

- 6.1.24 (New)
Unless otherwise specified in the process package or in the enquiry, controlled volume pumps shall be hydraulically operated sandwich/ double diaphragm type with rupture detection system through pressure transmitter for any of the following applications:
(i) Where liquids to be handled are flammable/ hazardous/ toxic/ radioactive.
(ii) Where liquids to be handled are expensive/ poisonous.
(iii) Where liquids contain solids such as slurries.
(iv) Any other application where no product leakage is acceptable.

- 6.1.25 (New)
For sizing of pump, maximum volumetric efficiency above 90% shall not be considered.

- 6.1.26 (New)
Thrust load on the plunger at safety relief valve set pressure shall not exceed 90% of design plunger thrust load.

- 6.1.27 (New)
Unless otherwise specified, each pump shall be provided with a calibration pot (with level gauge, as required) / graduated cylinder for calibration.

For multi head pumps, separate calibration cylinders or necessary piping arrangement with isolation valves shall be provided such that flow through each head can be calibrated.

For pumps with rated capacity greater than or equal to 1000 LPH (1 m³/hr), calibration pot shall be sized for minimum 15 seconds.

Calibration pot shall not be used for pumps in pyrophoric services.

- 6.1.28 (Addition)
For Pyrophoric services, pump head and check valve housing shall be made up of single cast to ensure there is no leakage of Pyrophoric liquid through pump liquid end casing. Also, a suitable provision for N₂ blanketing/purging of oil reservoir shall be included by pump vendor his scope for pumps offered in Pyrophoric pumping liquid services. N₂ consumption shall be minimum and return shall be vented safe to atm. Additionally, provision shall also to be provided for N₂ flushing in and return between the double diaphragms, for carrying out safe maintenance of pump in case of any diaphragm fails. Pump vendor shall provide similar references meeting above requirement in his proposal if they offered pump for Pyrophoric liquid presence in pumping liquid services.

6.3 LIQUID END CONNECTIONS

- 6.3.1 (Substitution)
Unless otherwise specified, inlet & outlet connections (including all purchaser's interface connections) shall be flanged type (either weld neck type or socket welded type). Slip on type or Backing type flanges are not acceptable.

- 6.3.4 (Substitution)
Openings for nozzles and other pressure casing connections shall be standard pipe sizes in accordance with ASME B16.5. Openings of 32 mm (1.25"), 65 mm (2.5"), 90 mm (3.5"), 125 mm (5"), 175 mm (7") & 225 mm (9") shall not be used.

6.4 **FLANGES**

6.4.1 (Substitution)
Flanges as per ANSI B16.5 shall be used.

6.5 **PUMP CHECK VALVES**

6.5.3 (Modification)
The words "if specified" stand replaced with "Unless otherwise specified".

6.8 **RELIEF VALVE APPLICATION**

6.8.1 (Modification)
The second sentence stands replaced with "The internal/integral relief valve set pressure shall be at least

- 110 % of the rated discharge pressure OR
- 2 kg/cm² over the rated discharge pressure OR
- Equal to the external relief valve set pressure, whichever is greater".

6.8.2 (Substitution)
All type of pumps (either diaphragm type or packed-plunger type) require external relief valves for mounting on piping within the pump package skid.

6.8.3 (New)
For pumps having capacities up-to 1 m³/hr, vendor shall furnish his standard proven relief valve. The material of construction of relief valve shall be equivalent or superior as compared to the material of wetted parts of the pump. However as a minimum the material of relief valve body shall be CS (ASTM A216 Gr. WCB) and internals shall be of SS 316. The inlet and outlet connections shall be flanged as per ANSI standards with raised faces. For pumps greater than 1 m³/hr, the relief valve shall be as per purchaser's specification and of the make approved by the purchaser.

6.8.4 (New)
Unless otherwise specified, the external relief valve set pressure shall be 10% over the rated discharge pressure or 2 kg/cm² over the rated discharge pressure whichever is higher.

Conventional valves shall be used for constant back pressure. Pilot operated pressure relief valves shall be used when Back pressure is greater than 50% of set pressure or when the difference between operating pressure and set pressure is within 10% of the set pressure.

6.8.5 (New)
When a back pressure valve is required, it shall be supplied by the vendor, irrespective of whether it is internal or external.

6.15 **NAMEPLATES AND ROTATION ARROWS**

6.15.3 (Modification)
Unless otherwise specified, SI units shall be shown on nameplate.

7 ACCESSORIES

7.1 DRIVERS

7.1.1.1 (Addition)

For multi-head pumps, ganging effect shall not be considered while sizing the driver.

7.3 BASEPLATES

7.3.1 (Addition)

The pump driver unit with all accessories and auxiliaries shall be supplied as a skid mounted package with all piping and auxiliaries within the confines of the skid. All accessories such as pulsation dampeners, relief valves, calibration pots etc. shall be mounted with isolation valves and shall be properly supported within the skid. Any instrument requiring connection to purchaser's control system shall be wired up-to a junction box (suitable for the specified area classification) at the edge of the skid.

7.3.12 (Modification)

- a) Replace the words "if specified" with "Unless otherwise specified".
- b) Baseplate to be provided with minimum 2" flanged drain connection.

7.3.22 (Modification)

Anchor bolts shall be furnished by the vendor.

7.8 PULSATION SUPPRESSION DEVICES

7.8.1 (Modification)

The words "If specified" stands replaced with "Unless otherwise specified".

7.8.3 (New)

Unless otherwise specified elsewhere, pulsation suppression device, shall be designed to limit amplitude of pulsation within $\pm 3\%$ of mean line pressure

The pulsation dampeners shall conform to ASME SEC VIII Div. 1.

7.8.4 (New)

Selection of material of complete pulsation dampener (i.e. both wetted and non wetted parts) and the bladder/ diaphragm shall be suitable for the liquid being handled & shall be at least equal or superior to wetted component's MOC.

7.8.5 (New)

When bladder/diaphragm type suppression device is specified, a gas charging assembly (kit) shall also be supplied by vendor.

7.8.6 (New)

Suction and discharge pulsation dampeners shall not be used for pumps in pyrophoric services.

8 INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

8.2 INSPECTION

8.2.1.1(f) Words "when specified" stand deleted.

8.2.3.5 (New)

Inspection shall also include dimensional check of pump and motor duly mounted on the base plate, in accordance with certified general assembly drawing.

8.3 TESTING

8.3.1.1 (Addition)

Unless otherwise specified, the test shall be witnessed by the Purchaser or by their authorised representative or by both together.

8.3.4.2 (Modification)

Flow repeatability and linearity tests shall be run in all the cases as described.

8.3.4.4 (Substitution)

Dismantle Inspection of pump after performance test shall be applicable only in case of abnormality in mechanical behaviour (such as excessive noise & vibration, bearing temperature rise etc.) during performance test.

8.4 PREPARATION FOR SHIPMENT

8.4.1 (Modification)

The equipment shall be protected for a storage of 12 months at site. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

9 VENDOR'S DATA

9.1 GENERAL

9.1.1 (Modification)

The information to be furnished by the vendor is specified in 9.2 & 9.3 and purchaser's Vendor Data Requirements as included in the inquiry document.

Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX" to the purchaser (Destination & contact person as per order).

No drawing shall be taken up for review till the DCI for inquiry/order is finalized by vendor.

If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document.

9.2 PROPOSAL

9.2.1 (Addition)

All documents shall be furnished in metric units and shall be in English language.

9.3 CONTRACT DATA

9.3.5.4 **Technical Data Manual/Mechanical Catalogue (Modification)**

Words "when specified" stand deleted.

- 9.3.5.5 All post order documents shall be submitted / approved through EIL VDM portal.
- 9.3.5.6 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

निश्चित विस्थापन पम्पस्-रोटरी के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR POSITIVE DISPLACEMENT PUMPS - ROTARY

6	04/09/24	REVISED & ISSUED AS STANDARD SPECIFICATION	AS	MG / TK	NK	MN
5	26/06/19	REVISED & ISSUED AS STANDARD SPECIFICATION	MKA	NK	SM	RKT
4	30/09/13	REVISED & ISSUED AS STANDARD SPECIFICATION	SKK	AM	DB	DM
3	15/06/07	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	SM	VKM	RK	GRR
2	04/09/92	REVISED & ISSUED AS STANDARD SPECIFICATION	VKM	KDS	VJN	GRR
1	15/12/97	REVISED & ISSUED AS STANDARD SPECIFICATION	VKM	KDS	SKG	AS
0	12/02/86	ISSUED AS STANDARD SPECIFICATION	VKM	MR	SNG	---
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
Approved by						

Abbreviations:

ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASTM	:	American Society for Testing and Materials
CD/DVD	:	Compact Disc / Digital Versatile Disc
DCI	:	Document Control Index
EIL	:	Engineers India Limited
ISO	:	International Organization for Standardization
MAWP	:	Maximum Allowable Working Pressure
NPIPA	:	Net Positive Inlet Pressure Available
NPIPR	:	Net Positive Inlet Pressure Required
NPSH	:	Net Positive Suction Head
NPSHA	:	Net Positive Suction Head Available
NPSHR	:	Net Positive Suction Head Required
P&ID	:	Piping and Instrumentation Diagram
PLV	:	Pressure Limiting Valve
PSV	:	Pressure Safety Valve
PTR	:	Proven Track Record
VDM	:	Vendor Document Management
VDR	:	Vendor Data Requirements

SMED-II (Rotating Equipment) Standards Committee

Convenor: Mr. Nalin Kumar

Members: Mr. Tarun Kumar
Mr. J S Duggal
Mr. Abhay Kumar
Mr. Mahesh Easwaran
Mr. Mahesh Gupta
Mr. Pintu Lal
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I SCOPE (Substitution)

- (i) This specification together with the attendant Data Sheets and other specifications/attachments to inquiry/order defines the minimum requirements for Positive Displacement Pumps - Rotary type and their accessories/auxiliaries.
- (ii) Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.
- (iii) Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.

- (iv) Except as modified herein, the Positive Displacement Pumps (Rotary) shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard 676-4th Edition, February 2022, Positive Displacement Pumps - Rotary**.
- (v) Except for new paragraphs, the number and title of the paragraphs in this specification correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance with **API Standard 676, Fourth edition, February 2022**.

The word in parenthesis following the number or title of a paragraph indicates the following:

(Addition)	:	An addition to a part, section or paragraph referred to.
(Modification)	:	An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph.
(Substitution)	:	A substitution has been made for the corresponding section or paragraph of the standard in its totality.
(New)	:	A new section or paragraph having no corresponding section or paragraph in the Standard.
(Delete)	:	The paragraph is deleted.

1.1 EXPERIENCE CRITERIA (New)

- 1.1.1 The pump model offered shall be from the existing pump model series and shall be from the regular manufacturing range of the vendor (**Prototypes are not acceptable**).

The mechanical design as well as the hydraulic performance (including NPIPR/NPSHR) for the complete range of operation of the offered model shall have been established in the shop test. (Details are to be furnished, if required).

The offered pump model size, type and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions (including viscosity) and pumping liquid and material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.

(Note: Similar operating/design conditions & driver rating would mean approx. 80% or higher; Pumping liquid and material of construction would mean references in the same model series, are also acceptable.)

1.1.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump model meets the above experience requirements furnishing details of flow, differential pressure, operating pressures & temperatures, pumping liquid, viscosity, driver rating, speed, mechanical design (i.e. type of pump), material of construction etc., as applicable in the format. In addition, manufacturer's catalogue and general reference list for Positive Displacement Pumps (Rotary) shall also be furnished along with the proposal.

1.1.3 Multiple references can be furnished to justify the above. Bareshaft pump supplies/partial scope supplies will not be construed as valid references.

2 NORMATIVE REFERENCES

(Modification)

For undated references (including any amendments) the latest edition as on date of issue of inquiry or at a date specified in the inquiry document shall be applicable.

2.4 (Modification)

The last sentence stands deleted.

3 TERMS & DEFINITION

3.50 **VENDOR** (Substitution)

The vendor shall be a manufacturer of Positive Displacement Pumps - Rotary (as per API 676) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete Positive Displacement Pumps (Rotary) package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed Positive Displacement Pumps (Rotary).

4 GENERAL

4.1 **UNIT RESPONSIBILITY** (Addition)

The pump vendor shall have UNIT RESPONSIBILITY of complete pump package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.

5.3 DOCUMENTATION REQUIREMENTS

Hierarchy of Documents (Addition)

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications/scope of work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date

specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

6 BASIC DESIGN

6.1 GENERAL

6.1.1.1 (Modification)

Pump shall be selected for the specified capacity at the min. specified viscosity and the specified discharge pressure (max. differential pressure).

6.1.5 (Addition)

The maximum permissible sound level shall not exceed 85 dBA when measured at 1 meter from pump surface.

6.1.14.3 (Modification)

"If specified" stands deleted.

6.1.15 (Modification)

Unless otherwise specified, equipment shall be designed to be suitable for outdoor installation without a roof.

6.2 SELECTION AND RATING OF PUMP TYPE

6.2.1 (New)

Pumps where difference between NPIPA/NPSHA and NPIPR/NPSHR is less than one (1) metre are not acceptable. Vendor shall clearly indicate in his proposal the required NPSH value in terms of liquid column of the operating medium.

6.3 PRESSURE-CONTAINING AND PRESSURE-RETAINING PARTS

6.3.2 (Modification)

PLVs/PSVs shall be furnished by vendor.

6.3.3.2 (Modification)

"If specified" stands deleted.

6.3.7 (Substitution)

Jackets shall be designed for a minimum of 8.0 kg/cm²g working pressure and shall be suitable for hydrostatic testing at a minimum of 12.0 kg/cm²g.

6.4 CASING CONNECTIONS

6.4.3 Casing Opening Sizes

6.4.3.1 (Modification)

In the event that nozzle size of 32 mm (1½ inch), 65 mm (2½ inch), 90 mm (3½ inch), 125 mm (5 inch), 175 mm (7 inch) and 225 mm (9 inch) are offered, forged companion flanges (weld neck type) with nuts, bolts and gaskets shall be supplied along with pumps.

6.4.4 Suction and Discharge Nozzles

- 6.4.4.1 (Substitution)
All nozzles at purchaser's interface shall be flanged. Threaded connection at purchaser's interfaces shall not be used. Machined and Studded suction and discharge nozzles details shall be provided by vendor.
- 6.4.4.2 (Substitution)
Inlet and outlet connection shall be suitable for maximum allowable working pressure.
- 6.5 **AUXILIARY CONNECTIONS**
- 6.5.3.5 (Modification)
"If specified" stands changed to "Unless otherwise specified".
- 6.6 **FLANGES**
- 6.6.1 (Modification)
Flanges as per ASME / ANSI B16.5 or B16.1 shall be provided.
- 6.7 **EXTERNAL FORCES AND MOMENTS**
- 6.7.1 (Modification)
For twin screw and triple screw pumps, allowable forces and moments on inlet and outlet nozzles shall be twice the values indicated in table-2 nozzle loadings as minimum.
- The vendor shall furnish the results of the pipe load test for the proposed pump model(s) along with their proposal, indicating the shaft deflections at the coupling end, considering the pipe nozzle loads as twice the API 676 values.
In case pipe load test has not been conducted in the past, the vendor shall demonstrate the pipe load test (either Physical Testing or Computer Simulation Study) for the proposed pump model(s) at their manufacturing shops within four months of placement of order.
- 6.8 **ROTATING ELEMENTS**
- 6.8.1 Rotors
- 6.8.1.2 (Modification)
"If specified" stands deleted.
- 6.8.1.7 (Modification)
"If specified" stands changed to "Unless otherwise specified".
- 6.8.1.9 (Addition)
Certificate of balancing of rotor shall be furnished for twin screw pumps.
- 6.8.1.10 (New)
Rotors shall be interchangeable between identical pumps.
- 6.8.2 Timing Gears
- 6.8.2.3 (Modification)
"If specified" stands deleted.
- 6.9 **MECHANICAL SHAFT SEALS**
- 6.9.1 (Addition)
Only balanced type mechanical seal shall be provided.
- 6.9.19 (Modification)
"If specified" stands deleted.

- 6.10 **BEARINGS AND BEARING HOUSINGS**
- 6.10.6 (New)
For vertical pumps, provision shall be made within the pump to absorb thrust developed by the pump. Thrust developed by the pump shall not be transferred to the electric motor.
- 6.13 **MATERIALS**
- 6.13.2 Materials of Construction
- 6.13.2.13 (Modification)
Based on the fluid properties and composition, vendor shall recommend if reduced hardness materials are required for the intended duty.
- 6.13.2.13.1 (Modification)
The words "are specified" stand modified to "are recommended".
- 6.13.2.13.2 (Modification)
The words "are specified" stand modified to "are recommended".
- 6.13.2.13.3 (Modification)
The words "are specified" stand modified to "are recommended".
- 6.13.3 Castings
- 6.13.3.6 (Modification)
"If specified" stands changed to "Unless otherwise specified".
- 6.15 **STEAM HEATING / ELECTRICAL HEATING (New)**
- 6.15.1 If steam heating is contemplated from viscosity consideration, pump shall be provided with jackets on stuffing box and casing. If jacket is not feasible, steam heating coil may be offered as an alternative with coil inlet and outlet having flanged connections and suitably located to prevent condensate settlement. Material of coil shall be corrosion resistant suitable for pressure and temperature of the steam. Vendor shall specify the consumption of steam (kg/hr) and give specific confirmation on suitability for specified steam condition. If steam is not available, electrical heating may be provided for stuffing box and casing. Vendor to provide details of electrical heating like coil details, MOC, electrical power consumption etc.
- 7 **ACCESSORIES**
- 7.1 **DRIVERS**
- 7.1.3 Steam Turbines
- 7.1.3.1.2 (Modification)
The note after the clause stands deleted.
- 7.1.4 Gear Units
- 7.1.4.1 (Substitution)
Integral Gears with motor / geared motors are acceptable only for single screw pumps.
- 7.2 **COUPLINGS AND GUARDS**
- 7.2.15 (c,ii) (Modification)
"If specified" stands deleted.

7.3 **BELT DRIVES** (Substitution)

Belt Drives shall not be used.

7.4 **BASEPLATES**

7.4.1 (Substitution)

The vendor shall supply the common baseplate of fabricated steel, drain rim type, suitable for mounting of pump, driver and all associated auxiliaries. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate.

7.4.11.1 (Modification)

Baseplate to be provided with minimum 2" flanged drain connection

7.4.21 (Substitution)

Anchor Bolts shall be furnished by the vendor.

7.5 **PRESSURE-LIMITING VALVES (PLVs)**

7.5.2 (Modification)

PLVs / PSVs shall be furnished by vendor.

7.5.2.4 (Modification)

"If specified" stands deleted.

7.5.4 (New)

Unless otherwise specified, the PLV/PSV shall be as per purchaser's specification and of the make approved by the purchaser.

Unless otherwise specified, PLV/PSV shall be of external type. These shall be supplied loose by the vendor to be installed by purchaser in the purchaser's piping.

The material of construction of PLV/PSV shall be equivalent or superior as compared to the material of wetted parts of the pump. However, as a minimum the material of PLV body shall be CS (ASTM A216 Gr. WCB) and internals shall be of SS 316. The inlet and outlet connections shall be flanged as per ANSI standards.

Unless otherwise specified, the PLV/PSV set pressure shall be 10% over the rated discharge pressure or 2 kg/cm² over the rated discharge pressure, whichever is higher. PLV/PSV shall be selected to pass 100% rated capacity of pump.

Conventional valves shall be used for constant back pressure. Pilot operated pressure relief valves shall be used when Back pressure is greater than 50% of set pressure or when the difference between operating pressure and set pressure is within 10% of the set pressure.

8 **INSPECTION, TESTING AND PREPARATION FOR SHIPMENT**

8.2 **INSPECTION**

8.2.1 General

8.2.1.5 (New)

Inspection shall also include dimensional check of pump and driver duly mounted on the baseplate in accordance with certified general assembly drawing.

8.3 **TESTING**

8.3.1 General

8.3.1.2 (Modification)
"If specified" stands deleted.

8.3.4 Performance Test

8.3.4.1 (Addition)

The performance test shall be conducted by the vendor in his shop to obtain complete test data including speed, discharge pressure, suction pressure, efficiency, capacity, power, bearing temperature and vibrations etc. This test shall be conducted at rated speed. For all pumps (except for single screw pumps) performance test shall be carried out with testing oil (Performance Test using water is not acceptable). For single screw pumps, performance test shall be carried out with suitable fluid.

Where the viscosity of testing liquid is different from the pumping fluid, vendor shall submit viscosity correlation curves and calculations for arriving at the performance corresponding to the rated viscosity, prior to test for purchasers' approval.

8.3.4.2 (Modification)
"If specified, and" stands deleted.

8.3.4.3.1 This clause stands deleted.

8.3.5 Mechanical Run Test

8.3.5.1 This clause stands deleted.

8.3.5.2 (Substitution)

The pump shall be mechanically run for four hours. This shall be performed at rated flow. During Mechanical Run Test, vibration shall be measured on the bearing housing and on the baseplate for the capacity range of +/-10% of rated capacity. On the test bed the vibration amplitude shall not exceed 75 micron.

8.3.6 (Modification)

Test tolerance for single screw pumps shall be as per below table:

Characteristic Capacity	Tolerance(%)
At 100% speed*	+10, -0 of rated capacity
At 90% speed*	+10, -0 of rated capacity
At 60% speed*	+15, -0 of rated capacity
At 30% speed*	+15, -0 of rated capacity
Rated Power	Zero positive tolerance. (However, pumps may be accepted up-to 104% of guaranteed BKW).
NPSHR (at rated Capacity)	Zero positive tolerance.

*: pumping speed is in the units of capacity (i.e. m³/hr) & not in speed units (i.e. rpm)

8.3.7 Optional Tests

8.3.7.2 Complete Unit Test (Modification)

All the pumps (except for steam turbine drive pump) with forced feed lubrication system shall undergo complete unit test at rated speed in pump vendor shop. Job drive, job mechanical seal & job coupling shall be used (with motor getting loaded only upto its full load current value). Shop LO system, Shop machine monitoring instrumentation & controls & shop sealing system can be utilized for this test.

8.3.7.3 Sound Level Test (Substitution)

Unit Noise level shall be measured for reference during shop testing in accordance with ISO 3744.

- 8.3.7.4 High Discharge Pressure Test (Modification)
"If specified" stands deleted.
- 8.3.10 Strip Test (New)
After the performance test, the pump shall be stripped off to check for its wear and workmanship. Shaft under packing shall be checked for any abnormal rubbing and wear.
Note: Strip test / Dismantle Inspection of pump after the performance test shall be applicable only in case of abnormality in mechanical behaviour (such as excessive noise & vibration, bearing temperature rise etc.) during performance test.
- 8.3.11 Material Certificate (New)
As a minimum material test certificate (chemical and mechanical properties) shall be supplied for rotor, shaft sleeve and casing (Inserts if applicable).

8.4 PREPARATION FOR SHIPMENT

- 8.4.1.1 (Modification)
The preparation shall be suitable for at least 12 months of outdoor storage from the time of shipment unless specified otherwise in the inquiry or order. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

9 VENDOR'S DATA

9.1 GENERAL

- 9.1.1 (Substitution)
The information to be furnished by the vendor is specified in Annexure-D and purchaser's Vendor Data Requirements as included in the inquiry document.
Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX" to the purchaser (Destination & contact person as per order).
No drawing shall be taken up for review till the DCI for inquiry/order is finalized by vendor.

If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document.

Annexure-D

- D.1.1a) (Substitution)
The purchaser's/owner's/consultant's corporate name.
- D.2 PROPOSALS
- D.2.1 General
- D.2.1.2 (New)
All vendor data/drawings/documents shall be in English Language and in Metric Systems.
- D.3 ENGINEERING DESIGN DATA
- D.3.5.5 All post order documents shall be submitted / approved through EIL VDM portal.
- D.3.5.6 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

डोजिंग पैकेज (स्किडमाउंटिड) हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR DOSING PACKAGES (SKID MOUNTED)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by	
1	09.02.2021	REVISED AND ISSUED AS STANDARD SPECIFICATION	MK	AM	DB / AKN Standards Committee Convenor	SC Standards Bureau Chairman
0	03.07.2014	ISSUED AS STANDARD SPECIFICATION	SKK	AM	DB / AKN Standards Committee Convenor	SC Standards Bureau Chairman

Abbreviations:

ANSI : American National Standard Institute
API : American Petroleum Institute
ASTM : American Society for Testing and Materials
ASME : American Society for Mechanical Engineers
EC : Experience Criteria
NPSHA: Net Positive Suction Head Available
NPSHR: Net Positive Suction Head Required
PWHT : Post Weld Heat Treatment
PTR : Proven Track Record
VDM : Vendor Document Management
VDR : Vendor Data Requirements
B/L : Battery Limit
P&ID : Piping and Instrumentation Diagram
PMS : Piping Material Specification
VMS : Valve Material Specification
eDMS : Electronic Document Management System

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1.0 GENERAL

1.1 Scope

This specification describes the minimum requirements for engineering, manufacture, packaging, shop inspection & testing and supply of Skid Mounted Dosing Packages.

The Dosing package(s) shall be used to dose metered quantity of chemicals as per the requirements specified in the process data sheets, process P&IDs and other specifications forming part of inquiry document.

1.2 Conflicting Requirements

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications/scope of work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

2.0 CODES AND STANDARDS

a) Codes, Standards and Regulations

The following codes and standards-latest edition (as applicable) shall apply. In case any additional codes and standards are mentioned in the list of attachments, the same shall also be applicable.

Code	Title
API 675	Positive Displacement Pumps-Controlled Volume
ASME Section VIII Div.1	Rules for Construction of Pressure Vessels
ASME Sec. II A	Ferrous Material Specification
ASME Sec. II C	Specifications for Welding Rods, Electrodes, and Filler Metals
ASME Sec. II D	Material Properties
ASME Sec. V	Non Destructive Examination
ASME Sec. IX	Welding and Brazing Qualifications
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.47	Large Diameter Steel Flanges
ASME B16.20	Metallic Gaskets for Pipe Flanges
ASME B 16.21	Non -Metallic Gaskets for Pipe Flanges
ASME B 31.3	Process Piping

Code	Title
IS 4049 (Part-II)	Specification for Formed Ends for Vessels
API 650	Welded Tanks for Oil Storage
IS : 803	Code of Practice for Design, Fabrication, Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks
IS 4682	Code of Practice for Lining Vessels & Equipments for Chemical Process

Other international standards may be acceptable subject to their being equivalent or superior backed by proven track record for the application and prior approval of the Company.

b) **Standard Specifications**

Standards	Title
6-41-0021	Standard Specifications for Positive Displacement Pumps Controlled Volume
6-81-0052	Inspection and test plan for Pump Reciprocating (Controlled Volume)
6-78-0001	Specification for Quality Management System Requirements from Bidders
6-78-0003	Specification for Documentation Requirements from Suppliers
6-51-0064	Specification for energy efficient medium voltage induction motors
6-51-0006	Specification for Flameproof Control Stations
6-81-1064	Inspection and test plan for energy efficient medium voltage motors
6-81-1006	Inspection & Test Plan for Flame Proof Control Stations
7-12-0001	Vessel Tolerances
7-12-0002	Support for Horizontal Vessel
7-12-0004	Skirt Base Details
7-12-0006	Angle Leg Support
7-12-0007	Pipe Leg Support
7-12-0008	Bracket Support for Vertical Vessels
7-12-0009	Manhole with Hinged Cover
7-12-0010	Manhole with Davit
7-12-0013	Nozzle Reinforcement and Projection
7-12-0015	Standard Bolt Hole Orientation
7-12-0018	Internal Flanges
7-12-0024	Lifting Lug Top Head Type
7-12-0026	Earthing Lug

Standards	Title
7-13-0001	Earth Connections
7-13-0002	Anchor Chair
7-13-0006	Level Indicator Supports
7-13-0007	Gauge Hatch with Cover
7-13-0010	Cage Ladder for Fixed Roof Tank
7-68-0509	Steel Ladder Joint Details
7-68-0663	Structural Arrangement of Cone Roof – (2.5 M < Dia < 6.0 M)
7-68-0680	Roof Structure for Cone Roof Tank, Joint Details (Dia ≤40 M)
7-68-0681	Roof Structure for Cone Roof Tanks Central Drum (Detail B).
7-68-0682	Cone Roof Structure Schematic Joint Details & Central Drum.
6-26-0001	Standard Specification for Mechanical Agitators

Following project specifications attached elsewhere in the bid package are referenced to and made a part of this specification. In case any additional standard specifications are mentioned in the list of attachments, the same shall also be applicable

3.0 EXPERIENCE CRITERIA

3.1 Dosing Skid-Supplier/Packager

- 3.1.1 The Supplier of the Dosing Package (Skid Mounted) shall be a packager of Dosing Packages (Skid Mounted) with API 675 Pumps and shall be the Single Point Responsibility Vendor (SPRV) of the complete Dosing Package (Skid Mounted).
- 3.1.2 The vendor shall have designed, engineered, packaged, tested and supplied, in the last Ten (10) years, at least ONE (1) unit of Dosing Package (Skid Mounted) similar in terms of skid size & weight, fluid/chemical handled, capacity of dosing vessels/tanks and type, capacity & capacity control method of metering pumps (API 675), from the proposed manufacturing plant, with minimum operating experience of one year, as on bid due date.
- 3.1.3 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered Dosing Package (Skid Mounted) meets the above experience requirement furnishing details of skid size & weight, fluid/chemical handled, capacity of dosing vessels/tanks, type, capacity & capacity control method of metering pumps etc., as applicable in the format. In addition, manufacturer's catalogue and general reference list for Dosing Package (Skid Mounted) shall also be furnished along with the proposal.

3.2 Positive Displacement Pumps (Controlled Volume)

- 3.2.1 Pumps shall be procured from CONSULTANT /OWNER approved vendor list.
- 3.2.2 The Experience Criteria (EC) as specified in the Standard Specification for Positive Displacement Pumps (Controlled Volume) [Spec.# 6-41-0021], shall be met for the offered model of pump.

3.3 Static Equipment

- 3.3.1 Vessel/Tank shall be procured from CONSULTANT /OWNER approved vendor list.

In case, Package vendor fabricates the vessel/tank on his own or sources it from his approved sub-supplier, following experience criteria shall be met:

Vendor shall have fabricated and supplied at least one number vessel/tank of similar material of construction, dimensions and thickness in the last ten (10) years.

Reference list for the similar supplied vessel/tank shall be provided to establish experience of fabrication of similar vessels/tank.

- 3.3.2 Mixers/Agitators shall be procured from CONSULTANT /OWNER approved vendor list.

In case, Package vendor manufactures the Mixers/Agitators on his own or sources it from his approved sub-supplier, following experience criteria shall be met:

Vendor shall have manufactured and supplied at least one number Mixer/Agitator of similar material of construction, dimensions and operating speed in the last ten (10) years.

Reference list for the similar supplied Mixers/Agitators shall be provided to establish experience of manufacture of similar Mixers/Agitators.

- 3.4 Vendor may procure material/equipment from any of CONSULTANT /OWNER approved vendors. However current validity of vendor approval & their approved product range and the conditions imposed while according vendor approval as per the approved letter shall be verified by the vendor before the placement of order.

4.0 SCOPE OF SUPPLY/WORK

Package vendor scope has been defined broadly in document "Scope of Supply". However, vendor shall refer the entire enquiry specification for complete vendor's scope of supply/work.

5.0 BASIC DESIGN

5.1 General

- 5.1.1 The Process datasheets and P&IDs shall be referred to, for operating conditions.
- 5.1.2 The equipment shall be suitable for outdoor (without-roof) installation.
- 5.1.3 All controls shall operate in a fail-safe mode.
- 5.1.4 All Electrical Devices and instruments shall meet the requirements for the specified area classification in which they are installed.

5.2 Positive Displacement Pumps (Controlled Volume)

- 5.2.1 Pumps shall be designed, manufactured and tested in accordance with API Std. 675 and as modified as per the attached EIL Standard specification no. 6-41-0021.
- 5.2.2 Maximum allowable working pressure (MAWP) & temperature of the equipment shall not be less than the design pressure & temperature specified in the data sheet nor less than those specified in specifications, codes & standards.

- 5.2.3 The dosing package vendor shall calculate the acceleration head for each pump item, based on the system configuration. Calculations for Acceleration head & NPSHR shall be furnished. The dosing package vendor shall ensure that NPSHA is greater than “Acceleration Head + NPSHR” by a margin of at least 1.0 meter, either by proper selection of pump speed or by proper valve design or else by providing a suction side Pulsation dampener.
- 5.2.4 Pulsation dampeners shall be provided as per pump data sheets and P&ID.
- a) The suction side pulsation dampener (if provided) shall be as per the following details:
- | | |
|-----------------------------|--|
| Design Code: | ASME Sec. VIII Div.I |
| Allowable pulsation level: | ± 3% |
| Material of construction: | As per applicable Piping Material Specification (PMS) indicated in P&IDs |
| Type of pulsation dampener: | Inverted Bottle, Direct Contact type. |
- b) The discharge side pulsation dampener (if provided) shall be as per the following details:
- | | |
|-----------------------------|--|
| Design Code: | ASME Sec. VIII Div.I |
| Allowable pulsation level: | ± 3% |
| Material of construction: | As per applicable Piping Material Specification (PMS) indicated in P&IDs |
| Type of pulsation dampener: | Inverted Bottle, Direct Contact type/Bladder Type. |
- c) Note: In case Discharge Pulsation dampeners are of bladder type with gas charging, bidder shall provide a gas charging kit which should include pressure gauge, pressure regulator etc. Unless otherwise specified, one number gas charging kit shall be supplied against each order.
- 5.2.5 All coupling and exposed rotating parts shall be provided with suitable guards of non-sparking type.
- 5.3 Drum Unloading Pump and Connecting Hoses**
- 5.3.1 Drum unloading pumps shall be of “Air Operated Double Diaphragm (AODD)” type and shall be as per manufacturer’s standard.
- 5.3.2 Typical data sheet(s) for AODD pumps is enclosed with the inquiry document. The dosing package vendor is advised to refer the inquiry specifications and completely fill-up the same with operating data and data related to construction, performance of pump & submit the same during detailed engineering stage. Technical literature, manufacturer’s standard performance curve, Plant air consumption data etc. for the AODD pumps shall also be submitted for purchaser’s review during detailed engineering stage.
- 5.3.3 The drum unloading pumps wherever specified shall be of portable type, driven pneumatically i.e.by plant air.
- 5.3.4 These pumps shall be used for transfer of chemicals to the dosing vessel/tank from the chemical drum / barrel (By Purchaser) (standard capacity of 200 litres). Pumps shall be selected for a transfer rate of minimum 1000 litres per hour.

- 5.3.5 For connecting the plant air supply to the air inlet side of each drum unloading pumps, air inlet shall be provided with an air dryer requiring no electric power, air filter cum regulator with pressure gauge, bleed type master air valve, pressure relief valve & flexible hoses. The air outlet shall be equipped with air discharge muffler.
- 5.3.6 For transferring the chemical from the drum/barrel to the dosing tank/vessel through drum unloading pump, flexible metallic hose with quick coupling connection (suitable for handling the particular chemical) with liquid filter, shall be provided in the inlet line. The outlet line should also be provided with a flexible metallic hose with quick coupling connection, (suitable for handling the particular chemical) check valve, isolation valve and a flanged connection which can be connected to the nozzle on the dosing vessel / tank.
- 5.3.7 The pump shall be provided with a suitable adapter such that it can fit on the top of chemical drum. Liquid inlet, outlet and air inlet connections of the pump shall be suitable for fitting the respective flexible metallic hoses.
- 5.3.8 The drum unloading pump shall be procured from a reputed AODD pump manufacturer having proven experience for similar services. The dosing package vendor shall furnish, AODD pump manufacturer's general reference list for the proposed pump model during detailed engineering.

5.4 Calibration Pot / Graduated Cylinder

Unless otherwise specified, calibration pot / graduated cylinders shall be provided for calibration of each controlled volume pump as specified in the Scope of supply. For multi head pumps, separate calibration cylinders or necessary piping arrangement with isolation valves shall be provided so that flow through each head can be calibrated. This requirement shall govern over and above the P&ID.

5.5 Skid

- 5.5.1 The skid shall be designed and built to ensure that all the equipment along with accessories, local control station(s) and piping are located and mounted suitably for ease of operation and maintenance.
- 5.5.2 All the components of a particular chemical dosing package shall be assembled & mounted on the skid, and shall be duly interconnected with piping & power/control cabling. The inlet and outlet connections for purchaser's interface shall be terminated at the skid edge with flanges of the specified sizes & ratings. The local control station(s) & the junction box(es) for instrumentation shall be located at the edge of skid.
- 5.5.3 The skid shall be suitable for four point lift & shall be provided with lifting lugs.
- 5.5.4 The skid shall be provided with cable trays for routing of purchaser's power / control cables.

5.6 Static Equipment

5.6.1 Mixers/ Agitators

- 5.6.1.1 The Vendor/Supplier shall furnish the Filled in Mixer Data sheet in the format provided after award of contract.
- 5.6.1.2 Unless otherwise specified, all mixers/agitators shall be provided with dry running mechanical vapor seals (cartridge type).

5.6.2 Design

5.6.2.1 Pressure Vessels

5.6.2.1.1 Minimum Wall Thickness

Vessel shell and heads shall have minimum wall thicknesses calculated with Design pressure and temperature, in accordance with the codes, but in no case, shall the thickness be less than the criteria indicated below:

- a) For Carbon steel vessels: 6mm (including corrosion allowance not exceeding 3.0 mm), but not less than that calculated as per below formula :

For Vessels with Diameter less than 2400 mm,

$$\text{Wall Thickness} = \{(\text{Dia./1000}) + 1.5 + \text{C.A.}\}$$

For Vessels with Diameter 2400 mm & above,

$$\text{Wall thickness} = \{(\text{Dia}/1000) + 2.5 + \text{C.A.}\}$$

- b) For Stainless Steel vessels: 3 mm, but not less than that calculated as per following for Vessels with Diameter more than 1500 mm

$$\text{Wall thickness} = \{(\text{Dia}/1000) + 2.5\}$$

5.6.2.1.2 Design Pressure

Design pressure shall be calculated as per the following, unless otherwise specified elsewhere in the package:

- a) Design pressure shall be the highest of the following:
- Maximum operating pressure (kg/cm²) x 1.1
 - Maximum operating pressure + 2.0 kg/cm²
 - 3.5 kg/cm²
- b) Design pressure at any lower point is to be determined by adding the maximum operating liquid head and any gradient within the vessel.
- c) Vessel operating under vacuum (or partial vacuum) shall be designed for differential external pressure of 1.055 Kg/cm².

5.6.2.1.3 Design Temperature

Design temperature shall be calculated as per the following, unless otherwise specified elsewhere in the package:

- a) For Vessels operating at 0° C and over, the design temperature shall be operating temperature plus 15° C. However, design temperature shall not be less than 65°C.
- b) For Vessels operating below 0° C, design temperature shall be lowest operating temperature.
- c) Minimum Design Metal Temperature (MDMT) shall be lower of minimum atmospheric temperature and minimum temperature envisaged during operation.

5.6.2.1.4 Corrosion Allowance

Minimum Corrosion allowance for Carbon steel vessels shall be 3.0 mm, unless otherwise specified elsewhere in the package.

All internals shall be designed for full load condition. For Welded internals, twice the corrosion allowance shall be considered. For Removable internal parts, single corrosion allowance shall be considered. All bolted internals shall be provided with SS bolts and two nuts.

5.6.2.1.5 Vessels shall be designed as per ASME Sec. VIII Div. 1 (latest edition including latest addenda in accordance with design data enclosed with the package). All Design calculations shall be carried out considering all loads for erection, operation and hydro test condition.

5.6.2.2 **Storage Tanks**

5.6.2.2.1 Any pressurized tank (irrespective of diameter) and atmospheric storage tanks (diameter more than 2.0 m) shall be designed and fabricated as per API 650 code. However, small atmospheric tanks can be designed & fabricated as per manufacturer's standard & good engineering practice.

