESSURE
   ii) 11/2" FLANGED CONNECTION FOR TEMPERATURE (FOR #600 &BELOW)
   2" FLANGED CONNECTION FOR TEMPERATURE (ABOVE #600)
7. FOR TYPICAL INTERFACING DETAILS BETWEEN DCS/MCC AND DRIVES (LIKE MOTORS, MOV, SOV etc) REFER TO THE APPROVED "DRIVE CONTROL PHILOSOPHY, Doc no. PY-SC-4-M104-8121-01".
8. ALL VALVES, INSTRUMENT TAG AND INTERLOCK NUMBER SHALL BE PREFIXED WITH 606
   EG. PG-1101 SHALL BE READ AS 606-PG-1101.
   TI-1102 SHALL BE READ AS 606-TI-1102.
9. PRESSURE AND TEMPERATURE SHOWN IN THE PARAMETER TABLES WILL OCCUR CORRESPONDING TO THE RESPECTIVE FLOW CONDITION.
10. ONLY TYPICAL REPRESENTATION OF AIR COOLED DUMP CONDENSER AND CST ARE SHOWN IN THE DRAWING. ACTUAL ARRANGEMENT (SUCH AS NO. OF FANS ETC) WILL BE AS PER THE VENDOR DESIGN.
11. "##" INDICATES MOTORIZED VENT VALVES IN THE ACC VENDOR SCOPE. SIZE , LOCATION AND NUMBER OF MOTORIZED VENT VALVES SHALL BE AS PER ACC VENDOR DESIGN.

BHEL/VENDOR SCOPE

VENDOR SCOPE | BHEL (PE&SD)

PE&SD INTERNAL REVIEW		
C&I	NAME	SIGN.

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHD/APPD			CHD/APPD			CHD/APPD			CHD/APPD			CHD/APPD			CHD/APPD			CHD/APPD
ZONE			ZONE			ZONE			ZONE			ZONE			ZONE			ZONE		

PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	D.S.K		12.07.18	–N.A.–
CHD.	A.K.S		12.07.18	
APPD.	M.S.S.N		12.07.18	

DEPT.	UNTOL. DIMS.		SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.	NO.OF ITEMS
PE&SD	CR. ~~C/M/F~~		NTS	–N.A.–	–N.A.–	–N.A.–	–N.A.–
CODE. 450							

TITLE: P&ID FOR DUMP CONDENSER, CST AND CONDENSATE SYSTEM

CARD CODE: N.A.

BHEL DRG NO.: PY-DP-1-M104-1008-05 REV.: 00

CUST DRG NO.:

SHT. No 1 NO. OF SHT. 1

COMPUTER FILE NAME: PY-DP-1-M104-1008-01-S01-R01.DWG

SIGN. AND DATE | REF. DRG. NO. | INVENTORY NO

ANNEXURE-7

ऊर्जा दक्ष मध्यम वोल्टेज इंडक्शन मोटरों के लिए विनिर्देश

SPECIFICATION FOR ENERGY EFFICIENT MEDIUM VOLTAGE INDUCTION MOTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
1	12.08.14	REVISED & ISSUED AS STANDARD SPECIFICATION	SS/SHIRALI	VKJ	BRB	SC
0	20.04.09	ISSUED AS STANDARD SPECIFICATION	SD	BRB	JMS	ND

Abbreviations:

AL	:	Aluminium
BASEEFA	:	British Approvals Service for Electrical Equipment in Flammable Atmospheres
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mines and Fuel Research
CPRI	:	Central power research institute
CT	:	Current Transformer
CU	:	Copper
DGMS	:	Directorate General of Mines Safety
DOL	:	Direct On Line
EIL	:	Engineers India Limited
ERTL	:	Electronics Regional test laboratory
FM	:	Factory Mutual
FRP	:	Fiber Reinforced Plastic
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
JEC	:	Japanese Electro-technical Committee
KLPL	:	Karandikar laboratories Pvt. Ltd.
LCIE	:	Laboratoire Central des Industries Electriques
NEMA	:	National Electrical Manufacturers Association
PESO	:	Petroleum and Explosive Safety Organisation
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
RPM	:	Revolutions per Minute
UL	:	Underwriter's Laboratories
VFD	:	Variable Frequency Drive
VDE	:	Verband Deutscher Elektrotechniker

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Mr. A.K. Chaudhary (Inspection)
Ms. N.P. Guha (Project)

CONTENTS

1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of energy efficient-High efficiency (IE2) 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	:	Electrical insulation- Thermal evaluation and designation.
IS - 2223	:	Dimensions of flange mounted AC Induction motors.
IS - 2253	:	Designation for types of construction and mounting arrangement of rotating electrical machines.
IS - 2254	:	Dimensions of vertical shaft motors for pumps.
IS - 2968	:	Dimensions of slide rails electric motors.
IS - 4029	:	Guide for testing three phase induction motors.
IS - 4889	:	Method of determination of efficiency of rotating electrical machines.
IS - 6362	:	Designation of methods of cooling of rotating electrical machines.
IS - 7816	:	Guide for testing insulation resistance of rotating machines.
IS - 8223	:	Dimensions and output series for rotating electrical machines.
IS - 8789	:	Values of performance characteristics for three phase induction motors.
IS - 9283	:	Motors for submersible pump sets.
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 – 12615	:	Energy Efficient induction motors - Three phase squirrel cage.
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.
IS / IEC60079-0:		Electrical apparatus for explosive gas atmospheres (General requirements)
IS/IEC-60079-1:		Explosive atmospheres-Equipment protection by flame proof enclosures "d".
IS/IEC60079-2	:	Explosive protection by pressurized enclosure "p".
IS/IEC60079-7	:	Explosive atmospheres-Equipment protection by increased safety – "e".
IS/IEC-60079-15:		Construction, test & marking of type of protection "n" electrical apparatus.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code)
IS/IEC 60034-1	:	Rotating electrical machines:-Rating & Performance
IS/IEC-60034-5:		Degrees of protection provided by the internal design of rotating electrical machines.

IS/IEC 60034-8: Rotating electrical machines-Terminal marking and direction of rotation
IS/IEC 61241: Electrical apparatus for use in the presence of combustible dust

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 CEA regulations 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/ JEC/NEMA or equivalent agency shall be applicable.

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

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 10 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 $\pm$ 6 % or
b) The frequency differing from its rated value by not more the $\pm$ 3 % or
c) Any combination of (a) and (b)

4.3 Starting

a) Motors shall be designed for direct-on-line starting or other method of starting as specified in datasheet.
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. In addition, Locked Rotor

withstand time under hot conditions at 75% & 100% voltages, shall be minimum 1.4 times the starting time at the corresponding voltage.

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	Min. 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 UVW are connected to a power supply giving a terminal phase sequence in the order UVW. 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 specified, the starting current (as % rated current) shall be limited to maximum 600-700% (based on number of poles and KW rating) as per IS 12615:2011, subject to IS 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. Unless otherwise specified the minimum pull-up torque of motors, at rated voltage & frequency shall be minimum 50% of the rated full load torque.

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.

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 breakdown torque at the rated voltage shall be not less than 175% of the rated load torque with no negative tolerance. Unless otherwise agreed, the breakdown torque shall not exceed 300% of the rated load torque.

In case of motors driving equipment with pulsating loads (e.g. reciprocating compressors, crushers, ball mills) the minimum value of pull out torque at 75% 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 Motors fed by variable frequency drive shall additionally meet the following requirements.

5.7.1 The motors shall be suitable for the current wave forms produced by the power supply including harmonics generated by the drive. The necessary coordination by motor manufacturers with drive manufacturers regarding harmonics generated by VFD shall be taken care and incorporated in motor design suitably.

5.7.2 The motors shall be designed to operate continuously at any speed over the range as per process requirement with minimum range as 10–100% of rated speed or as specified in data sheet. The characteristics shall be based on the application – in terms of constant torque / variable torque as per the driven equipment. Additional cooling fan shall be provided if required to limit the temperature rise to specified limits, alternatively option of applying suitable de-rating may be considered.

5.7.3 The motors shall withstand torque pulsation resulting from harmonics generated by the solid state power supply.

5.7.4 The motors required to be transferred to DOL bypass mode shall be rated for specified variations in line voltage and frequency.

5.8 The minimum values for performance characteristics of these motors shall be as given in the tables 1, 2 & 3 of IS 12615-2011 for IE2 motors, subjected to tolerance as per IS/IEC. Motor meant for application with VFD, the efficiency value can be one class lower as per IS.

6.0 CONSTRUCTIONAL DETAILS

6.1 Windings

6.1.1 Unless otherwise specified, 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 350 °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 provided 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.

6.2 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. The terminal box shall have side cable entry from non-driving 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 for installation in hazardous area. The terminal box design shall allow rotation in steps of 90 ° C to facilitate cable entry from any direction at site.

6.2.2 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 The terminal box shall be provided entries for suitable cable glands corresponding to the size of the specified cable. Crimp type tinned Copper 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.

6.2.4 For flameproof motors, terminal box can be provided in increased safety 'Exe' execution.

6.2.5 The terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the maximum cables sizes as specified below 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	2.5 cu
3.7 kW	6 cu
5.5 kW	10 cu
7.5 kW	16 cu
9.3 kW	16 cu
11.0 kW	16 cu
15.0 kW	50 Al.
18.5 kW	70 Al
22.0 kW	70 Al
30.0 kW	95 Al
37.0 kW	120 Al
45.0 kW	150 Al
55.0 kW	240 Al
75.0 kW	2x95 Al
90.0 kW	2x120 Al
110.0 kW	2x240 Al
125.0 kW/132 kW	2x240 Al
160.0 kW	2x240 Al

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

6.3 Motor Casing and Type of Enclosure

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

6.3.2 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/Exde).

6.3.3 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.

6.3.4 Unless otherwise agreed, motors shall have standard frame sizes (min.) 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 The bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the non-driving end.

6.4.3 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.

6.4.4 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/ oil seal/ V 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.

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

7.0 MISCELLANEOUS ACCESSORIES

7.1 Anti-Condensation Heaters

All motors rated 30 kW and above shall be provided with 240 V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shutdown periods.