5.6.2.2.2 All internals shall be designed for full load condition. For Welded internals, twice the corrosion allowance shall be considered. For Removable internal parts, single corrosion allowance shall be considered. All bolted internals shall be provided with SS bolts and two nuts.

5.6.2.2.3 The Corrosion allowance for Tanks shall be as given in respective Tank data sheets attached with the bid package. Otherwise, it shall be determined by its intended service conditions and service life.

5.6.3 **Fabrication**

5.6.3.1 **Materials**

Materials of various pressure parts of equipment shall be selected as follows for general industrial condition/services, unless otherwise specified in respective Process data sheets. Minimum grade for Stainless Steel shall be SS 304.

Plates : SA 516 Gr. 60/70 (for CS vessels)/ IS 2062 Gr. B (for CS tanks)/ SS 304 (for SS Vessels/Tanks)

SA 516 Gr.60 for Caustic/Sour/Amine service tanks & vessels

Forgings : SA 105/SA 182 F 304

Pipes : SA 106 Gr. B/SA 312 TP 304

External bolting : SA 193 Gr. B7/ SA 194 Gr. 2H

Gasket : As per PMS

MOC of internals shall be as per respective Process Data Sheets attached with the bid package.

5.6.3.2 CS Plates used shall conform to the latest issue of specification SA-20 with additional requirements mentioned herein.

- a) Only normalized plates free from injurious defects with workmanlike finish shall be used. Reconditioning/repair of plates by welding shall not be permitted.
- b) One product analysis of each heat shall be carried out and reported. Chemical analysis shall be as per applicable specifications with carbon content not exceeding 0.23%.

Additionally, one of following requirements for carbon equivalents (Ceq) based on heat analysis shall be satisfied.

$$Ceq = C + Mn/6 < 0.42 \quad \dots(1)$$

$$Ceq = C + Mn/6 + (Cr + Mo + V)/5 + (Cu+Ni)/15 < 0.43 \quad \dots(2)$$

Equation -(1) shall be used when applicable material specify C and Mn only.

Equation -(2) is applicable for restricted chemistry requirements or for supplementary requirements of S19 & S21 of specification SA-20.

SS plates shall conform to Specification SA 480 with additional requirements mentioned herein:

- a) All plates shall be hot rolled, pickled & shall have No. 1 finish on both sides with reference to Specification SA-480. In addition, all stabilized grades of SS (SS 347, SS 321 etc.) shall be given stabilization heat treatment.
- b) Unless otherwise specified; plates, pipes, forgings & fittings representative of each heat shall be subjected to Inter granular corrosion tests as per ASTM A262 practice E for all 300 series material. The bend test specimen shall be examined at a magnification of 200X.

5.6.3.3 Heads

- a) All Carbon steel cold formed dished heads or knuckles shall be stress relieved. Hot formed dished ends or knuckles which have not been uniformly heated in the normalizing range in the final stages of manufacturing shall be normalized. When completed vessel involves PWHT, heat treatment intended above for cold formed dished heads or knuckles is not applicable.
- b) Cold formed dished ends of SS vessels shall not be solution annealed unless any of the following condition exists:
 - Specifically called for any Equipment/service.
 - Hardness value after forming exceeds 235 BHN.
 - Nominal thickness of plate is 16 mm or above.
- c) Hot formed dished ends of SS vessels shall be solution annealed.
- d) Whenever Heat treatment on Stainless Steel is carried out, it shall be followed by micro etching test & IGC test as per ASTM A 262 practice E unless otherwise specified to ascertain suitability & effectiveness of Solution annealing. The bend test specimen shall be examined at a magnification of 200X.

5.6.3.4 Material Certificates shall conform to EN 10204 Type 3.1 and shall be submitted to EIL/Owner/Third party.

- 5.6.3.5 Material of construction (MOC) of the Mixers shall be compatible with the process service applicable.
- 5.6.3.6 Pipes for nozzles shall conform to API 5L, IS: 1978, A-53 or A-106. For Caustic, Sour and Amine services, all nozzle pipes shall be A-106. Pipes for nozzle & heating coil shall be of seamless quality. SS tanks shall have SS nozzles of compatible grade.
- 5.6.3.7 All Vessels/ Tanks shall be provided with lifting lugs.
- 5.6.3.8 Unless otherwise specified, Bottom plate slope shall be 1:50 from the centre of the tank towards the shell.
- 5.6.3.9 For vessels, all Nozzle Flanges shall be of Weld Neck type. For Caustic, Sour and Amine services all nozzle flanges shall be WN type in Vessels as well as Tanks.
- 5.6.3.10 Nozzles upto 50 mm NB size shall be stiffened with 2 numbers of 40 mm wide x 6 mm thick stiffeners welded at 90 apart.
- 5.6.3.11 Rolling direction of plate for shell shall be lengthwise.
- 5.6.3.12 All Tanks shall be provided with Vent connection, level indicators & earthing connections. A gauge hatch with cover for gauging & sampling purpose is to be provided on the tank, if specified on the Tank datasheet
- 5.6.3.13 All vessels shall be transported to site in single piece.
- 5.6.3.14 Roof Supporting Structure for Storage Tanks, if provided internally, shall be protected with proper primer and painting as per the provisions of painting specification, as these structures are designed without corrosion allowance.
- 5.6.4 **Tolerances**
- 5.6.4.1 Equipments tolerances shall be as per attached Standards/applicable code.
- 5.6.5 **Cleaning and Painting**
- 5.6.5.1 Vessels shall be cleaned internally to remove scale, rust, dirt, foreign material by wire brushing.
- 5.6.5.2 All external surfaces shall be cleaned, primed and painted in accordance with painting specification for specified environment.
- 5.6.5.3 SS surfaces both inside & outside shall be pickled & passivated in accordance with Specification ASTM 380 after hydro test.
- 5.7 **Piping**
- 5.7.1 **Piping Design Codes**
- The design and engineering shall conform to the following standards as applicable:
- ASME B 31.3 “Process Piping”
 - IBR “Indian Boiler regulations”

5.7.2 Piping Design Basis

- 5.7.2.1 Preferred level of bottom of piping from skid top shall be 500 mm.
- 5.7.2.2 Minimum level of overhead piping shall be such that clear 2.2 M headroom is available below pipe/insulation/supports.
- 5.7.2.3 All hydrocarbon vents to atmosphere should be vented at minimum 3 meters above the nearest operating platform, existing within a radius of 12 meters. A 3/8" diameter weep hole in the tail pipe for drainage to safe location at low point of line shall be provided. All steam vents to atmosphere should be vented at minimum 3 meters above the nearest operating platform, existing within a radius of 8 meters. A 3/8" diameter weep hole in the tail pipe for drainage at low point of line shall be provided.
- 5.7.2.4 All PSVs and Control valves discharging to flare header shall be located close to and above flare header for maintaining free draining requirement. PSVs and control valve assembly along with prefabricated spools, valves, flanges, gaskets and bolts shall be supplied loose by vendor for installation by owner. Size of PSV inlet line shall be decided considering far away location of the PSV.
- 5.7.2.5 Hydrostatic test, Leak test, Non destructive Examination shall be carried out as per applicable piping design codes.
- 5.7.2.6 Hydrostatic Vents and Drains shall be provided at High Point and Low points respectively as per PMS and or good engineering practice.
- 5.7.2.7 Piping systems shall be adequately flexible to cater for thermal expansion/contraction under start-up, operating and shut down conditions to ensure that the stresses and loads do not exceed the values permitted in the applicable code.
- 5.7.2.8 All instruments and valves requiring attention during normal operation shall be conveniently operable.
- 5.7.2.9 Adequate space shall be provided for removal of equipment components for routine maintenance.

5.7.3 Pipe Support Design Basis

All piping shall be adequately supported, guided or anchored so as to prevent undue vibration, deflection/expansion or loads on connected equipment and leakage at flanged joints. Piping at valves and equipments such as pumps, requiring periodic maintenance, shall be supported in such a way so that the valves and Equipments can be removed with a minimum necessity of installing temporary pipe supports.

5.7.4 Piping Material Specification/ Valve Material Specification

The job piping material specification as applicable to incoming and outgoing lines is provided. Vendor shall follow these piping classes if shown in P&IDs. Basic details for valves are provided in the Piping Material Specification. Detail Valve material specification shall be provided to the successful bidder. In case of variation in material/components from this specification it shall be the responsibility of the vendor to ensure suitability and establish equivalence of proposed material.

5.7.5 Battery Limit

All incoming and outgoing Piping shall be terminated by the vendor at one location with isolation valves/flanges as per the approved P & IDs. B/L interface orientation shall be finalized during detail engineering. Battery Limit Drawing shall indicate exact location, levels and scope of package piping for all incoming and outgoing lines. All piping at Battery Limit shall be anchored.

5.7.6 Painting

The protective paint system shall be provided to protect external surface of uninsulated low alloy steel and carbon steel piping and equipments and insulated surface of low alloy steel, carbon steel and stainless steel piping and equipments. The painting system shall be suitable for the type of environment where package unit is to be installed.

5.7.7 Welding

Welding procedure qualification, welder's qualification, all welding work, equipment for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the accepted national/international standards and practices.

5.8 Electrical

5.8.1 Following minimum electrical facilities shall be provided by Vendor on local control station:

- a) Start
- b) Stop
- c) Field ammeter, as required.

Selector switch shall be provided, as required, as per P&ID & operational requirements. The interlocking between the MCC feeder and field equipment shall be arranged in Local Control Station by the Vendor.

5.8.2 All motors shall have a enclosure protection Ex-d with efficiency class IE-3 as per IS 12615-2011/IEC 60034-30 and shall meet the requirements of IS/IEC 60079-1 & 60079-0.

5.8.3 All the 415 Volts supply feeders, to feed Dosing Pumps & Agitator Motors shall be arranged by Purchaser. kW rating of motors for Dosing System shall be decided by Bidder for the starting and running conditions specified in pump/ agitator datasheet. Vendor to furnish Motor List, indicating kW rating, enabling Purchaser to provide MCC with required number & rating of feeders as per the format mentioned in the Job Specification-Electrical for Dosing Package.

5.8.4 The power & control cables from Purchaser's MCC to individual motor & local control stations, shall be supplied, laid & terminated by the Purchaser. However, Vendor shall supply all cable glands and lugs, as required. All cable glands shall be flameproof Ex (d) double-compression type of Ni-plated Brass. The cable-lugs shall be of tinned Copper and crimping type. Exact size of Purchaser-supplied power and control cables shall be finalised during detail engineering. Provisions, as required, in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.

5.8.5 Purchaser's power cables will be 1100V grade, Copper or Aluminum conductor, XLPE or PVC insulated, PVC extruded inner sheath, armoured with overall FRLS PVC sheath.

- 5.8.6 Purchaser's control cables will be 1100V grade, Copper conductor, overall shielded, twisted pair, XLPE/ PVC insulated, armoured with overall FRLS PVC sheath.
- 5.8.7 Cable size for motor space heater shall be 3 x 2.5 mm² with Cu Conductor, 3/4-inch entry.
- 5.8.8 The cable trenches/ trays from sub-station to battery limit of individual package shall be in the scope of Purchaser. Cable trays on Dosing Skids shall be provided by Vendor, as required, for routing of Purchaser-supplied power & control cables within skid.
- 5.8.9 Earthing of all package equipments within the skid shall be done by the bidder. Earth terminals shall be provided on skid for connection by Purchaser to main plant earth grid.
- 5.8.10 Earthing shall be carried-out as per standard IS: 3043. All hardware for earthing shall be hot dip galvanized @ 610 gm/m². GI Earth Plate shall be provided and all non-current carrying parts of electrical apparatus, vessels and skid structure shall be bonded with this GI earth plate. Purchaser shall connect earth plate with main plant earth network. Sizes of earth conductors to be used shall be as per Job Specification-Electrical for Dosing Package.
- 5.8.11 All the equipment, indigenous and imported, shall have a valid statutory approval of PESO/CCOE towards explosion protection and copies of the same (PESO/CCOE approvals) shall be furnished during detailed engineering stage.
- 5.8.12 All local control stations shall be flameproof Ex (d) type.
- 5.8.13 For project specific requirement, Bidder shall refer Job Specification-Electrical for Dosing Package
- 5.8.14 In case of any conflict between various requirements/ parameters, the most stringent one shall be applicable.
- 5.9 Instrumentation and Controls**
- 5.9.1 General**
- 5.9.1.1 All electronic field instruments shall be certified for installation in hazardous area classification of Location as per Job specification sheet. Instrument shall also be weatherproof to IP-65 as a minimum. For environmental conditions, refer elsewhere in the package.
- 5.9.1.2 SS Tag plate shall be provided for all instruments.
- 5.9.1.3 The instrumentation selected for the package shall be rugged in design and must be well proven for use in similar applications. Items of Prototype design or items of experimental nature or design undergoing testing etc. shall not be selected and supplied by bidder. The instruments as being offered / supplied should have been operating satisfactorily in hydrocarbon industry like Refinery, Petrochemical and Gas Processing Plant for a period of minimum 6 months on the bid due date under similar conditions as specified in purchasers datasheet.
- 5.9.1.4 Bidder shall supply 10% subject to minimum 1 no. of each type of instrument installation materials such as fittings, valves, tubes, etc. as loose supply. Prices for these spares shall be included in the base price.

5.9.1.5 Bidder shall supply instruments from EIL approved vendors. For items not appearing in approved vendor list, bidder shall furnish proposed sub-vendor list for purchaser's approval.

5.9.1.6 For Caustic and NACE services, minimum wetted parts/ Sensor material shall be SS316L against SS316 material indicated in respective instrument specifications.

5.9.2 Instrument Specifications

5.9.2.1 Transmitters

- a) The SMART transmitter shall be two wire microprocessor based type and it shall incorporate a non-volatile memory which shall store complete configuration data of transmitter and sensor characterization. All necessary signal conversions, including conversion to produce output with the required protocol shall be carried out in the transmitter electronics. The configuration data of the instruments shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, bidder to ensure that battery drain alarm is provided as diagnostic maintenance message. Transmitter body material shall be metallic. Integral output LCD display shall be provided for all transmitters.
- b) SMART Transmitters shall be able to communicate to Universal Hand Held communicator (HHC Model no. : HART 475 or equivalent model, not in Vendor's scope). In case any of transmitter is not able to accept commands from HHC, vendor shall supply suitable intrinsically safe dust proof hand held configurator (one no. suitable for HART transmitters) with complete license and upgrade packing rechargeable battery charger and other accessories suitable for the specified area classification along with suitable carry case for easy mobility.
- c) When HART protocol is specified, the following features must be ensured;
 - i) It shall allow multi masters (two for example, primary and secondary) for configuration, calibration, diagnostics and maintenance. The primary could be the control system or host computer and the secondary could be the hand-held communicator.
 - ii) It shall be capable of implementing universal commands from either of these locations.
 - iii) All HART transmitters shall be configurable for under current and over current.
 - iv) All HART transmitters shall be compliant to NAMUR NE 43 recommendations.
- d) The Overall rangeability shall be 1:100 for Normal transmitters with calibrated accuracy of $\pm 0.065\%$ of span. The Overall rangeability shall be 1:100 for Diaphragm seal transmitters with calibrated accuracy of $\pm 0.2\%$ of span.
- e) Transmitter shall also run complete diagnostic subroutines and shall provide diagnostic alarm messages for sensor as well as transmitter healthiness. In the event of detection of failure, the output shall be driven to a predefined value, which shall be field configurable.
- f) The over-range/ static pressure protection of the transmitter shall be 130% of maximum operating range.

5.9.2.2 Level Instruments standpipe philosophy

5.9.2.2.1 Standpipe shall be used for clean, non-viscous and non-crystallizing services for installation of level instruments on vessels/ equipments if more than 4 nozzles are required for level instruments on a vessel. Standpipe shall also be used wherever shown in Licensor's drawings. Size of standpipe shall be 2" minimum.

5.9.2.2.2 Maximum number of nozzles allowable on standpipe is as follows:

- a) 8 with no displacer / guided wave radar type level instrument on standpipe.
- b) 6 with displacer/ guided wave radar type level instrument on standpipe

5.9.2.3 Level Gauge

a) Level gauges shall be steel armored reflex or transparent type with body and cover material of forged carbon steel as a minimum and shall have tempered borosilicate glass with asbestos free gasket. Transparent type of gauges shall be provided with integral illuminators operating at 230V, 50 Hz supply and suitable for electrical area classification. All gauge glasses must have a rating equal to or more than the vessel design pressure and temperature. SS Calibrated scale shall be provided with scale graduations in mm.

b) Reflex type will be used for clean and colorless liquids, except liquids level interface. Transparent type will be used on acid, caustic, dirty or viscous, coloured liquids and liquid interface. Transparent type with Mica or Kel-F shields shall be used for treated water, boiler and condensate services, and for corrosive liquids, which will attack glass.

c) The visible range of level gauge shall be selected to cover the complete operating level as well as measuring range of the other level instruments provided for the same purpose.

In general, the visible length of the level gauges shall be 220, 470, 720, 980, 1230 mm. In any case, the maximum visibility length shall not exceed 1500 mm for a single gauge.

d) For level gauging in very viscous liquids, liquids with crystals and high pressure rating (600# and above), float operated magnetic gauges with 2" (50 mm) flanged end connections, shall be used. C to C length of single magnetic level gauge shall not be more than 2500mm. The float and chamber material of magnetic level gauge shall be non magnetic type. Float chamber (or cage) shall be provided with ¾" flanged end vent and drain connections. The design shall also facilitate float removal.

5.9.2.4 Level Transmitter

a) Guided Wave Radar type instruments with external chamber and side-side connections, complete with isolation valves, vent and drain details shall be used for level measurement upto 2400 mm. In general, Guided Wave Radar instruments shall be used with C-C lengths of 356 mm, 813 mm & 1219 mm etc.

b) Guided Wave Radar instrument shall have ± 3 mm accuracy.

c) Differential pressure transmitter shall be used for level instruments above 2400 mm, for services requiring purge or where liquid might boil in external portion.

d) Differential Pressure transmitters for use on corrosive or fouling service shall generally be diaphragm with extended filled capillary type. Flush or extended diaphragm type differential pressure transmitter shall be considered for special

applications only. Diaphragm material shall normally be stainless steel or any other special alloy.

- e) Transmitters shall also meet the requirements specified in clause no. 6.9.2.1 as applicable.

5.9.2.5 Pressure Gauges

- a) Pressure gauges shall be weatherproof with dial size of 150 mm and shall have features like screwed bezels, externally adjustable zero, over range protection (at least 130% of max. operating pressure), blowout discs and Shatter proof glass window. Pressure gauge sensing element shall be of SS 316 and movement & Case of SS 304, as a minimum.
- b) Pressure gauge dial shall be white, non-rusting plastic with black figures. The dial face shall be marked with pressure element material. Pointers shall have micrometer adjustment.
- c) Pressure gauge shall have 1/2" NPT (M) bottom connection.
- d) Pressure gauge shall have an accuracy of $\pm 1\%$ of URV (Upper Range Value).
- e) Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS-3624 standard dials, wherever possible. Pressure gauge with design pressure more than 130% of range shall be provided with Gauge saver. The material of construction of gauge saver shall be same as socket material or superior.
- f) Diaphragm seals, filled type or mechanical type shall be provided where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of the clean out type with flushing connection.
- g) Pressure gauges shall be weather proof to IP-55 as per IEC-60529/IS-2147 as a minimum. Pressure gauge case material shall be minimum SS304.
- h) The pressure sensing element shall be bourdon, diaphragm or bellows depending upon process conditions.

5.9.2.6 Pressure Transmitter

- a) Pressure transmitter shall have electronic state-of-art capacitance or any other type of sensor meeting all functional specifications. Body & Element material for transmitters shall be SS316, as a minimum, and shall be able to withstand over pressure of at least 30% of range or maximum working pressure whichever is higher.
- b) All transmitters shall have an integral LCD display. Remote mounted meters may be provided if required in addition.
- c) Threaded end connections shall be NPT as per ANSI B 1.20.1. Flanged end connections shall be as per ANSI B 16.5.
- d) Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services.
- e) Transmitters shall also meet the requirements specified in clause no. 6.9.2.1 as applicable.
- f) Pressure transmitters used for diaphragm rupture detection shall have dedicated instrument isolation valve in addition to manifold.

5.9.2.7 Pressure Relief Valve & Rupture Disc

- a) All pressure relieving devices shall be designed in accordance with ASME code for 'Boilers and Pressure Vessels', API-521. Pressure Relief Valve shall meet relief valve requirements as defined in API RP-520 (Part-I & II) and in API-526.
- b) Pressure relief valves shall be full nozzle full lift type except for thermal relief valves which shall be modified nozzle type. Type of Pressure relief valve such as Conventional, bellows & pilot shall be decided by vendor based on process parameters such as set pressure, back pressure, etc.
- c) Percentage Accumulation shall be 10% for Pressure Relief Valve and 10% / 25% (as per process requirement) for Thermal relief Valve.
- d) Body materials shall be as per piping material specification. Nozzle and disc material shall be SS 316 as a minimum with machined SS guide and spindle. Whenever semi nozzle designs are unavoidable, body material shall be at least same as nozzle and disc material.
- e) Spring material shall be selected as per operating conditions. Normally it shall be Cadmium / Nickel / Zinc / Aluminum plated Carbon Steel.
- f) Pressure Relief Valve shall have flanged connections for sizes 1" and above and shall have screwed connection for sizes 3/4" and below. Thermal Relief Valve shall have screwed connection with 0.38 cm² orifice size and inlet outlet shall be of 3/4" NPT(M) X 1" NPT(F) sizes.
- g) Rupture discs shall be reverse buckling type, in general and shall be supplied in pre-torqued holder assembly, mounted between standard ANSI flanges. Disc material shall be compatible with the vessel contents and shall be consistent with the bursting requirements. Disc shall be supplied with tell-tale assembly.
- h) The bursting tolerance of the rupture disc shall be 5% of the specified bursting pressure or less.
- i) Vendor shall supply three nos. spare discs along with each Rupture disc assembly ordered.

5.9.2.8 Variable Area Flowmeter (Rotameter) and Transmitter

- a) Variable area flow meters or rotameters shall be as per ISA-RP 16.1, 16.2, 16.3, 16.4, 16.5 and 16.6. Rotameter shall be of flanged body construction.
- b) Rotameter shall be of metal tube type with local indication.
- c) The material for tube & float shall be SS 316 as a minimum (or better material as per piping material specification).
- d) The packing material shall be PTFE if the liquid temperature is below 230 C. For temperatures above 230 C, packing shall be of GRAFOIL.
- e) Rotameter shall have an accuracy of minimum $\pm 2\%$ FSD.
- f) Rotameter transmitter shall be SMART type with HART protocol with integral LCD display. Rotameter transmitters shall be intrinsically safe, 4-20mA two wire type capable of operation on 24VDC power supply with a load capacity not less than 600 ohms.

5.9.2.9 Orifice Plates and Flanges

- a) Flow measurement shall normally be carried out by using thin, square-edge concentric orifices plate mounted between a pair of weld-neck type orifice flanges with flange taps. The minimum pressure rating of flanges shall be 300 lb ANSI.

Where D, D/2 taps are required, the ratings of the orifice flanges shall be same as that of the pipe class. Flanged end connections shall be as per ASME B16.5

- b) Eccentric type of orifice plates shall be used for specific applications, like dual phase.
- c) Segmental type shall be used for specific applications.
- d) Quadrant edge or conical entrance orifice plates shall be used for services with low Reynolds number.
- e) Orifice Plate material shall be SS 316 as a minimum or better
- f) Each Orifice Plate shall have an integral handle, which shall, upon assembly with flanges, extend to a distance of 50 mm. with following information punched on it:
 - Tag Number.
 - Nominal flange size in inches and rating in pounds.
 - Plate and flange material to ASTM specifications.
 - Bore dia in mm.
- g) Sizing of orifice plate shall be carried out in accordance with ISO-5167(latest edition).

5.9.2.10 Restriction Orifice Plates

- a) The material of the orifice plates shall be normally SS 316, as a minimum. Flange material & rating shall be as per piping specification.
- b) Sizing of orifice plate shall be carried out in accordance with ISO-5167 (Latest Edition).
- c) Each Orifice Plate shall have an integral handle, which shall, upon assembly with flanges, extend to a distance of 50 mm beyond flange edge with Tag no., nominal pipe size in inches, rating in psi and material of plate punched on it.
- d) Thickness of the orifice plate shall be calculated to meet the service condition requirement. Minimum thickness shall be 3.18mm.

5.9.2.11 Self Actuated Pressure Control Valve

- a) Body material shall be as per piping material specification. Trim material shall be Stainless Steel SS 316 as a minimum. Actuator shall be diaphragm type and diaphragm material shall be Stainless Steel as a minimum.
- b) All pressure parts shall be designed to withstand maximum shut off pressure.
- c) Valve shall have flanged connections for sizes 1" and above and shall have screwed connection for sizes 3/4" and below.
- d) The line pressure sensing for the self actuated control valve/regulator shall be internal, in general.
- e) The set pressure of the self actuated control valve shall be adjustable throughout each spring range externally. A locking mechanism shall be provided to avoid inadvertent set point adjustment.
- f) Flow direction shall be clearly stamped or cast on the valve/regulator body to ensure correct installation.

5.9.2.12 Temperature Gauge

- a) Local temperature gauges shall be in general bimetallic type. The temperature bulb shall be of stainless steel construction. The case of bimetallic type temperature

gauges shall be all angles rotatable type. The gauge movement material shall be of stainless steel, as a minimum.

- b) Temperature gauges shall have accuracy of $\pm 1\%$ of URV (Upper Range Value). All local temperature gauges shall have 150 mm dial size. The bulb size shall be selected to suit the Thermowell.
- c) All gauges shall be of weatherproof construction to IP 55 as a minimum.
- d) Thermometer stem adjustable gland with union connection and bushing shall be suitable for 1/2" NPTF connection.
- e) The temperature gauges shall be provided with 1½" flanged thermowell with ½" NPT (F) connection for temperature gauges. .
- f) Zero adjustment screw for temperature gauge shall be external type.
- g) Unless otherwise specified, the temperature gauge shall have an over range protection of at least 130% of specified range or maximum working temperature, whichever is higher.

5.9.2.13 Thermowell

- a) Thermowells and flanges shall be minimum of 316 SS or better material to suit the service conditions. Pressure rating of flanges shall be as per respective piping specification. Thermowell shall be fabricated from bar-stock.
- b) Immersion length of Thermowells for different line sizes shall be as follows:-

<u>Line Size</u>	<u>Immersion length (U)</u>
4" to 6"	280 mm
From 8 "to 20"	320 mm
>20" & Vessels/columns	400 mm

- c) Immersion length is based on 200 mm length between flange face and inner well of pipe. In vessels, where fouling with vessel internals is expected, the immersion length shall be suitably modified. The minimum line size shall be of 4" for installation of Temperature element. Any pipe of less than 4" nominal bore shall be blown to 4" size to install thermowell.

5.9.2.14 Control Valves

- a) Control valves shall normally be Globe type single seated or double seated. For clean services, guiding shall be top and bottom/ cage type. For highly viscous services, cage guiding shall be avoided.
- b) Flanged control valves shall be used. Body material, body rating and flange rating, shall be as per piping specifications as a minimum. Minimum control valve body size shall be 1" in general. Reduced trims can also be considered.
- c) Trim characteristics shall be equal percentage type unless required otherwise. Anti-cavitation trim shall be selected wherever cavitation is expected in the valve. Control valve body and flange rating shall be minimum 300#.
- d) Noise from control valve during operation shall be limited to OSHA specified level or better. The maximum allowable noise is 85 dBA SPL (Sound Pressure Level). Low noise trim shall be considered where noise level exceeds maximum limit.

- e) Valve seat leakage shall be as per ANSI/FCI 70.2 and shall be selected with due consideration to meet the requirement. Minimum class IV leakage shall be provided.
- f) Flanged bolted type gland packing boxes shall be used. Packing shall normally be PTFE on liquid and gas service up to 200°C (design). For high temperature application (above 200 °C (design) temperature, grafoil or equivalent gasket suitable for the specified service shall be provided. Asbestos based packing material shall not be used.
- g) Material used for trim shall be minimum 316 SS, with guide bushing of hardened stainless steel like 440 C, 17-4 PH, etc. upto a pressure drop of 10 kg/cm². Stellite trims shall be provided for higher pressure drops (more than 10 kg/cm²) and wherever required to meet service conditions.
- h) Valve actuator shall be pneumatic spring opposed diaphragm type, in general. Piston type actuators may be used for very high shut off pressure requirements. Additional equipment necessary to meet fail safe condition shall also be included in case double acting piston type actuator is selected. In either case, actuator shall be able to withstand maximum shut-off pressure (1.5 times of design pressure) with the minimum instrument air pressure specified. The actuator shall be painted as below:
- Direct action (open on air failure) valves - Green color.
 - Reverse acting (close on air failure) valve - Yellow color.
- i) Control valve positioner shall be Smart type with HART protocol (latest version). The positioner shall be provided with necessary hardware/ software for maintenance, diagnostics, programming etc.
- j) Positioner output shall include but not limited to actual valve stem travel, input current, actuator pressure, travel direction, accumulated travel, cycle counter etc.
- k) Positioner shall provide diagnostic information such as Valve signature data with seat load, bench set and valve friction, dynamic error and dynamic linearity of control valve, diagnostic graphics with adequate resolution. When mounted on control valve, the factory valve signature test report shall be provided.
- l) All control valve supplied by bidder must comply with fugitive emission requirements as per leakage class-C of ISO-15848-1(Latest edition).

5.9.3 Installation Requirement

5.9.3.1 Bidder shall ensure and supply all erection hardwares required for the installation of complete instrumentation items which form part of the package unit. This includes items like instrument valves and manifolds, mounting accessories, impulse piping, tubing, pipe/tube fittings, canopies for instruments, identification tags etc. as a minimum.

5.9.3.2 All instruments shall be provided with isolation, vent / drain and equalizing arrangement.

5.9.3.3 Instrument connection sizes shall be as follows:

- a) On Vessel/ Equipment- 2"
- b) On Pipe - 3/4" NPT for direct type. 1.5" flanged for Diaphragm seal type and thermowells.

6.0 INSPECTION AND TESTING

- 6.1** All Equipments shall be subjected to inspection by EIL/Owner /Third party. The Inspector shall have free access to the Contractor/Vendor's shop/work site. The Contractor/Vendor shall provide all facilities like tools and tackles, instruments and personnel to inspector. All the Inspection shall be carried out in accordance with the relevant Codes & requirements of Drawings & Specifications. Approval of Inspector shall in no way relieve the Contractor/Vendor of his responsibility for proper execution of work. Manufacturer's Quality Assurance (QA) plans shall be submitted for Owner / Consultant or his authorized inspection agency's approval before taking up manufacturing.
- 6.2** The Inspection shall include but not be limited to:
- Examination of materials of construction.
 - Welding procedure and Welder's qualification tests.
 - Various non-destructive tests like radiography etc. as per code.
 - Checking of dimensions
 - Pressure testing and certification etc.
 - Hardness testing
- 6.3** Wherever specified in code, dye penetrant/magnetic particle examination shall be carried out on the welds. Spot radiography shall be minimum requirement for all Equipments. Extent of radiography and acceptance criteria shall be as per the relevant provisions of the code.
- 6.4** All nozzles fabricated from plate, irrespective of thickness, shall be 100% radiographed.
- 6.5** The inner fillet of bottom or annular plate to shell weld shall be leak tested with penetrating oil after removal of slag prior to welding of outside fillet weld.
- 6.6** After completion, tank shall be hydrostatically tested by filling water and all weld joints shall be hammered and inspected for any leakage. In case of any defect it shall be repaired and retested as per the instructions of Inspector.
- 6.7** Equipments under Caustic, Amine & Sour (H₂S) service shall essentially be PWHT. The Hardness of the PM, Weld & HAZ shall be limited to 200 BHN in such cases.
- 6.8** It shall be the responsibility of Contractor/Vendor to prepare a Detailed Inspection and Test plan as per applicable Code and Specifications and get the same reviewed by EIL/Owner/Third party prior to execution of work.
- 6.9** Fittings, valves, instruments, other accessories like electric motor etc. shall be duly tested and manufacturer's test certificates shall be furnished.
- 6.10** Any other tests as per the Process Data Sheet / EIL standard / applicable codes shall also be performed.

Following "Witness" inspection & tests shall be carried out for the completely assembled chemical dosing package:

- Dimensional Inspection
- Cleanliness

- Hydro test / Pneumatic Leak test of assembled piping / joints

The dosing package vendor shall further note that “Witness” inspection is also specified for certain equipment i.e. controlled volume pumps, Mechanical Agitators etc. in the respective equipment data sheets which shall also be carried out.

Vendor shall provide test/ calibration/ inspection certificates of all the instrument items under dosing package scope for purchaser’s review/ record

7.0 COMMISSIONING SPARE PARTS

The vendor shall include in his scope of supply, spares required for erection and commissioning of the dosing package (inclusive of mechanical, electrical and instrumentation spares). List for the same shall be furnished by the dosing package vendor along with the bid.

If however, any additional spare is consumed during erection and commissioning, over and above the quoted erection and commissioning spares, the same shall be provided free of cost by the dosing package vendor.

8.0 RECOMMENDED SPARE PARTS FOR TWO YEARS NORMAL OPERATION

8.1 The vendor shall furnish a quotation for spare parts required for two years normal operation as per the equipment manufacturer’s recommendation along with unit rates for the package (inclusive of mechanical, electrical and instrumentation spares).

8.2 The recommended spares for two years operation for each rating and type of motor shall include the following as a minimum:

- a. Bearings for DE & NDE
- b. Cooling fan
- c. Terminal block
- d. Terminal box cover with screws.

9.0 SPECIAL TOOLS/TACKLES

Any special tools and tackles required for erection, site assembly and maintenance of dosing package (inclusive of mechanical, electrical and instrumentation spares) shall be included in the dosing package vendor’s scope of supply.

An itemized list of special tools/tackles included in the scope of supply, shall be furnished along with the bid.

10.0 EQUIPMENT LAYOUT

Vendor shall furnish the tentative equipment layout for dosing package(s) along with the bid. If any tentative skid size/layout is enclosed with the inquiry document vendor shall ensure that the proposed dosing package skid is accommodated within the space allocated for the specified dosing package

11.0 VENDOR DATA AND DRAWINGS

11.1 PROPOSALS

The vendor's proposals shall as a minimum include all data sheets, drawings and documents listed under "WITH BID" in the enclosed Vendor Data Requirements.

11.2 CONTRACT DATA

11.2.1 General

11.2.1.1 Drawings and data as required after purchase order has been specified in Vendor Data Requirements. Vendor to note that the drawing/ document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/ document specified there are several drawings to be furnished by the vendor or vice-versa.

Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX" to the purchaser (Destination & contact person as per order).

This document shall list out in consolidated form all drawings and documents required by purchaser (As specified in Data Sheets, Specifications and Vendor Data Requirements enclosed with the order).

Against each drawing/document vendor shall indicate the vendor's drawing numbers, titles, Rev. No., category (whether for information or approval) and schedule of submission.

This shall be the first document to be submitted by vendor within two weeks of order.

No drawing shall be taken up for review till DCI for the inquiry/order is finalized by the vendor.

11.2.1.2 All drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:

- i) Purchaser's and Consultant's Corporate Name
- ii) Project Name.
- iii) Client / Customer's Name.
- iv) Equipment Name and Item No.
- v) Purchase Order No.
- vi) Purchase Requisition No.

Title Block on drawings shall be placed on the lower right hand corner.

11.2.1.3 All vendor data/drawings/documents shall be in English Language and in Metric Systems.

11.2.1.4 Data specified in the VDR document is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

11.2.1.5 Whether or not specified, the vendor shall furnish the following, before shipment:

- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, parts numbers, materials, prices and delivery period. The vendor shall forward this supplementary list to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before field startup.
- A parts list for all equipment supplied. The list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that the purchaser may determine the interchangeability of the parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number.

- At least 8 weeks before shipment, the vendor shall submit his preservation, packaging and shipping procedures to the purchaser's for his information.

11.2.2 Drawings

11.2.2.1 Drawing review shall be through eDMS/ VDOCS in soft as per the details provided elsewhere in the inquiry document.

11.2.2.2 The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, the vendor shall furnish certified copies in the quantity specified in VDR.

11.2.2.3 Drawings/documents with following titles shall contain as a minimum the following information:

a) **General Arrangement Drawing**

A general arrangement drawing shall indicate:

- i) Outline dimensions (minimum three views) (All principal dimensions).
- ii) Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains lubricating oil, cooling water, steam & Electrical/Instrumentation.
- iii) Weight of each equipment/assembly/component.
- iv) The weight & location of center of gravity of the heaviest equipment/assembly/components that must be handled for erection.
- v) Identification and weight, dimensions of the heaviest equipment/assembly / subassembly /component required to be handled for maintenance.
- vi) Maintenance clearances and dismantling clearances.
- vii) Layout of auxiliary equipment and operating platform.
- viii) A list of reference drawings if any.
- ix) A list of any special weather-protection and climatic features.

b) **Foundation Drawing**

A foundation drawing shall indicate complete information required for foundation design by purchaser including the following:

- i) Foundation bolt sizes & pipe sleeve details and pocket sizes & locations.
- ii) Grouting thickness and other necessary technical details.
- iii) Static weight of each independently grouted item and location of center of gravity of each item in all three planes.
- iv) Weight distribution for each bolt/sub sole-plate location and total static weight.
- v) Dynamic loads, if any, caused due to various items grouted independently. (The cause of generation of such loads shall also be indicated).
- vi) The direction and magnitude of unbalance forces and moments (with their phase angles) generated by the out of balance of the rotating / moving parts of the machine at the relevant operating conditions. [These loads and their locations are to be given in all three planes. These shall be utilised for computing the amplitudes of vibration of the foundation].
- vii) Maximum permissible amplitude of vibration on the foundation at the base level. (The location of the points on the foundation base where such amplitudes are not to be exceeded shall be given in all three planes). The reference of relevant code, if any, shall also be indicated.
- viii) Total mass of static parts.
- ix) Total mass of reciprocating parts
- x) Suggested dynamic factor and ratio of weight of foundation to weight of skid/ equipment.
- xi) Scope of Supply of the Foundation Bolts (unless otherwise specified, by vendor).

c) **P&I Diagrams (with Bill of Materials)**

Vendor shall furnish P&I Diagrams along with Bill of Materials of each system in the vendor's scope of supply or specified in the order. P&I Diagram shall indicate the system details, location of various auxiliaries, instruments, controls and safety devices as required. Line sizes, piping class, valve sizes and class shall be clearly marked on the P&ID. Vendor's scope and purchaser's scope shall be clearly demarcated. Each item shall be identified by an item No./item tag no., which shall correspond to the item no. shown on the bill of materials. The bill of materials shall include items number, normal value, set value, range, quantity per unit, make and other specifications as applicable.

Legends adopted shall be indicated either at the bottom of drawing or on a separate drawing.

The legends shall be as per ISA.

d) **Data Sheet**

The Vendor shall provide completely filled in data sheets first for "as purchased" and then for "as built". This shall be done by the vendor correcting and filling out the data sheets and submitting copies to the purchaser.

e) **Technical Data Manual/Mechanical Catalogues**

Technical Data Manual/Mechanical Catalogue is a compilation of "as built" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

The vendor shall furnish the required number of Technical Data Manual/Mechanical Catalogues for the equipment, any auxiliaries and instruments that the vendor is providing. The Technical Data Manual/Mechanical Catalogue shall include the following documents as a minimum:

- i. All drawings and data as listed in the vendor data requirements.
- ii. All manufacturing, inspection and test data and records.
- iii. Installation and Instruction Manual
The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the skid and prepare the equipment for start-up. It shall also contain the following information:
 - (a) Instructions for erecting, piping, aligning.
 - (b) Pre-commissioning/commissioning/functional test procedures and acceptance criterion.
- iv. Operation and Maintenance Manual
This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered.

उपकेन्द्रीय पंखों
के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR
CENTRIFUGAL FANS

6	02.12.24	Revised & issued as Standard Specification	PL	<i>PL</i> TK	<i>Nalin</i> NK	MN
5	22.01.20	Revised & issued as Standard Specification	TP	NK	SM	RKT
4	11.12.13	Revised & issued as Standard Specification	MG	NK	DB	SC
3	22.04.08	Reaffirmed & issued as Standard Specification	JSD	NK	VKM	VC
2	09.04.03	Revised & issued as Standard Specification	NK	KDS	RK	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

Abbreviations:

AMCA	:	Air Movement & Control Association
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standards
DCI	:	Document Control Index
DCS	:	Distributed Control System
EC	:	Experience Criteria
EngDMS	:	Engineering Document Management System
FD	:	Forced Draft
ID	:	Induced Draft
ISA	:	Instruments Society of America
ISO	:	International Organization for Standardization
LCP	:	Local Control Panel
LGB	:	Local Gauge Board
MCR	:	Maximum Continuous Rating
NACE	:	National Association of Corrosion Engineers
P&ID	:	Piping and Instrumentation Diagram
PTC	:	Power Test Codes
PTR	:	Proven Track Record
VDOCS	:	Vendor Data Requirements
VDM	:	Vendor Document Management
VFD	:	Variable Frequency Drive

Rotating Equipment Standards Committee

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SECTION 1 - GENERAL

1.1 SCOPE

- i. This specification together with the attendant data sheets and other specifications / attachments to the inquiry/order defines the minimum requirements for centrifugal fans for non-critical applications upto static pressure differential of 800 mm of water column, excluding centrifugal fans as per API Std. 560 and API Std. 673.
- ii. Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.
- iii. Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with their proposal and include the same in their scope of supply.

1.2 ALTERNATIVE DESIGNS

The vendor shall not offer any alternative designs for proposal requirements.

1.3 CONFLICTING REQUIREMENTS

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications/scope of work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

1.4 DEFINITION OF TERMS

1.4.1 Rated point

Unless otherwise specified in the data sheets, the rated point shall be defined as under:

- (1) The highest speed necessary to meet any specified operating condition and
- (2) The rated capacity required by Centrifugal fan designs to meet all operating points.
(The vendor shall select this capacity point to best encompass specified operating conditions within the scope of the expected performance curve).

Unless otherwise specified fan performance shall be guaranteed at rated point. However, Fan shall be designed, selected and optimized for the operating case as indicated in the process datasheet.

- 1.4.2 **Maximum allowable temperature (MAT)** is the maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specific fluid at the specified temperature.
- 1.4.3 **Maximum Allowable Working Pressure (MAWP)** is the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified maximum operating temperature / design temperature.
MAWP & MAT of the Centrifugal Fans shall neither be less than the design Pressure & design Temperature, as specified in the datasheet nor less than the maximum discharge pressure calculated as per 1.4.4 below.
- 1.4.4 **Maximum Discharge Pressure** is the maximum possible suction pressure plus the maximum possible differential pressure i.e. shut off differential pressure at maximum continuous speed for any of the gas/ air condition and operating condition specified on data sheet. The above maximum suction pressure shall be specified operating pressure or the site barometric pressure (max value), whichever is higher.
Maximum discharge pressure shall be less than the design pressure specified in data sheet. In case, the Fan maximum discharge pressure exceeds the downstream design pressure, vendor to include in his proposal and provide suitable protection system (PSVs etc. in-line with process philosophy) if not already provided by purchaser.
- 1.4.5 **Maximum continuous speed (rpm)** is at-least equal to 105% of rated speed for variable speed drive and 100% of rated speed for constant speed drive.
- 1.4.6 **Trip speed (rpm)** is the speed at which the independent emergency overspeed device operates to shut-down the equipment.
- 1.4.7 **Witness** Inspection and testing means that a hold shall be applied to the production schedule and the test carried out with the purchaser/purchaser's representative in attendance.
- 1.4.8 **Observed** Inspection and testing means that the purchaser requires notification of the test timing. However, the test is performed as scheduled, and if the purchaser/purchaser's representative is not present the vendor can proceed to the next step.
- 1.4.9 **Supplier / Vendor** shall be a manufacturer of centrifugal fans having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete centrifugal fan package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed centrifugal fan.
- 1.4.10 The fan vendor shall have **UNIT RESPONSIBILITY** of complete centrifugal fan package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.
- 1.5 **REFERENCED PUBLICATIONS**
Unless otherwise specified, the editions of the following standards, codes and specifications that are in effect at the time of issue of this specification shall, to the extent specified herein form a part of this specification.

Std. 801	-	Industrial Process / Power Generation Fans – Specification Guidelines
Std. 802	-	Industrial Process / Power Generation Fans – Establishing Performance using Laboratory Models
Std. 803	-	Industrial Process / Power Generation Fans – Site Performance Test Standard
API		
Std. 677	-	American Petroleum Institute General Purpose Gear Units for Petroleum, Chemical & Gas Industry Services.
ASME		
PTC-11	-	The American Society of Mechanical Engineers Large Industrial fans.
BSI		
BS:848	-	British Standards Institution Fans for general purpose Part-1 Methods for testing performance
BIS		
IS:4894	-	Bureau of Indian Standards Specification for Centrifugal Fans
ISO		
ISO:1940	-	International Organisation for Standardisation Balancing qualities of Rotating rigid bodies.
NACE		
Std. MR0103	-	National Association of Corrosion Engineers Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments

1.6 EXPERIENCE CRITERIA

1.6.1 The fan model offered shall be from the existing fan model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the aero-dynamic performance for the complete range of operation of the offered model shall have been established in the shop test. (Details may be furnished, if required).

The offered fan model design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions & driver rating, rotor-dynamics, mechanical design, gas handled and material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.

(Note: Similar operating/design conditions & driver rating would mean approx. 80% or higher)

1.6.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered fan meets the above criteria by furnishing details of similar operating/design conditions {inlet flow, static head, operating/design pressures & temperatures, static efficiencies, driver rating, etc.}, Rotor Dynamics {Impeller type, impeller arrangement, Bearing Span, operating speed range etc.}, Mechanical Design {Bearing Type & Lubrication, MAWP etc.}, gas handled & material of construction etc. as applicable in the format.

In addition, manufacturer's catalogue and general reference list for centrifugal fan is to be furnished along with the proposal.

Multiple references may be furnished to justify the above.

SECTION 2 - BASIC DESIGN

2.1 GENERAL

- 2.1.1 Centrifugal Fans, drivers and auxiliary equipment shall be designed and constructed for a service life of 20 years and at-least two years of uninterrupted continuous full-load operation at the specified operating conditions.
- 2.1.2 Centrifugal fans shall be mechanically designed for a temperature at least 15°C beyond the extreme temperature anticipated for the specified operating conditions.
- 2.1.3 Centrifugal fan and its auxiliaries shall be suitable for unsheltered outdoor installation.
- 2.1.4 Centrifugal fan performance shall be based on the static pressure differential across the Centrifugal fan inlet & outlet flanges. To obtain this differential pressure, losses in the inlet and discharge for vendor supplied components such as silencer, control systems, metering systems etc. shall be added by Centrifugal fan vendor to the difference between outlet static pressure and inlet static pressure specified by the purchaser.
- 2.1.5 The head-capacity characteristic of the Centrifugal fan shall rise continuously from the maximum capacity to surge. Performance curve shall indicate operating points and expected surge line. The Centrifugal fan shall, without the use of a bypass, be suitable for stable operation at all capacities higher than the surge capacity shown in the proposal.
- 2.1.6 When the gas handled contains matter that lends itself to accumulation on the internal parts of Centrifugal fan or that may cause wear, a provision shall be made for injecting one or more sprays into the Centrifugal fan to prevent such effects. The cleaning system shall be designed for air, N₂, steam or water as specified by purchaser. Elements of blade cleaning system inside the Centrifugal fan housing shall be made of corrosion resistant material and shall be adequately supported to resist damage due to vibration. The vendor shall include in his proposal the complete details of such arrangements, when offered.
- 2.1.7 Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (fan + driver) train shall not exceed 85 dBA measured at 1 meter from fan surface in any direction for the recommended range of operation at site.
(Note: This shall not be a shop test acceptance criteria)
Fan manufacturer shall furnish silencers and/or acoustical treatment necessary to limit the noise level on the intake of fans. If required, fan manufacturer shall provide acoustical treatment for fan housings to meet the above noise level.

2.2 CENTRIFUGAL FAN HOUSING

Centrifugal fan housings shall be of cast or fabricated construction, suitably stiffened to avoid drumming, and shall be split to permit the removal of the impeller and the shaft without disturbing the bearing pedestals.

2.3 CENTRIFUGAL FAN HOUSING CONNECTION

- 2.3.1 Inlet and outlet nozzles shall terminate in duct-type flanges suitable for interconnection with the purchaser's system. The nozzle orientation shall be in accordance with the information on the data sheets. Facings of all connections shall be adequate to prevent leakage with proper gaskets and bolting.
- 2.3.2 A drain connection with block valve and blind flange shall be provided at the lowest point of the casing.
- 2.3.3 The casing body shall be equipped with bolted and gasketed man-way size (min. 610 x 610 mm) to allow for the inspection and cleaning of the impeller and rotor. If the

Centrifugal fan casing size and construction does not permit such a size of access door, the casing shall be equipped with removable panels to allow for inspection and cleaning of impeller and casing internals.

2.4 EXTERNAL FORCES AND MOMENTS

The vendor shall provide the following information during detailed engineering stage:

- a) Maximum allowable external forces and moments on inlet and outlet connections.
- b) Flexible connections (expansion joints) where required to restrict imposed loads on the casing connections and/or thermal expansions shall be provided by the vendor and information on these shall be furnished to the purchaser.

2.5 ROTATING ELEMENTS

- 2.5.1 Impeller shall be of cast or fabricated and welded construction. Cast impellers, if offered, shall be of one-piece construction, machined all over except on the internal fluid passages. Welded impellers, if offered, shall pass DP tests.
- 2.5.2 Impellers shall be keyed to the shaft and positively locked in place.
- 2.5.3 Centrifugal fan blades shall be backward curved design.
- 2.5.4 Centrifugal fan manufacturer shall examine the need of providing a barring over mechanism. Where required, the same shall be included in vendor's scope of supply.

2.6 SHAFT SEALING OF CENTRIFUGAL FANS

- 2.6.1 Unless otherwise specified, shaft seals shall be of the gland packing or labyrinth type.
- 2.6.2 Shaft seals shall be such as to permit removal for inspection and replacement from outside without disturbing the shaft or bearings.

2.7 CRITICAL SPEED AND BALANCE

- 2.7.1 The complete rotor shall be dynamically balanced to Grade 2.5 as per ISO 1940, prior to assembly.
- 2.7.2 The first lateral critical speed of the rotor shall be greater than 120% of the rated speed of the machine.

2.8 BEARINGS AND BEARING HOUSINGS

- 2.8.1 Antifriction bearings, if provided, shall be of standard type and shall meet minimum L-10 rating life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.
- 2.8.2 Journal type bearings when used shall have replaceable liners or shells, and shall be horizontally split.
- 2.8.3 Bearing housings shall be provided with labyrinth type seals to prevent oil leakage or contamination.

2.9 LUBRICATION

- 2.9.1 When oil lubrication is required and provided, the bearing housing shall be equipped with a reservoir of ample capacity, fitted with a sight glass and a constant oil level device. When grease lubrication is provided, the bearing housing shall be fitted with nipples and excessive grease plugs.

- 2.9.2 The rise in bearing grease/oil temperature with continuous running of the fan shall be within the allowable limits which shall not exceed 30°C for grease and 39°C for oil lubricated bearings above ambient temperature. Cooling arrangements shall be provided if required.

2.10 MATERIALS

- 2.10.1 The materials employed shall be selected with due regard to the gas handled, operating and design conditions, and the site conditions. Materials exposed to H₂S service shall comply with NACE MR 0103.
- 2.10.2 Repair welds, if any, shall require the prior approval of the purchaser. DP inspection is required for welded centrifugal fan wheels as a minimum.
- 2.10.3 Damper or variable guide vane operating mechanisms, linkages, and other external parts subject to rotary or sliding motions shall be corrosion resistant materials suitable for the site environment. Internal operating parts subject to rotary or sliding motions shall be stainless steel or other equally corrosion resistant material. Minor parts associated with such mechanisms (bolts, nuts, springs, washers, gaskets and keys) shall have equal corrosion resistance.

2.11 NAME PLATE AND ROTATION ARROWS

A nameplate and a rotation arrow made of 18 Cr-8 Ni Stainless Steel or Monel shall be attached by pins of a similar material to the casing, in a location permitting easy visibility. Vendor's Name, Serial Number, Size and Type, Normal Capacity, Maximum Continuous Speed/Minimum permissible speed, Maximum Design Pressure, Maximum Design Temperature, Purchaser's Equipment Number as a minimum, shall be clearly stamped on the name plate.

SECTION 3 - ACCESSORIES

3.1 DRIVERS

3.1.1 General

The type of driver shall be as specified by the purchaser and, unless otherwise specified, shall be supplied by the vendor. The driver shall conform to the corresponding data sheets and specifications listed in the inquiry/order.

3.1.2 Motors

Electric motor drivers shall have a maximum continuous rating (MCR) (i.e. service factor equal to 1) not lower than the following:

Fan Rated Power in KW* (Including gear & coupling losses)	Motor MCR (% of Fan Rated BKW)
≤ 18.5	125%
> 18.5 to ≤ 55	115%
> 55	110%

Note: * including all mechanical & transmission losses & with 0% +ve tolerance.

3.1.3 Steam turbine

Steam turbine driver shall be capable of continuously developing 110% of the maximum power required for any of the specified operating conditions while operating at the corresponding speed under specified steam conditions (minimum inlet steam condition and maximum steam outlet condition, unless specified otherwise).

As a minimum, steam turbine rating shall be equal to the motor rating of the standby fan.

3.1.4 **Gears**
Gear Units, when used, shall be designed, manufactured, tested & supplied in accordance with API Std. 677. Unless otherwise specified, the gear service factor shall not be less than those indicated in the same standard i.e. API Std. 677, for the related services.

3.1.5 **Belt Drives**
V-belts if used, shall be of the anti-static type suitable for specified area classification. The scope of supply for such drivers shall include V-belts, Plummer blocks, Pulleys (both driving and driven), slide rails for the motor, V-belt guard and other necessary accessories.

3.2 COUPLINGS AND GUARDS

3.2.1 Coupling shall be of forged steel and of non-lubricated, laminated disc type, with stainless steel laminations with adequate spacer to permit removal of coupling hub without disturbing the Centrifugal fan or driver. The coupling shall be dynamically balanced to Grade 2.5 as per ISO 1940.

3.2.2 All exposed rotating parts and V-belts shall be enclosed in removable, weather proof, metallic guards of robust construction. Unless otherwise specified, the guards shall be made from non-sparking materials.

3.2.3 Couplings and shaft ends shall be straight bored and not tapered fit.

3.2.4 Removable coupling guard shall be provided which shall be fabricated from non-sparking material, and shall be open at the bottom to permit manual shaft rotation. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kgs. Coupling guard shall have a hinge to open and Inspection window to see the healthiness of the coupling shims.

3.2.5 Coupling service factor shall not be less than 1.5 over driver rating. However, while selecting the coupling, it shall be ensured by fan vendor that the allowable shaft stresses of the fan train are not exceeded under any circumstances including any offset condition or conditions of maximum torque. For fan trains having gear-box, the coupling service factor shall not exceed the gear-box service factor.

3.3 MOUNTING PLATE

3.3.1 Base-plate

3.3.1.1 The vendor shall furnish a common base-plate for the centrifugal fans, driver and the speed reducers, if any.

3.3.1.2 Base-plates shall be of fabricated construction and provided with grouting holes.

Anchor bolts shall be furnished along with the base-plate.

When specified on the data sheets, the base-plate shall be suitable for the use of anti-vibration mounting pads.

Base-plates shall be provided with levelling pads, levelling and alignment screws and lifting lugs.

Shims used for alignment shall be of SS MOC and shall be placed under the driver. These shims should cover full pedestal area.

3.4 CONTROLS AND INSTRUMENTATION

3.4.1 General

3.4.1.1 Instrumentation and their installation shall conform to the purchaser's instrumentation specification referred in the inquiry document.

3.4.1.2 Unless otherwise specified, all controls and instrumentation shall be suitable for outdoor installation.

3.4.1.3 Vendor shall review the total centrifugal fan control system for start-up and all other specified operating conditions as specified by the purchaser and ensures compatibility with the vendor supplied control equipment.

3.4.1.4 Non contacting speed measurement probe shall be provided for variable speed machine.

3.4.2 Control Systems

3.4.2.1 The Centrifugal fan flow shall be controlled either by changing the angles of the IGV/ Dampers or by varying the speed of the Centrifugal fan through variable speed fluid coupling or by changing speed of the driver (variable speed) as specified.

3.4.2.2 In case Inlet Guide Vanes (IGV)/Variable speed fluid coupling is specified as a means to vary the capacity of the Centrifugal fan, the same shall be provided with suitable actuators complete with associated instrumentation & controls.

3.4.3 Dampers & Inlet Guide Vanes

3.4.3.1 Inlet and outlet dampers shall have flanged and drilled airtight frames for bolting to the Centrifugal fan or ductwork. They shall be parallel blade type. Damper shafts shall be sealed or packed to prevent leakage, except for atmospheric air inlet dampers.

3.4.3.2 The inlet damper or guide vane mechanism shall be interconnected to a single operator. The operating mechanism shall be designed so that the inlet dampers or the guide vanes can be manually secured in any position.

3.4.3.3 Inlet variable guide vane operating mechanisms shall be located outside the flowing gas stream. The mechanism shall be readily accessible for in-place inspection and maintenance and be of bolted construction to permit removal if necessary.

3.4.3.4 Flow control dampers, when provided, shall be capable of manual operation with a force not exceeding 10 kg. When specified on the data sheets, dampers shall be equipped with actuators for remote operation. Damper panels shall be free from flutter and shall be mounted in a manner that they can under no circumstances enter the body of Centrifugal fan in the event of breakage.

3.4.3.5 Inlet guide vanes, if specified shall be provided with following:

- An external guide vane position indicator.

- Spindles shall be supported at both ends.

- Manual operation of guide vane from grade level shall be possible.

- The guide vane ring shall be protected by a dust cover which shall allow full access to all parts for inspection.

- Dampers shall be louver type with opposed blade.

4.3 TESTING

- 4.3.1 The vendor shall carry out performance test in his shop either as per AMCA Standard 210, ASME PTC-11, IS:4894 or BS:848:Part-1.
- 4.3.2 A four hour mechanical run test shall be conducted at rated speed to verify the mechanical performance in terms of vibration, bearing temperature etc. The test may be done concurrently along-with the performance test.
- 4.3.3 Acceptance of shop test does not constitute a waiver of requirements to supply equipment as per order and to meet field performance under specified operating conditions nor does purchaser's shop inspection relieve the vendor from his responsibilities.
- 4.3.4 Steam turbine driven Centrifugal fans can be tested using the manufacturer's shop driver. Relevant data of the shop driver including efficiency and power factor for various loads, shall be made available.
- 4.3.5 The measured performance of the Centrifugal fan shall fall within specific tolerances of the quoted performance. Permissible tolerances are:
- i) **Capacity:** No negative tolerance shall be permitted.
 - ii) **Static Differential Pressure:** No negative tolerance shall be permitted.
 - iii) **Power absorbed:** The tolerance on the power absorbed shall be +0% only.
 - iv) **Vibration:**
At the time of testing the Centrifugal fan in the manufacturer's shop, the bearing housing shall not vibrate in any direction beyond the limits specified below:

Speed (RPM)	Peak-to-Peak Amplitude (microns)
Upto 1000	60
1000-2000	40
2000-4000	35
above 4000	25
 - v) **Temperature**
The rise in bearing grease/oil temperature with continuous running of the fan shall be within the allowable limits which shall not exceed 30°C for grease and 39°C for oil lubricated bearings above ambient.

4.5 PREPARATION FOR SHIPMENT

- 4.5.1 The vendor shall, upon completion of inspection and tests, apply at least one coat of a primer on all un-machined surfaces. Exposed machined surfaces and the interior of the Centrifugal fan shall be sprayed with a suitable rust inhibitor.
- 4.5.2 All untapped openings shall be provided with 4 mm thick metal closures with full rubber gaskets and bolted with not less than 4 bolts. Tapped openings, not otherwise closed, shall be plugged.
- 4.5.3 The fan shall be supplied with a nameplate containing the following information:
- Purchaser's Item No.
 - Manufacturer's Name
 - Type and Serial No
 - Rated capacity (in Nm³/hr).
 - Total pressure rise (in mbar / mmWC)
 - Speed / Speed range (in rpm).
- The nameplate shall be of stainless steel and relevant information shall be punched into the same.

- 4.5.4 The equipment shall be suitably packed, fastened to avoid damage during transit and crated for shipment. Lifting, unpacking and handling instructions shall be securely attached to the exterior of the largest packing in a well-marked weatherproof container. The upright position, lifting points, gross weight and dimensions shall be clearly marked on each package. Each package shall properly identify the equipment contained therein.
- 4.5.5 Unless otherwise specified, the equipment shall be protected for a storage of 12 months at site, if any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

SECTION 5 - VENDOR'S DATA

5.1 PROPOSALS

The vendor's proposals shall as a minimum include the following:

- a) All data sheets, drawings and documents specified under "WITH BID" Section in the Vendor Data Requirement Form.
- b) Vendor's confirmation/comments on post-order Vendor Data Requirements (Type of Documents) indicated in Vendor Data Requirement forms data sheets and specs.
- c) List of recommended commissioning spares included in the offer.
- d) Mandatory spares (where specified by the purchaser) included in the offer.
- e) Quotation for vendor's standard spare parts for Two Years Normal Operation
This list shall be made separately for each items including auxiliaries and drivers in the form of a table & shall show:
 - i) Part name, description and number.
 - ii) Quantity installed in one unit.
 - iii) Quantity recommended per unit for 2 years normal operation.
 - iv) Quantity recommended for number of units of an item as specified in the inquiry.
 - v) Quantity recommended as insurance for the number of units of an item specified in the inquiry.
- f) An itemised list of special tools included in the offer.
- g) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment.
- h) Any limitations of vendor's test-facility to carryout the specified tests.
- i) A specific compliance statement that the scope of supply, the offered equipment/systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviations as listed in the proposal.

5.2 CONTRACT DATA

5.2.1 General

- 5.2.1.1 Drawings and data as required after purchase order has been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/document specified there are several drawings to be furnished by the vendor or vice versa.

Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX" to the purchaser (Destination & contact person as per order).

This document shall list out in consolidated form all drawings and documents required by purchaser (As specified in Data Sheets, Specifications and Vendor Data Requirement forms enclosed with the order).

Against each drawing/document vendor shall indicate the vendor's drawing numbers, titles, Rev. No., category (whether for information or approval) and schedule of submission.

This shall be the first document to be submitted by vendor within two weeks of order. **No drawing shall be taken up for review till the DCI for inquiry/order is finalized by vendor.** If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document.

5.2.1.2 All transmittal letters (covers), drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:

- i) Purchaser's and Consultant's Corporate Name
- ii) Project Name.
- iii) Client / Customer's Name.
- iv) Equipment Name and Item No.
- v) Purchase Order No.
- vi) Purchase Requisition No.

Title Block on drawings shall be placed on the lower right hand corner.

5.2.1.3 All vendor data/drawings/documents shall be in English Language and in Metric Systems.

5.2.1.4 Data specified in the VDR is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

5.2.1.5 Whether or not specified the vendor shall furnish the following, before shipment:

- As built running clearances and when applicable; thrust bearing, radial bearing and seal running clearances.
- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, parts numbers, materials, prices and delivery period. The vendor shall forward this supplementary list to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before field start-up.
- A parts list for all equipment supplied. The list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that the purchaser may determine the inter-changeability of the parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number.
- At least 8 weeks before shipment, the vendor shall submit his preservation, packaging and shipping procedures to the purchaser's for his review.

5.2.2 **Co-ordination Meeting**

When specified, a co-ordination meeting shall be held at Purchaser's office, preferably within 4 weeks of order.

An agenda shall be prepared for this meeting and would include the following points related to technical aspects.

- a. Any clarifications required by the vendor on purchaser's order.
- b. Vendor Data Index & Schedule.
- c. Vendor Data Review/approval modalities.
- d. Sub-vendor lists proposed by vendor.
- e. Utility requirements.
- f. Preliminary General Arrangement & layout drawings & purchaser's interface drawings.

5.2.3 **Drawings**

5.2.3.1 The number of prints and/or reproducible required and the times within which these are to be submitted by vendor are specified in Purchaser's inquiry/order.

5.2.3.2 The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, the vendor shall furnish certified copies in the quantity specified. All drawings must be clearly legible and shall be folded to 216 mm x 279 mm size.

5.2.3.3 **General Arrangement Drawing**

A general arrangement drawing shall contain as a minimum the following information:

- i) Outline dimensions (minimum three views) (All principal dimensions).
- ii) Allowable forces and moments on suction and discharge nozzles.
- iii) Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains lubricating oil, sealing fluid, cooling water, steam & Electrical/Instrumentation.
- iv) Direction of rotation viewing from the driving end.
- v) Weight of each assembly/component.
- vi) The weight & location of centre of gravity of the heaviest assembly/components that must be handled for erection.
- vii) Identification and weight, dimensions of the heaviest assembly / subassembly / component required to be handled for maintenance.
- viii) Maintenance clearances and dismantling clearances.
- ix) Speeds of Driven Equipment and driver and driver rating. Location of driver terminal box (in case of Electric Driver)
- x) Layout of auxiliary equipment and operating platform.
- xi) Make, Type and Size of couplings and the location of guards and their coverage.
- xii) A list of reference drawings if any.
- xiii) A list of any special weather-protection and climatic features.

5.2.3.4 **Foundation Drawings**

A foundation drawing shall indicate complete information required for foundation design by purchaser including the following:

- i) Foundation bolt sizes & pipe sleeve details and pocket sizes & locations.
- ii) Grouting thickness and other necessary technical details.
- iii) Static weight of each independently grouted item (such as fan, fluid coupling, gear-box, driver, change-over clutches, control panel etc.) and location of centre of gravity of each of such items in all three planes.
- iv) Weight distribution for each bolt/subsole-plate location and total static weight.
- v) Dynamic loads, if any, caused due to various items grouted independently. (The cause of generation of such loads shall also be indicated).
- vi) The direction and magnitude of unbalance forces and moments (with their phase angles) generated by the out of balance of the rotating / moving parts of the machine at the relevant operating conditions. [These loads and their locations are to be given in all three planes. These shall be utilised for computing the amplitudes of vibration of the foundation].
- vii) GD^2 value of each item resolved to driver speed.
- viii) Maximum permissible amplitude of vibration on the foundation at the base level. (The location of the points on the foundation base where such amplitudes are not to be exceeded shall be given in all three planes). The reference of relevant code, if any, shall also be indicated.
- ix) Total mass of rotating parts.

- x) Suggested dynamic factor and ratio of weight of foundation to weight of machine.
- xi) Short circuit loads caused in motor drivers.
- xii) Operating speed of the machine and the driver.
- xiii) Scope of Supply of the Foundation Bolts (unless otherwise specified, by vendor).
- xiv) Maximum permissible magnitude of the unbalance forces and moments generated by the out of balance of the rotating / moving parts of the machine as allowed by the relevant codes, if any. (The reference of such code, if any, shall also be indicated).
- xv) Recommended separation margin (if any), between the machine operating speeds and the natural frequencies of the machine foundation system along with the basis of such recommended separation margins.

[Note: Unless otherwise indicated by vendor, the dynamic forces as given in v) & xi) above are considered as additional static loads for designing the foundations statically. Such dynamic forces are not unbalance forces and therefore, these shall not be utilised for computing the amplitudes of vibration.]

5.2.3.5 Cross-sectional Drawing (with Bill of Materials)

The vendor shall supply cross-sectional or assembly type drawings for all equipment furnished showing all parts, design assembly and running clearances, and balancing data required for erection and maintenance. Each part shall be numbered which shall correspond to the part number on the bill of materials. The bill of materials shall include the part no., name of component, materials quantity installed per unit & sizes where applicable (say for bolts, nuts, rings, gaskets etc.). All boughtout items shall also be indicated with make and brief specifications. A separate cross-sectional drawing showing installation and setting dimensions for the seals shall be furnished.

5.2.3.6 Installation Manual

The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the equipment and prepare the equipment for start-up. It shall include any special information required for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data. It shall also contain the following information:

- (a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centreline shift between normal site ambient temperature position and that at normal equipment operating temperature).
- (b) A description of rigging procedures, including the lifting of the assembled equipment, and methods of disassembly, repair, adjustment, inspection and reassembly of the equipment and auxiliaries.
- (c) Pre-commissioning/commissioning/functional test procedures and acceptance criterion.

5.2.3.7 Operation and Maintenance Manual

This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered. It shall include a section to cover special instructions for operation at extreme environmental and/or extreme operating conditions. The following shall be included in this manual:

- (a) Instructions covering start-up, normal shutdown, emergency shutdown, operating limits and routine operational procedures.
- (b) A description of equipment construction features and the functioning of component parts or systems (such as control, lubrication, sealing systems etc.).
- (c) Outline and sectional drawings, schematics and illustrative sketches in sufficient details to identify all parts and clearly show the operation of all equipment and components and the methods of inspection and repair. Standardised sectional drawings are acceptable only if they represent the actual construction of the

- equipment.
- (d) The following maintenance information:
- i. Maximum and minimum bearing, labyrinth and seal clearances including any other clearance between moving and stationary parts of the equipment affecting proper running and maintenance of the equipment.
 - ii. Instructions for measuring and adjusting cold clearances, shaft runout, concentricity etc.
 - iii. Rotor float allowance.
 - iv. Interference fits on parts that are required to be removed or replaced for maintenance of normally consumable spares.
 - v. Balancing tolerances.
 - vi. Lubricating schedules indicating recommended grades of oil, their properties, replacement period etc.
 - vii. Normal maintenance procedure.
 - viii. Preventive maintenance schedules and criterion for replacement of parts.
 - ix. Trouble - shooting procedures.
- (e) The following reassembly information:
- i. Bolting sequence and torque values for all bolts affecting equipment performance/integrity/safety.
 - ii. Reassembly sequences together with required inspection checks.
 - iii. Adjustment procedures to achieve required positions, clearances, float and so forth.
 - iv. Detailed procedures for pre-operational checks, including settings and adjustments.
 - v. Seals and coupling installation procedures.
 - vi. Parts list indicating cross-sectional drawings of various assemblies and sub-assemblies, part numbers, materials of construction etc. to facilitate identification of parts and for procurement of spares.

5.2.4 Performance Characteristic Curves

5.2.4.1 The vendor shall provide complete performance curves to encompass the map of operations, with any limitations indicated thereon.

5.2.4.2 All curves submitted prior to final performance testing shall be marked "PREDICTED". Any set of curves resulting from a test shall be marked "TESTED".

5.2.4.3 Certified test curves and data shall be submitted within 15 days after testing and shall include STATIC PRESSURE, power recalculated to the proper operating speed and efficiency plotted against capacity.

5.2.5 Data Sheet

5.2.5.1 The Vendor shall provide completely filled in data sheets, first for "AS PURCHASED" and then for "AS BUILT". This shall be done by the vendor correcting and filling out the data sheets and submitting copies to the purchaser.

5.2.6 Technical Data Manual/Mechanical Catalogue

5.2.6.1 Technical Data Manual/Mechanical catalogue is a compilation of "AS BUILT" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

5.2.6.2 Not later than two weeks after successful completion of all specified tests, the vendor shall furnish the required number of technical data manual/mechanical catalogues for the equipment, any auxiliaries and instruments that the vendor is providing. The technical data manual/mechanical catalogue shall include the following documents as a minimum:

- i) All drawings and data as listed in the vendor data index & schedule. (For drawings, where purchaser's approval is required, the final certified drawings shall be attached.) Sections shall be organised in a manner that data & drawings related to one subject is grouped together such as Mechanical, Electrical, Instrumentation etc.
 - ii) All manufacturing, inspection and test data and records.
 - iii) Following information shall also be included in the Technical Data Manual/Mechanical Catalogue:
 1. Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.
 2. Instructions for preserving the equipment after it has been installed. This is particularly required in cases where a long time gap is expected between equipment installation and commissioning.
 3. Field performance test procedures and acceptance criterion.
- 5.2.6.3 Technical Data Manual/Mechanical Catalogue shall be in Hard board folder(s) of size 265 mm x 315 mm and shall not be more than 90 mm thickness; it may be of several volumes and each volume shall have a volume number, index of volumes & index of contents of that particular volume.
- 5.2.6.4 Title sheet (Top sheet) of each volume of Technical Data Manual/Mechanical catalogue shall contain the contract information as defined under 5.2.1.2 besides the volume number.
- 5.2.6.5 In case order contains more than one item, separate dedicated Technical Data Manual/Mechanical catalogues shall be submitted for each item.
- 5.2.6.6 All post order documents shall be submitted / approved through EIL VDM portal.
- 5.2.6.7 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

सेन्ट्रीफ्यूगल पंखों
के लिए मानक विनिर्देश
(इंडियूस्ड ड्राफ्ट/फोर्सड ड्राफ्ट समेत)
(ए.पी.आई.673)

STANDARD SPECIFICATION FOR
CENTRIFUGAL FANS
(INCLUDING FD/ID FANS)
(API 673)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
0	04.04.2022	Issued as Standard Specification	RP/IMG	TK	NK	SM

Abbreviations:

AMCA	:	Air Movement & Control Association
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standards
DCI	:	Document Control Index
DCS	:	Distributed Control System
EC	:	Experience Criteria
eDMS	:	Electronic Document Management System
FD	:	Forced Draft
ID	:	Induced Draft
ISA	:	Instruments Society of America
ISO	:	International Organization for Standardization
LCP	:	Local Control Panel
LCS	:	Local Control Station
LGB	:	Local Gauge Board
MCR	:	Maximum Continuous Rating
NACE	:	National Association of Corrosion Engineers
P&ID	:	Piping and Instrumentation Diagram
PTC	:	Power Test Codes
PTR	:	Proven Track Record
VDM	:	Vendor Document Management System
VDR	:	Vendor Data Requirements
VFD	:	Variable Frequency Drive

Rotating Equipment Standards Committee

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GENERAL

1 SCOPE

- i. This specification together with the attendant data sheets and other specifications / attachments to the inquiry document defines the minimum requirements for the design, manufacture, inspection, testing and supply of Centrifugal Fans including Induced Draft (ID) and Forced Draft (FD) Fans and their auxiliaries, for use in petroleum, Chemical and gas industry based applications.

Unless otherwise specified fan shall comply to requirements specified for special purpose application.

- ii. Vendor shall make all possible efforts to comply strictly to the requirements of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.

- iii. Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.

1A Amendments / Supplements to API Standard 673

- 1A.1 Except as modified herein, the Fans and their auxiliaries shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard - 673, Third Edition, December 2014, "Centrifugal Fans for Petroleum, Chemical and Gas Industry Services"**.

- 1A.2 Except for new paragraphs, the number and title of the paragraphs in the following Modifications to **API Standard 673** correspond to the respective clauses and sub-clauses of the above standard. Clauses not addressed in this specification shall be strictly in accordance to **API Standard 673, Third Edition, December 2014** requirements.

The word in parenthesis following the number or title of a clause indicates the following:

- (Addition) : An addition to a clause or sub-clause referred to.
(Modification) : An amplification or rewording has been made to a part of the corresponding clause / sub-clause but not a substitution replacing the entire clause/ sub-clause.
(Substitution) : A substitution has been made for the corresponding clause / sub-clause.
(New) : A new clause / sub-clause having no corresponding clause / sub-clause in the Standard.
(Delete) : This clause / sub-clause is deleted.

1B EXPERIENCE CRITERIA (NEW)

- 1B.1 The Fan model offered shall be from the existing fan model series and shall be from the regular manufacturing range of the vendor. (Prototypes are not acceptable).

The mechanical design as well as the aero-dynamic performance for the complete range of operation of the offered model shall have been established in the shop test. (Details are to be furnished, if required).

The offered fan model series/ blade series shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions & driver rating as well as type of drive arrangement*, rotor dynamics, mechanical design, gas handled & material of construction supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.

(Note: Similar operating/design conditions & driver rating would mean approx. 80% or higher)

(*: dual drive, variable frequency drive, variable speed through fluid coupling etc.)

- 1B.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered fan model and blade profile meets the above experience requirements furnishing details of similar operating/design conditions {Inlet flow, static head, operating/design pressures & temperatures, driver rating etc.}, Rotor Dynamics {number of Impeller, impeller diameter, type of impeller blades, arrangement (SISW/ DIDW), Speeds, drive arrangement etc.}, Mechanical Design {MAWP, fan AMCA arrangement, Seals & Sealing System, lubrication, IGV etc}, gas handled & material of construction etc. as applicable in the format.

Multiple references may be furnished to justify the above. In addition, manufacturer's catalogue and general reference list for "Centrifugal fans" for services covered under this specification shall also be furnished along with the proposal.

References of FD/ ID fans supplied against API 560 shall also be considered for FD / ID fans. For other applications, references of fans supplied against API 673 shall only be considered.

1.0 SCOPE (Modification)

Paragraph 1 of API Standard - 673, Third Edition, December 2014, "Centrifugal Fans for Petroleum, Chemical and Gas Industry Services stands modified as per para 1, para 1A and para 1B above.

2.0 NORMATIVE REFERENCES

2.1 Addition

API **American Petroleum Institute**
API 692 - Dry Gas Sealing System for Axial, Centrifugal, Rotary Screw Compressors and Expanders, First Edition

(Note: API standard 692 shall be used for requirements related to Dry gas sealing system instead of Chapter-4 of API standard 614, 5th edition, unless otherwise specified.)

ASME **The American Society of Mechanical Engineering**
PTC-11 - Large Industrial fans.

BSI **British Standards Institution**
BS:848 - Fans for general purpose
Part-1 Methods for testing performance

BIS **Bureau of Indian Standards**
IS:4894 - Specification for Centrifugal Fans

3.0 TERMS AND DEFINITIONS

3.4 (Modification)

Unless otherwise specified, fan vendor shall certify & guarantee the performance of the fan at the rated point. Fan shall be designed to deliver the capacity and static pressure at rated point without any negative tolerance. The BKW at the above condition shall be guaranteed with zero positive tolerance.

3.17 MAXIMUM ALLOWABLE TEMPERATURE (MAT) (Modification)

Maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified maximum allowable pressure.

3.18 MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP) (Modification)

Maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified maximum operating temperature / design temperature.

MAWP & MAT of the Centrifugal Fans shall neither be less than the design Pressure & design Temperature, as specified in the datasheet nor less than the maximum discharge pressure calculated as per 3.20 below.

3.20 MAXIMUM DISCHARGE PRESSURE (Modification)

Maximum possible suction pressure plus the maximum possible differential pressure i.e. shut off differential pressure at maximum continuous speed for any of the gas/ air condition and operating condition specified on data sheet. The above maximum suction pressure shall be specified operating pressure or the site barometric pressure (max value), whichever is higher.

Maximum discharge pressure shall be less than the design pressure specified in data sheet.

In case, the Fan maximum discharge pressure exceeds the downstream design pressure, vendor to include in his proposal and provide suitable protection system (PSVs etc. in-line with process philosophy) if not already provided by purchaser.

3.24 (Modification)

Unless otherwise specified, fan vendor shall certify & guarantee the performance of the fan at the rated point.

3.36 STANDARD VOLUME FLOW (Modification)

Nm^3/hr is an abbreviation for capacity in normal cubic meters per hour referred to 1.033 kg/cm²a pressure, 0°C temperature with a compressibility factor of 1.0 and 0% relative humidity.

Sm^3/hr is an abbreviation for capacity in standard cubic meters per hour referred to 1.033 kg/cm²a pressure, 15°C temperature with a compressibility factor of 1.0 and 0% relative humidity.

3.41 FAN VENDOR (Addition)

Unless otherwise specified, the vendor shall be the manufacturer of Centrifugal Fan as per API 673 (including erstwhile API 560 5th edition), having adequate design, engineering, manufacturing, packaging & testing facilities and shall have supplied similar Centrifugal Fan, as per API 673 (including erstwhile API 560 5th edition), as a single point responsibility vendor.