For motors with heaters 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

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.

8.0 CRITICAL SPEEDS

The first actual critical speed of stiff rotors shall not be lower than 120 % 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 120 % of the synchronous speed.

9.0 PAINTING

All metal surfaces shall undergo manufacturer's standard cleaning /painting cycle. After preparation of the under surface, the equipment shall be painted with two coats of epoxy based final paint. Color shade of final paint shall be 632 of IS: 5/ RAL-7035. All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then these shall be greased.

10.0 INSPECTION AND TESTING

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

10.2 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.

10.3 The manufacturer shall carry out the following routine and acceptance tests as per applicable Standards/ITP on all the motors.

a) Visual check (Nameplate, terminal box location, terminal type, clearance, size, entries, space adequacy & gland size, direction of rotation etc.)
b) Dimension check (shaft height etc.)
c) Cable glands, cable lugs size and no. of entries in terminal box.
d) Winding resistance
e) No load test & measurement of voltage, speed, current, power input
f) Measurement of starting torque, starting current, full load torque, breakdown torque
g) Reduced voltage starting & running
h) Insulation resistance before and after high voltage test
i) High voltage
j) Vibration

10.4 The manufacturer shall submit the following type test certificates (one sample from each type/rating):

a) Full load test & measurement of voltage, current, power slip, power factor, bearing, noise
b) Efficiency & pf at 100%, 75% and 50% load
c) Temperature rise test
d) Momentary overload test
e) Vibration
f) Noise level
g) Over speed
h) Measurement of starting torque, starting current, full load torque.

10.5 For VFD fed motors, all tests as specified in the VFD specification shall be followed in addition to the above.

11.0 CERTIFICATION

The motors and associated equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRI/ ERTL/ BASEEFA/ LCIE/ UL/ FM/ KLPL or equivalent). All indigenous motors shall conform to Indian standards and shall be certified by recognised testing agencies. All motors (indigenous & imported) shall also have valid statutory approvals (e.g. PESO, DGMS etc). as applicable for the specified location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

12.0 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 purchase 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.

Client :HPCL	**Dept./Sect. :** 16/43
Project :VRMP	
Location VIZAG	**Pipe Class : A1A** Sheet 1 of 6

PIPE CLASS : **A1A**
RATING : 150
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	93	149	204	260	316	343	371
PRESS	20.03	20.03	18.28	16.17	14.06	11.95	9.84	8.78	7.73

SERVICE

NON CORROSIVE/ FLAMMABLE / NON FLAMMABLE/ NON LETHAL -PROCESS & HYDROCARBONS; LUBE OIL BEFORE FILTER; AMMONIA, STEAM & CONDENSATE (NON IBR); UTILITIES- INST AIR(BEYOND A3A), PLANT AIR, NITROGEN, CARBONDIOXIDE; WATER - BEYOND A3A AND A10A; IN OFFSITES ONLY BEYOND A10A;

NOTES

5 FOR PERMANENT 'T' TYPE BW STRAINERS,REFER EIL'STD 7-44-0303 & 7-44-0304; AND FOR TEMPORARY STRAINERS,REFER EIL'STD 7-44-0300; FOR SPACER AND BLIND REFER EIL'STD 7-44-0162.

7 FOR RESTRICTION ON USE OF BALL,PLUG & BUTTERFLY VALVES,REFER GENERAL NOTES.

36 THIS IS A PRESSURE BALANCED PLUG VALVES WHICH SHALL BE USED ONLY IF SPECIFIED IN P&ID.

92 GATE VALVES OF SIZE 26" AND ABOVE SHALL BE IN ACCORDANCE WITH B-16.34/ BS-1414 AND FLANGE ENDS SHALL BE IN ACCORDANCE WITH ASME B16.47 SERIES B.

101 NDT REQUIREMENTS AS PER EIL STANDARD B016-6-44-0016.

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
	2.0" & ABOVE	BUTTWELDED	
DRAINS	ON LINES <= 1.5"	REFER EILSTD 7-44-0350, DF3	
	ON LINES >= 2.0"	AS PER P&ID OR 0.75". REFER EIL STD. 7-44-0351, D4	
VENTS	ON LINES <= 1.5"	REFER EIL STD. 7-44-0350, VF3	
	ON LINES >= 2.0"	AS PER P&ID OR 0.75". REFER EIL STD 7-44-0351, V4	
TEMP.CONN	1.5"	FLANGED. REFER EIL STD 7-44-0353	
PRESS.CONN	0.75"	SW NIPPLE WITH VALVE TO SPEC AS PER EIL STD 7-44-0354	

Client :HPCL	**Dept./Sect. :** 16/43
Project :VRMP	
Location VIZAG	**Pipe Class : A1A** Sheet 2 of 6

BRANCH PIPE (SIZE IN INCHES)

	.50	.75	1.00	1.25	1.50	2.00	2.50	3.00	3.50	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00	42.00	44.00	46.00	48.00
84.00																																	
80.00																																	
76.00																																	
72.00																																	
70.00																																	
68.00																																	
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58.00																																	
56.00																																	
54.00																																	
52.00																																	
50.00																																	
48.00																																	T
46.00																																T	R
44.00																															T	R	R
42.00																														T	R	R	R
40.00																													T	R	R	R	R
38.00																												T	R	R	R	R	R
36.00																											T	R	R	R	R	R	R
34.00																										T	R	R	R	R	R	R	R
32.00																									T	R	R	R	R	R	R	R	R
30.00																								T	R	R	R	R	R	R	R	R	R
28.00																							T	R	R	R	R	R	R	R	R	R	R
26.00																						T	R	R	R	R	R	R	R	R	R	R	R
24.00																					T	R	R	R	R	R	R	R	R	R	R	R	R
22.00																																	
20.00																			T		R	R	R	R	R	R	R	R	R	R	R	R	R
18.00																		T	P		R	R	R	R	R	R	R	R	R	R	R	R	R
16.00																	T	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
14.00																T	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
12.00															T	P	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
10.00														T	P	P	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
8.00													T	P	P	P	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
6.00												T	P	P	P	P	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
5.00																																	
4.00										T		P	P	P	P	P	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
3.50																																	
3.00								T		P		P	P	P	P	P	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
2.50																																	
2.00						T		P		P		P	P	P	P	P	P	P	P		R	R	R	R	R	R	R	R	R	R	R	R	R
1.50					T	T		H		H		H	H	H	H	H	H	H	H		H	H	H	H	H	H	H	H	H	H	H	H	H
1.25																																	
1.00			T		T	H		H		H		H	H	H	H	H	H	H	H		H	H	H	H	H	H	H	H	H	H	H	H	H
0.75		T	T		T	H		H		H		H	H	H	H	H	H	H	H		H	H	H	H	H	H	H	H	H	H	H	H	H
0.50	T	T	T		T	H		H		H		H	H	H	H	H	H	H	H		H	H	H	H	H	H	H	H	H	H	H	H	H

BRANCH PIPE (SIZE IN INCHES)

RUN PIPE (SIZE IN INCHES)

CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : IPMCS
Report No. : 50

A1A

Client :HPCL	**Dept./Sect. :** 16/43
Project :VRMP	
Location VIZAG	**Pipe Class : A1A** Sheet 3 of 6

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	2	2	XS	B-36.10	ASTM A 106 GR.B	BE, SEAMLESS	PI21917Z0	
PIP	PIPE	3	14	STD	B-36.10	ASTM A 106 GR.B	BE, SEAMLESS	PI21917Z0	
PIP	PIPE	16	36	STD	B-36.10	ASTM A 672 GR.B60 CL.12	BE, E.FS.W	PI2A813Z0	
PIP	PIPE	40	48	XS	B-36.10	ASTM A 672 GR.B60 CL.12	BE, E.FS.W	PI2A813Z0	
NIP	NIPPLE	.5	.75	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
NIP	NIPPLE	1	1.5	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
Flange Group									
FLG	FLNG.WN	.5	24	M	B-16.5	ASTM A 105	150, RF/125AARH	FWC0127Z0	
FLG	FLNG.WN	26	48	M	B-16.47-B	ASTM A 105	150, RF/125AARH	FWB0127Z0	
FLG/300	FLNG.WN	2	24	M	B-16.5	ASTM A 105	300, RF/125AARH	FWC0147Z0	
FLB	FLNG.BLIND	.5	24		B-16.5	ASTM A 105	150, RF/125AARH	FBC0127Z0	
FLB	FLNG.BLIND	26	48		B-16.47-B	ASTM A 105	150, RF/125AARH	FBB0127Z0	
FLB/300	FLNG.BLIND	.5	24		B-16.5	ASTM A 105	300, RF/125AARH	FBC0147Z0	
FEF	FLNG.FIG.8	.5	8		ASME-B16.48	ASTM A 105	150, FF/125AARH	FGK0121Z0	
FEF	SPCR&BLND	10	24		ASME-B16.48	ASTM A 105	150, FF/125AARH	FCK0121Z0	
FEF	SPCR&BLND	26	48		EIL'STD	ASTM A 516 GR.70	150, FF/125AARH	FCE6321Z0	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 105	SW, 6000	WA602D3Z0	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 105	SW, 3000	WA602D2Z0	
ELB90	ELBOW.90	2	14	M	B-16.9	ASTM A 234 GR.WPB	BW, 1.5D	WAG684Z10	
ELB90	ELBOW.90	16	48	M	B-16.9	ASTM A 234 GR.WPB-W	BW, 1.5D	WAG754Z10	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 105	SW, 6000	WB602D3Z0	

Client :HPCL	**Dept./Sect. :** 16/43
Project :VRMP	
Location VIZAG	**Pipe Class : A1A** Sheet 4 of 6

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
ELB45	ELBOW.45	1	1.5		B-16.11	ASTM A 105	SW, 3000	WB602D2Z0	
ELB45	ELBOW.45	2	14	M	B-16.9	ASTM A 234 GR.WPB	BW, 1.5D	WBG684Z10	
ELB45	ELBOW.45	16	48	M	B-16.9	ASTM A 234 GR.WPB-W	BW, 1.5D	WBG754Z10	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WE602D3Z0	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WE602D2Z0	
TEQ	T.EQUAL	2	14	M	B-16.9	ASTM A 234 GR.WPB	BW	WEG684ZZ0	
TEQ	T.EQUAL	16	48	M	B-16.9	ASTM A 234 GR.WPB-W	BW	WEG754ZZ0	
TRED	T.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WR602D3Z0	
TRED	T.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	
TRED	T.RED	2	14	M, M	B-16.9	ASTM A 234 GR.WPB	BW	WRG684ZZ0	
TRED	T.RED	16	48	M, M	B-16.9	ASTM A 234 GR.WPB-W	BW	WRG754ZZ0	
REDC	REDUC.CONC	2	14	M, M	B-16.9	ASTM A 234 GR.WPB	BW	WUG684ZZ0	
REDC	REDUC.CONC	16	48	M, M	B-16.9	ASTM A 234 GR.WPB-W	BW	WUG754ZZ0	
REDE	REDUC.ECC	2	14	M, M	B-16.9	ASTM A 234 GR.WPB	BW	WVG684ZZ0	
REDE	REDUC.ECC	16	48	M, M	B-16.9	ASTM A 234 GR.WPB-W	BW	WVG754ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 105	PBE	WNH026ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 105	PBE	WPH026ZZ0	
CAP	CAP	2	48	M	B-16.9	ASTM A 234 GR.WPB	BW	WFG684ZZ0	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WJ602D3Z0	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WJ602D2Z0	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 105	SW, 6000	WK602D3Z0	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 105	SW, 3000	WK602D2Z0	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 105	SW, 6000	WL602D3Z0	

Client :HPCL	**Dept./Sect. :** 16/43
Project :VRMP	
Location VIZAG	**Pipe Class : A1A** Sheet 5 of 6

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 105	SW, 3000	WL602D2Z0	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WM602D3Z0	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WM602D2Z0	
Valves Group									
GAV	VLV.GATE	.25	1.5		API 602/ ISO 15761	BODY-ASTM A 105,TRIM-STELLITED,STEM-13%CR.STEEL	SW, 800, 3000, B-16.11, SHT NO.- 51001	51001ZZZ0	
GAV	VLV.GATE	2	42		API 600/ ISO 10434	BODY-ASTM A 216 GR.WCB,TRIM-13% CR.STEEL	FLGD, 150, B-16.5, RF/125AARH, SHT NO.- 51301	51301ZZZ0	92
GLV	VLV.GLOBE	.25	1.5		BS EN ISO 15761	BODY-ASTM A 105,TRIM-STELLITED,STEM-13%CR STEEL	SW, 800, 3000, B-16.11, SHT NO.- 52001	52001ZZZ0	
GLV	VLV.GLOBE	2	16		BS-1873	BODY-ASTM A 216 GR.WCB,TRIM-13% CR.STEEL	FLGD, 150, B-16.5, RF/125AARH, SHT NO.- 52301	52301ZZZ0	
CHV	VLV.CHECK	.25	1.5		BS EN ISO 15761	BODY-ASTM A 105,TRIM-STELLITED	SW, 800, 3000, B-16.11, SHT NO.- 53001	53001ZZZ0	
CHV	VLV.CHECK	2	24		BS 1868	BODY-ASTM A 216 GR.WCB,TRIM-13% CR.STEEL	FLGD, 150, B-16.5, RF/125AARH, SHT NO.- 53301	53301ZZZ0	
CHV	VLV.CHECK	26	28		API-594	BODY-ASTM A 216 GR.WCB,TRIM-13% CR.STEEL	FLGD, 150, B-16.47 B, RF/125AARH, SHT NO.- 53925	53925ZZZ0	
BLV	VLV.BALL	.5	16		BS EN ISO 17292	BODY-ASTM A 105 / A 216GR.WCB,TRIM-BODY SEAT-RPTFE	FLGD, 150, B-16.5, RF/125AARH, SHT NO.- 54301	54301ZZZ0	
PLV	VLV.PLUG	.5	24		BS-5353	BODY-ASTM A 105 / A 216GR.WCB,TRIM-PLUG-HARDENED	FLGD, 150, B-16.5, RF/125AARH, SHT NO.- 55301	55301ZZZ0	
PLV/1	VLV.PLUG	.5	36		BS-5353	BODY-ASTM A 105 / A 216GR.WCB,TRIM-PLUG-HARDENED	FLGD, 150, B-16.5, RF/125AARH, SHT NO.- 55315	55315ZZZ0	36
BFV	VLV.BTRFLY	3	24		BS EN 593	BODY-ASTM A 216 GR.WCB,TRIM-13% CR.STEEL	WAFL, 150, B-16.5, WAF/125AARH, SHT NO.- 56301	56301ZZZ0	
BFV	VLV.BTRFLY	26	48		BS EN 593	BODY-ASTM A 216 GR.WCB,TRIM-13% CR.STEEL	FLGD, 150, B-16.47 B, RF/125AARH, SHT NO.- 56315	56315ZZZ0	

Client :HPCL	**Dept./Sect. :** 16/43
Project :VRMP	
Location VIZAG	**Pipe Class : A1A** Sheet 6 of 6

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Bolt Group									
BOS	BOLT.STUD	.5	48		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	
Gasket Group									
GAS	GASKET	.5	24		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 150	GK65072Z0	
GAS	GASKET	26	48		B-16.20-ANSI B16.47B	SP.WND SS316+GRAFIL+ I RING	SPIRAL, 150	GK56272Z0	
GAS/300	GASKET	.5	24		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL+ I RING	SPIRAL, 300	GK66274Z0	
Trap/Strainer Group									
TRP	TRAP.STEAM	.5	1.5		MNF'STD	B:A105;T:13%CR;S:SS304	FLGD, THRMDNMC, 150,RF/125AARH	TR3065530	
TSR	STRNR.TEMP	1.5	24		EIL'STD	B:A516GR.70;INT:SS304	CONETYPE, 150,FF/125AARH	ST16831Z0	
PSR	STRNR.PERM	.5	1.5		MNF'STD	B:A105;INT:SS304	SW, Y-TYPE, 800	SP303D510	
PSR	STRNR.PERM	2	14	M	EIL'STD	B:A234GR.WPB;INT:SS304	BW, T-TYPE	SP13344Z0	
PSR	STRNR.PERM	16	24	M	EIL'STD	B:A234GR.WPBW;INT:SS304	BW, T-TYPE	SP13644Z0	

JOB SPECIFICATION
FOR
SURFACE PREPARATION
AND PROTECTIVE COATING

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
1	23-03-2017	Issued as a job specification	SM	SS	SG
0	09-02-2017	Issued as a job specification	SM/DD	SS	SG

Abbreviations:

AS	:	Alloy Steel
ASTM	:	American Society for Testing and Materials
AWWA	:	American Water Works Association
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
GI	:	Galvanized Iron
ID	:	Internal Diameter
ISO	:	International Organization for Standardization
LTCS	:	Low temperature Carbon Steel
MS	:	Mild Steel
NB	:	Nominal Bore
OD	:	Outside Diameter
OSHA	:	Occupational Safety and Health Act
RCC	:	Reinforced Cement Concrete
RH	:	Relative humidity
SS	:	Stainless Steel
SOR	:	Schedule of Rate
SSPC	:	Steel Structure Painting Council
WFT	:	Wet Film Thickness
NA	:	Not applicable

1.0 GENERAL

1.1 This technical specification shall be applicable for the work covered by the contract and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that the 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 the job.

1.3 This specification covers the requirement for protective coating for new construction.

2.0 SCOPE

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

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 and chimneys, if any. The items listed in the heading of tables of paint systems are indicative only. However, the CONTRACTOR is fully responsible for carrying out all the necessary painting, coating and lining job 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:

- All un-insulated carbon steel & alloy steel equipment like vessels, columns, storage tanks, exchangers, parts of boilers etc.
- All un-insulated carbon steel and low alloy plant and related piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.
- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping and other insulated items present, if any.
- All items contained in a package unit.
- All structural steel work, pipes, structural steel supports, walkways, handrails, ladders, platforms etc.

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

- Identification of colour bands on all piping, as required, including insulated aluminium clad, galvanized, SS and nonferrous piping.

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

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

- Supply of all primers, paints and all other materials required for painting (other than OWNER supplied materials)

- Application of pre-erection/fabrication and shop primer.

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

- All CS piping, equipment, storage tanks and internal surfaces of RCC tanks in ETP plant.

- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating).

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. Un-insulated austenitic stainless steel.
b. Plastic and/or plastic coated materials.
c. Non-ferrous materials like aluminum, Cu-Ni alloys, galvanized steel.

In general Galvanized steel doesn't require painting. However if painting is required due to OWNERs instructions, contractual or for colour coding requirement then coating system in Table 4.0 shall be followed.

2.3 Documents

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

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

b. Piping line list.

c. Painting specifications including special civil defense requirements.

2.4 Unless otherwise instructed, final paint coating (i.e. application of field primer, intermediate and top coats) on pre-erection/ shop primed equipment shall be

applied at site, only after all welding, testing on systems are completed as well as after completion of steam purging.

2.5 Changes and deviations required for any specific job due to OWNERs 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:

ISO-12944	:	Corrosion protection of steel structures by protective paint system.
ASTM-Vol. 6.01&6.03	:	American standard test methods for paints and coatings.
IS-101	:	Methods of sampling and test for paints, varnishes and related products.
IS-5	:	Colours for ready mixed paints and enamels.
RAL DUTCH	:	International standard for colour shade (Dutch standard).
IS-2379	:	Indian standard for pipe line identification-colour code

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 (NACE), U.S.A.

3.2.4 Various international standards equivalent to Swedish standard for surface preparations are given in Table-1.

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

3.4 The paint manufacturers' instructions shall be followed as far as practicable at all times for the 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-4 to 13 of this standard.
c. Mixing and thinning.
d. Application, recommended limit on time intervals in between coats & DFT.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning, all equipment, scaffolding materials, shot & grit blasting equipment , air compressors etc. required shall be suitable for the work and shall be arranged by the CONTRACTOR in sufficient quantity at the site. The manufacturers test certificates / data sheets for all the above mentioned items shall be reviewed by Engineer-In-Charge at site before start of the work.