4.0 GENERAL

4.1 UNIT RESPONSIBILITY (Substitution)

Vendor shall have the UNIT RESPONSIBILITY of the complete fan package & shall be responsible for complete design, engineering, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents, including sub vendor's drawings, pertaining to the order shall be duly reviewed & approved by the vendor before onward submission.

5.0 REQUIREMENTS

5.3 ALTERNATIVE DESIGN (Substitution)

The vendor shall not offer any alternative designs for proposal requirements.

5.4 CONFLICTING REQUIREMENTS (Substitution)

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Datasheet/P&ID/Process Package
2. Mechanical Data Sheets.
3. Job Specifications/Scope of Work (if any)
4. This Specification
5. Other Standards & Specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry document shall be applicable.

In case of any ambiguity in the above documents, the vendor shall seek clarification from the owner / purchaser and the decision of the owner/purchaser shall be final and binding.

6.0 DESIGN

6.1 GENERAL

6.1.1 (Substitution)

The Centrifugal fan and driver equipment (including auxiliaries) covered by this standard shall be designed and constructed for a minimum service life of 20 years and at least 3 years of uninterrupted operation. Fan shall not exceed the rating limits of manufacturer design.

Note: It is recognized that this is a design criteria only.

6.1.7 (Modification)

Unless otherwise specified, the maximum permissible sound pressure level of the centrifugal fan-driver train (Driver + Driven equipment train + auxiliaries) shall not exceed 85 dBA measured at 1 meter from the equipment surface for the recommended range of operation. Acoustic Housing, if required, for Noise attenuation shall be supplied by the vendor, if found necessary to limit noise level within specified limits.

6.1.8 (Substitution) Unless otherwise specified, cooling water system(s) shall be designed for the following condition:

Velocity over heat exchanger surface	:	1.5 - 2.5 m/sec.
Maximum Allowable Working Pressure	:	> 8.0 kg/cm ² g
Test Pressure	:	= 1.5 x MAWP
Maximum Pressure Drop	:	0.7 kg/cm ²
Maximum Inlet Temperature	:	33°C
Maximum Outlet Temperature	:	45°C
Maximum Temperature Rise	:	12°C
Minimum Temperature Rise	:	6°C
Fouling Factor on Water Side	:	0.0004 m ² hr °C/kcal
Shell Side Corrosion allowance	:	3.2 mm

6.1.10 (Addition)
Equipment shall be designed to operate simultaneously at the maximum allowable working pressure (MAWP) and trip speed without damage.

6.1.11 (Modification)
The vendor shall develop arrangement of the fan & driver equipment including ducting and auxiliaries in accordance with the purchaser's requirement particularly with regard to the orientation of inlet & outlet connections of the fan. The arrangement shall provide adequate clearance areas and safe access for operation, maintenance, and removal. The vendor shall also indicate recommended location of operating/maintenance platforms, around the fan-driver unit, if required.

6.1.12 (Substitution)
Motors & instruments shall be as per the electrical & instrumentation specifications enclosed with inquiry / order.

6.1.14 (Modification)
If recommended by the vendor, the requirement of field dowelling (if required after final alignment) shall be indicated on the General Arrangement Drawing.

6.1.16 (Modification)
The word "if specified" stands deleted.

6.1.17 (Addition)
Unless otherwise specified all equipment along with auxiliaries shall be suitable for outdoor installation without roof.

6.1.22 (Substitution)
The rated speed of the fan shall not exceed 1500 rpm unless otherwise approved by purchaser.

For fan selection, it should also be considered that:

- Reduced speed is desirable for erosive service and for units subject to fouling deposit on the rotor

6.1.23 (Substitution)
Unless otherwise specified in the data sheets, Fan arrangement and bearing support shall be as per AMCA 801:2008, Arrangement 7 design, with fan impeller located between bearings. The bearings shall be mounted independently of the fan housing on rigid pedestals and sole plates, and the bearings shall be protected from air or gas streams.

Fan shall be provided with a common base plate for the electric motor driver and inboard bearing pedestals. Outboard bearings shall be supported independently on rigid pedestals and soleplates, outside the fan housing.

Unless otherwise specified, FD Fans shall be Single Inlet Single Width (SISW) and ID fans shall be Double-inlet double width (DIDW).

- 6.1.24 Deleted
- 6.1.25 The word 'Purchaser' shall be replaced with the words 'Fan vendor' in the second sentence of the paragraph.
- 6.1.26 (Modification)
Fans in air service shall be suitable to operate for entire barometric pressure range and temperature range as specified on process data sheet.
Note to this clause shall be replaced by as below:
As specified, capacity control to achieve various operating conditions specified on data sheet shall be done by variable speed control or inlet guide vane or inlet dampers or discharge blow off or fluid couplings.
- 6.1.27 (Substitution)
The head-capacity characteristic of the Centrifugal fan shall rise continuously from the maximum capacity to surge. The fan shall, without the use of a bypass, be suitable for stable operation at all capacities higher than the surge capacity shown in the performance curve.

Unless otherwise specified, fans shall have a continuously rising pressure characteristic (pressure versus flow rate plot) from the rated capacity to specified turndown flow/ fan minimum flow. Performance curves, corrected for the specified gas at the specified conditions, shall be based on performance tests in accordance with AMCA 210, including, where applicable, evase and inlet box(es).

Applications that include a variable-frequency drive (VFD) and/or for a system having a non-parabolic system resistance curve shall be reviewed in details to ensure stable operation of the fan over the intended operating range. Allowable operating region shall be marked on the performance curve. The non-operable speed range should also be marked.

Performance curve submitted by vendor shall include following as a minimum for each operating case:
Discharge pressure; Power; Static head; and efficiency versus capacity (from surge point to overload)
- 6.1.29 (Substitution)
Fan shall be mechanically designed, as a minimum, for continuous operation at the following temperatures:
a. 55° C above the maximum specified inlet gas temperature for Induced draught fans/ Process gas fan
b. 14° C above the maximum specified ambient air temperature to Force draught fans/ fan in atmospheric air inlet application.

In no case it shall be less than the design temperature as specified on Process data sheet.
- 6.1.31 (Modification)
Unless otherwise specified, independent suction stack shall be provided for each FD fan. The height of inlet stack for the FD fan/ fan in atmospheric air inlet application shall be as a minimum 6 meter above grade. In case a flow element (i.e. annubar, venturi etc.) is required, the inlet stack height shall be increased to accommodate the straight length required upstream & downstream of the proposed flow element to maintain the flow accuracies.
- 6.1.32 (Modification)
The fan-inlet equipment for FD fan / atmospheric air intake application shall include intake cap or rain-hood, trash-screen(s), inlet filters (when specified), inlet stack / duct

along with supports, inlet damper or guide vanes, inlet boxes, silencer, flexible connection(s) etc. as required.

The vendor shall also provide necessary brackets welded to the inlet stack, for mounting a platform(s) & access ladder(s) (both by purchaser) around the stack for maintenance of flow element and filters.

The ID / Process gas fan-inlet equipment shall include inlet duct along with supports (when specified), inlet damper or guide vanes, inlet boxes, flexible connection(s), companion flange(s) etc. as required.

All components that are shipped separately shall be flanged for assembly. The inlet equipment assembly shall be designed for the load(s) (i.e. wind, seismic, shear, overturning moments etc.) indicated in the inquiry.

The fan outlet equipment shall include flexible connection(s), companion flange(s), outlet damper etc., as required. The type of outlet damper (i.e. slide gate type, multi-louver type, slide plate type etc.) shall be as specified in the inquiry.

6.1.33 (Modification)

The word "if specified" stands deleted.

Unless otherwise specified, the cleaning system shall be designed for cleaning in stand-still condition.

The medium for cleaning of FD fan's impeller shall be Water and for ID fan's impeller, it shall be LP Steam.

6.2 Fan housing

6.2.1 (Addition)

The housing and inlet box(es) shall be split with bolted, flanged and gasketed connection to allow for removal of the assembled rotor without disturbing the duct connections. Fan vendor to indicate the minimum space required for the rotor removal in the fan GAD.

Unless otherwise specified 3 mm of corrosion allowance shall be considered for all fan housings.

6.2.7 (Addition)

Fan housing including shaft seal housing and seal end plate shall be of thickness suitable for containing pressure and limiting distortion under the rated pressure at operating temperature.

6.3 Fan housing connection

6.3.1 (Modification)

Inlet and outlet nozzles shall terminate in ASME flanges or duct type flanges suitable for interconnection with the purchaser's system. The nozzle orientation shall be in accordance with the information on the data sheets / arrangement drawings. Facings of all connections shall be adequate to prevent leakage with proper gaskets and bolting. Gaskets and bolting for purchaser's inlet and discharge connection shall be provided by vendor.

6.3.1.1 The words "if specified" stand deleted.

6.3.1.2 Deleted

6.3.2.12.11 (Substitution)

Accessible drain connection of minimum 50 mm (2 inch) size with block valve and blind flange shall be provided at the lowest point of the casing and inlet box(es) and bottom of

the suction stack.

6.4 EXTERNAL FORCES AND MOMENTS (Modification)

6.4.1 Fan housing shall be designed for external loads to be imposed on fan housing from the ancillary equipments (ducting, sound trunks, silencers, filters etc.). If these equipments are not supplied by fan vendor, it is fan vendor's responsibility to get expected maximum external loads from purchaser / heater vendor and shall design the housing and supports to accept the specified loads.

6.5 Rotating elements

6.5.1 (Substitution)

Material of construction shall be as specified in the Process data sheet.

6.5.2 (Modification)

Unless otherwise specified, impeller blade shall be following design

- Backward curved hollow airfoil construction (2.5 mm minimum thickness skin material) for FD fan / fan in atmospheric air intake application / fan in clean process gas service
- Backward curved single thickness (6mm, min), non airfoil shape for ID fan/ Process gas fan in corrosive and / or erosive environments.
- Solid blades with airfoil shape shall not be used.

6.5.4 (Modification)

Shaft sleeves shall be provided for fans other than ambient air application and shall be of SS 316 construction.

6.5.5 (Modification)

Un-keyed fits are not acceptable however flanged mounted impellers can be offered. Cast iron or Ductile iron hubs are not acceptable.

6.5.6 (Substitution)

Fan vendor to ensure that gas temperature change rates-heating or cooling for the process operating conditions shall remain within limit of maximum allowable rate of change in order to maintain adequate hub to shaft interference fit.

6.5.12 (New)

Fan manufacturer shall examine the need of providing a barring over mechanism. Where required, the same shall be included in vendor's scope of supply.

6.6 SHAFT SEALING OF FANS

6.6.1 (Modification)

Unless otherwise specified, shaft seal for fans in atmospheric air application and ID fans shall be of asbestos free gland packing or labyrinth or carbon ring type.

6.7 DYNAMICS

6.7.2.2 (Modification)

Lateral critical speed shall be determined analytically by means of damped unbalance rotor response analysis for all fans covered by this specification to ensure acceptable amplitudes of vibration at any speed from zero to trip and the results shall be assessed in accordance with the annexure D.

D-1 of Annexure D: "if specified" stands deleted.

- 6.7.3.1(a) (Substitution)
The words “electric motor or steam turbine driven fans with gears over 200 hp (150 kW)” shall be replaced by “fan trains incorporating gearbox”.
- 6.7.3.1(e) (Modification)
The words “synchronous motor rated 700 hp (500 kW) or higher” shall be replaced by “driver rated power 160 kW or higher”.
Torsional analysis report for complete train shall also be provided.
- 6.7.3.6 (Substitution)
Fan vendor shall ensure smooth operation of the fans over the entire speed range, in case of variable speed fans, by suitable selection/ design of all train components including coupling.
In case after exploring all options, torsional resonances (Critical speeds) for VFD driven fans are calculated to still fall below the maximum continuous speed, fan vendor shall furnish Skip Speed range and ensure incorporation of the skip-speed in VFD panel / DCS. Also Alarm for speed in non-operable region shall be provided.

Fan vendor shall ensure that at least 10% margin above or 10% margin below shall be ensured from any of the speeds required for the specified operating case.
- 6.7.5 Vibration and balancing for Special purpose fans**
- 6.7.5.1.1 (Modification)
Train lateral analysis shall be performed for all fans having dual drive / variable speed drive.
- 6.7.5.2.2 (Modification)
The words “if specified” stand deleted.
- 6.8 Bearings and Bearing housings**
- 6.8.5.9 (Addition)
Unless otherwise specified, bearing housings for ID fans or fans operating above 150°C shall be provided with water cooling as a standard feature.
- 6.8.5.10 (Modifications)
All induced draft fans or process fans (operating above 95°C) shall be supplied with heat slingers.
- 6.8.5.17 (Substitution)
A flat surface at least 25 mm in diameter shall be supplied for the location of magnetic based vibration measuring equipment.
- 6.9 Lubrication**
- 6.9.1 (Addition)
Grease Packed antifriction bearings shall not be provided.
- 6.10 Materials**
- 6.10.1.2 (Substitution)
The materials employed shall be selected with due regard to the gas handled, operating and design conditions and the site conditions. Materials exposed to H₂S service shall comply with NACE MR 0175/NACE MR 0103 (as applicable).

6.10.1.6 (Modification)
Damper or variable guide vane operating mechanisms, linkages, and other external parts subject to rotary or sliding motions shall be corrosion resistant materials suitable for the site environment. Internal operating parts subject to rotary or sliding motions shall be stainless steel or other equally corrosion resistant material. Minor parts associated with such mechanisms (bolts, nuts, springs, washers, gaskets and keys) shall have equal corrosion resistance.

7.0 **Accessories**

7.1 **Drivers**

7.1.2 **Motors**

7.1.2.1 (Modification)
Electric motor drivers shall have a maximum continuous rating (MCR) (i.e. service factor equal to 1) not lower than the following unless higher rating is dictated by the Note 1 and / or Note 2 and / or Note-3:

Fan Rated BKW*	Motor MCR (% of fan Rated BKW)
Up-to 22 kW	: 125%
22 kW to 55 kW	: 115%
Higher than 55 kW	: 110%

* including all mechanical & transmission losses & with 0% +ve tolerance.

The electric motor shall be suitable for the electrical area classification specified on the data sheet.

Note:

1. For FD fans/ fan in atmospheric air application, the motor rating shall also be adequate for operation of fans at the specified minimum ambient conditions at the rated speed in un-throttled conditions or the start-up conditions specified on data sheets.

2. For ID fans, the motor rating shall also be adequate for operation of ID fans at the specified minimum flue gas temperature at the rated speed in un-throttled conditions or the start-up conditions specified on data sheets.

3. The motor rating shall be at least 110% of greatest power required (including gear / coupling losses) for any of the specified operating condition.

API Note stands deleted.

7.1.3 **Steam turbine**

7.1.3.1 (Modification)

Steam turbine driver shall be capable of continuously developing 110% of the maximum power required for any of the specified operating conditions while operating at the corresponding speed under specified steam conditions (minimum inlet steam condition and maximum steam outlet condition, unless specified otherwise).

As a minimum, steam turbine rating shall be equal to the motor rating of the standby fan.

7.1.4 **Gear Box (Substitution)**

Unless otherwise specified, motor driven fans shall be direct-driven. If Speed Increasers and Reducers are specified the same shall be in accordance with API Std. 677 (up to 1500 kW). Beyond 1500 kW, Gear box shall be as per API 613.

- 7.1.5 **Variable Frequency Drives (New)**
Variable frequency drives (VFD) system shall be as per electrical specifications enclosed with the inquiry/order.
- 7.1.6 **Variable Speed Hydraulic/Fluid Coupling (New)**
Refer Appendix A for complete details.
- 7.2 **Couplings**
- 7.2.1 (Modification)
Vendor shall provide all metallic, dry, flexible type couplings with spacer. The coupling shall have a minimum service factor of 1.5 over driver rating.
- 7.2.9 (Modification)
All exposed rotating parts shall be enclosed in removable, weather proof, metallic guards of robust construction. The guards shall be made from non-sparking materials. Coupling guard shall be supported from the baseplate. The Coupling Guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kg.
- 7.2.11 (New)
Couplings and shaft ends shall be straight bored and not tapered fit up to a driver rating of 1500 KW. Above 1500 KW, Coupling & shaft ends can be tapered fit in accordance with API Std. 671.
- 7.3 **Belt Drives (New)**
Unless otherwise specified, belt drives shall not be used for Fans.
- 7.4 **Mounting Plates**
- 7.4.1.1 (Substitution)
Vendor shall furnish a common base plate for the motor, gear reducers, variable speed fluid coupling if any and the inboard bearing pedestals. Outboard Bearings shall be supported on rigid independent pedestal and soleplate, outside the fan housing. Also the fan and supporting structure for ducts shall be foundation mounted so as to be unaffected by vibration or by other forces from the fan.
- 7.4.1.12 (Substitution)
Anchor bolts shall be furnished along with the base plate and outboard bearing pedestal.
- 7.5 **Controls and instrumentation**
- 7.5.1.1 (Substitution)
Unless otherwise specified, Controls and Instrumentation and their installation shall conform to the purchaser's instrumentation specification referred in the inquiry document.
- 7.5.1.8 (Modification)
Non contacting speed measurement probe shall be provided for variable speed machine.
- 7.5.1.10 **MACHINE HEALTH MONITORING (New)**
Unless otherwise specified, fan shall be provided with two no. (X & Y) accelerometers along with transmitters on each bearing housing for measuring vibration.
- 7.5.3.1 (Addition)
The fan flow shall be controlled through variable IGV's, Inlet Dampers, Speed variation through variable speed fluid coupling, variable speed driver or discharge blow off as specified. In case variable speed coupling is specified as a means to vary operating speed of the fan, the vendor shall provide a fluid coupling and associated instrumentation and controls, which shall conform to the requirements as specified in the Appendix-A of this

specification and shall be included in fan vendor's scope of supply.

7.5.3.8 (New)

Pneumatic actuators shall be mechanically suitable for design pressure of instrument air specified in MR and shall provide the required output with minimum instrument pressure.

7.5.4 **Dampers or Inlet guide vanes**

7.5.4.1 (Modification)

Unless otherwise specified in damper specification enclosed with inquiry document, the damper shall have opposed blade construction in case of control dampers.

7.5.4.2 (Modification)

The words "If specified" stand deleted.

7.5.4.6 (New)

Outlet dampers and Flow control dampers, when provided, shall be capable of manual operation with a force not exceeding 10 kgf. When specified on the data sheets, dampers shall be equipped with actuators for remote operation. Damper panels shall be free from flutter and shall be mounted in a manner that they can under no circumstances enter the body of fan in the event of breakage.

7.5.4.7 (New)

If the ID fan is equipped with an inlet box damper, it shall be ensured by the fan vendor that the inlet duct does not foul with each other and with either of the inlet box dampers & their actuators. The inlet box dampers shall be easily approachable by ensuring that their actuators are on the outer side of Y type transition piece.

7.6 **Piping**

7.7.1 (Modification)

The words "If specified" stand deleted from 1st and 5th sentences. Rain hood shall be galvanised carbon steel or other corrosion resistant material specified elsewhere in MR. Trash screen shall be of 300 series stainless steel.

The supporting structure for the suction stack and rain-hood of the FD Fan/ fan in atm. air application shall be engineered by the fan vendor and supplied by purchaser / heater contractor (as applicable).

7.8.3 (Addition)

Mineral wool fiber insulation shall not be used in silencer construction.

7.9 **Coatings, insulation and jacketting**

7.9.1 (Addition)

The clips or studs shall be placed on 300 mm centers and drilled for holding wires for installation of insulation having a thickness of minimum 50 mm.

7.12 **Blanking Plates (New)**

In case, blanking plates at discharge of FD fans are required to be provided by the fan vendor, then fan vendor to note that installation/removability of the same shall be carried without disturbing the fan components. In addition the storage location on the fan body for blanking plates shall be shown in the FD fan general arrangement drawing.

7.13 **Vibration Isolators (New)**

In case the ID/FD fans are mounted on furnace top as in case of cracker furnaces/ other furnaces, vibration isolators along with any positive holding arrangement like bolts shall be provided for the mounting of the same.

8 Inspection, Testing and Preparation for Shipment

8.1.3 (Substitution)

Vendor shall notify the purchaser not less than 4 weeks before the date of scheduled testing and reconfirm the same at least one week before the firm test date.

8.1.9 (New)

Rejections made by Purchaser's inspector, based on inspection or tests shall be final. Acceptance by the inspector shall in no way release the Vendor from guarantees as to materials, workman-ship, and performance of the equipment inspected.

8.1.10 General (New)

8.1.10.1 The purchaser's inspector shall have access to the manufacturer's shop at all times during which work on the equipment is in progress. The vendor shall have the responsibility of providing the purchaser's inspector with all requisite facilities/equipment for carrying out satisfactory inspection.

8.1.10.2 Witness Testing by purchaser's/purchaser's representative's participation in the testing shall be as specified on the data sheet.

8.1.10.3 Vendor shall furnish the following data for examination by the purchaser/purchaser's representative during Shop Inspection and Testing.

- i) All necessary material test certificates.
- ii) Running Test Data to verify that the requirements of the specification are being met.
- iii) Quality Assurance Records.

8.1.10.4 All coating/painting of surfaces shall be deferred until the specified inspection of that part is completed.

8.1.10.5 All dimensions shall fall within the tolerances shown on the approved drawings. In the absence of approved tolerances, the manufacturer's standard shall apply.

8.1.10.6 Steam turbine driven fans can be tested using the manufacturer's shop driver. Relevant data of the shop driver, including efficiency and power factor for various loads, shall be made available.

8.2.3 Mechanical Inspection

8.2.3.1 (Modification)

The words "If specified" stand deleted.

8.2.3.4 (Modification)

The words "If specified" stand deleted.

8.2.3.5 (Modification)

The words "If specified by the purchaser" stands deleted in case the process gas contains H₂S.

8.3 Testing

8.3.3 Mechanical running Test

8.3.3.1 (Modification)

The words "If specified" stand deleted.

Note "some fan ... Smaller unit" stand deleted.

- 8.3.3.3.1 (Modification)
The words 'two hours' shall be replaced with 'four hours'.
- 8.3.3.3.2 (Addition)
For Fan with variable speed drives, the fan rotor shall be subjected to an over speed test of at least 110 % of maximum continuous speed for 5 min.

Following an over speed test, each impeller shall be examined for cracks (using the liquid penetrant method) and for deformation or other effects. After this examination, fan rotor shall be dynamically rebalanced.
- 8.3.3.3.4 (Modification)
The rise in bearing/ sump oil temperature rise shall not exceed the limits of clause no. 6.8.5.7.
- 8.3.4.1 **Performance Test**
- 8.3.4.1.1 (Modification)
The vendor shall carry out performance test in his shop either as per AMCA Standard 210 or ASME PTC-11 or BS:848:Part-1 or IS:4894.
- 8.3.4.1.2 The measured performance of the fan shall fall within permissible tolerances of the quoted performance for guaranteed case. Permissible tolerances are:
i) **Capacity:** No negative tolerance
ii) **Static Differential Pressure:** No negative tolerance
iii) **Power absorbed:** +0%
- 8.4 **Preparation for shipment**
- 8.4.1 (Modification)
Unless otherwise specified, the equipment shall be protected for a outdoor storage period of 12 months at site. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.
- 8.4.20 (New)
The equipment shall be suitably packed, fastened to avoid damage during transit and crated for shipment. Lifting, unpacking and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. The upright position, lifting points, gross weight and dimensions shall be clearly marked on each package. Each package shall properly identify the equipment contained therein.
- 9.0 **Vendor's data**
- 9.1.1 (Substitution)
The information to be furnished by the vendor is specified in 9.2 & 9.3 and purchaser's Vendor Data Requirements as included in the inquiry document.
All vendor data/drawings/documents shall be in English Language and in Metric Systems.
- 9.1.2.a (Substitution)
The purchaser's/owner's/consultant's corporate name.
- 9.1.3 **CO-ORDINATION MEETING (Substitution)**
When specified, a co-ordination meeting shall be held at Purchaser's office, preferably within 4 weeks of order. An agenda shall be prepared for this meeting and would include the following points related to technical aspects:

- Any clarifications required by the vendor on purchaser's order.
- Document Control Index (DCI).
- Vendor Data Review/approval modalities.
- Sub-vendor lists proposed by vendor.
- Utility requirements.
- Preliminary General Arrangement & layout drawings & purchaser's interface drawings.

9.2 PROPOSALS

9.2.1 GENERAL (Substitution)

The vendor's proposal shall as a minimum include the following:

- All data sheets, drawings and documents specified under "WITH BID" Section in the Vendor Data Requirement Form.

9.3 CONTRACT DATA

9.3.1 GENERAL

9.3.1.1 (Substitution)

Drawings and data as required after purchase order has been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/document specified there are several drawings to be furnished by the vendor or vice versa.

Data specified in the VDR is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX" to the purchaser (Destination & contact person as per order). This shall be the first document to be submitted by vendor within two weeks of order. **No drawing shall be taken up for review till DCI for the inquiry/order is finalized by vendor.**

If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document

9.3.1.3 (Substitution)

The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, the vendor shall furnish certified copies in the quantity specified.

9.3.1.4 (Substitution)

Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal.

APPENDIX A - Fluid Coupling

A.1 General

A.1.1 Scope

This appendix describes the minimum requirements for the design, manufacture, inspection, testing and supply of Fluid couplings and its auxiliaries, used for Fans.

A.1.2 Experience Criteria

- A.1.2.1 The fluid-coupling model offered shall be from the existing fluid-coupling model series and shall be from the regular manufacturing range of the fluid-coupling manufacturer. (Prototypes are not acceptable).

The offered fluid coupling model series shall be field proven (at least one unit) with minimum operating experience of one year for fan application and for similar power rating, speed, mechanical design, materials etc. supplied in last TEN (10) years, from the proposed manufacturing plant, as on bid due date.

(Note: Similar operating/ design conditions & driver rating would mean approx. 80% or higher).

A.2 Basic design

- A.2.1 Fluid coupling shall be self-supporting on either side by bearing housing and shall be of box type construction.
- A.2.2 All metallic, dry, flexible type couplings with spacer shall be provided between the fluid coupling and the driver/fan.
- A.2.3 The fluid coupling and the driver shall be mounted on a common base plate.
- A.2.4 The oil cooler shall have at least 20% on over design margin on heat duty.

A.3 Controls & instrumentation

- A.3.1 Capacity of fan shall be regulated with a stepless variable speed-scoop tube controlled fluid coupling.
- A.3.2 For the control of scoop tube, the same shall be provided with pneumatic actuators, positioners, all connecting linkages, air kit, dust cover, manual operator, air lock relay, position transmitter for indicating the position of scoop tube etc. Provision shall also be made available for manual operation. Speed indication of the coupling shall be provided. In the event of instrument air, plant air or electric power failure, pneumatic actuator of the scoop tube shall decouple the fluid coupling (i.e. zero speed).
- A.3.3 The instrumentation & controls shall be suitable for the specified area classification.
- A.3.4 Unless otherwise specified, as a minimum, for each fluid coupling, following indicating instrument and instruments for alarm annunciation and shutdown annunciation/actuation shall be provided by the vendor:

A.3.4.1 Temperature Indications:

- Circulation Oil to Fluid Coupling - Locally mounted Temperature Gauge
- Cooling Water Return from Oil Cooler - Locally mounted Temperature Gauge

A.3.4.2 Speed Indications:

- Fan Speed Indication on LGB/LCP.
- Potential free Repeat Contact for Fan Speed Indication on Remote panel/DCS.

A.3.4.3 Push Button Stations:

- Main Equipment Start on LGB/LCP
- Main Equipment Stop on LGB/LCP
- Potential free Repeat Contact for Main Equipment Stop from Remote panel/DCS.

A.3.4.4 Alarm and Shutdown Annunciation:

- Low Cooling Water Flow from Oil Cooler - Alarm Annunciation on Remote Panel/DCS.
- High Oil Temperature supply and/or return from Fluid Coupling - Alarm Annunciation on Remote Panel/DCS.
- High-High Oil Temperature supply and/or return from Fluid Coupling - Shutdown Annunciation on Remote Panel/DCS and Interlock to trip the fan.

A.3.4.5 Fan vendor shall wire and provide indicating lamps on the LGB/LCP for visual indication of common alarms and common shutdown alarms. Potential Free Contacts for the same shall be provided by the purchaser at the LGB/LCP. The LGB/LCP shall be suitable for the specified area classification.

A.3.4.6 Other instrumentation & controls, as deemed necessary by the vendor, for safe operation of the fluid coupling, shall be also provided by the vendor.

A.3.5 Fan vendor shall provide sight flow glasses on all oil lines and breather valve on oil reservoir of fluid coupling.

A.4 Inspection & testing

A.4.1 The following Tests shall be conducted at the Fluid Coupling Manufacturer's shop. These tests shall be witnessed by Purchaser/Purchaser's representative.

1. Heat Test / Temperature Rise Test.
2. Free Running Test.
3. Performance Test for all the operating conditions i.e. at different speeds of the Fan.
4. Vibration Test.
5. Overspeed Test.

A.4.2 Vendor shall submit a detailed test procedure under all the above-mentioned headings, for purchaser's review & approval during detailed engineering stage.

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STANDARD SPECIFICATION FOR DIESEL ENGINE AND DG SET

3	21.01.22	Revised & Issued as Standard Specification	<i>[Signature]</i> JTP	<i>[Signature]</i> JSD/JK	<i>[Signature]</i> NK	<i>[Signature]</i> SM
2	27.08.14	Renamed, Revised & Issued as Standard Specification	RM	NK	DB/ AKN	SC
1	13.05.08	Reaffirmed & Issued as Standard Specification	JSD	NK	VKM	VC
0	16.09.03	Issued as Standard Specification (Superseding EIL Spec. 6-41-0040 Rev.1)	SM	KDS	RK	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
Approved by						

Abbreviations:

ASME	:	American Society of Mechanical Engineers
BMEP	:	Brake Mean Effective Pressure
COP	:	Continuous Power
CPCB	:	Central Pollution Control Board
DG Set	:	Diesel Engine Generating Set
eDMS	:	Electronic Documents Management System
EEMUA	:	Engineering Equipment & Material User's Association
EC	:	Experience Criteria
ECP	:	Engine Control Panel
FM	:	Factory Mutual
IC	:	Internal Combustion
ISO	:	International Organization for Standardization
OEM	:	Original Equipment Manufacturer
PTR	:	Proven Track Record
PRP	:	Prime Rated Power
SFC	:	Specific Fuel Consumption
UL	:	Underwriter's Laboratories Inc.
UHC	:	Unburnt Hydro-Carbon
VDR	:	Vendor Data Requirement
VDOCS	:	Vendor Document Management System
VDM	:	Vendor Data Management

Rotating Equipment Standards Committee

Convenor: Mr. Nalin Kumar

Members: Mr. Tarun Kumar
Mr. Anukul Mandal
Mr. J S Duggal
Mr. Abhay Kumar
Mr. Mahesh Easwaran
Mr. Ayush Mathur (Projects)

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ANNEXURES:

ANNEXURE-A: DERATION CALCULATION

SECTION 1 - GENERAL.

1.1 SCOPE

- 1.1.1 This specification together with the attendant Data Sheets and other specifications/ attachments to inquiry / order defines the minimum requirements for the Diesel engine/ Diesel engine Generator (DG) sets and their accessories/ auxiliaries for general industrial purposes.

This specification includes diesel engines for the following applications:

- Generator packages
- Fire water pump packages
- Prime mover for rotating equipment

This specification does not cover the following applications:

- Diesel engine for marine application
- Two stroke diesel engine
- Dual fuel engine
- Crude/Gas engines

- 1.1.2 Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser
- 1.1.3 Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified operating conditions.

1.2 CONFLICTING REQUIREMENTS

- 1.2.1 In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:
1. Equipment Data Sheets
 2. Job Specifications (if any)
 3. This specification
 4. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry document shall be applicable.

In case of any ambiguity in the above documents, the vendor shall seek clarification from the owner/purchaser -and the decision of the owner/purchaser shall be final and binding.

1.3 DEFINITION OF TERMS

- 1.3.1 All the definitions as indicated in ISO: 3046 shall apply for Diesel Engine.
- 1.3.2 All the definitions as indicated in ISO: 8528 shall apply for DG set.
- 1.3.3 DG set: A diesel generator (DG) (also known as diesel genset) is the combination of a diesel engine with an electric generator (often an alternator) to generate electrical energy.

1.3.4 DG package: A DG set package which includes DG set(As per cl.no 1.3.3 above) and all its associated auxiliaries such as cooling water system, air intake/exhaust system, fuel system, lube oil system, starting system etc.

1.3.5 Diesel engine as mechanical drive applications are such as driver for fire water pumps, driver for process pump & compressors etc.

1.4 REFERENCED PUBLICATIONS

ISO:3046-1	Reciprocating Internal Combustion Engines - Performance Part 1: Standard reference conditions, declarations of power, fuel and lubricating oil consumptions and test methods.
ISO:3046-3	Reciprocating Internal Combustion Engines - Performance Part 3: Test measurements
ISO:3046-4	Reciprocating Internal Combustion Engines - Performance Part 4: Speed governing
ISO:3046-5	Reciprocating Internal Combustion Engines - Performance Part 5: Torsional vibrations
ISO:3046-6	Reciprocating Internal Combustion Engines - Performance Part 6: Overspeed protection
ISO:8528-1	Reciprocating Internal combustion engine driven alternating current generating sets; Part 1: Application, ratings and performance
ISO:8528-2	Reciprocating Internal combustion engine driven alternating current generating sets; Part 2: Engines
ISO:8528-5	Reciprocating Internal combustion engine driven alternating current generating sets; Part 5: Generating sets
ISO:8528-6	Reciprocating Internal combustion engine driven alternating current generating sets; Part 6: Test methods
IS:5571	Guide for selection and installation of Electrical equipment for hazardous area (other than mine)
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks
ASME	The American Society of Mechanical Engineering Boiler and Pressure vessel code, Section VIII, Rules for Construction of Pressure vessels, and Section IX, Welding and Brazing Qualifications.
ISO-15550	Internal combustion engines-Determination and method for the measurement of engine power-General requirement
NPFA 20	Standard for the installation of stationary pumps for fire protection
ASME PTC 17	Performance test code-Reciprocating internal combustion engines

The editions of referenced publications that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

1.5 EXPERIENCE CRITERIA (EC)

1.5.1 FOR DIESEL ENGINE

1.5.1.1 The vendor shall be a manufacturer of Diesel Engine and shall also be the manufacturer of the proposed Diesel Engine having adequate design, engineering, manufacturing and testing facilities for the same.

1.5.1.2 The Diesel Engine model offered shall be from the existing manufacturing range of the vendor and already type tested at either manufacturer's works or outside. The Engine model offered shall meet the following minimum service and manufacturing experience requirements specified in clause 1.5.1.3 below.

1.5.1.3 The Diesel Engine proposed shall be identical in terms of Model no., Speed, ISO standard Power rating and similar in terms of Fuel used, Type of Cooling arrangement, Materials, Mechanical Design etc. as compared to at least ONE (1) unit of the proposed engine model which have been designed, manufactured, tested and supplied from the proposed manufacturing plant in the last TEN (10) years and shall have completed ONE (1) year of operation at site as on bid due date

1.5.2 FOR DG SET

1.5.2.1 The DG set vendor shall either be the manufacturer of the offered diesel engine or an authorised packager of the manufacturer of offered diesel engine OR their Authorized Generator set OEM (GOEM)

Note: "OEM means Original Equipment Manufacturer of the proposed Diesel Engine"

"GOEM means Original Equipment Manufacturer of the proposed Diesel Engine Generator Set"

1.5.2.2 The Diesel Engine of the offered DG set shall meet the requirements as specified in clause no. 1.5.1.1 to 1.5.1.2.

1.5.2.3 The DG set vendor shall have engineered, packaged, supplied, installed, commissioned and tested, in the last Ten (10) years, at least One (1) Diesel engine driven Generator set of similar (80% or higher) power rating as compared to the offered DG set and shall have completed ONE (1) year of operation at site as on bid due date.

1.5.3 Proven Track Record (PTR)

The vendor shall furnish PTR for the offered Engine model/offered DG set in the prescribed format attached with the inquiry document. Since this reference list will be used for establishing provenness of proposed engine model/DG set for operating under specified operating conditions, it is in vendor's own interest to select such references, where the proposed engine model/DG set is supplied and operating at conditions similar to those specified for item against which the proposed engine model/DG set is offered. In addition, manufacturer's catalogue and general reference list shall also be furnished for the proposed engine model/DG set.

Vendor shall also furnish PTR for engine model/DG set packaging & unitization in the prescribed format attached with the inquiry document.

SECTION 2 - BASIC DESIGN

2.1 GENERAL

- 2.1.1 The Diesel Engine shall be vendor's standard model meeting the requirements as defined in ISO:3046. It shall be 4 stroke cycles, water cooled, naturally aspirated/ turbocharged (as per manufacturer standard) suitable for delivering the power requirement of the driven equipment (alternator etc.) after taking into consideration the transmission losses, site de-ration and power requirements of auxiliaries and other parasitic loads.
[Engine Manufacturer's de-ration calculations for the specified site conditions in duly completed "Annexure-A or Annexure-B" shall be furnished along with the bid. As a minimum, the vendor shall consider the de-ration due to ambient temperature, altitude, relative humidity, cooling water temperature, inlet and exhaust losses etc. De-ration factor shall be worked out as per ISO:3046. In case, there is no de-ration for the specified site conditions, the Engine Manufacturer's categorical statement along with proper technical justification shall be furnished]
- 2.1.2 Standard reference conditions for diesel engine/ DG set shall be as defined in ISO: 3046-1/ ISO: 8528-1.
- 2.1.3 The generator/ alternator used in the proposed DG set shall meet the requirements as specified in electrical specifications.
- 2.1.4 Diesel engine, including all auxiliaries, shall be designed and constructed for a minimum service life of 20 years. Vendor shall specify in the proposal the minimum period of uninterrupted operation.
- 2.1.5 Diesel engines shall be provided with removable cylinder liners.
- 2.1.6 Direction of rotation of the diesel engine shall be permanently marked on the engine in a visible location
- 2.1.7 If recommended by vendor, barring device (manual/pneumatic/electric) shall be provided
- 2.1.8 Hot surfaces above 70 Deg C shall be provided with personnel protection either by suitable insulation or screening.
- 2.1.9 The vendor shall provide emission data including NOx, CO, SOx and UHC for the operating range

2.2 RATED POWER OUTPUT AND SPECIFIC FUEL CONSUMPTION (SFC)

- 2.2.1 The power rating of the DG set/Genset is the net exportable power output available at the alternator terminals after deducting the electrical power consumed by the essential independent auxiliaries.
- 2.2.2 For DG set/Genset used for intermittent, standby and emergency service, the power rating category shall be Prime Power Rating (PRP) as per ISO 8528-1 provided the actual average power output of genset over 24 hours of operation (excluding stop time) does not exceed 70% of the PRP or the permissible average power output confirmed by engine manufacturer, whichever is higher.
- 2.2.3 For DG set/Genset used for continuous service, the power rating category shall be Continuous Power Rating (COP) as per ISO 8528-1. The genset shall be offered to have

their published COP rating equal or higher than the required rating. In case the COP rating is not published, the genset shall be offered to meet the required rating with 70% of the published PRP Rating.

- 2.2.4 Unless otherwise stated the power rating of the DG set/Genset is the power output expressed in kilowatts at rated frequency and a power factor of 0.8 lagging. The genset rating indicated by the manufacturer in the Equipment Data Sheet shall be with no negative tolerance.
- 2.2.5 Sizing criteria for diesel engine for mechanical drive application as given below:

The net site power available after considering the de-rating due to site condition and power losses, due to other parasitic loads and engine driven auxiliaries shall be higher of the following two values:

- a) 30 percent in excess of the maximum BKW required driving the pump at rated condition.
- b) Maximum BKW rated impeller as indicated by the manufacturer in the pump data sheets.

10 percent overload capacity for 1 hour in 24 hours is also required. Additionally, following shall be met for fire water pump diesel driver applications "The diesel engine shall also be suitable for operating the pump at 150% of rated flow".

- 2.2.6 Specific fuel consumption shall be indicated with reference to the engine power required for delivering the rated electrical power at alternator terminal i.e. 100% rating of the genset plus the electrical power consumed by essential independent auxiliaries. The tolerances shall be as per ISO: 3046-1.
- 2.2.7 The vendor shall furnish with his proposal, a list of engine auxiliaries, which require electrical power. All such auxiliaries shall be further categorized on the basis of:
- If these are required to run continuously / intermittently.
 - If these are required to run before engine starting, during starting or required to run after start-up.
 - If the above are required to be fed from engine developed power (In such a case, feeding arrangement shall be in vendor's scope).

The vendor shall clearly identify those auxiliaries, which will be required to be fed by the Purchaser.

2.3 ENGINE STARTING SYSTEM & LUBRICATION SYSTEM

- 2.3.1 Unless otherwise specified, the type of starting arrangement shall be battery starting for 1010 KVA or lesser rating of DG set. For more than 1010 kVA DG set, battery starting system can be also specified based on availability in the market and subject to client's approval.
- 2.3.2 Where the engine is specified/ offered with compressed air starting, the vendor shall specify the starting air pressure required for cranking. Unless otherwise specified the vendor shall also provide Two air compressors (one driven by a diesel engine and the other by electric motor) and air receiver(s). The system shall be provided with necessary instruments, controls and safety devices.
- Starting air compressors and its diesel engine driver shall be as per manufacturer's standard and shall be proven with adequate running experience. Vendor shall however

furnish full technical details of air compressor unit and its instruments/ controls with the bid.

The air receiver supplied by the Vendor shall be sized for at least six consecutive starts without recharging. Air receivers shall meet ASME Section VIII & IX specifications and be equipped with a safety valve, pressure gauge and drain valve.

In case both air compressors are proposed to be driven by electric motors (instead of one diesel engine drive), the same can be accepted only if an additional DG set having suitable capacity to start these air compressor motor(s) during black out condition is provided.

2.3.3 Engines shall be capable of starting without the use of cold starting aids for ambient temperatures of 4°C and above.

The Vendor shall provide suitable cold starting aids with engines for quick starting at ambient temperatures below 4°C and such aids shall be clearly detailed out in the offer. Lubricating oil heaters shall not be used as a cold starting aid.

2.3.4 Where the engine is specified/ offered with battery starting arrangement, the starter shall be suitable for the specified electrical area classification. Where the engine is specified to be equipped with a dual starter, the synchronizing switch and the corresponding wiring/ connection with the starter shall be provided by the Vendor.

[Dual starter means any of the two starting system of the following: Hand Starting with Starting Handle, Battery Starting, Air Starting through Pneumatic Motor, Air Starting through Air Injection into Cylinders, Hydraulic Motor etc]

2.3.5 Where the engine is specified / required to start and/or stop automatically, the vendor shall provide the necessary controls (Automatic-cum-manual) in the engine panel, the inter-connecting wiring, piping/tubing from panel to the engine and the starting/stopping equipment. A pilot lamp shall be provided in the starting equipment/control panel to indicate that the controller is in automatic position. In the event the engine does not start after three attempts the controller shall stop further cranking and operate the audio visual alarm.

2.3.6 Pre-lubrication requirement:

a) For engines requiring pre-lubrication immediately before start-up, electric motor driven pre-lubrication pump connected to an emergency power source with timer, suitably interlocked with the starting system, shall be provided by the vendor. Unless otherwise specified the emergency power source shall be furnished by the vendor.

b) For engines which do not require pre-lubrication immediately before start, but require periodic pre-lubrication to keep engine lubricated for automatic start, an AC motor driven pre-lubrication pump with automatic start-stop and timers, set for specific running time to provide pre-lubrication after preset periods of intervals shall be provided by the vendor. The logic to establish the pre-lubrication shall be provided & implemented by the vendor in the engine control panel, supplied by them.

c) For engines, which have only manual starting/stopping, a vendor's standard manual pre-lube pump shall be provided, unless vendor does not recommend the same and proposes other means to be adopted for any pre-lubrication after prolonged shut down periods. Such means shall be explained in the bid.

2.3.7 Pre-lubrication pump shall be provided with a discharge check valve.

- 2.3.8 Differential pressure indicator shall be provided for lubrication oil filters.
- 2.3.9 Oil side pressure of the lubrication cooler shall be higher than the water side pressure.

2.4 ENGINE FUEL SYSTEM

2.4.1 Fuel oil treatment system (if required) and fuel oil control system shall be supplied by the vendor. Unless otherwise specified, this fuel treatment system shall be of vendor's standard design proven for the specified type of fuel. If required to maintain fuel supply temperature, a fuel cooler shall be provided in the return line to the fuel tank.

2.4.2 Unless otherwise specified, DG set rating i.e. less than 500 kVA (PRP Rating) & installed in open to sky condition, a base frame mounted fuel tank with manufacturer standard capacity can be acceptable. A separate fuel day tank(s) of 990 liters shall be provided for each DG set of rating more than 500 kVA (PRP rating) & if they are installed in open to sky condition.

Fuel Day tank(s) shall be located outside the room (if DG set is installed inside a room), irrespective of the capacity/ size of the fuel day tank. Suitable weather protection with fencing around shall be provided for fuel day tank which are located outside DG room.

2.4.3 The fuel day tank, if provided, shall be, as a minimum, equipped with vent piping with flame arrester, shielded level gauge, strainer and a hand hole of not less than 150 mm diameter, besides the required fuel connections and a drain valve. Unless otherwise specified, manual operated portable pump with suitable capacity (1000 lph as a minimum) along with flexible hose and quick connects coupling shall be provided by FW main pump supplier for filling of diesel in day tanks from diesel barrel/drum. Day tank shall be metallic.

2.4.2.4 The height of installation of the day tank shall be indicated by the vendor in the general arrangement drawing. In case, Fuel Day tank is mounted above engine fuel connection level, a fuel float (surge) tank shall be provided along with its interconnecting piping/ hoses to ensure that the system does not permit gravity flow to the engine through fuel supply line during engine shutdown.

2.4.2.5 The Fuel day tanks shall be of manufacturer's standard.

2.4.2.6 Unless otherwise specified, for fire water pump application and all other applications, the capacity of the Fuel Day tank(s), as a minimum, shall be suitable for running of the engine at full load for six hours. The size of a single fuel day tank shall be limited to maximum of 990 liters & desired capacity as per above can be arrived at by interconnecting multiple tanks.

2.5 ENGINE JACKET COOLING SYSTEM

2.5.1 Engine jacket cooling system (primary circuit) shall be closed circuit liquid cooled type including circulating pump, make up tank, heat exchanger, temperature regulating device, engine outlet cooling water temperature high alarm & trip device etc. If required, jacket water heater shall be provided.

2.5.2 The heat exchangers i.e. oil coolers and engine cooling water coolers can be of any one of the following types as specified in the inquiry:

- a) Water cooled shell and tube type.
- b) Air cooled type i.e. Radiator type with engine driven or electric motor driven fan

2.5.3 For radiator cooled engines with engine driven radiator fans, the radiator, temperature control valve, expansion tank with level gauge, radiator guard and other necessary piping and valves shall be mounted on the engine base.
For remote mounted radiator system, vendor shall supply electric motor driven radiator fan and additional cooling water booster pump located in the engine return line. Height of the expansion tank in the closed circuit cooling shall be at the highest level in the complete circuit. Piping connections from cooling water outlet from the top of the Engine to the top portion of the radiator shall be continuously sloping towards the engine without any pockets.

2.5.4 Heat exchangers shall be of shell & tube type with secondary cooling medium (raw water/ or any other coolant specified in the inquiry) passing through the tubes. Heat exchanger shall be of vendor's standard design and sized for heat rejection of at least 15% greater than engine full load heat rejection.

2.6 COMBUSTION AIR INTAKE & ENGINE EXHAUST SYSTEM

2.6.1 The vendor shall prepare a layout drawing showing the layout and routing of air intake and engine exhaust piping/ducting, and include in his scope complete piping/ducting, nozzles, expansion joints and supports as required as per his layout and routing.

2.6.2 The type and location of air intake filter shall be vendor's standard and shall be suitable for the climatic/environmental conditions applicable to the site of installation of the engine.

2.6.3 In case the filter is located outside the engine building/ engine enclosure, vendor shall provide the following for the filter:

- Insect screen
- Rain hood
- Supporting structure with approach for maintenance.

Unless otherwise specified, coalescing filters shall be provided for high humidity environment (60% Relative Humidity or higher).

2.6.4 Exhaust gas discharge shall be located away from inlet air and ventilation air intakes to prevent re-entry of offensive fumes and also should not cause discomfort to personnel or hazards to building or equipment.

2.6.6 Exhaust gas piping (as applicable) shall be provided with thermal insulation & cladding for personnel protection. The insulation thickness shall be adequate to limit the surface temperature at cladding not exceeding 60 degC. The extent of insulation and cladding shall be at least up to 3m of height from grade including complete length of exhaust piping within engine room.

2.6.7 Unless otherwise specified, the height of the exhaust stack for DG set shall be as per guidelines provided in "Environmental Regulations on Engines for Generator set application and Generator sets" issued by Central Pollution Control Board (CPCB).

2.6.8 Unless otherwise specified, for the DG sets installed in a room, if a ventilation system is required/ recommended, the same shall be included in vendor's scope of supply. Vendor shall indicate the details of the ventilation system, if required, along with the proposed installation arrangement in engine room. The vendor, while designing the ventilation system, shall consider sufficient no. of air changes to maintain the temperature inside the engine room equal to ambient temperature.

- 2.6.9 DG sets not installed in room shall be supplied with enclosure for noise control and weather protection. The enclosure shall be provided with vendor standard ventilation system designed to maintain the temperature inside the engine room close to ambient temperature.
- 2.6.10 Exhaust stack height shall be as per CPCB norms or state pollution norms, whichever is stringent for the DG set. In case, DG sets are installed in open to sky condition (without shed or room), height of nearest building shall be considered for arriving exhaust stack height as per CPCB/State pollution norms.
- 2.6.11 Air inlet & exhaust gas shall be provided with silencers if required

2.7 GOVERNING

- 2.7.1 The governing class shall be selected by the vendor suitable for meeting the voltage and frequency variations specified in Electrical specifications.
- 2.7.2 In case of parallel running generators (i.e. for generators required to run in synchronization), the governor and fuel injection pumps provided shall have identical characteristics.

2.8 NOISE AND EXHAUST GAS EMISSION

- 2.8.1 Unless otherwise specified, any applicable legislation/ statutory requirements relating to the protection of environment and to the health and safety of personnel, with regard to noise and exhaust gas emission, as applicable to the place of installation shall be fully complied with by the Engine manufacturer.

2.9 NAME PLATE

A name plate of stainless steel or Monel shall be attached by pins of a similar material to the Engine and to any other piece of major auxiliary equipment, in a location permitting easy visibility. The purchaser's item number, the vendor's name, serial number, rating and testing data appropriate to the unit shall appear on all name plates.

SECTION 3 - ACCESSORIES

3.1 COUPLINGS AND GUARDS

- 3.1.1 Couplings shall be sized for maximum continuous torque, which is based on the potential maximum power of the diesel engine.
- 3.1.2 Couplings shall be of flexible type, however for generators up to 1010KVA, the coupling may be accepted as per vendor standard based on their past field proved experience. The coupling used shall be successfully proven for the service being used. The service factor used shall be conservatively selected for the maximum horsepower rating of the engine with a factor of not less than 1.7.
- 3.1.3 Non sparking guards are required over all moving parts. The guards shall be securely attached to the base plate on foundation by means of bolts. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kgs.

3.2 BASE PLATE

- 3.2.1 Unless otherwise specified, a common baseplate for the complete unit (engine and the alternator) shall be supplied by the vendor. A baseplate shall be a single fabricated steel unit, unless the purchaser and the vendor mutually agree that it may be fabricated in multiple sections.
- 3.2.2 When specified, the base plate shall be suitable for column mounting i.e. of sufficient rigidity to be supported at specified points without continuous grouting under structural members.
- 3.2.3 The base plate shall be provided with lifting lugs for a four point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the base plate or the machinery mounted on it.
- 3.2.4 The bottom of the base plate between structural members shall be open. When installed on a concrete foundation, accessibility for grouting under all load carrying structural members shall be provided.

3.3 SPECIAL TOOLS

When special tools and fixtures are required to disassemble, assemble or maintain the unit, they shall be included in the quotation and furnished as part of the initial supply of the machine. Standard tool kit for normal maintenance shall be provided for each diesel engine/ DG set.

3.4 INSTRUMENTATION

The vendor shall supply instrumentation and control system as specified in the inquiry. If in the opinion of the vendor, additional instruments, controls and safety devices are required, the vendor shall include the same in his scope of supply.

Engine control panel (ECP) mounted on the diesel engine, containing essential safety protection and control shall be provided. ECP shall be provided with communication interface to the local control panel and the purchaser's control system for remote operation and control, monitoring.

SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.1 GENERAL

- 4.1.1 The Inspector representing Purchaser shall have entry to the plant while and wherever work for the equipment is being performed.
- 4.1.2 The Vendor shall have the responsibility of providing Purchaser's Inspector with all requisite facilities/ equipment for carrying out proper inspection and witnessing of test.
- 4.1.3 Engines of nominal rating up to 1000 kW shall be subjected to Engine Manufacturer's routine shop test and the test certificates shall be submitted to the purchaser's inspector for his review, provided the engine manufacturer is an ISO:9000 certified vendor.
Unless otherwise specified in the inquiry/ order, for all other cases, engines shall be witness tested in accordance with the latest edition of ISO:3046.

The routine load and fuel consumption test shall be of the following duration:

- a) Part Loads (50% & 75%) - ½ hour each
- b) Full Load (100%) - 4 hours
- c) 10% Overload - 1 hour

After the specified tests have been completed satisfactorily, the fuel stop on the fuel injection pump shall be set and sealed at the specified site rating including provision for 10 percent overload.

Loads (50%, 75%, 100% & 10% over load) specified above are for PRP rated DG set. Same can be applied for COP rated DG set also (i.e. COP DG set can be load tested as PRP rated DG set, however, 10% overload is not applicable).

- 4.1.4 The hydrostatic test certificates for the heat exchanger/intercooler, fuel tanks and other pressure vessels shall be furnished to the Purchaser's inspector for his review at the time of load testing of the diesel engine.
- 4.1.5 The engine control panel after assembly and wiring, shall be functionally tested at the sub-vendor's works in the presence of the Purchaser's Inspector.
- 4.1.6 In addition to the inspection and tests specified in clause no. 4.1.3 to 4.1.5 above, the genset shall be subject to Full Load Test for 4 hours & overload test of 1hr @ 110% load (if applicable) at DG set/genset vendor's shop & Job site. DG set site testing may be allowed at available load in case full load is not available at job site. Unless otherwise specified, load bank for job site testing is not required.

4.2 PREPARATION FOR SHIPMENT

- 4.2.1 Immediately upon completion of all tests and inspections, all exposed machined surfaces shall be cleaned and coated with suitable rust preventive by the Vendor and the unmachined surfaces shall be painted by at least two coats of red oxide primer.
- 4.2.2 DG set along with its auxiliaries/ accessories shall be transported in assembled condition as far as possible.
- 4.2.3 All untapped openings shall be provided with 4 mm thick metal closures with full rubber gaskets and bolted by not less than 4 bolts. All connections including those for instruments, instrument leads, lubricating oil and the like shall be identified with securely attached tags indicating the type of connection, the instrument or the line description as applicable.
- 4.2.4 The equipment shall be crated for domestic/export shipment as specified in the data sheets considering for storage at job site for atleast 12 months. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals. Lifting load-cut, and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. Upright position lifting points, weight (including packing) and dimensions shall be clearly identified with item nos., serial nos., package nos., and the names of the equipment.
- 4.2.5 Two copies of the manufacturer's installation and instruction manual per clause 5.2.5.2, shall be packed and shipped with the equipment.

SECTION 5 - VENDOR'S DATA

5.1 GENERAL

The information to be furnished by the vendor is specified in 5.2 & 5.3 and purchaser's Vendor Data Requirements as included in the inquiry document.

Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX" to the purchaser (Destination & contact person as per order).

No drawing shall be taken up for review till the DCI for inquiry/order is finalized by vendor.

If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document.

5.2 PROPOSALS

The vendor's proposals shall as a minimum include the documents specified in purchaser's Vendor Data Requirements as included in the inquiry document.

All vendor data/drawings/documents shall be in English Language and in Metric Systems.

The vendor's proposals shall as a minimum include the following:

- (a) All data sheets, drawings and documents listed under "WITH BID" in the Vendor Data Requirement (VDR) Form enclosed with the inquiry.
- (b) Vendor's confirmation/ comments on post-order Vendor Data Requirements (Type of Documents, no. of prints and date needed) indicated in Vendor Data Requirement forms data sheets and specifications.
- (c) List of recommended commissioning spares included in the offer.
- (d) List of mandatory spares (where specified by the purchaser) included in the offer.
- (e) List of spare parts for two years normal operation shall be made separately including auxiliaries and drivers in the form of a table & shall show
 - i) Part name, description and number.
 - ii) Quantity installed in one unit.
 - iii) Quantity recommended per unit for 2 years normal operation.
 - iv) Quantity recommended for number of units of an item as specified in the inquiry.
 - v) Quantity recommended as insurance for the number of units of an item specified in the inquiry.
- (f) An itemized list of special tools included in the offer.
- (g) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment. These spares to be included as commissioning spares.
- (h) Any limitations of vendor's test-facility to carryout the specified tests.
- (i) A specific compliance statement that the scope of supply, the offered equipment/ systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviations as listed in the proposal.

5.3 CONTRACT DATA

5.3.1 General

- 5.1.1.1 Drawings and data as required after purchase order is specified in Vendor Data Requirement. Vendor to note that the drawing/ document descriptions/ titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one

drawing/ document specified there are several drawings to be furnished by the vendor or vice versa.

Vendor to note that, the submission of all post order drawing & documents shall be done through EIL. Vendor Document Management System portal. Vendor shall complete & forward the Document Control Index (DCI) to the purchaser (Destination & contact person as per order) through above Vendor Document Management System portal.

This document shall list out in consolidated form all drawings and documents required by purchaser vide VDR as included in the purchase requisition. Any other data, drawing/ document as specified in Data Sheets and Specifications shall also be included by the vendor in the DCI. Against each drawing/document, vendor shall populate their list of document indicating the vendor's drawing numbers, titles, Rev. No. and schedule of submission.

This shall be the first document to be submitted by vendor within two weeks of DCI approval.

No drawing shall be taken up for review till DCI for the inquiry/order is finalized by vendor.

5.1.1.2 All transmittal letters (covers), drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:

- (i) Purchaser's and Consultant's Corporate Name
- (ii) Project Name.
- (iii) Equipment Name and Item No.
- (iv) Purchase Order No.
- (v) Purchase Requisition No.

Title Block on drawings shall be placed on the lower right hand corner.

5.1.1.3 All vendor data/ drawings/ documents shall be in English Language and in Metric Systems.

5.1.1.4 Data specified in the VDR is the minimum requirements of Purchaser. Any additional document/ data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

5.1.2 Co-ordination meeting

When specified, a co-ordination meeting shall be held at Purchaser's office or through web online, preferably within 4 weeks of order.

An agenda shall be prepared for this meeting and would include the following points related to technical aspects.

- (a) Any clarifications required by the vendor on purchaser's order.
- (b) Vendor Data Index & Schedule.
- (c) Vendor Data Review/approval modalities.
- (d) Sub-vendor lists proposed by vendor.
- (e) Utility requirements.
- (f) General Arrangement & layout drawings & purchaser's interface drawings.

5.1.3 Drawings

5.1.3.1 The timeframe within which the drawings are to be submitted by vendor are specified in Purchaser's inquiry/order.

5.1.3.2 The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, certified copies shall be submitted by vendor as a part of final documents (Technical Data Manual/Mechanical catalogues) in the specified quantity. All drawings must be clearly legible and shall be submitted A4 or A3 paper sizes (except overall layout/ Foundation/ GA drawings which shall be submitted in A2 paper sizes). Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the enquiry/ contract document(s).

5.1.3.3 Drawings/documents with following titles shall contain as a minimum the following information:

a) **General Arrangement Drawing**

A general arrangement drawing shall indicate:

- i) Outline dimensions (minimum three views) (All principal dimensions).
- ii) Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains, fuel, cooling water & Electrical/ Instrumentation.
- iii) Direction of rotation viewing from the driving end.
- iv) Weight of each assembly/ component.
- v) The weight & location of centre of gravity of the heaviest assembly/components that must be handled for erection.
- vi) Identification and weight, dimensions of the heaviest assembly / subassembly / component required to be handled for maintenance.
- vii) Maintenance clearances and dismantling clearances.
- viii) Speed
- ix) Layout of auxiliary equipment and operating platform.
- x) Height of installation of the day tank (if applicable).
- xi) Make, Type and Size of couplings and the location of guards.
- xii) A list of reference drawings if any.
- xiii) A list of any special weather-protection and climatic features.

b) **Foundation Drawings**

A foundation drawing shall indicate complete information required for foundation design by purchaser including the following:

- a) Foundation bolt sizes & pipe sleeve details and pocket sizes & locations.
- b) Type of grout material, its recommended make & grade.
- c) Grouting thickness and other necessary technical details.
- d) Static weight of each independently grouted item (such as diesel engine, gear box (if required), driven equipment, control panel etc.) and location of centre of gravity of each of such items in all three planes.
- e) Weight distribution for each bolt/subsole-plate location and total static weight.
- f) Dynamic loads, if any, caused due to various items grouted independently. (The cause of generation of such loads shall also be indicated).
- g) The direction and magnitude of unbalance forces and moments (with their phase angles) generated by the out of balance of the rotating / moving parts of the machine at the relevant operating conditions. [These loads and their locations are to be given in all three planes. These shall be utilised for computing the amplitudes of vibration of the foundation].
- h) GD^2 value of each item resolved to driver speed.
- i) Maximum permissible amplitude of vibration on the foundation at the base level. (The location of the points on the foundation base where such amplitudes are not to be exceeded shall be given in all three planes). The reference of relevant code, if any, shall also be indicated.

- j) Total mass of rotating parts.
- k) Total mass of reciprocating parts.
- l) Suggested dynamic factor and ratio of weight of foundation to weight of machine.
- m) Short circuit loads caused in motor drivers.
- n) Operating speed of the machine and the driving motor.
- o) Scope of Supply of the Foundation Bolts (unless otherwise specified, by vendor).
- p) Maximum permissible magnitude of the unbalance forces and moments generated by the out of balance of the rotating / moving parts of the machine as allowed by the relevant codes, if any. (The reference of such code, if any, shall also be indicated).
- q) Recommended separation margin (if any), between the machine operating speeds and the natural frequencies of the machine foundation system along with the basis of such recommended separation margins.
[Note: Unless otherwise indicated by vendor, the dynamic forces as given in e) & l) above are considered as additional static loads for designing the foundations statically. Such dynamic forces are not unbalance forces and therefore, these shall not be utilised for computing the amplitudes of vibration.]

5.1.4 Data sheet

- 5.1.4.1 The Vendor shall provide completely filled in data sheets, first for "As Purchased" and then for "As Built". This shall be done by the vendor correcting and filling out the data sheets and submitting copies to the purchaser.

5.1.5 Technical Data Manual/Mechanical catalogues

- 5.1.5.1 Mechanical catalogue is a compilation of "As Built" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

- 5.1.5.2 Not later than two weeks after successful completion of all specified tests, the vendor shall furnish the required number of mechanical catalogues for the equipment, any auxiliaries and instruments that the vendor is providing. The mechanical catalogue shall include the following documents as a minimum:

- i) All drawings and data as listed in the vendor data index & schedule. (For drawings, where purchaser's approval is required, the final certified drawings shall be attached.) Sections shall be organized in a manner that data & drawings related to one subject is grouped together such as Mechanical, Electrical, Instrumentation etc.
- ii) All manufacturing, inspection and test data and records.
- iii) Installation and Instruction Manual
The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the equipment and prepare the equipment for start-up. It shall include any special information required for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data.
- iv) Operation and Maintenance Manual
This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered. It shall include a section to cover special instructions for operation at extreme environmental and/or extreme operating conditions. The following shall be included in this manual:

- a) Instructions covering start-up, normal shutdown, emergency shutdown, operating limits and routine operational procedures.
 - b) A description of equipment construction features and the functioning of component parts or systems (such as control, lubrication, etc.).
 - c) Outline and sectional drawings, schematics and illustrative sketches in sufficient details to identify all parts and clearly show the operation of all equipment and components and the methods of inspection and repair. Standardised sectional drawings are acceptable only if they represent the actual construction of the equipment.
 - v) Following information shall also be included in the Mechanical Catalogue:
 1. Storage instructions for storing and preserving the equipment (including auxiliary units) at the plant site before installation of the same.
 2. Field test procedures and acceptance criterion.
- 5.1.5.3 Technical Data Manual/ Mechanical Catalogue shall be in Hard board folder(s) of size 265 mm x 315 mm (10½" x 12½") and shall not be more than 90 mm thickness; it may be of several volumes and each volume shall have a volume number, index of volumes & index of contents of that particular volume.
- 5.1.5.4 Title sheet (Top sheet) of each volume of mechanical catalogue shall contain the contract information(s) as defined under 5.2.1.2 besides the volume number.
- 5.1.5.5 In case order contains more than one item, separate dedicated Technical Data Manual/ Mechanical Catalogues shall be submitted for each item.
- 5.2.5.6 Final / "As-Built" drawings / documents shall also be submitted as electronic files on secondary storage media (CD-ROM / DVD-ROM disks) and in Vendor Document Management System portal. The number of prints and/or reproducible required to be submitted by vendor are as specified in Purchaser's inquiry/order.

ANNEXURE-A

Deration Calculation for Diesel engine in genset application

1.	ISO Standard Power (as per ISO 3046-1) of the engine, (obtained after deducting power loss due to essential dependent auxiliaries) (P_{iso})		
	P_{iso}	:	kW
2.	Deration on account of site conditions (refer datasheet for ambient conditions) as per ISO 3046-1		
	Temperature (around the engine and alternator)	:	kW
	Altitude (d1)	:	kW
	Humidity (d2)	:	kW
	CW temp (d3)	:	kW
	Inlet losses (d4)	:	kW
	Exhaust back press (d5)	:	kW
	Total Deration ($P_{deration} = d1 + d2 + d3 + d4 + d5$)	:	kW
3.	Service Power (as per ISO 3046-1) of the Engine (i.e. at stated conditions)		
	$P_{service} = P_{iso} - P_{deration}$:	kW
4.	Power Loss in the Alternator under stated conditions (P_{alt})		
	P_{alt} [i.e. $KVA * pf(100 - \eta_{alt}) / \eta_{alt}$]	:	kW
5.	Power consumed by essential independent auxiliaries (P_{aux})		
	P_{aux}	:	kW
6.	Any other Power Loss applicable to the offered genset (P_{misc})		
	P_{misc}	:	kW
7.	Net output required for electrical consumption (P_{output}) (Note-4)		
	($P_{output} = \underline{\hspace{2cm}}$ kW (minimum))	:	kW
8.	Actual Power Required from Engine (P_{actual})		
	$P_{actual} = P_{output} + P_{alt} + P_{aux} + P_{misc}$:	kW

Ensure that $P_{service} \geq P_{actual}$ and shall furnish calculations / supporting documents.

Note: As per Annex-A of ISO-3046-1, the following describes the typical list of auxiliaries:

1. Essential dependent auxiliaries (as applicable)
 - a) engine-driven LO pressure pump;
 - b) engine-driven LO scavenge pump for dry-sump engines;
 - c) engine-driven engine-cooling water pump;
 - d) engine-driven raw-water pump;
 - e) engine-driven radiator-cooling fan;
 - f) engine-driven engine-cooling fan for air-cooled engines;
 - g) engine-driven gaseous fuel compressor;
 - h) engine-driven fuel-feed pump;
 - i) engine-driven fuel-pressure pump for common rail or servo-injection system;
 - j) engine-driven scavenge-air blower and/or charge-air blower;
 - k) engine-driven generator, air compressor or hydraulic pump supplying power to items in sl. No. 2 below;
 - l) engine-driven cylinder lubricating pump;
 - m) air cleaner or air silencer (normal or special);

- n) exhaust silencer (normal or special).
2. Essential independent auxiliaries (as applicable)
- a) separately driven auxiliaries as defined above from Sl. no. a) to l).
 - b) governing or control system using power from an external source.
3. Non-essential dependent auxiliaries (as applicable)
- a) engine-driven starting air compressor;
 - b) engine-driven generator, air compressor or hydraulic pump when supplying power to items not shown in sl. No. 2 above;;
 - c) engine-driven bilge pump;
 - d) engine-driven fire pump;
 - e) engine-driven ventilation fan;
 - f) engine-driven fuel-transfer pump;
4. Cl.no 2.2.3 of this specification shall be referred for COP rated DG set

Deration Calculation for Diesel Engine in mechanical drive application

1. ISO Standard Power (as per ISO 3046-1) of the engine, (obtained after deducting power loss due to essential dependent auxiliaries) (P_{iso})
 P_{iso} : kW

2. Deration on account of site conditions (refer datasheet for ambient conditions) as per ISO 3046-1
 Temperature (around the engine and alternator) : kW
 Altitude (d1) : kW
 Humidity (d2) : kW
 CW temp (d3) : kW
 Inlet losses (d4) : kW
 Exhaust back press (d5) : kW
Total Deration ($P_{deration} = d1 + d2 + d3 + d4 + d5$) :
 kW

3. Service Power (as per ISO 3046-1) of the Engine (i.e. at stated conditions)
 $P_{service} = P_{iso} - P_{deration}$: kW

4. Transmission losses in gear-box (P_{trans})
 P_{trans} : kW

5. Any other Power Loss applicable to the offered genset (P_{misc})
 P_{misc} : kW

6. Net output required for Mechanical drive (P_{output})
 $(P_{output} = \text{driver rating}^{\#})$:
 kW
{#: The driver rating shall be as calculated per respective specification}

8. Actual Power Required from Engine (P_{actual})
 $P_{actual} = P_{output} + P_{trans} + P_{misc}$: kW

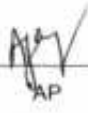


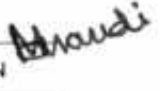
Ensure that $P_{service} \geq P_{actual}$ and shall furnish calculations / supporting documents.

Note: As per Annex-A of ISO-3046-1, the following describes the typical list of auxiliaries:

1. Essential dependent auxiliaries (as applicable)
 - a) engine-driven LO pressure pump;
 - b) engine-driven LO scavenge pump for dry-sump engines;
 - c) engine-driven engine-cooling water pump;
 - d) engine-driven raw-water pump;
 - e) engine-driven radiator-cooling fan;
 - f) engine-driven engine-cooling fan for air-cooled engines;
 - g) engine-driven gaseous fuel compressor;
 - h) engine-driven fuel-feed pump;
 - i) engine-driven fuel-pressure pump for common rail or servo-injection system;
 - j) engine-driven scavenge-air blower and/or charge-air blower;
 - k) engine-driven generator, air compressor or hydraulic pump
 - l) engine-driven cylinder lubricating pump;
 - m) air cleaner or air silencer (normal or special);
 - n) exhaust silencer (normal or special).

सामान्य प्रयोजन स्टीम टर्बाइनो के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR GENERAL PURPOSE STEAM TURBINES

4	28.03.24	REVISED & ISSUED AS STANDARD SPECIFICATION	 AP	 TK	 NK	MN 
3	16.07.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PM	NK	SM	RKT
2	13.02.13	ISSUED AS STANDARD SPECIFICATION (Superseding EIL Spec. 6-43-0042 Rev.1)	JSD	TK	DB	DM
1	13.05.08	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	JSD	NK	VKM	VC
0	24.07.03	ISSUED AS STANDARD SPECIFICATION (Superseding EIL Spec. 6-41-0042 Rev.1)	NK	KDS	RK	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

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A GENERAL

- (i) This specification together with attendant data sheets and other specifications/attachments to the inquiry/order covers the minimum requirements for General-Purpose Steam Turbines. These requirements include basic design, materials, related lubrication systems, controls, auxiliary equipment and accessories.
- (ii) Compliance with this Specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/ auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions. In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with his proposal and include the same in their scope of supply.
- (iii) Except as modified herein, the general purpose steam turbines and their auxiliaries shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard 611, Sixth Edition, June 2022, "General Purpose Steam Turbines for Petroleum, Chemical and Gas Industry Services"**.
- (iv) Except for new paragraph, the number and title of the paragraphs in this Specification correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance to **API Standard 611, Sixth Edition, June 2022**. The word in parenthesis following the number or title of a paragraph indicates the following:
- | | | |
|----------------|---|---|
| (Addition) | : | An addition to a part, section or paragraph referred to |
| (Modification) | : | An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph. |
| (Substitution) | : | A substitution has been made for the corresponding section or paragraph of the standard in its totality. |
| (New) | : | A new section or paragraph having no corresponding section or paragraph in the Standard. |
| (Deleted) | : | This paragraph is deleted. |

1 SCOPE (Modification)

General Purpose Steam turbines may be used, subject to market availability & proven track record for cases where all the following conditions exists.

1. Inlet Pressure ≤ 60 bar(g)
2. Inlet Temperature ≤ 475 deg C
3. Speed ≤ 6000 rpm
4. Turbine Rating ≤ 3000 kW and
5. Driven equipment is usually spared or is in noncritical service.

2 NORMATIVE REFERENCES

- 2.1 (Addition)
Vendor shall take all the measure to comply with any state or local codes, statutory regulation, ordinances or rules that are applicable to equipment.

5 REQUIREMENTS

- 5.1 (Modification)
All data, drawing, hardware and equipment supplied to this standard shall be in SI system of measurement.

6 BASIC DESIGN

6.1 GENERAL

6.1.1.1 (Modification)

EXPERIENCE CRITERIA

- (a) The turbine model offered shall be from the existing turbine model series / frame size and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the performance of the offered model shall have been established in shop test / field experience. (Details are to be furnished, if required).

- (b) The offered turbine model/frame size and design shall be field proven (at least ONE unit) with minimum operating experience of one year for identical size (model number) and similar operating/ design conditions & power rating, rotor dynamics, mechanical design, material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.

(Note: Similar operating/design conditions would mean approx. 80% or higher)

6.1.1.2 (Modification)

The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered turbine model {Identical frame designation} meets the above experience criteria requirement furnishing details of similar operating/design conditions {Inlet flow, operating/design pressures & temperatures, speeds, power rating, maximum torque, number of blade rows/stages, bearing span etc}, Rotor Dynamics {No. of Blade Rows, No. of Stages/Casings, Bearing Span, Rated Speed, Speed Range etc.}, Mechanical Design {MAWP, Seals & Sealing System, lubrication, number of controlled extraction/inductions, Impulse/Reaction Type}, & material of construction etc. as applicable in the format.

In addition, manufacturer's catalogue and general reference list for "General Purpose Steam Turbine for Petroleum, Petro chemical and Gas Industry Services" shall also be furnished along with the proposal.

Multiple references may be furnished to justify the above. As an alternative, vendor may show to the satisfaction of the purchaser that the equipment offered is comprised of modules such as Inlet Module, Middle Module(s) & Exhaust Modules, each of which individually satisfies the requirement specified above.

6.1.1.3 (Deleted)

6.1.2 (Modification)

The equipment (including auxiliaries) shall be designed and constructed for a minimum service life of 20 years and at least three years of uninterrupted operation.

6.1.16 (Substitution)

Unless otherwise specified, cooling water system shall be designed for the following condition:

Velocity over heat exchanger surface	:	1.5 - 2.5 m/sec (Note-2)
Maximum Allowable Working Pressure	:	≥ 8.0 kg/cm ² g
Test Pressure	:	≥ 12.0 kg/cm ² g
Maximum Pressure Drop	:	1.0 kg/cm ² g
Maximum Inlet Temperature	:	33°C
Maximum Outlet Temperature	:	45°C

Maximum Temperature Rise	:	12°C
Minimum Temperature Rise	:	6°C
Fouling Factor on Water Side	:	0.0004 m ² hr°C/kcal
Shell Side Corrosion allowance	:	3.2 mm

Provision shall be made for complete venting and draining of the system.

Note-1: TSV set pressure (in CW isolatable circuits) shall not exceed the design pressure of purchaser's CW header.

Note-2: These limits are not applicable to bearing housing with internal water passages.

6.1.18 (Deleted)

6.1.19 (Addition)

Unless otherwise specified, the maximum sound pressure level of the turbine shall not exceed 85 dBA measured at 1 meter from the equipment surface for the recommended range of operation. Vendor shall supply his recommended type of sound attenuation device (i.e insulated metal cover or blanket type insulator) to achieve the same.

6.1.21 (Modification)

Motors, electrical/instrument components and electrical/instrument installations shall be suitable for the area classification specified by the purchaser, and shall meet the requirements as defined in the electrical/instrument specification attached with the inquiry /order.

6.1.24 (Substitution)

Unless otherwise specified, the vendor shall develop the arrangement of the equipment including piping & auxiliaries. The arrangement shall provide adequate areas and safe access for operation and maintenance.

6.1.27 (Addition)

Unless specified otherwise, all back pressure steam turbines shall be provided with desuperheater if the exhaust temperature of turbine at any operating condition, including no load exhaust temperature exceeds the exhaust steam header design temperature.

6.3 PRESSURE CASINGS

6.3.19 (Substitution)

On all turbines, the vendor shall provide automatic draining system using thermodynamic type steam traps.

6.5 CASING CONNECTIONS

6.5.7 (Addition)

When a common baseplate is supplied by the turbine supplier; the steam chest, steam ring, casing drains and other drains shall be routed to the edge of the baseplate and terminated in a common drain header having a blind flange at purchaser's interface.

6.5.11(e) (Modification)

The words 'if specified' stand deleted.

6.6 EXTERNAL FORCES & MOMENTS

(Modification)

Turbines shall be designed to withstand external forces & moments 1.85 times the values of Annexure I. All forces and moments shall be shown on the general arrangement drawing.

6.8 SEALS

6.8.1 (Modification)

Unless otherwise specified, outer glands shall be sealed at the shaft by combination of carbon-ring and brush seals or by non-contacting end face mechanical seals.

6.8.12 (Substitution)

Brush seals if offered, shall be configured by steam turbine vendor, as per vendor's standard practice & proven track record, to minimize gland seal leakage.

6.9 DYNAMICS

6.9.4.4 (Modification)

The word 'if specified' stands deleted.

6.10 BEARINGS AND HOUSINGS

6.10.4.2.2 (Modification)

The word 'if specified' stands deleted.

6.11 LUBRICATION

6.11.2 (Modification)

Use of any synthetic oil is not preferred. In case synthetic oil is recommended by vendor, the same shall be specifically highlighted in Vendor's proposal for Purchaser's acceptance.

6.11.4 (Substitution)

Unless otherwise specified, pressurised lube oil system shall conform to the requirements of API 614 (General Purpose application).

7 ACCESSORIES

7.1 GEAR UNITS

7.1.3 (Substitution)

Unless otherwise specified, Gear box shall be in accordance with API Std. 677 (up to 1500 kW) and beyond 1500 kW, Gear box shall be as per API 613.

7.2 COUPLING AND GUARDS

7.2.1 (Addition)

As a minimum, coupling shall be rated using service factor of 1.5 over turbine rating.

7.2.13 (Modification)

The word 'if specified' stands deleted.

7.2.14 (Modification)

Unless otherwise specified, couplings for Steam turbines with Forced lubrication system or speed greater than 3000 rpm shall conform to API 671. In case of gearbox driven steam turbines, both low speed and high speed couplings shall conform to API 671.

7.3 BASEPLATES AND SOLEPLATES

7.3.1 General

7.3.1.1 (Substitution)

Unless otherwise specified, the equipment shall be furnished with base plate.

7.3.2.14 (Substitution)
Anchor bolts shall be furnished by the vendor having unit responsibility.