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

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

5.1 General

5.1.1 Adhesion of the paint film to the 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. In order to achieve the maximum durability, one or more of the following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by the Engineer-In-Charge.

a. Abrasive blast cleaning

b. Mechanical or power tool 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 thermally sprayed metal coatings, in case of mechanical or power tool cleaning 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 thermally sprayed metal coatings.

Before surface preparation by blast cleaning, the surface shall be degreased by aromatic solvent to remove all grease, oil etc as per SSPC-SP-1.

5.1.3 Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity >85%. In case of internal coating of storage tanks, dehumidifier shall be used to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3ºC below the metal substrate temperature during entire period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer

coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on the substrate.

Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by the CONTRACTOR for the given site conditions, before starting operation of dehumidifier, to ensure that desired values of dew point and moisture content in enclosed space is achieved.

Dehumidification to be maintained round the clock for surface preparation and painting till the total coating application is over.

Dehumidifier shall not be stopped under any condition till the entire blasted surface is primed to the satisfaction of the technical representative of the paint manufacturer. In case the dehumidifier breaks down in middle of the job, the same shall be replaced at the risk and cost of the CONTRACTOR.

5.1.4 The Engineer in-Charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances, the CONTRACTOR shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the OWNER.

5.1.5 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 the 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 before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.6 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 out. The surface must be thoroughly washed with water to remove acid and loose particles and then dried completely before application of paint.

5.2 Procedure for surface preparation

5.2.1 Air blast cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives such as Al_2O_3 particles, chilled cast iron or steel grit, copper slag or nickel slag at a pressure of 7.0 kg/cm^2 and at an appropriate distance & angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron or steel shall be in the form of shot or grit of size in the range of G16 – G42 conforming to SSPC AB1 and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak. For all other abrasives, size shall be in the range of G16 – G24. 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. The compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the material for liners. Nozzle orifice may vary from 3/16" to 3/4". 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 or 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. If there is dew on the metal surface, it shall be cleaned. The surface profile shall be uniform to provide good adhesion (i.e. 35 to 50 microns) to the paint. If possible, a vacuum collector shall be installed to collect and recycle the abrasives.

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 the 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/steam and thoroughly dried with compressed air jet before application of paint.

5.3 Non-compatible shop coat primer

For equipment on which application of total protective coating (primer + intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with the paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipment (coated with primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per Table-3 of paint systems depending upon the 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 a particular environment.

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

As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipment, structures, piping, etc, shall be carried out only after its erection and all welding, testing, steam purging (wherever carried out) have been completed.

5.7 Coating procedure and application

All coatings shall be applied by airless spray except for the following special cases, where application can be carried out by brush subject to suitability of the application of the paint product by brush.

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application

Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

5.7.1 Surface shall not be coated in rain, wind or in an environment where injurious airborne elements exist, when the steel surface temperature is less than 5 ^{0}F above dew point, when the relative humidity is greater than 85%, when the temperature is below 40^{o}F and when the ambient/substrate temperature is below the paint manufacturers 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 20 km per hour.

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

5.7.3 To the maximum extent practicable, each coat of paint shall be applied as a continuous film with uniform thickness and free of probes. Any spots or areas missed in application shall be re-coated 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 re-coating 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's instructions 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 the complete coverage of the surface. The tinting material shall be compatible with the material underneath and shall not be detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Airless spray application shall be in accordance with the following procedure:
As per steel structure paint manual Vol.1 & Vol.2 by SSPC, USA. Airless spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor, issued 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 atomization 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 keeps the paint uniformly mixed during the spraying. The unit shall consist of in-built strainer. Usually, a very small quantity of thinning is required before spray. In case of high build epoxy coating (two packs), 45:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally, fluid hoses should not have ID less than 3/8" and not longer than 50 ft. to obtain optimum results.

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

5.7.7 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 surfaces, and rough/ pitted steel. Wide flat brushes are suitable for large flat areas but they shall not have width over 5 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, daubers, or sheepskin.

5.7.8 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 this exceeds, the paint material has possibly deteriorated or mixing is faulty.

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

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

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

5.9 Spot repair of damaged primer

5.9.1 Where pre-erection/shop primer has been damaged at isolated localized spots during handling and transportation or after erection / welding, its repair shall be done as given below and as per the Table-3 of this specification.

5.9.2 Repair of damaged inorganic zinc silicate pre-erection/pre-fabrication/shop primer (F9) after erection / welding in the design temperature of -90°C to 400°C and damaged silicone aluminium (F-12) pre-erection/pre-fabrication/shop primer after erection/welding for design temperature range of 401 – 550 °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 damage was observed on pre-erection / pre fabrication or shop primer of inorganic zinc silicate coating (F-9). Similarly one coat of F-12 shall be applied wherever damage observed on pre-erection / pre-fabrication/shop primer of silicone aluminium (F-12).

5.9.3 If damaged areas are found to be extensive and spread over large areas, then entire pre-erection/pre-fabrication/shop primer shall be removed by blasting to achieve SSPC-SP-10 and entire blasted surface shall be primed again with F-9 or F-12, as applicable, for the intended design temperature. (See note of Table-3).

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 or Air assisted pressure pot.

5.10.3 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 choose 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 based on compatibility of the above paint system.
- Identify the need of repair of shop primer and execute as per Table-3.

5.11 Documentation / records

5.11.1 A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of 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 equipment and calibration.

5.11.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 5.11.2 -5.11.7 above as well as the approved procedure of work (5.11.1 above). The job record consisting of information in accordance to 5.11.2 – 5.11.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

TABLE-1: 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 No.1	Extremely clean surface can be expected to have prolonged 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 free of all visible residues with desired surface profile.	Sa 2½	SSPC-SP-10	NACE No.2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc

Sl. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
					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	NACE No.3	For steel required to be painted with conventional paints, for exposure to mildly corrosive atmosphere and 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	NACE No.4	-

6.0 PAINT MATERIALS

Typical characteristics and codes of various paint materials used in this specification are as follows.

TABLE-2: PAINT MATERIALS
(Refer to *general notes* at the end of this section)

DESCRIPTION	P-6	P-7	P-4
Technical name	Epoxy Zinc Phosphate Primer	Cold Galvanizing product	Etch Primer/Wash Primer
Type and composition	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack synthetic resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.
Volume solids % Minimum	49	37	9
DFT per coat, µ	40-50	40-50	8-10
Theoretical covering capacity in m^2/coat/ litre	8-10	4m^2/kg	8-10
Weight per litre in Kg/litre	1.4±0.05	2.67 kg at 15^oC	1.2±0.05
Touch dry at 30^oC (max.)	30 min.	10 min.	2 hrs.
Hard dry at 30^oC (max.), hrs	8	24	24
Over-coating interval, hrs	Min. 8	Min. 4	Min. 4-6
Pot life at 30 ^oC for two component paints, hrs	6 - 8	NA	NA
Adhesion (ASTM D 4541)	>7	NA	NA

Temperature resistance (min) ° C (ASTM D 2485 method B)	80 Dry service	50 Dry service	NA

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-2	F-3	F-6A/B	F-6C
Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build coating	Solvent less epoxy coating
Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint (free of alkyd/polyester resins).	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two-Pack Aromatic polyamine cured epoxy resin medium suitably pigmented. F-6B: polyamide cured epoxy resin medium suitably pigmented	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented
Volume Solids % Minimum.	40	36	57	98
DFT per coat, µ	30-40	30-40	100-125	250-500
Theoretical covering capacity in m^2/coat/litre	10-15	11-15	5-6	2-3
Weight per liter in Kg/litre	1.15±0.03	1.15±0.03	1.42±0.03	1.40±0.03
Touch dry at 30° C (max)	30 min.	30 min.	3 hrs	3 hrs
Hard dry at 30° C (max.), hrs	8	8	16	16
Full cure at 30° C (for immersion/ high temperature service)	NA	NA	5 days	5 days

Over-coating Interval, hrs	Min.12.	Min. Overnight	Min. Overnight Max. 5 days	Min. 8. Max. 48
Pot life (approx.) at 30°C for two component paints, hrs	5-8	NA	3-6	0.5
Adhesion (ASTM D 4541)	>5	>4	>7	>8
Abrasion Resistance (ASTM D4060) For 1000 g load	<300 mg /1000 cycles/CS17 OR <100 mg /1000 cycles/CS10	NA	NA	NA
Temperature resistance (min.) ° C (ASTM D 2485 method B)	80 Dry service	60 Dry service	80 Dry service	120, dry service 50, immersion

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-7	F-8	F-9 (primer)	F-11	F-12
Technical name	High build coal tar epoxy coating.	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 up to 250°C dry temp.	Heat resistant silicone Aluminium Paint suitable up to 540°C dry temp.
Type & composition	Two pack polyamide cured epoxy resin blended with coal tar medium, suitably pigmented	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 as per ASTM D4752.	Heat resistant synthetic medium based two pack Aluminium paint suitable up to 250°C.	Single pack silicone resin based medium with Aluminium flakes.
Volume Solids % Minimum.	62	75	57	35	18
DFT per coat in µ	100-125	100-125	65-75	15-20	15-20
Theoretical covering capacity in M^2/coat/ litre	5.2-6.5	6.0-7.2	8-9	10-12	8-10
Weight per liter in Kg/litre	1.40±0.03	1.41±0.03	2.3±0.03	0.95±0.03	1.00±0.03
Touch dry at 30°C (maximum), hrs	4	3	0.5	3	0.5
Hard dry at 30°C (maximum), hrs	48	24	12	12	24
Full cure 30°C (for immersion /high temperature service)	5 days	5 days	NA	NA	NA