7.4 CONTROLS AND INSTRUMENTATION

7.4.2.2 ELECTRONIC GOVERNING SYSTEM

7.4.2.2.1 (Modification)
A dedicated electronic governor system shall be furnished for Steam turbines with power rating ≥ 160 kW.

7.4.2.2.7 (Modification)
The word 'if specified' stands deleted.

7.4.2.3 OVERSPEED TRIP SYSTEM

7.4.2.3.3 A dedicated electronic voting trip shall be furnished for Steam turbines with power rating ≥ 160 kW.

7.4.2.3.7 A 2 out of 3 voting trip shall be supplied for Steam turbines with power rating ≥ 160 kW.

7.4.4.9.4 (Modification)
Thermal relief valves shall be provided for accessories or cooling jackets that can be blocked-in by isolation valves and same shall be furnished by the vendor having unit responsibility.

7.4.5.2 (Modification)
The words 'if specified' stand deleted.

8 INSPECTION AND TESTING

8.1 GENERAL

8.1.6 (Modification)
The vendor shall notify the purchaser not less than 4 weeks before the date of schedule testing and reconfirm the same at least one week before the firm test date.

8.2 INSPECTION

8.2.1.3 (Substitution)
The vendor shall list in the proposal, the parts (and the type of examination) that shall be subjected for surface and sub-surface examination as per vendor's standard practice for the subject equipment.

8.3 TESTING

8.3.1.3 (Substitution)
Notice period shall be as per paragraph 8.1.6 above.

8.3.3.1(a) (Modification)
The words 'If specified' stand deleted.

8.3.3.1(i) (Addition)
The contract shaft seals and bearings shall be used in the machine for the mechanical running test.

8.4 PREPARATION FOR SHIPMENT

8.4.4 (Modification)

The preparation shall be suitable for at least 12 months of outdoor storage from the time of shipment unless specified otherwise in the inquiry or order.

8.4.5 (Modification)

If any extra precaution is to be taken by the Purchaser for storage beyond the specified period, the same shall be explicitly indicated in the operation and maintenance manuals.

9 VENDOR'S DATA

9.1 GENERAL

9.1.1 (Modification)

Drawings & data to be submitted by the vendor shall be as specified in purchaser's Vendor Data Requirements.

विशिष्ट प्रयोजन स्टीम टर्बाइनो के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR SPECIAL PURPOSE STEAM TURBINES

4	04.09.24	REVISED AND ISSUED AS STANDARD SPECIFICATION	<i>Molay</i> MKA	<i>mm</i> JSD/TK	<i>Nalin</i> NK	MH	<i>blandi</i>
3	26.06.20	REVISED AND ISSUED AS STANDARD SPECIFICATION	JSD	NK	SM	SKS	
2	16.06.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	RM	NK	DB/ AKN	SC	
1	18.03.09	REVISED AND ISSUED AS STANDARD SPECIFICATION		DB	VKM	ND	
0	24.07.03	ISSUED AS STANDARD SPECIFICATION (Superseding E/I Spec. 6-41-0043 Rev.1)	NK	KDS	RK	SKG	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman	Approved by

Abbreviations:

API	:	American Petroleum Institute
ASTM	:	American Society for Testing and Materials
BFW	:	Boiler Feed Water
CD/DVD	:	Compact Disc / Digital Versatile Disc
DCI	:	Document Control Index
EIL	:	Engineers India Limited
IEC	:	International Electrotechnical Commission
MAWP	:	Maximum Allowable Working Pressure
MKS	:	Meter-Kilogram-Seconds unit
NEMA	:	National Electrical Manufacturer's Association
P&ID	:	Piping & Instrumentation Diagram
PSV	:	Pressure Safety Valve
PTR	:	Proven Track Record
SI	:	International System of units
TCV	:	Temperature Control Valve
TRL	:	Technology Readiness Levels
TT	:	Temperature Transmitter
VDM	:	Vendor Data Management

SMED-II (Rotating) Standards Committee

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1.0 SCOPE (Substitution)

1.1 GENERAL

- (i) This specification together with attendant data sheets and other specifications/attachments to the inquiry/order covers the minimum requirements for Special-Purpose Steam Turbines. These requirements include basic design, materials and related lubrication systems, controls, auxiliary equipment and accessories.
- (ii) Vendor shall make all possible efforts to comply strictly to the requirements of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser
- (iii) Compliance with this Specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories /auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions. In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.
- (iv) Except as modified herein, the special purpose steam turbine and their auxiliaries shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard - 612, Eighth Edition, November 2020, "Petroleum, Petrochemical and Natural Gas Industries – Steam Turbines – Special-Purpose Applications"**. All requirements specified in the following paragraphs are additions, modifications or substitution (as noted in parenthesis) to above standard and appear in the alphabetical or numerical order as followed in the above Standard.
- (v) Except for new paragraph, the number and title of the paragraphs in this Specification correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance to **API Standard 612, Eighth Edition, November 2020**. The word in parenthesis following the number or title of a paragraph indicates the following:

(Addition)	:	An addition to a part, section or paragraph referred to
(Modification)	:	An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph.
(Substitution)	:	A substitution has been made for the corresponding section or paragraph of the standard in its totality.
(New)	:	A new section or paragraph having no corresponding section or paragraph in the Standard.
(Deleted)	:	This paragraph is deleted.

1.2 CONFLICTING REQUIREMENTS

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Datasheet/P&ID/Process Package
2. Mechanical Data Sheets.
3. Job Specifications/Scope of Work (if any)
4. This Specification
5. Other Standards & Specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry document shall be applicable.

In case of any ambiguity in the above documents, the vendor shall seek clarification from the owner/purchaser -and the decision of the owner/purchaser shall be final and binding

1.3 EXPERIENCE CRITERIA

1.3.1 The turbine model offered shall be from the existing turbine model series / frame size and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the performance of the offered model shall have been established in shop test / field experience. (Details are to be furnished, if required).

1.3.2 The offered turbine model/frame size and design shall be field proven (at least ONE unit) with minimum operating experience of one year for identical frame (model number), number of controlled extraction/inductions and similar operating/design conditions & power rating, rotor dynamics, mechanical design, material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.
(Note: Similar operating/design conditions would mean approx. 80% or higher)

1.3.3 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered turbine model {Identical frame size} meets the above experience requirements furnishing details of similar operating/design conditions {inlet flow, operating/design pressures & temperatures, rated speed, power rating, maximum torque, etc}, Rotor Dynamics {no. of blade rows, no. of blade rows/stages, no. of stages/casings, bearing span, speed range etc.}, Mechanical Design {MAWP, seals & sealing system, lubrication, number of controlled extraction/inductions, impulse/reaction type}, & material of construction etc. as applicable in the format.

In addition, manufacturer's catalogue and general reference list for "Special Purpose Steam Turbine for Petroleum, Petro chemical and Gas Industry Services" shall also be furnished along with the proposal.

Multiple references may be furnished to justify the above. As an alternative, vendor may show to the satisfaction of the purchaser that the equipment offered is comprised of modules such as Inlet Module, Middle Module(s) & Exhaust Modules, each of which individually satisfies the requirement specified above.

3 DEFINITION OF TERMS

3.1.80 UNIT RESPONSIBILITY (Substitution)

The unit responsibility (except for Steam Turbine Generating Sets) shall rest with the driven equipment manufacturer. For Steam turbine Generator Package, Vendor shall have the UNIT RESPONSIBILITY of the complete equipment and all auxiliaries included in the order & shall be responsible for complete design, engineering, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents, including sub vendor's drawings, pertaining to the order shall be duly reviewed & approved by the vendor before onward submission.

3.1.81 Vendor (Modification)

Unless otherwise specified, the vendor shall be the manufacturer of Steam turbine per API 612, having adequate design, engineering, manufacturing, packaging & testing facilities and shall have supplied similar Steam Turbine, as per API 612. Vendor shall also be the manufacturer of proposed steam turbine.

5 REQUIREMENTS

5.1 UNITS OF MEASURE (Substitution)

Drawings and maintenance dimensions shall be in MKS and / or SI units. Use of an EIL datasheet indicates that MKS units shall be used.

5.2 STATUTORY REQUIREMENTS (Substitution)

Vendor shall take all the measures to comply with any state or local codes, statutory regulations, ordinances or rules that are applicable to the equipment.

6.0 BASIC DESIGN

6.1 GENERAL

6.1.1 (Substitution)

The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a minimum service life of 20 years and at least 5 years of uninterrupted operation.

NOTE: It is recognized that this is a design criteria only.

6.1.3 (Substitution)

Equipment shall qualify experience criteria mentioned in above Cl. 1.3 with at least 1 year of filed provenness equivalent to TRL level 7 of API 691.

6.1.3.1 (Modification)

The words 'if specified' stand deleted.

6.1.5 (Substitution)

Turbine shall be capable of the following:

- (a) Delivering the turbine rated power at its corresponding speed with coincident minimum specified steam inlet conditions, maximum specified steam exhaust conditions and specified normal steam extraction/induction flows.
- (b) Delivering the specified power (if any) at its corresponding speed with coincident minimum specified steam inlet conditions, maximum specified steam exhaust condition and zero steam extraction/ induction flows.
- (c) Continuous operation at maximum continuous speed and at any other speed within the range specified with a maximum continuous speed of atleast 105 % of rated speed.
- (d) Continuous operation at turbine rated power and speed with maximum specified steam inlet conditions and minimum or maximum specified steam exhaust condition, and normal to maximum specified steam extraction/induction flows.
- (e) Continuous operation at the lowest speed at which maximum torque is required with minimum specified steam inlet conditions and maximum specified exhaust conditions with normal to maximum steam extraction/induction flows.
- (f) Operation with variations from rated steam conditions and steam purity limits as per NEMA SM 23 or IEC 60045-1
- (g) Operation uncoupled/no load operation for alternator sets with maximum specified steam inlet conditions.

6.1.9 (Modification)

Unless otherwise specified, the maximum sound pressure level of the turbine shall not

exceed 85 dBA measured at 1 meter from the equipment surface for the recommended range of operation.

- 6.1.10 (Substitution)
Unless otherwise specified, cooling water system shall be designed for the following condition:
- | | | |
|--------------------------------------|---|----------------------------------|
| Velocity over heat exchanger surface | : | 1.5 - 2.5 m/sec. |
| Maximum Allowable Working Pressure | : | ≥ 8.0 kg/cm ² g |
| Test Pressure | : | ≥ 12.0 kg/cm ² g |
| Maximum Pressure Drop | : | 1.0 kg/cm ² g |
| Maximum Inlet Temperature | : | 33°C |
| Maximum Outlet Temperature | : | 45°C |
| Maximum Temperature Rise | : | 12°C |
| Fouling Factor on Water Side | : | 0.0004 m ² hr °C/kcal |
| Shell Side Corrosion allowance | : | 3.2 mm |
- Provision shall be made for complete venting and draining of the system.

- 6.1.13 Electrical Classification (Substitution)
Motors, electrical/instrument components and electrical/instrument installations shall be suitable for the area classification specified by the purchaser, and shall meet the requirements as defined in the electrical/instrument specification attached with the inquiry /order.

- 6.1.18 (Modification)
The line 'If specified, the vendor's representative shall witness one or more of the following:' shall be read as "The vendor's representative shall witness all of the following:'

- 6.3.3. (Modification)
The words 'if specified' stand deleted.

6.7 SEALS AND INTERNAL STATIONARY COMPONENTS

6.7.1 SEALS

- 6.7.1.6 (Modification)
The words 'unless otherwise specified' stand deleted.

6.8 DYNAMICS

6.8.2 LATERAL ANALYSIS

- 6.8.2.4 (Modification)
This clause shall be substituted with the following:
'Unless otherwise specified, for machinery trains with flexible coupling a train lateral analysis shall be performed.

- 6.8.2.5 (Modification)
This clause shall be substituted with the following:
'Unless otherwise specified, for machinery trains with rigid coupling a train lateral analysis shall be performed.

6.9 BEARINGS AND BEARING HOUSINGS

6.9.3 BEARINGS HOUSINGS

6.9.3.5 The words 'if specified' stand deleted.

6.10 LUBRICATION AND CONTROL-OIL SYSTEM

6.10.2 (Modification)

The words 'If specified' stand deleted.

6.12 NAMEPLATES AND ROTATION ARROWS

6.12.6 (Addition)

MKS and/or SI Units shall be shown on the nameplate.

7. ACCESSORIES

7.1 TURNING GEAR

7.1.5 (Modification)

Unless otherwise specified, turning device shall be driven by an electrical motor.

7.1.6 (Modification)

The turning gear rotational speed shall be as recommended by the vendor.

7.1.7 (Substitution)

A turning gear operating stations with associated control features shall be provided and detailed out by the vendor.

7.2 RELIEF VALVES

7.2.1.3 (Modification)

Unless otherwise specified, PSVs shall be supplied by vendor.

7.2.1.7 (Addition)

Thermal relief valves shall be provided for components that contain liquid and could be blocked in by isolation valves.

7.6 MOUNTING PLATES

7.6.1 General

7.6.1.1 (Modification)

Unless otherwise specified, the equipment shall be furnished with base plate.

7.6.1.12 (Substitution)

Anchor bolts shall be furnished by the vendor.

7.6.2 Baseplate

7.6.2.14 (Modification)

Where recommended by the vendor, subplates shall be provided by the vendor.

7.6.3 Soleplates and Subsoleplates

7.6.3.3 (Modification)

Replace the words "If subsoleplates have been specified" with "Where recommended by the vendor, subplates shall be furnished by the vendor and".

7.7 CONTROLS & INSTRUMENTATION

7.7.2.3 CONTROL SYSTEM

7.7.2.3 Turbine Overspeed Shutdown (Trip) System

7.7.2.3.12 The words 'If specified' stand deleted

7.9 SPECIAL TOOLS

7.9.3 (Addition)

When spreader beams or other special lifting devices are required for installation or maintenance, they shall be provided by the vendor for permanent retention by the owner.

7.9.4 (Addition)

Steam turbine design shall be suitable for steam blowing without inlet steam piping modification/line breaking/re-welding during start-up steam blowing. If the same is not suitable, steam blow-off device for steam blowing during initial commissioning stage without dismantling of inlet piping shall be provided by Vendor.

7.13 VENT SILENCERS (ADDITION)

7.13.1 (Addition)

Unless otherwise specified, vent silencers shall be supplied by vendor at steam turbine inlet, extraction and discharge (for back pressure turbine). These silencers shall be loose supplied by the vendor.

7.13.2 (Addition)

Unless otherwise specified, complete de-super heater assembly with associated instruments (TCV, TT, dual strainer in BFW line, etc.) in extraction lines & exhaust lines (back pressure) shall be supplied by vendor

8 INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

8.1 GENERAL

8.1.3 (Modification)

The vendor shall notify the purchaser not less than 4 weeks before the date of schedule testing and reconfirm the same at least one week before the firm test date.

8.2 INSPECTION

8.2.3 Mechanical Inspection

8.2.3.3 (Modification)

The words 'If specified' stand deleted.

8.3 TESTING

8.3.2 Hydrostatic Test

8.3.2.2.1 (Addition)

For steam turbine hydrostatic pressure, calculations shall be provided by vendor for each component of steam turbine.

8.4 PREPARATION FOR SHIPMENT

8.4.1 (Modification)

The preparation shall make the equipment suitable for 12 months of outdoor storage from the time of shipment unless otherwise specified in the inquiry or order. If any extra precaution is to be taken by the purchaser for storage beyond 12 months, the same shall be explicitly indicated in the operations and maintenance manual.

8.4.13.7 (Modification)

The words 'If specified' stand deleted.

8.4.14 (Modification)

The words 'If specified' stand deleted.

9 VENDOR'S DATA

9.2. (Modification)

The words 'If specified' stand deleted.

ANNEX-O CONTRACT DOCUMENTS AND ENGINEERING DESIGN DATA

O.1 INTRODUCTION (Modification)

The information to be furnished by the vendor is specified in O.1, O.2, O.3 and also in the Vendor Data Requirement document, forming part of the inquiry document.

Vendor documents shall be submitted / approved through EIL VDM portal. Vendor document review shall commence only after approval of Document Control Index (DCI). Post order, vendor shall submit "Document Control Index (DCI)" to the purchaser in EIL VDM Portal.

All vendor data/drawings/documents shall be in English Language and in Metric Systems.

O.2 PROPOSALS

O.2.1.6 (Addition)

The vendor's proposals shall as a minimum include the documents specified in purchaser's Vendor Data Requirements, forming part of the inquiry document.

O.3 ENGINEERING DESIGN DATA

O.3.5.4 Technical Data Manual (Modification)

Words "If specified" stand deleted.

O.3.5.5 (Addition)


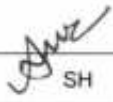


Drawings and data as required after purchase order has been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing / document specified there are several drawings to be furnished by the vendor or vice versa.

O.3.5.6 (Addition)

Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are as specified in Purchaser's inquiry/order.

वाष्प अनुमार्गन हेतु
मानक विनिर्देश

STANDARD SPECIFICATION FOR
STEAM TRACING

6	29.09.22	REVISED AND ISSUED AS STANDARD SPECIFICATION					
5	13.07.17	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN	
4	11.08.10	REVISED AND ISSUED AS STANDARD SPECIFICATION	SH	VKB	SC	DM	ND
3	31.03.09	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	VKB	SC	ND	
2	13.02.04	REVISED AND ISSUED AS STANDARD SPECIFICATION	PKG	BRB	BN	SKG	
1	15.03.99	REVISED AND ISSUED AS STANDARD SPECIFICATION	SH	BRB	NS	AS	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor		Standards Bureau Chairman
Approved by							

Abbreviations:

A/G	-	Above Ground
B/L	-	Battery Limit
BOP	-	Bottom of Pipe
GAD	-	General Arrangement Drawing
IBR	-	Indian Boiler Regulations
NB	-	Nominal Bore
P&ID	-	Piping and Instrumentation Diagram
PSIG	-	Pounds Per Square Inch
PVC	-	Poly Vinyl Chloride
SH	-	Steam High Pressure
SL	-	Steam Low Pressure
SM	-	Steam Medium Pressure
SWG	-	Standard Wire Gauge

Piping Standards Committee

Convenor : Mr. G. Balaji

Members : Mr. UdayanChakravarty
Mr. R. Giridhar
Mr K Anjaneyulu (SMED)
Mr. S. Ghoshal (SMMS)
Mr. SC Maity (Structural)
Mr. Pankaj Kumar Rai (Construction)

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1.0 PURPOSE

The purpose of steam tracing is to prevent the fall in process fluid temperature and maintain the same throughout the length of the line. Constant temperature maintenance helps in the free flow of fluid and its pumpability. Generally the Piping requiring steam tracing are indicated in P&IDs and line schedule, while size and number of tracers shall be provided according to this specification.

2.0 SCOPE

This specification outlines the requirements to be met in the design and installation of steam tracers for piping.

- Type of Steam (i.e. SL, SM or SH etc.) for tracing shall be as specified in the line schedule. The steam temperature shall be saturation temperature of the steam at a given pressure.
- Requirement for condensate return (i.e. open system or closed system & pressure in case of closed system) shall be obtained from process package.
- Size of Bought-out supply and return manifolds with inbuilt piston valves shall be 1.5" unless otherwise specified. The condensate return manifold shall be with pipe line connector having inbuilt trap and glandless piston type drain valve for upstream isolation and trap bypass. The trap shall be thermostatic type.
- Site fabricated supply & return manifold header shall be 3" NB unless otherwise specified.
- Size of tracer shall be ½" NB unless specified otherwise in the process package.
- Size of supply sub-header from Steam header & return sub-header to Condensate header shall be 1½" NB.
- Size of tracer supply & return lead lines shall be ½" pre-insulated tubing with adapters at both ends unless specified otherwise in the Job Engineering Design Basis (Piping).

Exceptions or variations covered in the process package shall take precedence over requirements covered herein.

3.0 REFERENCES

Standard Specification for Hot Insulation of Vessels, Piping and Equipment 6-79-0026; Latest editions of the specifications(s) referred shall be followed.

4.0 METHODOLOGY

4.1 Source of Steam Supply

Steam supply for tracing can be obtained from steam headers, independent steam supply sub-header or exhaust / bleed steam from other continuous steam users. In any case the steam tracers should always get steam even if process unit is out of operation. As far as practicable, steam supply manifold shall be laid such that lines requiring steam tracing are at minimum distance from the manifold.

4.2 Material

As per 'Piping Material Specification'.

4.3 Regulations

The IBR limit is shown in Annexure-1, Page 3 of 5 and Annexure-2, Page 3 of 6.

4.4 Procedure for Preparation of Steam Tracing Installation Drawings & Use of Steam Tracing Standards:

Steam tracing installation drawings shall be prepared in accordance with the standards as per following procedure.

- 4.4.1 The numbering of steam supply and condensate return manifolds shall be as per Annexure -1, Page 3 of 5.
- 4.4.2 Steam supply sub-headers, steam supply manifolds, condensate sub-headers and condensate recovery manifolds shall be located on piping GADs of Units and Offsites.
- 4.4.3 Details of steam supply and condensate return manifolds shall be prepared. These details will indicate among other details, the size and number of various supply and return leads to and from the designated steam traced lines, as given in chart-I of Annexure-1, Page 3 of 5 and chart-I of Annexure-2, Page 3 of 6.

4.5 List of Specifications to be used for Steam Tracing

4.5.1 For Site Fabricated Manifolds

- | | | |
|----|---|------------------------|
| a) | Steam supply manifolds | Annexure-1 Page 1 of 5 |
| b) | Condensate recovery manifolds | Annexure-1 Page 2 of 5 |
| c) | Typical diagram | Annexure-1 Page 3 of 5 |
| d) | Details of tracer arrangement | Annexure-3 Page 1 of 3 |
| e) | Position of tracers w.r.t. pipes and tracer arrangement around valves & flanges | Annexure-3 Page 2 of 3 |
| f) | Typical tracing arrangement in Offsites - plan | Annexure-1 Page 4 of 5 |
| g) | Typical tracing arrangement in Offsites - elevation | Annexure-1 Page 5 of 5 |
| h) | Typical tracing arrangement in Units. | Annexure-3 Page 3 of 3 |

4.5.2 For Bought-out Manifolds

- | | | |
|----|---|------------------------|
| a) | Steam supply manifolds | Annexure-2 Page 1 of 6 |
| b) | Condensate recovery manifolds | Annexure-2 Page 2 of 6 |
| c) | Typical diagram | Annexure-2 Page 3 of 6 |
| d) | Typical diagram | Annexure-2 Page 4 of 6 |
| e) | Details of tracer arrangement | Annexure-3 Page 1 of 3 |
| f) | Position of tracers w.r.t. pipes and tracer arrangement around valves & flanges | Annexure-3 Page 2 of 3 |
| g) | Typical tracing arrangement in Offsites - plan | Annexure-2 Page 5 of 6 |
| h) | Typical tracing arrangement in Offsites - elevation | Annexure-2 Page 6 of 6 |
| i) | Typical tracing arrangement in Units. | Annexure-3 Page 3 of 3 |

- 4.5.3 For Steam tracing insulation 6-79-0026

4.6 Design & Installation:

Design and installation of steam tracing system for piping shall be as detailed. Site fabricated bends shall be used in place of forged elbows except near steam supply and condensate return manifolds. However, in case of pre-insulated tubing, only site fabricated bends with approved bending tool shall be used. Bought-out manifolds with inbuilt glandless piston valves shall be used unless otherwise specified.

4.6.1 Steam Supply Sub Headers

4.6.1.1 The layout of steam supply sub-header and supply manifold shall be arranged to minimize length of supply lead lines.

4.6.1.2 Isolation valve in the sub-headers shall be of Globe type.

4.6.1.3 Y-Type Strainer of 40 mesh size as per applicable piping class shall be provided in the steam supply sub header. Strainer shall be located between Isolation Valve and supply manifold.

4.6.1.4 Where single tracer is used directly from steam main, strainer in supply sub header shall not be provided.

4.6.2 Steam Supply Manifold

Location of manifolds shall be planned to minimize the length of the supply leads served by it. Manifold shall be provided when three or more tracers are required. Length of supply lead shall not exceed 15 mtrs. Supply manifold shall generally be located on pipe rack or technological structure.

4.6.3 Supply & Return Leads

The routing shall be by field for minimum length of run avoiding interferences. Clearances and maintenance joints shall be provided for operation & maintenance.

4.6.4 Tracers

4.6.4.1 Sizing:

Unless otherwise specified in the process package the size and number of tracers shall be as listed below:

Traced line size	No. of ½" NB tracers
4" NB & smaller	1
6" NB to 16" NB	2
18" NB & larger	3

4.6.4.2 Useful length of tracers: Following shall be used for maintaining length of ½"tracer in open and closed systems (excluding supply and return lead lines).

Operating pressure (PSIG)	20	50	100	150	200	250	300&above
Tracing Length (meters)	23.0	38.0	46.0	53.0	61.0	69.0	76.0

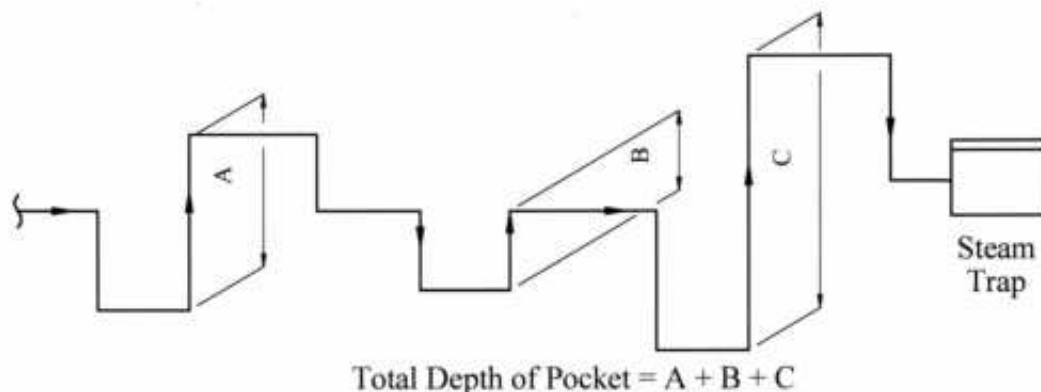
4.6.4.3 Installation

a) The tracers shall be held in position by three turns of 16 SWG soft annealed galvanized iron wire spaced every one meter.

b) Whenever there is a single line to be traced, steam supply and return manifolds need not be used. In such cases, the steam supply line maybe tapped from the nearby steam header/sub header and routed along the line to be traced. At the end of the tracer run, these tracers can be drained by separate steam trapping assembly, in case Condensate return manifold is not available.

- c) The position of tracers around traced pipe shall be as per Annexure-3, Page 1&2 of 3.
- d) The tracers shall start at the highest point in a system in general. As far as possible tracers shall be routed with a continuous slope towards trap. Total pocket depth* shall not exceed 850mm for 1.0 kg/cm² of differential pressure available (i.e. difference of pressure between upstream and down stream of the steam trap)

* Tracer pocket depth is the distance the tracer rises in the direction of flow from a low point to high point. The total depth of pockets is the sum of all the pockets on the tracer and must not exceed the above given figure. The pocket should be considered from the point where the tracer starts its run along the traced pipe, up to the steam trap.



- e) Branch tracers to paired equipment and instruments to be provided with isolation valves and each branch to have its own trap. (See Annexure -3, Page 3 of 3)
- f) Tracer shall not be provided with low point drains.
- g) The tracers shall be laid so as not to interfere with the normal working, operation and maintenance of plant machinery.
- h) Wherever the traced piping is having flanged connections and traced piping needs to be disconnected for frequent maintenance, flushing etc., break flanges at suitable locations shall be provided on tracers. All flange connections provided on tracers shall be located outside the insulation.
- i) The installation shall be done to take care that the valves and steam traps on supply and return manifolds are easily approachable. Maximum 12 nos. of supply leads/return lines (including spares) are permitted per supply manifold/condensate return manifold.
- j) The steam supply lead lines should be routed together, as far as possible. In case of several tracers routed together, the spacing between individual tracers may be reduced to allow box type insulation. However the spacing will be adequate in all cases to permit good welding and individual clamping by U clamps, or other approved type of fastener.
- k) The tracers shall be anchored at the middle point of the tracer run and adequate free space shall be provided for the expansion of tracers at the free ends as shown in Annexure -3, Page 1 of 3.

4.6.5 Steam Traps

- 4.6.5.1 Each tracer or each branch of a tracer that is split, (i.e. a tracer on suction line of a parallel pump installation) shall be separately trapped at the outlet end.
- 4.6.5.2 Steam tracing installation shall be installed so as to facilitate rapid and easy removal and replacement of traps, rather than permit emergency hand operation of the tracers, should trap become inoperable.
- 4.6.5.3 The trap discharge line shall have a block valve only if tied into a system into which more than one trap discharge.
- 4.6.5.4 For an open condensate system, locate traps so that condensate gets drained to S.S. avoiding hazard to personnel.
- 4.6.5.5 Thermostatic traps shall be used for systems wherein tracer steam design pressure is less than 21 Kg/cm²g. Traps shall be provided with inbuilt strainers.
- 4.6.5.6 The steam traps shall be hooked up as per Annexure -1, Page 2, 3, 4 & 5 of 5 and Annexure-2, Page 2, 3, 5 and 6 of 6. In case of Offsite piping, Annexure -1, Page 4 & 5 of 5 and Annexure-2, Page 5 & 6 of 6, give the typical arrangement for steam trap assemblies.

4.6.6 Condensate Return System

4.6.6.1 For Units:

Refer Process Design Basis(PDB). In case of recovery follow P&IDs / PDB and in case of non-recovery, route condensate to Storm Sewer outside B/L.

4.6.6.2 For Offsites:

Discharge to ditches or other suitable location so as to cause no personnel hazard or excessive maintenance problem. In case no ditch is nearby, discharge as per note 6 on Annexure-1, Page 1 of 5.

4.7 Supporting of Steam Tracing Systems

All the components of steam tracing system shall be adequately supported. One of the methods of supporting the supply and return manifolds has been indicated in Annexure-1, Page 5 of 5. The supply lead lines and condensate return lines should be routed together, as far as possible, with same BOP, so that they can be supported from common structural steel. In case of Pre-insulated tubing, the same shall be routed and supported as per recommendations of Supplier. To avoid undue deflection and vibration, the spacing of supports in horizontal or vertical runs should not exceed 2 meters. The tracer lines may be secured to structural members with U clamps.

4.8 Testing

All tracers shall preferably be tested along with the steam piping to which they are connected. In cases where tracers are not tested with the feed steam piping, separate hydrostatic test shall be performed with test pressure of twice the design pressure. Hydrostatic test pressure shall be same for tracers falling within / outside IBR scope.

4.9 Insulation

Insulation thickness, material and method of application shall be as specified in insulation standard / specification or Process Design Basis.

Composite box type insulation may be provided on the steam supply lead lines, in case they are routed together. Similarly, this may be provided for the return lines to manifolds after the run of tracers.

4.10 Tracer Bonding With Heat Transfer Cement

In case of critical applications wherein medium pressure or high pressure steam is used for tracing, steam tracers shall be bonded using heat transfer cement.

Expansion loop shall be provided on long bonded tracer lines at 9 meter intervals and at 90° turn. This is accomplished by extending the tracer line through the heat transfer cement and insulation, making loop and returning back to traced line.

5.0 ATTACHMENTS

Annexure-1	Steam Tracing - Site Fabricated Manifolds (Typical Diagrams), 6-44-0007-A1
Annexure-2	Steam Tracing - Bought out Manifolds (Typical Diagrams), 6-44-0007-A2
Annexure-3	Steam Tracing – General Details (Typical Diagrams), 6-44-0007-A3

Abbreviations:

A.S.	: Alloy Steel
ASME	: American Society of Mechanical Engineers
C.I.	: Cast Iron
C.S.	: Carbon Steel
IBR	: Indian Boiler Regulations
LTCS	: Low Temperature Carbon Steel
NACE	: National Association of Corrosion Engineers
NB	: Nominal Bore
NDT	: Non Destructive Testing
P&ID	: Piping and Instrumentation Diagram
PMI	: Positive Material Identification
S.S.	: Stainless Steel

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Mr. S.C. Maity (Structural)
Mr. G.K. Iyer (Projects)
Mr. P.K. Rai (Construction)

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1.0 SCOPE

This specification covers general requirements of fabrication and erection of above ground and trench piping systems at site. The specification covers the scope of work of Contractor, basis of work to be carried out by Contractor and standards, specifications and normal practice to be followed during fabrication and erection by the Contractor.

2.0 SCOPE OF WORK OF CONTRACTOR

Generally the scope of work of Contractor shall include the following:

2.1 Transportation of required piping materials (as described in Cl.2.1.1), pipe support (material as described in Cl. 2.3) and all other necessary piping materials from Owner's storage point or Contractor's storage point (in case of Contractor's scope of supply) to work site/shop including raising store requisitions for issue of materials in the prescribed format & maintaining an account of the materials received from Owner's stores.

2.1.1 Piping materials include the following but not limited to the same.

- a. Pipes (All sizes and schedule)
- b. Flanges (All sizes, types & Pressure ratings).
- c. Fittings (All sizes, types and schedule)
- d. Valves (All sizes, types and Ratings)
- e. Gaskets (All sizes, types & Ratings)
- f. Bolts, Nuts or M/C Bolts (All types)
- g. Expansion Joint/Bellows (All types)
- h. Specialty items like online filters, ejectors, sample coolers, steam traps, strainers, air traps, springs, silencers, snubbers, steam and condensate manifolds, injection nozzles, MOVs, sight glass, spray nozzles, integrated steam traps, hoses, hose couplings, etc.
- i. Online instruments like control valve, orifice flange, rotameter, safety valves, restriction orifice, rupture disc, de-super heaters, corrosion probes, annubar, magnetic flow meter, ultrasonic flow meter, Coriolis mass flow meters, venturi PG/PT/ Flow transmitter, ejectors, static mixers, flame arrestors, thermal flow switches, pre-fabricated hook-ups etc.
- j. Shut Down Valves with and without fire box.

2.2 Shop & field fabrication and erection of piping in accordance with documents listed under Cl.3.0 i.e. 'BASIS OF WORK' including erection of all piping materials enumerated above.

2.3 Fabrication and erection of pipe supports like shoe, saddle, guide, stops, anchors, clips, cradles, hangers, turn-buckles, supporting fixtures, bracket cantilevers, struts, tee-posts including erection of spring supports, sway braces, dummy pipes, corrosion pads/protection shields, low friction pads, clamps, special support, expansion bellows, steam and condensate manifolds supports etc. Corrosion Pads/Protection shields, stiffeners and stiffening rings, if not covered in the specifications/standards, shall be of the same material as of parent pipes.

2.4 Site fabrication of Piping items

Site fabrication of Piping items shall include but not be limited to the following

- 2.4.1 Fabrication of piping specials like special radius bends, reducers, mitres etc.
 - 2.4.2 Fabrication of plain and threaded nipples from pipes as required during erection.
 - 2.4.3 Fabrication of swage nipples as and when required.
 - 2.4.4 Fabrication of odd angle elbow like 60°, 30° or any other angle from 90°/45° elbows as and when required.
 - 2.4.5 Fabrication of flange, reducing flange, blind flange, spectacle blinds as and when required.
 - 2.4.6 Fabrication of stub-in connection with or without reinforcement.
 - 2.4.7 Grinding of edges of pipes, fittings, flanges etc. to match mating edges of uneven/different thickness wherever required.
 - 2.4.8 Fabrication of circular pipe for steam rings, fire water lines, utility lines.
 - 2.4.9 Threading of all small bore piping as per piping material specifications.
 - 2.4.10 Drilling on blind flange for inserting / joining small bore lines.
 - 2.4.11 Fabrication and welding of reinforcement pads at branch pipe locations wherever required.
 - 2.4.12 Equipment nozzle reinforcement with pads, jacket & stiffeners wherever required.
 - 2.4.13 Fabrication of injection nozzles as per details provided wherever required.
 - 2.4.14 Fabrication of chain operation arrangement for valves, wherever required. All material required for this modification shall be supplied by Contractor.
 - 2.4.15 Fabrication and erection in position of funnels required for OWS/ SS/ Condensate blow down system as per direction of Engineer-in-charge.
 - 2.4.16 Grinding/ finishing of uneven surfaces/ joints after welding. Internal grinding of welds of orifice flanges to render smooth surface.
 - 2.4.17 Tapping and drilling of holes in flanges, blind flanges, piping connections for jack screw, if required.
 - 2.4.18 Providing bird screens at the outlet of lines open to atmosphere.
- 2.5** Modifications like providing additional cleats, extension of stem of valve, locking arrangement of valves etc. as and when required.
- 2.6** Piping isometrics for main process/utility lines shall be provided to the Contractor for Units. |

Preparation of miscellaneous small bore isometrics with bill of materials for process and utility lines (up to 1½" size) like instruments & pump flushing / cooling, sample connection, purging, pump casing vents & drains, pump base plate drains, control valve drains / vent to flare, instrument drains & vents, steam tracing (non-IBR) from steam supply stations up to condensate recovery station, and lines specified as field routed within the Unit battery limit

as and when required are in Contractor's scope of work. Approval for these isometrics prepared by the Contractor shall be taken from Engineer-in-charge before erection.

Small bore piping isometrics given by Owner shall be rechecked by Contractor before erection and installation.

- 2.7 Obtaining approval for drawings prepared by Contractor from statutory authority, if required. Contractor shall also arrange all necessary permits for hot work etc.
- 2.8 Spun concrete lining of the inside of pipes 3" NB & above including fittings and flanges as required in accordance with specification.
- 2.9 Rubber lining inside pipes, fittings, flanges as and when required, in accordance with specification.
- 2.10 Radiography, stress relieving, dye penetration, magnetic particle test etc. as required in specification.
- 2.11 Performing PMI using alloy analyzers as per 'Standard Specification for Positive Material Identification at Construction Sites, 6-82-0002'.
- 2.12 Casting of concrete pedestals and Fabrication and erection of small structures/ platforms for pipe supports and valve operation / attending some instruments, spectacle blinds etc., providing brackets, modification / extension of platforms, providing additional platforms / ladders for improving / providing accessibility.
- 2.13 Providing insert plates with anchor fasteners in concrete structures / paved floors and repair of platform gratings around pipe openings and providing suitable members for support under the platform grating.
- 2.14 Making material reconciliation statement and return of Owner's supply left over materials to Owner's storage.
- 2.15 Flushing and testing of all piping systems as per standard specification for inspection, flushing and testing of piping systems (Specification No. 6-44-0013). The accessories required for blinding the line like flange, blind flange, gasket (all sizes, type and rating), stud-bolts, flexible hoses etc. are to be arranged by the Contractor. During flushing the discharged water / air shall be drained / routed as directed by the Engineer – In Charge.
- 2.16 Contractor shall prepare welding specifications for all weld joints where dissimilar welding will be performed, and obtain approval from EIL.
- 2.17 Contractor to ensure meeting all requirements for carrying out work in shutdown/running plant.
- 2.18 Pickling (as and when applicable) as per Job specification(s) for chemical cleaning of CS suction piping of compressors, SS Piping, Weldments etc, as applicable.
- 2.19 Chemical Cleaning/ Hydro jet cleaning as per marked-up P&IDs with supply of chemicals, consumables, DM water, equipments, boilers, coupons, tools & tackles and other testing equipments required for the same.
- 2.20 For Offsites, only Piping General Arrangement drawings shall be issued. Isometrics, if required, shall be prepared by the Contractor.

3.0 BASIS FOR WORK

3.1 The complete piping work shall be carried out in accordance with the following:

3.1.1 "Approved for Construction" drawings and sketches issued by EIL to the Contractor - Plans and/or Isometrics.

3.1.2 "Approved for Construction" drawings and sketches issued by Turn-key bidders to the Contractor - Plans and/or Isometrics.

3.1.3 Approved Process Licensor's standards and specifications.

3.1.4 Drawings, sketches and documents prepared by Contractor duly approved by Engineer-in-Charge (such as isometrics of small bore piping and offsite piping etc.).

3.1.6 EIL specifications/documents as below:

- a. Process and Instrument Diagram.
- b. Job Piping Materials Specification (****-6-44-0005). **** denotes job number.
- c. Piping support, engineering standards.
- d. Line list
- e. Piping support indices (only in offsite), if supports are not shown in plan.
- f. Job specification of Non-destructive Requirement of Piping (****-6-44-0016)
- g. Job Welding Specification Charts for Piping Classes (****-6-77-0005)
- h. Job Welding specification for fabrication of piping (****-6-77-0001).
- i. Any other EIL or OTHER specifications attached with Piping Material Specification or special condition of contract (such as standard for cement lining of pipe, standard of jacketed piping, standard for steam tracing, Dimensional Tolerances etc.)
- j. Standard specification for positive material identification (PMI) at construction sites, 6-82-0002
- k. Standard Spec for application of torque & hydraulic bolt tension for flange joints (6-76-0002) and its addendum, if any.

3.1.7 Following codes, standards and regulations

- a. ASME B 31.3 : Process Piping
- b. ASME Sec. VIII : Code for unfired pressure vessel.
- c. IBR Regulations
- d. ASME Sec. IX : Qualification standard for welding and brazing procedures, welders, brazers and welding and brazing operators.

- e. NACE Std. : Code for Sour Services material requirements
MR-0175/MR0103/Job spec(NACE), as applicable

Note : All codes referred shall be latest edition, at the time of award of contract.

3.2 Deviations

Where a deviation from the "Basis of Work" and approved job procedure described above is required or where the basis of work does not cover a particular situation, the matter shall be brought to the notice of Engineer-in-Charge and the work carried out only after obtaining written approval from him in each case.

4.0 FABRICATION

4.1 Piping Material

Pipe, pipe fittings, flanges, valves, gaskets, studs bolts etc. used in a given piping system shall be strictly as per the "Piping Material Specification" for the "Pipe Class" specified for that system. To ensure the above requirement, all piping material supplied by the Owner / Contractor shall have proper identification marks as per relevant standards / EIL specifications / Licensors specification. Contractor shall provide identification marks on left over pipe lengths wherever marked up pipe lengths have been fabricated/erected. Material- traceability is to be maintained for A.S., S.S., NACE, LTCS, material for Hydrogen service and other exotic materials by way of transferring heat number, etc. (hard punching) as per approved procedure. This shall be in addition to colour coding for all piping materials to avoid mix-up.

For the purpose of common understanding the construction job procedure, to be submitted by the Contractor, shall include proposal for

- Maximizing prefabrication, inspection and testing at fabrication shop with minimum field joints.
- Positive material identification, handling, storage & preservation.

4.2 Dimensional Tolerances

Dimensional tolerances for piping fabrication shall be as per EIL Standard No. 7-44-0486. The Contractor shall be responsible for working to the dimensions shown on the drawings. However, the Contractor shall bear in mind that there may be variations between the dimensions shown in the drawing and those actually existing at site due to minor variations in the location of equipments, inserts, structures etc. To take care of these variations "Field Welds" shall be provided during piping fabrication. An extra pipe length of 100 mm over and above the dimensions indicated in the drawing may be left on one side of the pipe at each of the field welds. During erection, the pipe end with extra length at each field weld, shall be cut to obtain the actual dimension occurring at site. Isometrics, if supplied may have the field welds marked on them. However, it is the responsibility of the Contractor to provide adequate number of field welds. In any case no extra claims will be entertained from the Contractor on this account. Wherever errors / omissions occur in drawings and Bills of Materials it shall be the Contractor's responsibility to notify the Engineer-in-Charge prior to fabrication or erection.

4.3 IBR Piping

- 4.3.1 Contractor shall obtain approval for the piping systems falling under purview of IBR from the statutory Indian Boiler Regulations (IBR) authority of the state where the plant is situated. The Owner shall provide documentation for the IBR System. The Contractor shall carry out

the fabrications, erection and testing of this piping as per requirements of Indian Boiler Regulations and to the entire satisfaction of the local Boiler Inspector. The Contractor shall also get the approval of IBR inspector for all fabrication and testing done by him at his own cost. All certificates of approval shall be in proper IBR forms.

- 4.3.2 IBR Package for residual, field routed and site modified steam lines shall be prepared by the Contractor. IBR approval for the same shall be in Contractor's scope, at his own cost.

4.4 Pipe Joints

The piping class of each line specifies the type of pipe joints to be adopted. In general, joining of lines 2" and above in process and utility piping shall be accomplished by butt-welds. Joining of lines 1-1/2" and below shall be by socket welding/butt welding/threaded joints as specified in "Piping Material Specifications". However, in piping 1-1/2" and below where socket welding/ threaded joints are specified butt - welds may be used with the approval of Engineer-in-Charge for pipe to pipe joining in long runs of piping. This is only applicable for non-galvanized piping without lining.

Flange joints shall be used at connections to Vessels, Equipment's, Valves and where required for ease of erection and maintenance as indicated in drawings.

4.5 Butt Welded and Socket Welded Piping

End preparation, alignment and fit-up of pipe pieces to be welded, welding, pre-heating, post-heating and heat treatment shall be as described in the Job welding specification (****-6-77-0005) and NDT specification (****-6-44-0016).

4.6 Screwed Piping

In general, Galvanized piping shall have threads as per IS:554 or ANSI B2.1 NPT as required to match threads on fittings, valves etc. All other piping shall have threads as per ANSI B2.1, tapered unless specified otherwise.

Threads shall be clean cut, without any burrs or stripping and the ends shall be reamed. Threading of pipes shall be done preferably after bending, forging or heat treating operations. If this is not possible, threads shall be gauge checked and chased after welding heat treatment etc.

During assembly of threaded joints, all threads of pipes and fittings shall be thoroughly cleaned of cuttings, dirt, oil or any other foreign matter. The male threads shall be coated with thread sealant and the joint tightened sufficiently for the threads to seize and give a leakproof joint. Threaded joints to be seal-welded shall be cleaned of all foreign matter, including sealant and made up to full thread engagement before seal welding.

4.7 Flange Connections

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Flanged bolt holes shall straddle the normal centerlines unless different orientation is shown in the drawing.

Wherever jack screws are to be provided, drilling and tapping for the jack screws in the flange, shall be done as per EII. Standard before welding it to the pipe.

4.8 Branch Connections

Branch connections shall be as indicated in the piping material specifications. For end preparation, alignment, spacing, fit-up and welding of branch connections refer welding specifications. Templates shall be used wherever required to ensure accurate cutting and proper fit-up.

For all branch connections accomplished either by pipe to pipe connections or by using forged tees the rates quoted for piping shall be inclusive of this work.

Reinforcement pads shall be provided wherever indicated in drawings/ specifications etc. Reinforcement pads shall be pneumatically tested at 1.05 kg/cm²g with soap solution. This test shall be carried out before hydrostatic testing.

4.9 Bending

Bending shall be as per ASME B31.3 except that corrugated or creased bends shall not be used.

Cold bends for lines 1-1/2" and below, with a bend radius of 5 times the nominal diameter shall be used as required in place of elbows wherever allowed by piping specifications. Bending of pipes 2" and above may be required in some cases like that for headers around heaters, reactors etc.

The completed bend shall have a smooth surface, free from cracks, buckles, wrinkles, bulges, flat spots and other serious defects. They shall be true to dimensions. The flattening of a bend, as measured by the difference between the maximum and minimum diameters at any cross-section, shall not exceed 8% and 3% of the nominal outside diameter, for internal and external pressure respectively.

4.10 Forging and Forming

Forging and forming of small bore fittings, like reducing nipples for piping 1-1/2" and below, shall be as per ASME B 31.3.

4.11 Mitre Bends and Fabricated Reducers

The specific application of welded mitre bends and fabricated reducers shall be governed by the Piping Material Specifications. Reducers shall be fabricated as per directions of Engineer-in-Charge. The radiographic requirements shall be as per Material Specifications for process and utility systems and NDT Specification for steam piping under IBR, radiographic requirements of IBR shall be complied with.

4.12 Cutting and Trimming of Standard Fittings & Pipes

Components like pipes, elbows, couplings, half-couplings etc. shall be cut / trimmed / edge prepared wherever required to meet fabrication and erection requirements, as per drawings and instructions of Engineer-in-Charge. Nipples as required shall be prepared from straight length piping.

4.13 Galvanized Piping

Galvanized carbon steel piping shall be completely cold worked, so as not to damage galvanized surfaces. This piping involves only threaded joints and additional external threading on pipes may be required to be done as per requirement.

4.14 Jacketed Piping

The Jacketing shall be done in accordance with EIL Specification or Licensors specification as suggested in material specification or special condition of contract.

Pre-assembly of jacketed elements to the maximum extent possible shall be accomplished at shop by Contractor. Position of jump-over and nozzles on the jacket pipes, fittings etc. shall be marked according to pipe disposition and those shall be prefabricated to avoid damaging of inner pipe and obstruction of jacket space. However, valves, flow glasses, in line instruments or even fittings shall be supplied as jacketed.

4.15 Shop Fabrication / Prefabrication

The purpose of shop fabrication or pre-fabrication is to minimize work during erection to the extent possible. Piping spool, after fabrication, shall be stacked with proper identification marks, so as facilitate their withdrawal at any time during erection. During this period all flange (gasket contact faces) and threads shall be adequately fabricated by coating with removable rust preventive. Care shall also be taken to avoid any physical damage to flange faces and threads.

4.16 Miscellaneous

4.16.1 Contractor shall fabricate miscellaneous elements like flash pot, seal pot, sample cooler, supporting elements like turn-buckles, extension of spindles and interlocking arrangement of valves, operating platforms as required by Engineer-in-Charge.

4.16.2 Spun Concrete Lining

The work of inside spun concrete lining of pipes and specials of diameter 3" and above shall be done as per material specifications and special condition contract.

4.16.3 Fabrication of pipes from plate

Pipes shall be fabricated at site as and when required as per the specifications and the actual Piping Material Specification.

5.0 ERECTION

5.1 Cleaning of Piping before Erection

Before erection all pre-fabricated spool pieces, pipes, fittings etc. shall be cleaned inside and outside by suitable means. The cleaning process shall include removal of all foreign matter such as scale, sand, weld spatter chips etc. by wire brushes, cleaning tools etc. and blowing with compressed air/or flushing out with water. Special cleaning requirements for some services, if any, shall be as specified in the piping material specification or isometric or line list. S.S jacketed piping requiring pickling shall be pickled to remove oxidation and discolouring due to welding.

5.2 Piping Routing

No deviations from the piping route indicated in drawings shall be permitted without the consent of Engineer-in-Charge.

Pipe to pipe, pipe to structure / equipments distances / clearances as shown in the drawings shall be strictly followed as these clearances may be required for the free expansion of piping

/ equipment. No deviations from these clearances shall be permissible without the approval of Engineer-in-Charge.

In case of fouling of a line with other piping, structure, equipment etc. the matter shall be brought to the notice of Engineer-in-Charge and corrective action shall be taken as per his instructions.

5.3 Cold Pull

Wherever cold pull is specified, the Contractor shall maintain the necessary gap, as indicated in the drawing. Confirmation in writing shall be obtained by the Contractor from the Engineer-in-Charge, certifying that the gap between the pipes is as indicated in the drawing, before drawing the cold pull. Stress relieving shall be performed before removing the gadgets for cold pulling.

5.4 Slopes

Slopes specified for various lines in the drawings / P&ID shall be maintained by the Contractor. Corrective action shall be taken by the Contractor in consultation with Engineer-in-Charge wherever the Contractor is not able to maintain the specified slope.

5.5 Expansion Joints / Bellows

Installation of Expansion Joints/Bellows shall be as follows:

- 5.5.1 All Expansion joints / Bellows shall be installed in accordance with the specification and installation drawings, supplied to the Contractor.
- 5.5.2
- Upon receipt, the Contractor shall remove the Expansion Joints/ Bellows from the case(s) and check for any damage occurred during transit.
 - The Contractor shall bring to the notice of the Engineer-in- Charge any damage done to the bellows / corrugations, hinges, tie-rods, flanges/ weld ends etc.
 - Each Expansion Joint / Bellow shall be blown free of dust / foreign matter with compressed air or cleaned with a piece of cloth.
- 5.5.3
- For handling and installation of Expansion Joints, great care shall be taken while aligning. An Expansion Joints shall never be slinged from bellows corrugations/ external shrouds, tie / rods, angles.
 - An Expansion Joints / Bellow shall preferably be slinged from the end pipes / flanges or on the middle pipe.
- 5.5.4
- All Expansion Joints shall be delivered to the Contractor at "Installation length", maintained by means of shipping rods, angles welded to the flanges or weld ends or by wooden or metallic stops.
 - Expansion Joints stop blocks shall be carefully removed after hydrostatic testing. Angles welded to the flanges or weld ends shall be trimmed by saw as per manufacturer's instructions and the flanges or weld ends shall be ground smooth.
- 5.5.5
- The pipe ends in which the Expansion Joint is to be installed shall be perfectly aligned or shall have specified lateral deflection as noted on the relevant drawings.
 - The pipe ends / flanges shall be spaced at a distance specified in the drawings.

- 5.5.6 The Expansion Joint shall be placed between the mating pipe ends / flanges and shall be tack welded/bolted. The mating pipes shall again be checked for correct alignment.
- 5.5.7 Butt-welding shall be carried out at each end of the expansion joint. For flanged Expansion Joint, the mating flanges shall be bolted.
- 5.5.8 After the Expansion Joint is installed the Contractor shall ensure that the mating pipes and Expansion Joints are in correct alignment and that the pipes are well supported and guided.
- 5.5.9 The Expansion Joint shall not have any lateral deflection. The Contractor shall maintain parallelism of restraining rings or bellows convolutions.
- 5.5.10 Precautions
- For carrying out welding, earthing lead shall not be attached with the Expansion Joint.
 - The Expansion bellow shall be protected from arc weld spot and welding spatter.
 - Hydrostatic Testing of the system having Expansion Joint shall be performed with shipping lugs in position. These lugs shall be removed after testing and certification is over.

5.6 Flange Connections

While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled together, without inducing any stresses in the pipes and the equipment nozzles. Extra care shall be taken for flange connections to pumps, turbines, compressors, cold boxes, air coolers etc. The flange connections to these equipments shall be checked for misalignment, excessive gap etc. after the final alignment of the equipment is over. The joint shall be made up after obtaining approval of Engineer-in-Charge.

Hydraulic bolt tensioning & torque tensioning shall be performed on flange joints as per the requirements specified in "Standard Specification for application of Torque & Hydraulic Bolt Tension for flange joints," 6-76-0002 and its addendum, if any.

Temporary protective covers shall be retained on all flange connections of pumps, turbines, compressors and other similar equipments, until the piping is finally connected, so as to avoid any foreign material from entering these equipments.

The assembly of a flange joint shall be done in such a way that the gasket between these flange faces is uniformly compressed. To achieve this, the bolts shall be tightened in a proper sequence. All bolts shall extend completely through their nuts but not more than 1/4".

Steel to C.I. flange joints, if any, shall be made up with extreme care, tightening the bolts uniformly after bringing flange flush with gaskets with accurate pattern and lateral alignment.

5.7 Vents and Drains

High point vents and low point drains shall be provided as per the instructions of Engineer-in-Charge, even if these are not shown in the drawings. The details of vents and drains shall be as per piping material specifications / job standards.

5.8 Valves

Valves shall be installed with spindle / actuator orientation / position as shown in the layout drawings. In case of any difficulty in doing this or if the spindle orientation / position is not shown in the drawings, the Engineer-in-Charge shall be consulted and work done as per his instructions. Care shall be exercised to ensure that globe valves, check valves, and other uni-directional valves are installed with the "Flow direction arrow" on the valve body pointing in the correct direction. If the direction of the arrow is not marked on such valves, this shall be done in the presence of Engineer-in-Charge before installation.

Fabrication of stem extensions, locking arrangements and interlocking arrangements of valves (if called for), shall be carried out as per drawings/ instructions of Engineer-in-Charge.

5.9 Instruments

Installation of in-line instruments such as control valve, orifice flange, rotameter, safety valves, restriction orifice, rupture disc, de-super heaters, corrosion probes, annubar, magnetic flow meter, ultrasonic flow meter, Coriolis mass flow meters, venturi PG/PT/ Flow transmitter, ejectors, etc. and Shut Down Valves with fireboxes shall form a part of piping erection work.

Fabrication and erection of piping upto first block valve / nozzle / flange for installation of offline Instruments for measurement of level, pressure, temperature, flow etc. shall also form part of piping construction work. The limits of piping and instrumentation work will be shown in drawings / standards / specifications. Orientations / locations of take-offs for temperature, pressure, flow, level connections etc. shown in drawings shall be maintained.

Flushing and testing of piping systems which include instruments mentioned above and the precautions to be taken are covered in flushing, testing and inspection of piping (EIL Spec. 6-44-0013). Care shall be exercised and adequate precautions taken to avoid damage and entry foreign matter into instruments during transportation, installation, testing etc.

5.10 Line Mounted Equipments / Items

Installation of line mounted items like filters, strainers, steam traps, air traps, desuperheaters, ejectors, samples coolers, mixers, flame arrestors, sight glasses etc including their supporting arrangements shall form part of piping erection work.

5.11 Bolts and Nuts

The Contractor shall apply molycoat grease mixed with graphite powder (unless otherwise specified in piping classes) all bolts and nuts during storage, after erection and wherever flange connections are broken and made-up for any purpose whatsoever. The grease and graphite powder shall be supplied by the Contractor within the rates for piping work.

5.12 Pipe Supports

Pipe supports are designed and located to effectively sustain the weight and thermal effects of the piping system and to prevent its vibrations. Location and design of pipe supports will be shown in drawings for lines 2" NB & above. For lines 1½"NB & below Contractor shall locate and design pipe supports in line with EIL Stds. In case of IBR Lines 1½"NB & below only indicative supporting shall be provided & detailing of such supports is in Contractor's scope. Contractor shall obtain approval of Engineer - in - Charge on drawings prepared by Contractor, before erection. However, any extra supports desired by Engineer-in-Charge shall also be installed.

No pipe shoe / cradle shall be offset unless specifically shown in the drawings.

Hanger rods shall be installed inclined in a direction opposite to the direction in which the pipe move during expansion.

Piping (including small bore) shall not be supported directly from gratings of platforms including equipment platforms.

Preset pins of all spring supports shall be removed only after hydrostatic testing and insulation is over. Springs shall be checked for the range of movement and adjusted if necessary to obtain the correct positioning in cold condition. These shall be subsequently adjusted to hot setting in operating condition. The following points shall be checked after installation, with the Engineer-in-Charge and necessary confirmation in writing obtained certifying that:

- All restraints have been installed correctly.
- Clearances have been maintained as per support drawings.
- Insulation does not restrict thermal expansion.
- All temporary tack welds provided during erection have been fully removed.
- All welded supports have been fully welded.

पइपिंग निकायों के निरीक्षण, प्रक्षालन तथा
परीक्षण हेतु मानक विनिर्देश

**STANDARD SPECIFICATION FOR
INSPECTION, FLUSHING AND
TESTING OF PIPING SYSTEMS**

6	28.09.23	REVISED & ISSUED AS STANDARD SPECIFICATION	ABA	SH	GB	SM	
5	31.07.18	REAFFIRMED&ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RKT	
4	01.07.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN	ATD	DM
3	27.08.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC	
2	05.06.03	PMI REQ. INCLUDED AND ISSUED AS STANDARD SPECIFICATION	RN	DM	BN	SKG	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman	Approved by

Abbreviations:

ASME :	The American Society of Mechanical Engineers
IBR :	Indian Boiler Regulations
PMI :	Positive Material Identification
ppm :	Parts per million
SS :	Stainless Steel

Piping Standards Committee

Convenor: Mr. G. Balaji

Members : Mr. Udayan Chakravarty
Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
Mr. Rajesh Chitara (SMMS)
Mr. S.C. Maity (Structural)
Mr. Harsh Vardhan (Projects)
Mr. P.K. Rai (Construction)

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1.0 SCOPE

This specification covers the general requirements for inspection, flushing and testing of piping systems. However, testing of steam lines falling under IBR shall also be governed by Indian Boiler Regulations.

Flushing and testing of all piping systems shall be witnessed by the Engineer-In-Charge.

2.0 REFERENCES

ASME B31.3	:	Process Piping
IBR	:	Indian Boiler Regulations
6-82-0002	:	Standard Specification for Positive Material Identification (PMI) at Construction Sites

3.0 INSPECTION

During various stages and after completion of fabrication and erection, the piping system shall be inspected by the Engineer-In-Charge to ensure that:

- Proper piping material has been used.
- PMI has been performed as per EIL specification '6-82-0002'.
- Piping has been erected as per drawings and instructions of Engineer-In-Charge.
- All supports have been installed correctly.
- Test preparations mentioned in this specification have been carried out.

4.0 FLUSHING

Flushing of all lines shall be done before pressure testing.

Flushing shall be done by 'fresh potable water' or by 'dry compressed air wherever water flushing is not desirable to clean the pipe of all dirt, debris or loose foreign material.

Required pressure for water flushing shall meet the fire hydrant pressure or utility water pressure. For air flushing, the line/system shall be pressurized by compressed air at the required pressure which shall be 3.5kg/cm²g maximum. The pressure shall then be released by quick opening of a valve, already in line or installed temporarily for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermowells which may interfere with flushing shall not be included in flushing circuit.

The screens/meshes shall be removed from all permanent strainers before flushing. Screens/meshes shall be reinstalled after flushing but before testing.

During flushing temporary strainers shall be retained. These shall be removed, cleaned and reinstalled after flushing, but, before testing.

In case any equipment such as column, vessel, exchanger etc. form part of a piping circuit during flushing, this shall be done with the approval of Engineer-In-Charge. However, equipment thus included in the circuit shall be completely drained and dried with compressed air after flushing is completed.

During flushing discharged water/air shall be drained to the place directed by the Engineer-In-Charge. If necessary, proper temporary drainage shall be provided by the contractor.

Care shall be taken during flushing so as not to damage/spoil work of other agencies. Precautions shall also be taken to prevent entry of water/foreign matter into equipment, electric motors, instruments, electrical installations etc. in the vicinity of lines being flushed.

The contractor shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following:

Dropping of valves, specials, distance pieces, inline instruments and any other piping part before flushing. The flanges to be disengaged for this purpose shall be envisaged by the contractor and approved by the Engineer-In-Charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve distance pieces, piping specials etc. shall be reinstalled by the contractor with permanent gaskets. However, flanges at equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the contractor for each piping system for the flushing done in the proforma provided/approved by the Engineer-in-Charge.

5.0 PRESSURE TESTING

Pressure testing, in general shall be as per clause 345 of ASME B31.3, unless otherwise specified, herein. Lines carrying highly hazardous/poisonous fluids must have a sensitive leak test. For IBR lines, 'IBR Regulations' shall also be followed.

5.1 Extent of Testing

With the exclusion of instrumentation, piping systems fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding or fabrication.

To facilitate the testing of piping systems, vessels and other equipment may be included in the system with the prior approval of Engineer-In-Charge if the test pressure specified is equal to or less than that for the vessels and other equipment.

Pumps, compressors and other rotary equipment shall not be subjected to field test pressure.

Lines which are directly open to atmosphere such as vents, drains, safety valves discharge need not be tested, but all joints shall be visually inspected. Wherever necessary, such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockage. However, such lines if provided with block valve shall be pressure tested up to the last block valve.

Seats of all valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer's recommendation nor less than that required by the applicable code. Where allowable seat pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested shall be excluded from the test by isolation or removals, unless approved otherwise by the Engineer-In-Charge.

Restrictions which interfere with filling, venting, draining such as orifice plates etc. shall not be installed unless testing is complete.

Control valves shall not be included in the test system. Where bypasses are provided test shall be performed through the bypass and/or necessary spool shall be used in place of the control valve.

Pressure gauges which are part of the finished system, but cannot withstand test pressure shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility rests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valve or blinds.

5.2 General Requirements / Test Preparation for Testing

Testing shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer-in-Charge.

No pressure test shall be carried out against closed valve unless approved by the Engineer-in-Charge

The Engineer-in-Charge shall be notified in advance by the Contractor, of the testing sequence and programme, to enable him to be present for witnessing the test. The Contractor shall be fully responsible for making arrangements with the local boiler inspector to witness the tests for steam lines falling under IBR. IBR certificates for these tests shall be obtained in the relevant IBR forms and furnished to the Engineer-in-Charge.

Before testing, all piping shall be cleaned by flushing to make it free from dirt, loose scale, debris and other loose foreign materials.

All piping systems to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.

Wherever in the line any void exists due to any reasons, like absence of control valves, safety valves, check valves etc. it shall be filled with temporary spools.

All joints welded, screwed or flanged shall be left uninsulated and exposed for examination during the test. Before pressurizing the lines, each weld joint shall be cleaned by wire brush to free it from rust and any other foreign matter. All joints may be primed and painted prior to leak testing unless they are subject to sensitive leak test or testing with soap solution (e.g., reinforcement pads and lines to be pneumatically tested, etc.).

Where a system is to be isolated at a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spools have been recovered or disconnected prior to hydrostatic testing, shall be blinded off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point in the piping system to be tested, to avoid overstressing of any of the lower portions of the system.

For longer lines and vertical lines, two or more pressure gauges shall be installed at locations decided by the Engineer-in-Charge.

For lines containing check valves any of the following alternatives shall be adopted for pressure testing:

- Whenever possible pressurize up-stream side of valve.
- Replace the valve by a temporary spool and reinstall the valve after testing.
- Provide blind on valve flanges and test the upstream and downstream of the line separately and remove the blind after testing. At these flanges, temporary gaskets shall be provided during testing and shall be replaced by permanent gaskets subsequently.
- For check valves in lines 1½" and below flapper or seat shall be removed during testing (if possible). After completion of testing the flapper/seat shall be refitted.

Gas lines when hydrostatically tested shall be provided with additional temporary supports during testing as directed by the Engineer-in-Charge.

Piping which is spring or counter-weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg/ cm²g may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of draining the line to make repairs. However, steam shall not be used for this purpose, if the steam temperature is more than the design temperature of the line.

For jacketed pipes testing of core pipes shall be done on individual pieces where the pipe is continuously jacketed, before it is jacketed. The outer jacket shall be tested separately as a system. For piping with discontinuous jacketing the core pipe and the jacket shall be tested as separate continuous systems.

5.3 Testing Media, Test Pressure and Test Pressure Gauges

5.3.1 Testing Media

In general all pressure tests shall be hydrostatic using iron free water, which is clean and free of silt. Test fluid temperature shall be min. 5 °C. Maximum chloride content in water for hydrostatic testing for SS piping shall be 15- 20 ppm.

Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer-in-Charge.

If operating fluid in the line is much lighter than testing fluid, the additional weight of testing fluid may render piping supports (as designed) inadequate. This will call for additional temporary supports. The typical examples are flare and vapor lines. It is preferable that hydrostatic testing is avoided in such systems and instead pneumatic testing may be specified.

Where air/water tests are undesirable, substitute fluids such as gas oil, kerosene, methanol etc. shall be used as the testing medium, with due consideration to the hazards involved. These test fluids shall be specified in the line list given to the contractor.

5.3.2 Test Pressure

The hydrostatic/ pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer-in-Charge.

The selection of the piping system for one individual test shall be based on the following:

- Test pressure required as per line list.
- Maximum allowable pressure for the material of construction of piping.

Depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

5.3.3 Test Pressure Gauge

All gauges used for field testing shall have suitable range so that the test pressure of various systems falls in 35% to 65% of gauge scale range. Pressure gage dial shall be minimum of 150 mm. Size of Bourdon shall not be less than 75% of nominal diameter of dial range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programme, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge showing an incorrect zero reading or error of more than $\pm 2\%$ of full scale range shall be discarded. The Engineer-in-Charge shall check the accuracy of master pressure gauge used for calibration. Calibration certificate shall be furnished for the pressure gages.

5.4 Testing Procedure

5.4.1 Hydrostatic Test

All vents and other connections used as vents shall be left open while filling the line with test fluid for complete removal of air. In all lines for pressurizing and depressurizing the system, temporary isolation valves shall be provided if valved vents, drains do not exist in the system.

Pressure shall be applied only after the system / line is ready and approved by the Engineer-in-charge.

Pressure shall be applied by means of a suitable test pump or other pressure source which shall be isolated from the system as soon as test pressure is reached and stabilized in the system.

A pressure gauge shall be provided at the pump discharge for guidance in bringing the system to the required pressure.

The pump shall be attended constantly during the test by an authorized person. The pump shall be isolated from the system whenever the pump is to be left unattended.

Test pressure shall be maintained for a sufficient length of time not less than 10minutes. Test pressure shall be released only after physical checking of all the joints and attachments are completed, to permit thorough inspection of all joints and connections for leakage or signs of failure. Any joint found leaking during a pressure test shall be retested to the specified pressure after repair.

The pump and the piping system to be tested are to be provided with separate pressure indicating test gauges.

Care shall be taken to avoid increase in the pressure due to temperature variation during the test.

5.4.2 Pneumatic Test

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver, after cooler and oil separator.

Piping to be tested by air shall have joints covered with a soap and water solution so that the joints can be examined for leaks.

All other details shall be same as per hydrotesting procedure (specified above).

5.5 Completion of Testing

After the hydrostatic test has been completed, pressure shall be released by opening the vents, in a manner and at a rate so as not to endanger personnel or damage equipment.

All vents shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining, lines / systems shall be dried by air. In services like dry air, ethylene etc., small traces of water can cause problem. For such lines hot air drying is to be done after hydro-test.

After testing is completed the test blinds shall be removed and equipment / piping isolated during testing shall be connected using the specified gaskets, bolts and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the contractor for complete loop / circuit including equipment (except rotary equipment).

Pressure test shall be considered complete only after approved by the Engineer-in-Charge. Defects, if any, noticed during testing shall be rectified immediately and retesting of the system/ line shall be done by the contractor at his cost.

5.6 Test Records

Records in triplicate shall be prepared and submitted by the contractor for each piping system, for the pressure test done in the proforma provided/approved by the Engineer-in-Charge. Records shall also be submitted for the PMI undertaken as per EIL Std. Specification No. 6-82-0002.

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TECHNICAL NOTES FOR PIPES

8	18.06.24	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MN		
7	16.01.20	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RKT	
6	25.09.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	SH	AK	RN	ATD	SC
5	31.12.13	REVISED AND ISSUED AS STANDARD SPECIFICATION	UK	SH	AK	RN	SC
4	04.07.08	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	SC	DM	VC	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor		Standards Bureau Chairman
Approved by							

Abbreviations:

ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
BIS	:	Bureau of Indian Standards
E.FS.W	:	Electric Fusion Weld
E.R.W	:	Electric Resistance Weld
HAZ	:	Heat Affected Zone
HIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
LT	:	Low Temperature
MR	:	Material Requisition
NACE MR	:	National Association of Corrosion Engineers : Material Requirement
NB	:	Nominal Bore
NPT	:	Nominal Pipe Thread
PMI	:	Positive Material Identification
PR	:	Purchase Requisition
SMYS	:	Specified Minimum Yield Strength
SS	:	Stainless Steel

Piping Standards Committee

Convenor: Mr. G. Balaji

Members : Mr. Udayan Chakravarty
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1.0 GENERAL

- 1.1 All pipes and their dimensions, tolerances, chemical composition, physical properties, heat treatment, hydrostatic test and other testing and marking requirements shall conform to the latest codes and standards specified in the material requisition (MR). In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted. Post Order Concession/Deviation as mentioned in Cl. 5.17 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

1.2 Testing

- 1.2.1 Test reports shall be supplied for all mandatory tests as per the applicable material specifications. Test reports shall also be furnished for any supplementary tests as specified in the MR & Clauses 1.11 & 1.12.
- 1.2.2 Material test certificates (physical property, chemical composition & heat treatment report including Chart) shall also be furnished for the pipes supplied.
- 1.2.3 PMI shall be performed as per the scope and procedures as defined in the spec for PMI at Supplier's Works (6-81-0001).
- 1.2.4 Refer to specification nos. 6-81-0002 and 6-81-0003 for Inspection & Test plans for welded pipes and seamless pipes respectively.

1.3 Manufacturing Processes

- 1.3.1 Steel made by acid Bessemer process shall not be acceptable.
- 1.3.2 All longitudinally welded pipes should employ only automatic welding.
- 1.4 Pipe shall be supplied in single or double random length of 4 to 7 and 7 to 14 meters respectively.
- 1.5
- Seamless and E.R.W. pipes shall not have any circumferential seam joint in a random length. However, in case of E.Fs.W pipe, in one random length one welded circumferential seam of same quality as longitudinal weld is permitted. This weld shall be at least 2.5 m from either end. The longitudinal seams of the two portions shall be staggered by 90°. Single random length in such cases shall be 5 to 7 m.
 - Unless otherwise mentioned in the respective material code, E.Fs.W pipes < 36" shall not have more than one longitudinal seam joint and E.Fs.W pipes ≥ 36" shall not have more than two longitudinal seam joints.
- 1.6 Pipes with screwed ends shall have NPT external taper pipe threads conforming to ASME/ANSI B1.20.1.
- 1.7 Pipe with beveled ends shall be in accordance with ASME B16.25. Weld contours shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Up to 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Up to 10 mm	Figure 4
	> 10 mm & Up to 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

- 1.8** Galvanized pipes shall be coated with zinc by hot dip process conforming to IS 4736 for pipes to Indian Standards and ASTM A53 for pipes to ASTM Standards.
- 1.9** All austenitic stainless steel pipes shall be supplied in solution annealed condition. All types of 321 or 347 stainless steel pipes shall be in a stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to the normal solution annealing. Soaking time & holding temp. for stabilizing heat treatment shall be 4 hrs & 900°C respectively.
- 1.10** For welded Carbon steel pipes wherever heat treatment is specified, hardness of weld and HAZ shall be 200 BHN (max.). For welded Alloy steel pipes, maximum hardness of weld and HAZ after heat treatment shall be as per relevant ASTM material specification unless otherwise specified. In addition, for 9Cr-1Mo-V(P91) pipes, a minimum hardness of 190BHN shall also be ensured.
- 1.11 I.G.C. Test for Stainless Steels**
- 1.11.1** For all austenitic stainless steel pipes inter-granular corrosion test shall have to be conducted as per following:
- ASTM A262 Practice "B" with acceptance criteria of "60 mils/year (max.)".
- OR
- ASTM A262 Practice E : The bent specimen shall be examined under 20X magnification. The acceptance criteria is that there will be no crack or fissure in the bent specimen. The bent specimen shall also be subjected to metallographic examination at 250X magnification to ensure no crack or fissure. The photograph of the bent specimen along with comments shall be submitted for review.
- 1.11.2** When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg.SS 309, 310, 316, 316H etc.) ASTM A262 Practice "C" with acceptance criteria of "15 mils/year (max.)" shall have to be conducted.
- 1.11.3** For the IGC test as described in 1.11.1 & 1.11.2, two sets of samples shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and the other set corresponding to the highest pipe thickness.
- 1.12** All welded pipes indicated as 'CRYO' & 'LT' in MR shall be impact tested per requirement & acceptance criteria of ASME B31.3. The impact test temperature shall be -196°C & -45°C for stainless steel and carbon steel respectively unless specifically mentioned otherwise in MR.

1.13 NACE/HIC Requirements

1.13.1. Pipes under "NACE" category and those designated as "HIC1" shall meet the requirements given in NACE MR-0103 unless mentioned otherwise.

1.13.2. Pipes made from plates and designated as "HIC1" shall meet the HIC requirements of EIL specification 6-79-0013 unless mentioned otherwise.

1.14 Specified heat treatment for carbon steel and alloy steel and solution annealing for stainless steel pipes shall be carried out after weld repairs. Number of weld repairs at the same spot shall be restricted to maximum two by approved repair procedure.

1.15 For black or galvanized pipes to IS 1239, the minimum percentage of elongation shall be 20%.

1.16 All 1Cr-½Mo and 1¼Cr-½Mo seamless pipes shall be normalised and tempered.

1.17 For all welded alloy steel pipes with mandatory requirement of heat treatment and radiography, radiography shall be performed after heat treatment.

1.18 For Hydrogen service pipes following special requirements shall also be met:

1.18.1. All carbon steel pipes having wall thickness 9.53 mm (0.375") and above shall be normalised. Cold drawn pipes shall be normalised after the final cold draw pass for all thicknesses.

1.18.2. All alloy steel (Cr-Mo) pipes shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psig.

1.18.3. For carbon steel Pipes, hardness of weld and HAZ shall be 200 BHN (max.). For alloy steel Pipes, hardness of weld and HAZ shall be 225 BHN (max.).

1.18.4. For all Carbon steel and Alloy steel pipes with wall thickness over 20 mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°Celsius shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 20J (15 ft-lb).

1.19 For dual grades of SS where specified, chemical composition and mechanical properties of both grades specified shall be ensured.

2.0 IBR PIPES

2.1 IBR Documentation

2.1.1 Pipes under purview of IBR shall be accompanied with IBR certificate original in Form III-A duly approved and countersigned by IBR authority/local authority empowered by the Central Boiler Board of India (Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance) .

2.1.2 For materials 1¼Cr - ½Mo (ASTM A335 Gr.P11 / A691 Gr.1¼Cr), 2¼Cr - 1Mo (ASTM A335 Gr.P22 / A691 Gr.2¼Cr) & 9Cr -1Mo-V (A335 Gr.P91/A691 Gr.91), Form III-A approved by IBR shall include the tabulation of Et, Sc & Sr values for the entire temperature range given below. Et, Sc & Sr values shall be such that throughout the temperature range.

$$\begin{array}{l} E_t / 1.5 \geq \\ S_r / 1.5 \geq \\ S_c \geq \end{array} \quad \left| \quad S_A \right.$$

where ,

- S_A : Allowable stress at the working metal temperature.
 E_t : Yield point (0.2% proof stress at the working metal temperature)
 S_c : The average stress to produce elongation of 1%(creep) in 100000 hrs at the working metal temperature.
 S_r : The average stress to produce rupture in 100000 hrs at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

S _A (psi)												
Temp(°F) Material	500	600	650	700	750	800	850	900	950	1000	1050	1100
A335 Gr.P11	16200	15700	15400	15100	14800	14400	14000	13600	9300	6300	4200	2800
A691 Gr.1½Cr	18900	18300	18000	17600	17200	16800	16400	13700	9300	6300	4200	2800
A335 Gr.P22 / A691 Gr.2½Cr	17900	17900	17900	17900	17900	17700	17100	13600	10800	8000	5700	3800
A335 Gr.P91/ A691 Gr.91	28100	27700	27300	26700	25900	24900	23700	22300	20700	18000	14000	10300

Note : S_A values shall be as per the latest edition of ASME B31.3 prevailing.

2.2 For carbon steel pipes under IBR the chemical composition shall conform to the following:

- Carbon (max) : 0.25%
 Others (S, P, Mn) : As prescribed in IBR.

The chemical composition as indicated in this clause is not applicable for pipes other than IBR services.

3.0 ACCEPTABLE DEVIATIONS

- 3.1 Pipes to IS 3589 Gr.410 are acceptable in place of IS 3589 Gr.330.
- 3.2 Pipes of Grades SS317 of corresponding material are acceptable in place of Grades SS316 or SS316(2.5 Mo min.).
- 3.3 Pipes of Grades SS317L of corresponding material are acceptable in place of Grades SS316L or SS316L(2.5Mo min.).
- 3.4 Seamless pipes are acceptable in place of welded pipes except in the case of welded SS321/SS321H pipes with nominal thickness greater than 9.53mm.
- 3.5 Dual Grade SS304/304L conforming to all chemical composition requirements of SS304L and mechanical properties of SS304 is acceptable in place of SS304L or SS304 grades. Any specific additional requirements given in the MR shall also be complied.

- 3.6 Dual Grade SS316/316L conforming to all chemical composition requirements of SS316L and mechanical properties of SS316 is acceptable in place of SS316L or SS316 grades. Any specific additional requirements given in the MR shall also be complied.