Over-coating interval, hrs	Min. 24 hrs max.5days	Min. 10	Min. 12 hrs at 20°C & 50% RH	Min. 24	Min. 24
Pot life at 30°C for two component Paints, hrs	4-6	1.5	4-6	NA	NA
Adhesion MPa (ASTM D 4541)	>5	>5	>5	NA	NA
Temperature resistance° C (min) (ASTM D 2485 method B)	80 Dry service	80 Dry service	400 Dry service	250 Dry service	540 Dry service

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-14	F-15	F-16	F-17	F-20
Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardener	Ambient temperature curing Poly Siloxane/ inert polymeric coating suitable for under insulation for CS and SS.	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Glass flake reinforced vinyl ester coating.
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	Suitable for high temperature service and under insulation coating for CS, alloy steel and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Two component glass flake filled vinyl ester lining for under immersion services up to 90 deg. C.
Volume Solids % Minimum.	67	67	58	98	98
DFT per coat in microns	100-125	75-100	75-100	300-450	500-600
Theoretical covering capacity in M^2/coat/ litre	5-8	4-5	7.0- 9.0	6.5 – 8	1.6 minimum
Weight per liter in Kg/litre (mix paint)	1.45±0.03	1.65±0.03	1.3	1.7	>1.2
Touch dry at 30°C (max) , hrs	4	3	1	2	2
Hard dry at 30°C (max), hrs	24	24	16	24	4

Full cure 30°C (for immersion / high temp service)	168 hrs (7 days)	168 hrs (7 days)	NA	168 hrs (7 days)	96 hrs (4 days)
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	Min. 4 hrs Max.3 days
Pot life at 30ºC, hrs (for two component paints)	4	4-6	1	1	50 min-1 hr
Adhesion, MPa (ASTM D 4541)	>6	>7	>8 : siloxane NA: for inert polymeric matrix	>8	>7, Tensile strength >20N/mm2 (ASTM D 638)
Temperature resistance (min) º C (ASTM D 2485 method B)	-45 to 125 Under insulation & immersion	-45 to 150 Under insulation & immersion	550 Under insulation	-45 to 150 Immersion service	90 immersion service

General notes for TABLE-2:

1. Covering capacity and DFT achieved per coat depends on method of application. Covering capacity specified above is theoretical. For estimation of actual quantity of paints required, include the losses during application. Minimum specified DFT should be maintained in any case.
2. All primers and finish coats should be ambient temperature curing 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. Wherever a deviation is noticed from the specification in manufacturer data sheet, more stringent one between the data sheet and the specification shall prevail e.g. if this specification recommends Sa 2 ½ and the manufacturer data sheet requires Sa3, the surface preparation shall be done as per Sa 3. However in another case if this specification requires the surface preparation of Sa 2 ½ and the manufacturer data sheet recommends only Sa 2 as minimum, the surface preparation shall be done as per Sa 2 ½.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. Higher specific gravity of F-9 is also acceptable.
6. Internationally recognized & acceptable testing method shall be used for lab testing (for clause – 15.1) wherever testing standard is not mentioned.
7. Theoretical covering capacity, hard dry, full cure period & over coating interval shall be as per manufacturer's data sheets and no testing is required. Slight variation in the

values of these parameters may be permissible with the discretion of engineer-in-charge.

7.0 COATING SYSTEMS

The coating system should be selected based on the plant location as given below:

Classification based on plant location:

a) Plant located in inland area (more than 50 km from coast).
Environment classification – Industrial

- For offsite areas: Table-5 to be followed.
- For all unit areas including DM, CPP and cooling tower: Table-6 to be followed.

b) Plant located on sea coast or within 50 km from sea coast.
Environment classification- Industrial marine

- For offsite area, unit areas including DM, CPP, cooling tower etc.: Table-6 to be followed.

c) For external surface of above ground tanks, Table-8 to be followed for all locations (inland or coastal)

General notes for clause 7.0:

1. Coating systems (primers, finish paints etc.) based on area classification/environments/applications are tabulated in Table-4 to Table-13
2. Repair of pre-erection/pre-fabrication & shop priming after erection/ welding shall be done as per Table-3.

TABLE-3: REPAIR OF PRE-ERECTION/PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION/WELDING

(For all un-insulated CS, LTCS & low allow steel items in all environments)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
3.1	-90 to 400	SSPC-SP-3	1 coat of F-9	65-75	See Note-1 below and clause 5.9.3
3.2	401 to 550	SSPC-SP-3	1 coat of F-12	20	

Notes for Table-3:

Note-1: The application and repair of pre-erection/pre-fabrication or shop primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-9 or F-12 as applicable.

TABLE-4: COATING SYSTEM FOR GI HAND RAILS & GI ITEMS

(Refer clause 2.2.2)

Sl. No.	Design Temp. in °C	Coating System	Total DFT in Microns (min.)	Remarks
4.1	Up to 60	Hot Dip Galvanizing to 80-85 microns (600-610 gm/m^2)as per IS 4759, 2629, 4736, 2633 + 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	80 of finish coat (excluding the thickness of galvanizing)	-

General notes for Table-4:

1. No galvanized specimen shall have thickness less than 80 microns.
2. Repair of the damaged areas of galvanized coatings due to welding during erection shall be carried out as per recommended practice IS: 11759, using cold galvanizing spray process. Organic paint systems are not acceptable for the repair.
3. After repair of damaged galvanized coating by cold galvanization (P-7), the repaired area shall be top coated with paint system as given in table-4 above (i.e. 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat).
4. Suggested cold galvanizing manufacturers are ZINGA, LOCTITE or Z.R.C.
5. Galvanized gratings don't require painting in general until otherwise specified elsewhere or as per the requirement of the OWNER. Ladders, stairways & hand rails require painting to meet the colour coding requirement of the OWNER. Contractor has to ensure the applicable colour coding prior to application of coating as per this clause.

TABLE-5: COATING SYSTEM FOR NORMAL CORROSIVE AREAS (OFFSITES)
(For all un-insulated above ground CS, LTCS & low allow steel piping, equipment, valves, vessels & columns etc.)

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
5.1	-45 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	-	None	65-75	No over-coating shall be done on F-9 F-12 shall be ambient temperature curing type
5.2	-16 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @ 40 µ DFT/coat	1coat of F-6B @ 100 µ DFT/coat+ 1 coat of F-2 @ 40µ DFT/coat	245-255	
5.3	81 to 250	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	-	2 coats of F-11 @ 20µ DFT/coat (2x20=40)	105	
5.4	251 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	-	2 coats of F-12 @ 20µ DFT/coat (2x20=40)	105-115	
5.5	>400	SSPC-SP-10; 1coat of F-12 @ 20µ DFT/coat	-	2 coats of F-12 @20µ DFT/coat (2x20=40)	60	This system is suitable up to 540 º C

General notes for Table-5:

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. Flare line within unit or offsite areas shall be coated as per clause 6.3 of Table-6.
3. If the application of pre-erection/pre-fabrication/shop primer has already been completed, the same shall not be repeated in the field. In case the damages to the primer coat are severe and are spread over large areas, the Engineer-In-Charge may decide & advise re-blasting and re-application of the primer coat. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table-3.
4. In case of paint systems as per sl. nos. 5.4 and 5.5, the colour bands shall be applied over the aluminum paint as per the colour coding requirement for specific service of the piping.
5. All coating system including surface preparation, primer, intermediate and finish coat for piping is recommended to be done at field only until otherwise specified.

6. For equipment, vessels, columns & valves etc scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR and PR etc.

TABLE-6: COATING SYSTEM FOR CORROSIVE AREAS (PROCESS UNITS, COOLING TOWER, DM AND CPP)

(For all un-insulated above ground CS, LTCS & low allow steel piping, equipment, valves, vessels & columns etc.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
6.1	-45 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/ coat	-	-	65-75	a)No over coating on F-9 is allowed b) F-12 shall be ambient temperature curing type
6.2	-16 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/ coat	1 coat of P-6 @ 40 µ DFT/ coat	2 coats of F-6B @ 100 µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat (2x100 + 40= 240)	345-355	
6.3	81 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/ coat	-	2 coats of F-12 @ 20µ DFT/coat 2x20=40	105-115	
6.4	>400	SSPC-SP-10; 1coat of F-12 @ 20-25µ DFT/coat	-	2 coats of F-12 @ 20-25µ DFT/coat (2x20=40)	60	This system is suitable up to 540 ° C

General notes for TABLE-6:

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 as per tender document and scope of work.
2. If the application of pre-erection/pre-fabrication/shop primer has already been completed, the same shall not be repeated in the field. In case the damages to the primer coat are severe and spread over large areas, the Engineer-In-Charge may decide & advise re-blasting and re-application of the primer coat. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table-3.

3. For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system as per 6.3 above shall be followed.

4. For external surface of RCC Chimney, 2 coats of F-6 B@ 100µ DFT/coat to obtain a total DFT of 200 µ shall be applied after proper surface preparation as per guidelines in 5.1.6.

5. In case of paint systems as per sl. nos. 6.3 and 6.4, the colour bands shall be applied over the aluminum paint as per the colour coding requirement for specific service of piping given in clause 9.0.

6. For piping, equipment, vessels, columns & valves etc, scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, and PR etc.

TABLE-7: COATING SYSTEMS FOR EFFLUENT TREATMENT PLANT (ETP)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
7.1	For external surfaces of C.S./M.S. items: screens, walk way bridges, baffles, dual media filters, vertical pumps, piping in treated effluent sump, bio sludge pump, screw pump and pump house, CS tanks, sumps and vessels.					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat	2 coats of F-6A @100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat (2x100+40 =240)	305-315	-
7.2	For internal surfaces of CS/MS Items: bio-sludge sump, filter feed sump, process sump, sanitary sump, transfer sump, sludge, slop oil tank, scrapping mechanism in clarifier.					
	-14 to 80	SSPS-SP-10	1 coat of F-6A @ 65-100µ DFT/coat.	3 coats of F-6A @100µ DFT/coat (3x100=300)	300	Note-1
7.3	All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc. in process sump, TPI separator (process and oil), aeration tank and transfer sump etc.					
	-14 to 80	Blast cleaning to SSPC-SP guide lines and acid etching with 10-15% HCl acid followed by thorough water washing.	Epoxy screed lining		3000	Epoxy screed lining shall be applied as per manufacturer and Engineer-In-Charge instructions
7.4	C.S/M.S dual media filters (internal), chemical dosing tanks(internal) such as di-ammonium phosphate (DAP) and urea					
	Up to 60	SSPC-SP-10	1 coat of clear two component solvent free vinyl ester primer @ 100µ DFT/ Coat + 2 coats of F-20 @ 500µ DFT/ Coat		1100	-

Note-1
The paint /coating manufacturers shall provide their quality control test certificate of coating materials (F-6A) for immersion service of the exposed effluent.

TABLE-8: EXTERNAL COATING SYSTEMS FOR UN-INSULATED CARBON STEEL AND LOW ALLOY STEEL STORAGE TANKS

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system (Note-1)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
8.1	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external and internal floating roof and associated external structural works.					
8.1.1	-14 to 80	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat	2 coats of F-6B @ 100µ DFT /coat + 1 coat of F-2 @ 40µ DFT/ coat	345-355	F-6 should be suitable for occasional water immersion
8.1.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat	1 coat of F-15 finish coat @80µ DFT/ coat + 1coat of F-2 @ 40µ DFT/ coat	240	-
8.1.3	151 to 400	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat	2 coats of F-12 @20 µ DFT/ coat or 1 coat of F-16 @ 125 µ DFT / coat	105-115 or 190-200	For higher design temperatures, system as per 8.2.3 of this table is applicable
8.2	External surfaces of bottom plate (soil side) for all storage tanks.					
8.2.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	3 coats of F-7@ 100µ DFT/coat (3x100=300)	365-375	F-7 should be suitable for immersion service of the products given
8.2.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat (80+80=160)	1 coat of F-15 finish coat @ 80µ DFT/ coat	240	-

8.2.3	151 to 450	SSPC-SP-10	1 coat of F-16 @ 125 µ DFT/coat	1 coat of F-16 @ 125 µ DFT/coat	250	This system is suitable for design temperatures up to 550^{0}C
8.3	For underside of the bottom plate (in case tank is not lifted during PWHT) (Note- 2)					
8.3.1	-180 to 650 (Note-3)	For CS SSPC SP-10 For SS SSPC-SP-7 (15-25µ surface profile)	1 coat of inert polymeric matrix coating @ 125 µ	1 coats of inert polymeric matrix coating @ 125 µ	250-300	-

Notes for TABLE-8:

1. All paint coating application including primer for tanks shall be carried out at field after erection and completion of entire welding.

2. For underside of bottom plate :
   a) Painting shall be carried out before laying the bottom plate for tanks with non-Post Weld Heat Treatment (PWHT).
   b) For tanks with PWHT, painting shall be carried out after PWHT.
   c) In case tank is not lifted during PWHT then painting shall be applied before laying the bottom plate, clause no.8.3.1 shall be followed.

3. The temperature range indicated (-180 to 650 deg C) corresponds to the temperature resistance of coating material i.e. inert polymeric matrix coating.

Caution: PWHT temperature shall not exceed 650^{o}C

TABLE-9: INTERNAL COATING SYSTEMS FOR CARBON STEEL AND LOW ALLOY STORAGE TANKS

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
9.1	Crude oil, ATF, turpentine oil, lubricating oil: Underside of floating roof, internal surface of cone roof, inside of bottom plate, internal surfaces of shell - including wetted and free board height, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel, ladders and other CS internals.					
9.1.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat	240	-
9.2	Petroleum products & intermediates like LDO, HSD, gas oil, feeds of FCC-PC, FCC-LCO, VGO-HDT, ISOM, DHDT, reformate, DCU, NHT & gasoline, naphtha, isomerate and kerosene: Underside of floating roofs, internal surface of cone roof, inside of bottom plate, internal surfaces of bare shell for full height, underside of floating roof, oil side surfaces of deck plates, oil side surfaces of pontoons, support structures and ladders etc.					
9.2.1	-14 to 45	SSPC-SP-10	1 coat of F-9 @ 65-75 µ DFT/coat	-	65-75	-
9.2.2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat	240	-
9.3	Potable, Raw & Fire water All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.3.1	-14 to 60	SSPC-SP-10	1 Coat of F-6A @ 100 µ DFT/coat	2 Coats of F-6A @ 100µ DFT/ Coat (2x100=200)	300	Note-1
9.4	De-mineralized (DM) water & Condensates etc.: All internal surfaces, accessories and roof structures of cone and dome roof tanks.					
9.4.1	-14 to 60	SSPC-SP-10	1 Coat of F-6A @ 100µ DFT/coat	2 coats of F-6C @ 200µ DFT/ coat (2x200=400)	500	Single coat of F-6C is also acceptable

9.4.2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat (80+80=160)	240	-
9.5	Hydrochloric acid (HCl) 10 %: All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.5.1	-14 to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100µ DFT/ Coat	2 Coats of F-20 @ 500µ DFT/ Coat	1100	-
9.6	Aggressive solvents like hexane, hexene, benzene, xylene and toluene: All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.6.1	-14 to 65	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	-	65-75	-
9.7	Ethylene glycol tanks: Internal shell-full height, bottom plate, underside of roof and all accessories					
9.7.1	All	SSPC-SP-10	-	3 coats of vinyl chloride co-polymer @ 75µ /Coat; (3x75=225)	225	-
9.8	Inside pontoon and inside of double deck of all floating roofs					
9.8.1	-14 to 80	SSPC-SP-3	1 coat of F-8 @ 100µ DFT/coat	1 coat of F-8 @ 100µ DFT/coat	200	-
9.9	Wet slops, amine solutions, sour water , water draw off: All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.9.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat (80+80=160)	240	-
9.10	Vacuum residue, fuel oil , dry slop, bitumen and other high temperature hydrocarbon liquids: Underside of floating roof, internal surface of cone roof, bottom plate, inside of bare shell- including wetted and non wetted surfaces, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel and ladders					
9.10.1	Up to 150°C	SSPC-SP-10		1 coat of F-17 @ 375µ DFT/coat	375-425	-
9.11	Alkalis up to 50 % concentration: All internal surfaces, accessories and roof structures of cone and dome roof tanks					

9.11.1	Up to 60°C	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	2 Coats of F-6 A @ 100µ DFT/coat (2x100=200)	280	-

Notes for TABLE-9:

1. F-6 A shall be suitable for drinking water service and should have competent authority certification.

TABLE-10: COATING SYSTEMS FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND VESSLES

Sl. No.	Design Temp. in °C	Surface Preparation & Shop Primer	Coating system		Total DFT in Microns (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
10.1	Underground carbon steel plant piping					
10.1.1	25 to 75	-	As per document B016/B015-000-79-41-PLS-04	3layer polyethylene (3LPE) coating as per document B016/B015-000-79-41-PLS-04	--	--
10.1.2	76 to 150	-	SSPC-SP-10; 1 coat of F-17 primer @400 µ DFT/ coat	1 coat of F-17 @ 400 DFT/coat	800	-
10.1.3	151 to 450	-	SSPC-SP-10; 1 coat of F-16 primer @ 125µ DFT/ coat	1 coat of F-16 @125µ DFT/ coat	250	This system is suitable up to 550^{0}C
10.2	External side of un-insulated underground storage vessels					
10.2.1	-40 to 80	SSPC-SP -10; 1 coat of F-9 @ 65-75µ DFT/ coat	-	3 coats of F-7 @ 100µ DFT/coat	365-375	-
10.2.2	81 to 150	SSPC-SP -10	1 coat of F-17 primer @400 µ DFT/ coat	1 coat of F-17 @400µ DFT/ coat	800	-
10.2.3	151 to 450	SSPC-SP -10; 1 coat of F-16 @ 125µ DFT/ coat	-	1 coat of F-16 finish coat @125µ DFT/ coat	250	This system is suitable up to 550^{0}C

Notes for TABLE-10:

1 For underground vessels, scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, PR etc.

TABLE-11: COATING SYSTEMS FOR UNDER INSULATION (ALL UNIT AREAS & OFFSITES)

(For insulated piping, equipment, storage vessels, tanks, columns etc. of carbon steel, LTCS, alloy steel & stainless steels in all environments.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating system		Total DFT Microns (min.)	Remarks
			Primer	Finish paint		
11.1	Carbon steel, LTCS and Low alloy steel Piping, Storage tanks, Vessels, Equipments etc					
11.1.1	-45 to 125	SSPC-SP-10; 1coat of F-15 @ 75µ DFT/coat	None	2 coats of F-15 @75µ DFT/coat	225	
11.1.2	126 to 450 (Carbon steel)	SSPC-SP-10; 1 coat of F-12 @20µ DFT/coat	None	2 coats of F-12 @20µ DFT/coat	60	This system is suitable up to 540 ° C for low alloy steels
11.2	Stainless Steel, Alloy Steel, Alloy-20 Piping, Vessels & Equipments					
11.2.1	-45 to 125	SSPC-SP-7; (15-25µ surface profile) 1 coat of F-15 @75 µ DFT/coat	None	2 coats of F-15 @75µ DFT/coat	225	
11.2.2	126 to 550	SSPC-SP-7; (15-25µ surface profile) 1 coat of F-16 @125µ DFT/coat	None	1 coat of F-16 @125µ DFT/coat	250	
11.3	Cyclic service of CS, LTCS, SS, & Alloy Steels					
11.3.1	-45 to 150 (Note-1)	SSPC-SP-10 For CS, LTCS & low Alloy steel. SSPC-SP-7 for SS; (15-25µ surface profile) 1 coat of F-15 @75 µ DFT/coat	None	2 coats of F-15 @75µ DFT/coat	225	

11.3.2	-180 to 650 (Note-2)	SSPC-SP-10 for CS, LTCS & Alloy steel. SSPC-SP-7 for SS (15-25µ surface profile) 1 coat of Inert polymeric matrix coating @ 125µ DFT/coat	None	1 coat of Inert polymer matrix coating @ 125µ DFT/coat	250	(Note-3 & 4)

Notes

1. In case of overlapping of cyclic temperature ranges as mentioned in 11.3.1 and 11.3.2 then clause 11.3.1 shall be followed.

2. The temperature range indicated (-180 to 650 deg C) corresponds to the applicability of the coating material i.e. inert polymeric matrix coating.

3. Alternatively thermally sprayed aluminium (TSA) coating @ 500µ as per Annexure-1 of 6-79-0020 Rev.0 is acceptable.

4. This coating system is applicable for any other temperature range (180 to 650 °C) of CS, SS etc. which are not covered in clauses 11.1 or 11.2.

General notes for TABLE-11:

1. "Cyclic Service" is characterized by rapid or periodical temperature fluctuation or temperature cycles.
2. The blasting abrasives for SS and alloy steels shall be aluminum oxide or garnet only.
3. For insulated vessels & equipment scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR , MR, PR etc.

TABLE-12: COATING SYSTEM (INTERNAL PROTECTION) FOR CARBON STEEL COMPONENTS OF COOLERS/CONDENSERS FOR FRESH WATER SERVICE

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
12.1	Up to 80	SSPC-SP-10	1 coat of F-15 @ 80 µ DFT/coat	2 coats of F-15 @ 80 80 µ DFT/coat	240	-
12.2	81 to 140	SSPC-SP-10	---	1 coat of novolac epoxy	1500	-

TABLE-13: COATING SYSTEM (INTERNAL PROTECTION) FOR GALVANIZED OR NON FERROUS OR STAINLESS STEEL/ DUPLEX STAINLESS STEEL COMPONENTS OF COOLERS/ CONDENSERS FOR FRESH WATER SERVICE

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
13.1	Up to 80	Sweep Blasting	1 coat of F-15 @ 80µ DFT/coat;	1 coat of F-15 @ 80µ DFT/coat;	160	-
13.2	81 to 140	Sweep Blasting	-	1 coat of novolac epoxy	1500	-

8.0 STORAGE

8.1 All paints and painting materials shall be stored in rooms only which are 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 INFLAMMABLE" shall be clearly displayed outside. Manufacturers' recommendation shall be followed for storage of paint materials.

9.0 COLOUR CODE

As per ANNEXURE-1 (HPCL colour coding) of this document

10.0 IDENTIFICATION OF VESSELS, PIPING ETC.

As per ANNEXURE-1 (HPCL colour coding) of this document

11.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

As per HPCL's requirement and instructions. However for general guidelines, EIL standard 6-79-0020 may be referred.

12.0 QUALITY CONTROL, INSPECTION AND TESTING

12.1 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 manufacturers' test certificates. Paint formulations without certificates are not acceptable (see section 14.0 & 15.0).

12.2 The CONTRACTOR must produce test certificate from pre qualified paint manufacturer for various tests as detailed out in section 15.0 of this document. The Engineer-In-Charge shall have the right to test wet samples of paint at random for verifying quality of paint supplied. CONTRACTOR shall arrange to have such tests, when required by Engineer-in-Charge, performed at his cost at any one of the NABL accredited laboratories.

Samples for the test will be drawn at random in presence Engineer-In-Charge or his representations. Following tests to be carried out if called for by Engineer-in-Charge:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)
- Drying time (touch dry & full curing)
- Adhesion
- Storage stability (pot life)

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

12.3 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

Following tests are to be carried out during surface preparation:

- Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP-1 shall be tested as per following procedure to validate absence of oil and grease contamination:

a) Visual inspection - continue degreasing until all visible signs of contamination are removed.
b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination. Continue degreasing and inspection till test is passed.

- Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m^2 of blasted surface and a minimum of 3 checks per shift.

- Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m^2.Checks shall be done on each component at least once per 200 m^2 of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of IS 12944-4 (water cleaning). After cleaning, surface shall be retested for salt after drying.

- Blast profile measurement – This shall be done as described in sec 6.2 of **Annexure-I** of 6-79-0020 Rev 0 (Specification for thermally sprayed Aluminium).

- Test for blasting Media and Blasting air- this shall be done as described in sec 6.6 of **Annexure-I** of 6-79-0020 Rev 0 (Specification for thermally sprayed Aluminium).

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate or zinc rich epoxy or zinc phosphate. 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 rectifying any defects found during final inspection/guarantee period/defect liability period as defined in general conditions of the contract. Dry film thickness (DFT) 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.

12.4 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. 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.

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.

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 MS test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elko meter'. 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.

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.

12.9 Final inspection of finished coating shall consist of the following:

1) **Coating dry film thickness check:** DFT measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. DFT gauge calibration, number of measurement shall be as per SSPC-DA-2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.

2) **Adhesion testing:** Adhesion of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel panel coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m2 of coated surface.
3) **Holiday detection check:** Holiday testing shall be conducted in accordance with NACE SP0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP0188. Any holiday is unacceptable and should be marked and repaired immediately.

The CONTRACTOR shall arrange for spot checking of paint materials for specific gravity, glow time (ford cup) and spreading rate.

12.11 Final Inspection of coating system

A final inspection shall be conducted prior to the acceptance of the work. The coating CONTRACTOR and the facility OWNER shall both be present and they shall sign an agreed inspection report. Such reports shall include:

General

- Names of the coating CONTRACTOR and the responsible personnel
- Dates when work was performed

Coating Materials

- Information on coating materials being applied
- Condition of coating materials received

Environmental conditions

- Weather and ambient conditions
- Coating periods

Surface preparation

- Condition of surface before preparation
- Tools and methods used to prepare surface
- Condition of surface after preparation

Coating application

- Equipment used
- Mixing procedure prior to application
- Coating application techniques used

Testing

- Type and calibration of inspection instruments used
- Type of quality control tests performed, and results

13.0 GUARANTEE

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.

14.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR/SUB-CONTRACTOR

Painting CONTRACTOR who is awarded any job for EIL, Projects under this standard must have necessary equipment, machinery, tools and tackles for surface preparation, paint application and inspection. The CONTRACTOR must 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.

15.0 QUALIFICATION/ACCEPTANCE CRITERIA FOR PAINT COATING SYSTEM

15.1 Pre-qualification of paint coating manufacturer and his products

Paint manufacturer meeting the following requirements shall be considered by the CONTRACTOR for supply of the paint products.

- Manufacturer should have been in continuous business of paint coating formulation and manufacturer for at least past 5 years.

- Manufacturer should posses past experience of supplying his products to hydrocarbon, petrochemical, fertilizer. Chemical processing industry or offshore platforms in the past 5 years.

- Coating manufacturer should have supplied at least 10000 litre of an individual product to hydrocarbon, petrochemical, fertilizer. Chemical processing industry or offshore platforms.

- The manufacturer's manufacturing procedure & QA/QC system shall meet ISO 9001 requirements and preferably should posses ISO 14000 certificate.

- The Quality control set up should be manned by qualified paint technologists whose bio data should be sent along with quality control organization chart.

CONTRACTOR shall procure the paint materials from the qualified manufacturer meeting above requirements and after obtaining prequalification testing approval as per requirements mentioned in clause 15.2 below.

15.2 Pre-Qualification Testing procedure:

Pre-qualification testing of the paint products shall be carried out by selected paint manufacturer at any NABL accredited government laboratory like NTH. Paint manufacturer shall provide the paint samples to laboratory for testing of the parameters mentioned in Table-2 (typical characteristics) and Table-15 (tests on coating systems) of this specification. The testing laboratory will confirm the compliance of the paint material with respect to the acceptance criteria mentioned in the respective tables. CONTRACTOR shall furnish these test certificates along with all necessary supporting documents/information to EIL site for approval/ acceptance. The paint manufacturer will be qualified and approved by EIL site for supply of paints after review/assessment of the submissions made by the CONTRACTOR.

Test certificates which are more than 3 years old will not be considered. Paint manufacturers are advised to carryout pre-qualification testing accordingly for paint supply to EIL projects.

TABLE-15: PRE-QUALIFICATION TESTING

SYSTEM No.	COATING SYSTEM	REFERENCE CLAUSE (from table-3 to 12)	TOTAL DFT µ (min)
1.	F-9+P6+F6B+F2	6.2	345
2.	F12+F12+F12	6.4	60
3.	F15+F15+F15	8.1.2	240
4.	F16+F16	8.2.3	250
5.	F17	9.10.1	375
6.	F8+F8	9.8.1	200
7.	F9+F7+F7+F7	8.2.1	365
8.	F-20	9.5.1	1100
9.	F6A+F6C+F6C	9.4.1	500
10.	Inert Polymeric Matrix	8.3.1	250
11.	F6A+F6A+F6A	9.3.1	300

S. No.	TEST	FOR SYSTEM NUMBER	DURATION	ACCEPTANCE CRITERIA
1.	Cyclic Test Salt Spray : 72 hrs. Drying in air : 16 hrs. UV-A340 nm weather meter: 80 hrs. One cycle: 168 hrs. (25 cycles at 168 hrs. each cycle) (ASTM D5894)	1	4200 hrs	Shall pass. No chalking, cracking, flaking, blistering or peeling shall be observed.
2.	Chemical Resistance Test (ASTM D543)			
2a.	10% & 40% NaOH	3,5,8 & 11* *H_2SO_4 solution pH = 5.0 to 5.5 for system 11	1000 hrs	Shall pass. No cracking, discoloration, blistering, peeling or softening of film shall be observed.
2b.	5% H2SO4		168 hrs	
2c.	Xylene		4 weeks	
2d.	Acetone		4 weeks	
2e.	Ethanol		4 weeks	
2f.	Kerosene		4 weeks	
2g.	Sea water		2000 hrs	
3.	Immersion in DM/DI water @90^0 (ASTM C868)	3,5 & 8	30 days	No softening, blistering or film damage.

4.	Resistance to DM water using water immersion. (ASTM D870)	9	2000 hrs	Shall pass. No chalking, cracking, flaking, blistering or peeling.
5.	100% Humidity Test (ASTM D2247)	1 to 11 (except system-2)	1440 hrs	Shall pass
6.	Dry Heat Resistance Test (ASTM D2485 method B at 540º C for system 2 and 550º C for system 4)	2 & 4	-	Shall pass the test. No peeling, cracking, blistering, abnormal discoloration or loss of adhesion.
7.	Thermal Shock Resistance Test; 5 cycles @ 30 minutes in furnace at 120 º C and 15 minutes in water after quenching in water for each cycle. (ASTM D2485 method A)	2,3,4 & 10 (For system-2, testing to be done after heating the panels at 175°C for 2 hrs.)	-	Shall pass
8.	Cathodic Disbondment Test (ASTM G42 @60°C)	3 & 5	-	Shall pass

Each coating product to be qualified shall be identified by the following

1) Specific gravity of Base and curing agent (Ref. ISO 2811)
2) Ash content (ASTM D1650), volatile and non-volatile matters (ISO 3251) of each component

The identification shall be carried out on the batch, which is used for the Pre-qualification testing.

15.3 Information to be furnished during delivery of paint materials:

CONTRACTOR along with delivery of paint material has to furnish following information from paint manufacturer to EIL for acceptance/approval of products:

a) Batch test certificates:

Along with paint products delivery to site from the pre-qualified coating manufacturer, CONTRACTOR has to produce test certificate (from paint manufacturer) for each category of product for the following test items. All test results must mention clearly the batch no. and category of product tested. Tests to be conducted for following properties:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)

b) Product information sheet/ technical data sheet for each category of product.

The contractor shall be fully responsible for the quality of the paints products as per prequalification testing. After the paint materials are supplied to site, the supplier shall organize random sampling and testing in a NABL laboratory as per discretion of the Engineer-in-charge. Failing to meet the specified quality requirements may cause rejection of the paint products.

16.0 METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING

(Pre-Qualification tests (sec. 15.2), Batch testing (sec. 15.3) and Inspection testing (sec. 12.0))

16.1 Samples of coating materials should be submitted to the laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory.

16.2 All test panels should be prepared by testing laboratory. Surface preparation for a system shall be done in accordance with this specification. For individual products testing, minimum shall be Sa 2.5. Colour photographs of test panels should be taken before and after the test and should be enclosed along with test report.

Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code.

16.3 Manufacturers should intimate EIL, details of sample submitted for testing, name of testing agency, date, and contact personnel of the testing agency.

ANNEXURE-1

1.0 OBJECTIVE :

a. To specify the colour code for the Refinery Plant Systems in Onsite & Offsite areas
b. The objective of colour code is to ensure clear identification of different process and mechanical systems.

2.0 SCOPE & APPLICABILITY

a. The colour code covers refinery plant mechanical equipment like pipelines, supports, structurals, pumps, vessels, exchangers, columns, filters, valves, storage tanks and such mechanical systems.
b. Identification labeling is part of this colour code.
c. This colour code is applicable to all the existing Refinery Plants and systems in Onsite & Offsite areas.
d. This colour code is limited to the mechanical systems only
e. This colour code system is not applicable to
   i) Civil cement masonry based structures
   ii) Pipelines buried underground or submerged in water
   iii) Internal painting
f. This code does not envisage the specification of paint systems to be used

3.0 BASIS

This colour code is arrived at, after review of the following information and standards :

a. HPCL-VR existing Colour Code
b. EIL Colour code
c. BP Colour Code.
d. IS-2379: 1990 "Pipelines-Identification Colour Code"
e. DHT Project colour coding.
f. IS-5: 2007 for the purpose of Colour shade definition and identification.

4.0 RESPONSIBILITY

a. Head-Maintenance is responsible to ensure that this colour code is implemented in the existing Plants & offsite areas
b. Head-Operations is responsible to ensure awareness of this colour code among the operating personnel in all Plants.
c. Head-Maintenance Offsites is responsible to ensure that the colour code remains up-to-date in line with the prevailing statutory and OISD provisions.

5.0 BASE COLOUR & IDENTIFICATION BANDS:

5.1 Pipe lines & Storage tanks:

5.1.1 Base Colour:

For Pipelines & storage tanks, a combination system of "Base Colour & Identification Banding-Stenciling" is followed.

Base colour shall be applied throughout the entire length & area of un-insulated pipes, equipment, storage tanks etc.

Base colour coating of minimum 2 meters length shall be applied on the following:

a) metal cladding for insulated pipelines
b) on the non ferrous & SS pipes and plastic pipelines

Valves (gate/ globe/ diaphragm/butterfly etc.) except control/safety valves, shall be painted with the same colour as the main pipe line colour.

5.1.2 Colour Bands:

Colour bands are superimposed on the base colour to distinguish:

- One kind or condition of a fluid from another kind or condition of the same fluid
- One fluid from another but belonging to the same group

The Base colour may be common to a group of fluids whereas the colour band is exclusive to the fluid handled in the Pipeline. This approach is adopted only for Pipelines & Storage tanks.

For the Pipelines, the width of color band shall conform to following:

Nominal Pipe Size	Width of the Band in mm
3" NB and below	75
Over 3" NB upto 4" NB	Nominal size x 25
Over 4" NB upto 12" OD	Nominal size x 50/3
Over 14" OD	Nominal size x 15

All uninsulated pipe lines having temperatures above 100 deg.C (Heat resistant aluminium painted) need not be identified with colour bands. As special case, if required, colour bands may be applied using Teflon tapes.

For insulated pipe lines, the nominal size means the outside diameter of insulation.

For storage tanks, the color bands (at three locations) shall be a min. of 500 mm width for tanks upto 30 mts. dia and 1000 mm for tanks above 30 mts. Dia. These bands shall be painted over the entire height of the shell from bottom prominently at three locations visible from the approach road.

5.1.3 Lettering :

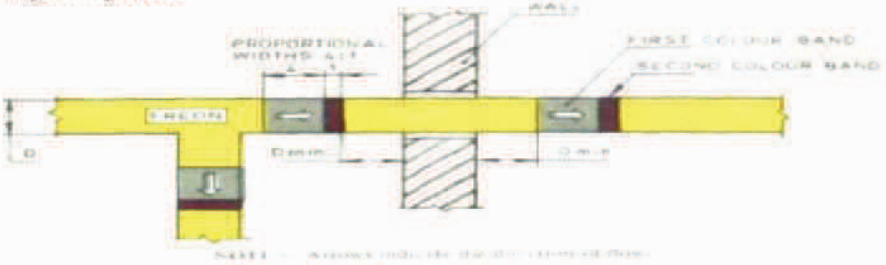
In case of Pipelines, stenciling is additionally carried out in the immediate vicinity of the identification bands.

For the Pipelines, the size of lettering shall conform to following:

Outside Diameter of Pipe or Covering (mm)	Size of Letter (mm)
20 to 30	10
Above 30 to 50	20
Above 50 to 80	30
Above 80 to 150	40
Above 150 to 250	90
Over 250	110

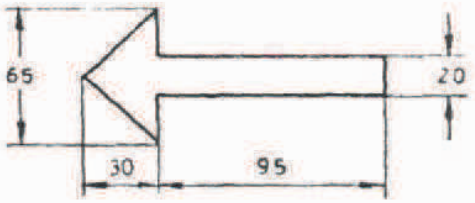
5.1.4 Marking of Direction of Flow:

Flow direction shall be indicated by arrows or letters painted near valves, junctions, walls, etc., and at suitable intervals along the pipe, in a manner best suited to local conditions (refer the fig. below). The arrows shall be painted black or white in color and in contrast to the color on which they are superimposed.

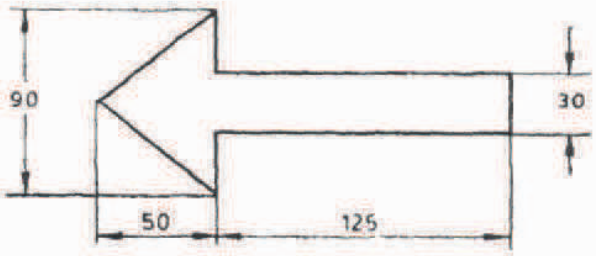


The size of arrow shall be as per the figure mentioned below. Product names shall be marked at pump inlet, outlet and battery limit in a suitable size

a) 8" dia & below (fig 6A)
b) above 8" dia size (fig. 6B)



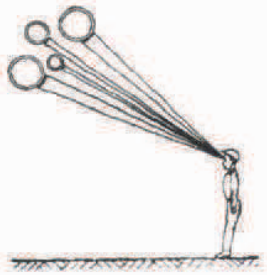
6A For Pipes DN 200 and Below



6B For Pipes Above DN 200

5.1.5 Visibility of Markings:

Attention shall be given to the visibility of color marking and the letterings. Where the pipelines are located above the normal line of vision of the operator, the lettering shall be placed below the horizontal line of the pipes, as shown in Figure below:



Preferably coloring shall be all around the pipe wherever possible, if not, the extent of coloring along the circumference is to be such that the colours and the markings are clearly visible.

The electrical illumination of plant in the night should be such that the shades of colors are not affected to ensure proper visibility in the night. Wherever legends and color bands are indicated, their location should be such that they are easily visible from floor/ground level during day time and extra illumination should be provided over them for night time or wherever visibility is poor.

Overhead pipe racks at road crossings shall be painted with zebra markings in yellow & black colour.

5.1.6 Locations for Marking Colour Bands

Base colour shall be applied throughout length of the piping whereas colour bands shall be applied at the following locations:

- At battery limit points
- At the intersection points and change of direction points in piping ways
- Other points such as mid-way of each piping ways, near valves, walls, either side of culverts/ road crossings
- For long stretch yard piping at 50m interval
- At start & terminating points
- Approaches, roads, overhead pipe rack crossings, stair case/monkey ladders

Flourescent bands on the pipelines are to be provided for night visibility for the locations such as overhead pipe racks at road crossings, stair cases, monkey ladders, wherever human interference is possible.

5.2 Equipment:

For equipment, general category items and miscellaneous items, only base colour is specified. No colour banding is required for this. Refer Table in Section 6.0 for base colour system for equipment.

Equipment number shall be stenciled in black and white on each vessel, heat exchanger, columns & machinery, after painting. Size of the letters printed for such purpose shall be 150 mm high for columns and vessels, 50 mm high for pump and other machinery.