4.0 HYDROSTATIC TEST

- 4.1 All pipes shall be hydrostatically tested.
- 4.2 The mill test pressure shall be as follows:
- 4.2.1 Seamless, E.R.W. & Spiral Welded

a) Carbon Steel

Material Std.	Test Pressure Std.
ASTM A106 Gr.B	ASTM A530
API 5L Gr.B, Seamless	API 5L
API 5L, E.R.W.	API 5L
API 5L, Spiral	API 5L
ASTM A333 Gr.3 & 6, Seamless	ASTM A530
ASTM A333 Gr.3 & 6, E.R.W.	ASTM A530

b) Seamless Alloy Steel

Material Std.	Test Pressure Std.
ASTM A335 Gr.P1, P12, P11, P22, P5, P9	ASTM A530
ASTM A268 TP 405, TP410	ASTM A530

c) Seamless Stainless Steel

Material Std.	Test Pressure Std.
ASTM A312 Gr.TP 304, 304L, 304H, 316, 316L, 316H, 321, 347	ASTM A999

d) Seamless Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B161 UNS N02200	ASTM B161
ASTM B165 UNS N04400	ASTM B165
ASTM B167 UNS N06600	ASTM B167
ASTM B444 UNS N06625	ASTM B444
ASTM B407 UNS N08800	ASTM B407
ASTM B423 UNS N08825	ASTM B423

e) Welded Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B725 UNS N02200, N04400	ASTM B725
ASTM B517 UNS N06600	ASTM B517
ASTM B443/B474 UNS N06625	ASTM B474
ASTM B424/B474 UNS N08825	ASTM B474
ASTM B514 UNS N08800	ASTM B514

4.2.2 Electric Fusion Welded

a) Carbon Steel & Alloy Steel E.F.S.W (16" & above)

Material Std.	Test Pressure Std.
API 5L Gr.B ASTM A671 Gr.CC65, 70 (Cl.32) ASTM A672 Gr.C60, 65, 70 (Cl.12,22) ASTM A671 Gr.CF60, 65, 66, 70 (Cl.32) ASTM A691 Gr.½Cr, 1Cr, 1¼Cr, 2¼Cr, 5Cr, 9Cr (Cl.42)	P = 2ST/D S = 90% of SMYS Except for API 5L Gr.B S = 85% of SMYS For API 5L Gr.B T = Nominal Wall Thickness D = O.D of Pipe

b) Stainless Steel E.F.S.W (2" to 6")

The hydrostatic test pressure in kg/cm² for the following materials shall be as given below :

Material Gr.1 :ASTM A312 TP 304 / 304H / 316 / 316H / 321 / 347 welded.

Material Gr.2 :ASTM A312 TP 304L / 316L welded.

Size	Pipe Schedule : 10S		Pipe Schedule : 40S		Pipe Schedule : 80S	
	Material Gr. 1	Material Gr.2	Material Gr.1	Material Gr.2	Material Gr.1	Material Gr.2
2"	100	80	155	130	230	190
3"	80	60	155	130	230	190
4"	80	50	155	130	230	190
6"	65	35	90	75	155	130

c) Stainless Steel E.F.S.W (8" and above).

Material Std.	Test Pressure Std.
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 1, 3 & 4)	P = 2ST/D S = 85% of SMYS T = Nominal Wall Thickness D = O.D of Pipe
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 2 & 5)	P = 2ST/D S = 72% of SMYS T = Nominal Wall Thickness D = O.D of Pipe

4.2.3 Carbon Steel Pipes to BIS Standards

Material Std.	Test Pressure Std.
IS 1239	IS 1239
IS 3589	IS 3589

4.3 Hydrostatic pressure testing shall be performed using iron free water, which is clean and free of silt. Test fluid temperature shall be min. 5 °C. Maximum chloride content in water for hydrostatic testing for SS piping shall be 50 ppm.

5.0 MARKING AND DESPATCH

5.1 All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition the purchase order number, the item code & special conditions like "IBR", "CRYO", "NACE", "H2" etc. shall also be marked.

5.2 Pipes under "IBR", "CRYO", "NACE" & "H2" shall be painted with one circumferential stripe of colour red, light purple brown, canary yellow & white respectively for easy identification. Width of stripe shall be 12mm for pipe sizes less than 3" and 25mm for pipes 3" and above.

5.3 Paint or ink for marking shall not contain any harmful metal or metallic salts such as zinc, lead or copper which cause corrosive attack on heating.

5.4 Pipes shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

5.5 Pipes shall be protected from rust & corrosion.

5.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

5.7 Both ends of the pipe shall be protected with the following material:

Plain end	:	Plastic cap
Bevel end	:	Wood, Metal or plastic cover
Threaded end	:	Metal or plastic threaded cap

5.8 Pipes may be provided with plastic push-fit type end caps/ steel caps without belt wire.

5.9 Steel end protectors to be used on galvanized pipes shall be galvanized. Plastic caps can also be used as end protectors for galvanized pipe ends.




5.10 If pipes are loaded in stacked condition for transport, then they shall be secured suitably to ensure that they can be safely transported without damage and unloaded safely.

6.0 REFERENCES

- 6.1 6-81-0001: Specification for Positive Material Identification (PMI) at Supplier's Works.
- 6.2 6-81-0002: Inspection & test plan for welded pipes.
- 6.3 6-81-0003: Inspection & test plan for seamless pipes.
- 6.4 6-79-0013: Material requirements for carbon steel components used in sour service for petroleum refinery environments

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TECHNICAL NOTES FOR VALVES

9	09.07.24	REVISED AND ISSUED AS STANDARD SPECIFICATION	 PK	 SH	 GB	MN	
8	15.02.23	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM	
7	13.07.17	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN	
6	04.08.10	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	ATD	SC		
5	04.07.08	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	SC	DM	VC	
4	15.11.00	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	BRB	NS	MI	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman	Approved by

Abbreviations:

AARH :	Arithmetic Average Roughness Height
API :	American Petroleum Institute
ASME :	American Society of Mechanical Engineers
ASTM :	American Society for Testing & Materials
BGO :	Bevel Gear Operator
BHN :	Brinell Hardness Number
BIS :	Bureau of Indian Standards
BS :	British Standard
BVIS :	Bureau Veritas Industrial Services
BW :	Butt Weld
CAT :	Category
CEIL :	Certification Engineers International Limited
CS :	Carbon Steel
DFT :	Dry Film Thickness
DNV :	Det Norske Veritas
DP :	Dye-Penetrant
eDMS :	Electronic Document Management System
IBR :	Indian Boiler Regulations
IGC :	Inter Granular Corrosion
IS :	Indian Standard
ISO :	International Organisation for Standardisation
LC :	Lock Closed
LO :	Lock Open
LT :	Low Temperature
LTCS :	Low Temperature Carbon Steel
MOV :	Motor Operated Valve
MP :	Magnetic Particle
MR :	Material Requisition
NACE :	National Association for Corrosion engineers
NDT :	Non Destructive Testing
NPT :	National Pipe Thread
PMI :	Positive Material Identification
PO :	Purchase Order
PR :	Purchase Requisition
Ra :	Roughness average
RFQ :	Request for Quotation
SCRD :	Screwed
SS :	Stainless Steel
SW :	Socket Weld
TUV :	Technischer Überwachungsverein
WAFL :	Lugged Wafer Type

Piping Standards Committee

Convenor: Mr. G. Balaji

Members: Mr. Udayan Chakravarty
Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
Mr. Rajesh Chitara (SMMS)
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1.0 GENERAL

- 1.1 Vendor shall supply valves in accordance with the valve specification sheets along with auxiliaries, if any, such as gear operator, bypasses, drains, locking etc. wherever specified in the specification sheets, subject notes and other enclosures to the material requisition (MR).
- 1.2 Vendor shall quote in strict accordance with the valve data / specification sheets, subject technical notes and all other enclosures to the MR. For 'Cat-I valves', no deviations whatsoever shall be accepted. For Cat-II Valves, if exceptions/ deviations become absolutely must, the same shall be requested as explained in clause 2.3.6 giving reasons for seeking such exceptions/ deviations. In case Post order concessions/ deviations are unavoidable, the request must be made by BIDDER through online system of EIL. eDMS in accordance with 6-78-0001.
- 1.3 All codes and standards for manufacture, testing, inspection etc. shall be of latest editions as on issue date of RFQ.
- 1.4 In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

2.0 DOCUMENTATION

- 2.1 All document submissions to EIL shall be through EIL. eDMS.
- 2.2 For 'Cat-I' valves, no documents shall be submitted with the offer.
- 2.3 For 'Cat-II' valves, vendor shall submit the following documents with the offer:
 - 2.3.1 Manufacturer's complete descriptive and illustrative catalogue / literature.
 - 2.3.2 Detailed dimensioned cross section drawing with parts / material lists, weight etc.
 - 2.3.3 Drawings for valves with accessories like gear operator, hydraulic / pneumatic operator, motor, extension bonnet, extended stems with stands, bypass etc. giving major salient dimensions and weights.
 - 2.3.4 One copy of the valve specification sheets signed as "Accepted" by the manufacturer. Deviations, if any shall be marked as applicable on the valve specification sheet.
 - 2.3.5 If the valve is regretted or has no deviation, the manufacturer shall write clearly on valve specification sheets as "Regret" or "No Deviation".
 - 2.3.6 If there is any deviation, the same shall be listed clausewise.
 - 2.3.7 On failure to submit documents as specified in clauses 2.3.1 to 2.3.6 above, the offer is likely to be rejected.
- 2.4 The following documents shall be submitted through eDMS of EIL after placement of the order:

- 2.4.1 For Cat-I valves of size 2" and above where end-to-end/ face-to-face dimensions are to manufacturers' standards, detailed dimensioned cross section drawing with parts, materials, weight, etc. shall be submitted for records/ information.
- 2.4.2 For 'Cat-II' valves, Vendor shall submit for review drawings mentioned in clauses 2.3.2 & 2.3.3 before start of manufacture. No other drawings shall be submitted for review unless otherwise mentioned in MR.
- 2.4.3 Test report shall be supplied for all mandatory tests as per the applicable code. Test reports shall also be furnished for any supplementary tests as specified in clauses 3.13, 3.14 & 3.15.
- 2.4.4 Material test certificates (physical properties, chemical composition & heat treatment report including Chart) of the pressure containing parts shall be furnished for the valves supplied. Material test certificates for the other parts shall also be furnished for verification during inspection.
- 2.5 In addition to submissions through EIL eDMS, Catalogues/Drawings shall be in submitted in hard copies (6 sets) and soft copies (2 CDs/DVDs) along with delivery for Purchaser's record for all categories/types of valves.

3.0 DESIGN AND CONSTRUCTION

- 3.1 Valve shall be designed, manufactured, tested, inspected and marked as per the manufacturing standards, design codes and standards indicated in the respective valve specification sheets. Any conflict between the requisition, enclosures, specification sheets and referred standards/ codes shall be brought to the notice of the purchaser for clarifications and resolution, before proceeding with the manufacture. The purchaser's decision shall be final and binding to the vendor. The drawings submitted for review shall not include any deviations except as communicated in writing in Deviation permits. The Drawings shall be reviewed only for design and construction features.
- 3.2 All flanged valves shall have flanges integral (except forged valves) with the valve body. Flange face finish shall be normally specified in the valve specification sheet as 125 AARH etc. The interpretation for range of face finish shall be as follows:

Stock Finish	:	1000 μ in AARH max.
125 AARH	:	Serrations with 125 to 250 μ in AARH
63 AARH	:	32 to 63 μ in AARH

- 3.3 For all weld end valves with bevel end as per ASME B16.25, the contour of bevel shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

Valve ends shall match thickness of the connecting pipe. Sloping of inside contour of valves shall be done wherever necessary to achieve this.

3.4 For flanged valves with ring joint flanges the hardness shall be as follows:

Flange Material	Min. Hardness of Groove (BHN)
Carbon Steel	140
1% Cr to 5% Cr, 9% Cr	150
9Cr-1Mo-V	190
Type 304, 316, 321, 347	160
Type 304L, 316L	150
Inconel UNS N06625	220
Incoloy UNS N08825	210
Duplex SS UNS S32205, UNS S31803	250

3.5 Following requirements for check valves shall be met over and above the valve specification sheet requirements:

3.5.1 Unless specified otherwise in the data sheet all check valves 3" & above (except in Class 900, Class 1500 & Class 2500 rating) shall have a drain boss at location "G" (Refer Fig.No.1 of ASME B16.34) where pocket is formed in valve body. A tapped drain hole with plug shall be provided as per ASME B16.34. Threads shall be as per ASME B1.20.1 (Taper) NPT.

3.5.2 For heavy check valves, provisions shall be available for lifting by way of lugs, eye bolts and other such standard devices.

3.6 If an overlay weld-deposit is used for the body seat ring seating surface, the corrosion resistance of the seat ring base material shall be at least equal to the corrosion resistance of the material of the shell.

3.7 Following valve bypass requirements shall be met:

3.7.1 By-pass requirement for Gate valves shall be as follows unless otherwise mentioned.

ASME 150 Class	On sizes 26" and above
ASME 300 Class	On sizes 16" and above
ASME 600 Class	On sizes 6" and above
ASME 900 Class	On sizes 4" and above
ASME 1500 Class	On sizes 4" and above
ASME 2500 Class	On sizes 3" and above

3.7.2 The by-pass piping arrangement shall be such that clearance between main valve body and by-pass assembly shall be the minimum possible for layout reasons. Vendor shall follow the sketch enclosed in Specification No. 6-44-0052-A1.

3.7.3 By-pass valve shall be a globe valve. The sizes shall be as under:

On main valve \leq 4" : 1/2"

On main valve 6" to 8"	:	3/4"
On main valve 10"& above	:	1"

By-pass piping shall be of same metallurgy as main valve. The by-pass piping, fittings and valve tag numbers shall be as specified in Specification No. 6-44-0052-A2. In case details of by-pass arrangement for any Valve tag number is missing, Vendor shall bring the same to notice of EIL and provide by-pass as per details specified. Bends are not acceptable in place of elbows except in the location specified in 6-44-0052-A1.

- 3.7.4 Vendor shall supply the by-pass valve duly tested and fitted to the main valve with proper supporting from the main valve body, as required. Valves with by-pass shall have the direction of flow marked on the bypass valve only. By-pass attachment to the main valve body shall not be screwed. All fillet welds for by-pass installation shall be 100% examined by DP/MP test and Butt-weld joints shall be 100% examined by radiography.
- 3.8 Valve body / bonnet shall be forged / cast as specified. Forgings are acceptable in place of casting but not vice-versa.
- 3.9 Stem shall be forged or machined from forged / rolled bar. No casting is permitted. However, integral stem of cast material is acceptable for Plug valves.
- 3.10 Stellite / hardfacing by deposition, shall be minimum 1.6 mm.
- 3.11 Renewable seat rings shall be seal welded for valves of size 3" and above to prevent loosening in service.
- 3.12 For Low Temperature & Cryogenic valve requirements, refer Specification. No. 6-44-0052-A3 unless otherwise specified.
- 3.13 For Hydrogen service valve requirements, refer Specification. No. 6-44-0052-A4 unless otherwise specified.
- 3.14 Valves under 'NACE' category shall meet the requirements specified in MR-0103 unless otherwise specified.
- 3.15 For all austenitic stainless steel valves Inter Granular Corrosion (IGC) test shall be conducted as per the following:
- 3.15.1 ASTM A262 Practice 'B' with acceptance criteria of '60 mils/year (max.)' for all materials - forged, rolled, wrought and casting.
- Or
- ASTM A262 Practice 'E' with acceptance criteria of 'No cracks as observed from 20X magnification' for all materials other than castings. 'Microscopic structure to be observed from 250X magnification' in addition.
- 3.15.2 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg. SS309, 310, 316, 316H etc.) ASTM A262 Practice 'C' with acceptance criteria of '15 mils/year (max.)' shall be conducted.
- 3.15.3 For the IGC test as described in Clauses 3.15.1 & 3.15.2, two sets of samples shall be drawn from each solution annealing lot. One set shall correspond to the highest Carbon content and the other to the highest pressure rating. When testing is conducted as per practice 'E', photograph of the microscopic structure shall be submitted for record.

- 3.16** All types of 321 or 347 stainless steel valves shall be in a stabilised heat treated condition. Stabilising heat treatment shall be carried out subsequent to the normal solution annealing. Soaking temperature and holding time for stabilising heat treatment shall be 900°C and 4 hours respectively.
- 3.17** Spiral wound bonnet gaskets are to be provided with inner/outer ring except when encapsulated gaskets type body-bonnet joints are employed. Outer ring may be avoided in case of non-circular spiral wound gasket used in Class 150 valve provided the outermost layer of spiral touches the bolts ascertaining the centering.
- 3.18** All Stainless Steel Castings shall be solution heat treated.
- 3.19** Only normalized and tempered material shall be used in the following specifications:

Castings : A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12

Forgings : A182 Gr.F11 Cl.2, A182 Gr.F12 Cl.2

3.20 Ball / Plug / Butterfly Valves

- 3.20.1** As a prequalification, fire safe test as per API 607 / API 6FA / BS EN ISO 10497 (Supersedes BS 6755 Part II) shall be carried out on soft seated ball, plug & butterfly valves and also on lubricated plug valves. The test shall be witnessed and certified by a third party inspection agency like Lloyds, BVIS, DNV, TUV or EIL/ CEIL unless otherwise specified. The vendor has to submit test certificate for the particular design of the valve offered, if fire safe design is required as per the Valve Material Specification sheet.
- 3.20.2** Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves.
- 3.20.3** Soft-seated ball, plug & butterfly valves shall be supplied with antistatic devices.
- 3.20.4** BW / SW end ball valves shall have a 100 mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling soft seats / seals. Specifications of the nipples shall be as indicated in the MR.
- 3.20.5** The ball of ball valve shall not protrude outside the end flanges of valve.
- 3.20.6** Ball valves shall be of floating ball/trunnion mounted type as per following:
- | | | |
|-------------------|--------------|------------------|
| Class 150 | 8" & below | Floating ball |
| | 10" & above | Trunnion mounted |
| Class 300 | 4" & below | Floating ball |
| | 6" & above | Trunnion mounted |
| Class 600 & above | 1.5" & below | Floating ball |
| | 2" & above | Trunnion mounted |
- 3.20.7** Unless otherwise specified in the data sheets, bore of all reduced bore ball valves shall be limited to one size lower than the nominal bore.

3.20.8 In case of ball valves, the ball shall have a cylindrical bore and shall be of solid construction except in the case of rising stem ball valves or where otherwise specified.

3.21 Motor Operated Valves:

3.21.1 The MOVs are to be installed in an open area and the actuators shall be suitable for all weather conditions. The testing of complete assemblies of MOVs along with the actuators shall be done by the supplier at his works.

3.21.2 Vendor shall be solely responsible for selection of suitable actuators & actuator control system. Vendor shall be single point responsible for the complete system (i.e. valves, actuators, actuators control system etc.).

3.21.3 Valve with motorized actuators shall be suitable for installation in horizontal/vertical lines.

3.21.4 All MOVs shall be provided with hand wheel for manual operation.

3.22 In case flange dimension standard / Butt weld end thickness have not been specified in Valve Material Specification attached with the MR, Vendor to obtain the same from EIL and supply strictly in line with specifications.

3.23 Yoke material shall be same as bonnet material where maximum temperature specified is more than 427°C.

3.24 Face to Face / End to End Dimensions of Valves:

The Face to Face dimensions for Flanged valves and End to End Dimensions for Butt Welded Valves shall be strictly as given below unless otherwise specified in the VMS sheet. Valves with Face-to-Face/End-to-End dimensions as per Manufacturers' Standards are acceptable only where not covered in the Dimension Standards listed below.

3.24.1 Gate Valves:

Type	Face-to-Face/End-to-End Dimension
Flanged End	Dimension 'A' for Solid Wedge & Double Disc Gate Valves as per ASME B16.10
Butt Welding End	Dimension 'B' for Short Pattern Gate Valves up to the sizes covered in ASME B16.10. For sizes not covered under Short Pattern, Dimension 'B' for Long Pattern Gate Valves as per ASME B16.10 shall be followed.

3.24.2 Globe Valves:

Type	Face-to-Face/End-to-End Dimension
Flanged End	Dimension 'A' for Globe Valves as per ASME B16.10
Butt Welding End	Dimension 'B' for Short Pattern Globe Valves up to the sizes covered in ASME B16.10. For sizes not covered under Short pattern, Dimension 'B' for Long Pattern Globe Valves as per ASME B16.10 shall be followed.

3.24.3 Check Valves:

Type	Face-to-Face/End-to-End Dimension
Flanged End Swing Check	Dimension 'A' for Swing Check Valves as per ASME B16.10
Butt Welding End Swing Check	Dimension 'B' for Short Pattern Swing Check Valves up to the sizes covered in ASME B16.10. For sizes not covered under short pattern, Dimension 'B' for Long Pattern Swing Check Valves as per ASME B16.10 shall be followed.
Lugged/Double Flanged Dual Plate Check Valves	As per API 594

3.24.4 Ball Valves:

The face-to-face dimensions of all ball valves shall be same as those of gate valves of the corresponding ASME Class rating as given in Clause 3.24.1 (except 10" onwards in Class 150 where the face-to-face dimensions shall be as per ASME B16.10 long pattern).

3.24.5 Plug Valves:

Class Rating	Face-to-Face Dimension
Class 150	Short Pattern as per ASME B16.10 up to 12" Venturi Pattern as per ASME B16.10 for above 12"
Class 300 & 600	Short Pattern as per ASME B16.10 up to 4" Venturi Pattern as per ASME B16.10 for above 4"

3.24.6 Butterfly Valves:

The face to face dimensions for butterfly valves shall be as per BS EN 558/API 609. For Class 150 Butterfly valves, Series 13 shall be followed and for Class 300 Butterfly valves, Series 14 shall be followed, unless otherwise specified.

3.25 In addition to all types of BW/SW ball valves, any other type of soft seated BW / SW end valve shall have a 100 mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling soft seats / seals. Specifications of the nipples shall be as indicated in the MR.

3.26 All Butt welds shall be 100% radiographed and all socket welds shall be 100% DP/MP tested.

3.27 Fugitive Emission Requirements:

Unless otherwise mentioned in VMS sheet, all valves with stem packing shall comply with the fugitive emission requirements detailed below as a pre-qualification.

3.27.1 Gate valves as per API-600 and all Gate/Globe valves as per API-602 shall comply with fugitive emission requirements of API 624.

Gate valves of Class rating 900 & above, Gate valves of size 26" & above and Globe valves of size 2" & above or valves where API-624 is not applicable due to non-graphite stem packing material, shall comply with Fugitive emission requirement of ISO-15848-1.

3.27.2 Quarter turn valves shall comply with Fugitive emission requirement of API 641. Quarter turn valves where API-641 is not applicable due to non-graphite stem packing material, shall comply with Fugitive emission requirement of ISO-15848-1.

3.27.3 As a prequalification, Fugitive emission type test as per Cl. 3.27.1 & 3.27.2 above shall have been carried out and the test shall have been witnessed and certified by a third party inspection agency like Lloyds, BVIS, DNV, TUV or EIL/ CEIL unless otherwise specified. The vendor has to submit test certificate covering the entire range of valves to be supplied.

Vendors who do not have Fugitive emission type test certificate covering the range of valves to be supplied, shall conduct the requisite test within 12 weeks from the date of purchase order or within contractual delivery date, whichever is earlier.

In case of non-conductance of Fugitive emission type test(s) within time frame specified above or failure in the test(s) conducted after receipt of order, the owner reserves the right to invoke any of the provisions of the purchase order including cancellation of the purchase order at the risk and cost of vendor.

3.28 Valves specified as LO (Lock open) and LC (Lock closed) shall be supplied with suitable arrangement for locking in open as well as in closed position. Lock is included in vendor's scope of supply.

3.29 For Lugged Wafer Type (WAFL) Butterfly Valves, lug shall be provided for each bolt.

3.30 For butterfly valves, where bolting for tapped hole in body is being supplied by Vendor and diameter of the bolting is more than or equal to 1", the bolting supplied shall be studs to ASME B18.2.1 with two nuts.

3.31 For Gate and Globe valves, the stem surface area in contact with the packing shall have a surface finish, Ra, of 0.80µm (32µin.) or smoother, unless otherwise specified.

4.0 OPERATION

4.1 Gear operation shall be provided as under as a minimum, unless otherwise specified:

Valve Type	Class	Size Requiring Gear-Operator
Gate Valve, Globe Valve & Diaphragm Valve	150 Class	12" and larger
	300 Class	12" and larger
	600 Class	10" and larger
	900 Class	6" and larger
	1500 Class	3" and larger
	2500 Class	3" and larger
Ball Valve / Plug Valve (Other than pressure balance plug valves)	150 Class	6" and larger
	300 Class	6" and larger
	600 Class	4" and larger
Ball Valve / Plug Valve (Other than pressure balance plug valves)	900 Class	3" and larger
	1500 Class	3" and larger
Butterfly Valve	150, 300 Class	6" and larger

For sizes lower than these ranges, hand wheel / lever / wrench shall be provided. For pressure balance plug valves manufacturer's recommendation shall be acceptable provided the requirements specified in clause 4.6 are met.

- 4.2 Gear operator shall be provided, with position indicators for open / close positions and with limit stops. (Limit stops are not applicable for gate valves). Gear box shall be fully encased and weather proof.
- 4.3 Where gear operator is not called for as per Clause 4.1 but vendor recommends a gear operator, the same shall be highlighted.
- 4.4 Gear operator shall be so designed as to operate effectively with the differential pressure across the closed valve equal to the cold non-shock pressure rating.
- 4.5 Ball, plug and butterfly valves, shall have "Open" position indicators with limit stops.
- 4.6 Hand-wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on either side. Effort to operate shall not exceed 35 Kg at hand-wheel periphery. However, failing to meet the above requirements, vendor shall offer gear operated valve and quote as per clause 4.3.

5.0 INSPECTION AND TESTING

- 5.1 Every valve shall be subjected to all the mandatory tests and checks called in the respective codes / data sheet by EIL inspection or any third party as approved by the purchaser. For IBR valves refer clause 7.0.
- 5.2 Every valve, its components and auxiliaries must be subjected to all the mandatory tests and checks called for in the respective codes, data sheets etc. by the manufacturer.
- 5.3 Though the extent of inspection shall be as under, exact extent with hold points shall be decided by EIL regional inspection office and recorded in the form of inspection plan. In case of third party inspection, the inspection plan shall be approved by the purchaser.

Forged Valves:

1. Visual and dimensional inspection.
2. Review of material test certificates.
3. Any mandatory or supplementary test.
4. Hydrostatic test on 10% valves selected on random basis.
5. Strip check is required for 1% of total ordered quantity of Gate & Globe valves (min. 1 No.) for each Valve sheet no., however, strip check is not required for CS/ Brass/ Bronze material valves with 13% Cr/ Brass/ Bronze trims.
6. Type test certificate for Fugitive Emissions as per Cl. 3.27.3.
7. Positive Material Identification
8. Type test certificates for cryogenic & Fire safe test to be submitted.

Cast Steel Valves:

1. Visual inspection with acceptance standards as per MSS SP-55 and dimensional inspection.
2. Review of material test certificates.

3. Review of radiographs and radiographic reports or any other NDT tests wherever applicable as per data sheet.
4. Any mandatory or supplementary test.
5. Hydrostatic test 100% for body, 10% other test.
6. Strip check is required for 1% of total ordered quantity of Gate & Globe valves (min. 1 No.) for each Valve sheet no., however, strip check is not required for CS/ Brass/ Bronze material valves with 13% Cr/ Brass/ Bronze trims.
7. Type test certificate for Fugitive Emissions as per Cl. 3.27.3.
8. Positive Material Identification
9. Type test certificates for cryogenic & Fire safe test to be submitted.

Samples for strip check shall be selected at random and shall generally be in the highest size in the lot.

- 5.4 In case of motor operated or actuator operated valves, functional / operational checks as per the requirements of the specifications shall be made on each valve.

6.0 RADIOGRAPHY OF CAST VALVES

- 6.1 Valve castings shall undergo radiographic examination as specified below.

Material	Rating	Size Range	Radiography
All	Class 150	24" and below	NIL**
		26" and above*	100%
	Class 300	16" and below	NIL**
		18" and above	100%
	Class 600& above	All sizes	100%

* No radiography is required for valves of size 26" and above in cooling water service.

**For sizes 24" & below in Class 150 and 16" & below in Class 300, radiography percentage if specifically mentioned in individual valve material spec sheet shall govern.

Radiography specified as random 10% or 20% etc. in the respective valve data sheet implies 10% or 20% etc. of number of valves ordered against each item number with a minimum of one valve against each item.

- 6.2 Radiography procedure, areas of casting to be radiographed shall be as per ASME B16.34 and acceptance criteria shall be as per ASME B16.34. However for areas of casting to be radiographed for types of valves not covered in ASME B16.34, vendor shall radiograph castings in line with ASME B16.34.
- 6.3 For random radiography wherever specified in individual data sheets, the sampling shall be per size of the quantity ordered for each foundry.
- 6.4 Radiography wherever specified in the data sheets or as per clause 6.1 shall be done by X-ray / γ -ray to get the required sensitivity.

7.0 IBR CERTIFICATION

7.1 For valves described "IBR", valves shall be in accordance with the latest IBR (Indian Boiler Regulation) including the requirements specified in the specification.

7.2 For SW / BW end carbon steel valves under IBR, the chemical composition shall conform to the following:

Carbon (Max)	:	0.25%
Others (S, P, Mn)	:	As per IBR

7.3 Valves coming under the purview of "IBR" (Indian Boiler Regulations) shall each be individually accompanied by IBR certificate original in Form III-C duly approved by IBR authority / local authority empowered by the Central Boiler Board of India. Photocopy of original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

7.4 All "IBR" valves shall be painted red in body-bonnet / body-cover joint.

8.0 MARKING

8.1 Valve markings, symbols, abbreviations etc. shall be in accordance with MSS-SP-25 or the standard referred in specification sheet as applicable. Vendor's name, valve rating, material designation, nominal size, direction of flow (if any) etc. shall be integral on the body.

8.2 Each valve shall have a corrosion resistant tag giving size, valve tag / code no., securely attached to the valve body.

8.3 Paint or ink for marking shall not contain any harmful metal or metal salts such as zinc, lead or copper which cause corrosive attack on heating.

8.4 Carbon Steel / Alloy Steel valves shall be painted with one coat of inorganic zinc silicate (minimum DFT 65 to 75 microns).

9.0 DESPATCH

9.1 Valve shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

9.2 Valves shall be protected from rust, corrosion and any mechanical damage during transportation, shipment and storage.

9.3 Rust preventive on machined surfaces to be welded shall be easily removable with a petroleum solvent or shall not be harmful to welding.

9.4 Each end of valve shall be protected with the following materials:

Flange Face	:	Wood or Plastic Cover
Bevelled End	:	Wood or Plastic Cover
SW & SCRD. End	:	Plastic Cap

9.5 End protectors of wood / plastic to be used on flange faces shall be attached by at least three bolts and shall not be smaller than the outside diameter of the flange. However, plastic caps for SW & SCRD end valves shall be press fit type.

- 9.6 End protectors to be used on bevelled end shall be securely and tightly attached.
- 9.7 For special service valves additional requirement for despatch shall be as prescribed in data sheet.

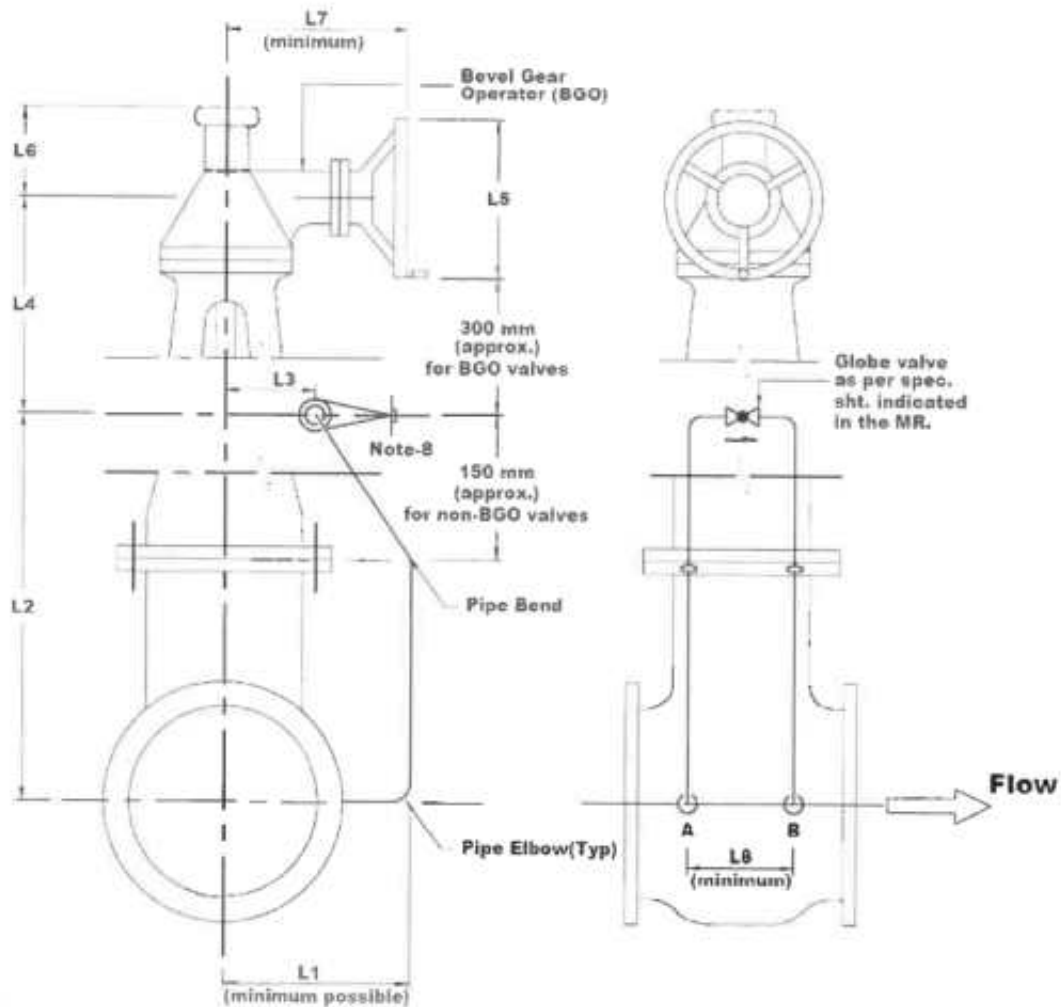
10.0 ATTACHMENTS

- 6-44-0052-A1 : Bypass Piping Arrangement
- 6-44-0052-A2 : Specifications for Bypass Piping, Fittings and Valves
- 6-44-0052-A3 : Special Requirements for Low Temperature and Cryogenic Valves
- 6-44-0052-A4 : Special Requirements for Hydrogen Service Valves

11.0 REFERENCES

- 6-78-0001 : Specification for Quality management system requirements from bidders
- 6-78-0003 : Specification for documentation requirements from suppliers
- 6-81-0001 : Specification for Positive Material Identification (PMI) at Supplier's Works
- 6-81-0004 : Inspection and Test plan for Valves

BYPASS PIPING ARRANGEMENT



NOTES:

1. The orientation & location of handwheel of bevel gear operator & the bypass arrangement shall be strictly as per this sketch.
2. The bypass connection ends including connection to boss in main valve body shall be socket welded upto 600# and butt welded for 900# and above rating.
3. The bypass arrangement shall be properly clamped to & supported by the body of the main valve.
4. Basic design of bypass shall be to MSS-SP-45.
5. Material of bypass pipe & 90° elbows shall be same or equivalent to the body material as indicated in Specification No. 6-44-0052-A2.
6. This sketch is applicable for both BGO & NON-BGO Valves.
7. Vendor shall furnish dimensions L1 to L8.
8. Stem shall not be horizontal in the case of CRYO Valves.

SPECIFICATIONS FOR BYPASS PIPING, FITTINGS AND VALVES

Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.	Remarks
A1A(51301), A3A(51321), A39A (51321), A9A(51301), A11A(51301), A33A(51301), B1A(51401), B9A(51401), D1A(51501), D9A (51501)	ASTM A106 Gr.B (SMLS) 0.5"-1.5": S160	ASTM A105 0.5"-1.5": SW 6000#	52001	
A6A(51301), B6A(51401)	ASTM A106 Gr.B (SMLS) 0.5"-0.5" : XXS 0.75"-1.5": S160	ASTM A105 0.5"-0.5" : SW 9000# 0.75"-1.5": SW 6000#	52001	
A13A(51301), B13A(51401)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : XXS	ASTM A105 0.5"-1.5" : SW 9000#	52001	
A2A(51302), B2A(51402), D2A (51502)	ASTM A106 Gr.B (SMLS)- IBR 0.5"-0.75": S160 1.0"-1.5" : XS	ASTM A105 - IBR 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52002	
A4A (51303), B4A (51403), D4A (51503)	ASTM A333 Gr.6 (SMLS)- LT 0.5"-0.75": S160 1.0"-1.5" : XS	ASTM A350Gr.LF2CL.1-LT 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52003	
B5A (51404), D5A (51504)	ASTM A106 Gr.B (SMLS) -H2 0.5"-0.75": S160 1.0"-1.5": XS	ASTM A105 - H2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52004	Note-1
A7A (51307)	ASTM A106 Gr.B (SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A105 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52007	
A16A (51311), B16A (51411), D16A (51511)	ASTM A106 Gr.B (SMLS) - NACE 0.5"-0.75" : XXS 1.0"-1.5": S160	ASTM A105 - NACE 0.5"-0.75" : SW 9000# 1.0"-1.5": SW 6000#	52011	Note-1
A19A (51313), B19A (51413), D19A (51513)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : S160	ASTM A105 0.5"-1.5": SW 6000#	52013	Note-1
E1A (51601), F1A (51701)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, S160	52101	
E2A (51602), F2A (51702)	ASTM A106 Gr.B (SMLS) - IBR 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 - IBR 0.5"-1.5" : BW, S160	52102	
E5A (51604), F5A (51704)	ASTM A106 Gr.B (SMLS) - H2 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 - H2 0.5"-1.5" : BW, S160	52104	Note-1
E9A (51605), F9A (51705)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : SCH XXS	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, SCH XXS	52105	

Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.	Remarks
E19A (51613), F19A (51713)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : SCH XXS	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, SCH XXS	52113	Note-1
A5Y (51384), A33Y (51384)	ASTM A106 Gr.B (SMLS) 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A105 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52085	
B1D (51430), D1D (51530)	ASTM A335Gr.P11(SMLS) 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A182 Gr.F11Cl.2 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52030	
D2D (51531)	ASTM A335Gr.P11 (SMLS) - IBR 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A182 Gr.F11Cl.2 - IBR 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52031	Note-1
B5D (51432), D5D (51532)	ASTM 335Gr.P11(SMLS)- H2 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A182 Gr.F11Cl.2 - H2 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52032	Note-1
B1E (51433)	ASTM A335Gr.P22(SMLS) 0.5"- 0.75" : S160 1.0"-1.5" : XS	ASTM A182 Gr.F22Cl.3 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52033	
D5E (51534)	ASTM A335Gr.P22(SMLS) - H2 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A182 Gr.F22Cl.3 - H2 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52034	Note-1
A4F (51336), B4F (51436)	ASTM A335 Gr.P5(SMLS) 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A182 Gr.F5 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52036	Note-1
B3F (51436)	ASTM A335 Gr.P5(SMLS) 0.5"-1.5" : XXS	ASTM A182 Gr.F5 0.5"-1.5" : SW 9000#	52036	Note-1
A4G (51339), B4G (51439)	ASTM A335 Gr.P9(SMLS) 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A182 Gr.F9 0.5"-0.75" : SW 6000# 1.0"-1.5" : SW 3000#	52039	Note-1
F2D (51731)	ASTM A335 Gr.P11 (SMLS) - IBR 0.5"-1.5" : S160	ASTM A234Gr.WP11Cl.1/ A182 Gr.F11Cl.2 - IBR 0.5"-1.5" : BW, S160	52131	Note-1
F2G (517GG)	ASTM A335 Gr.P91 (SMLS) - IBR 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A234Gr.WP91/ A182 Gr.F91 - IBR 0.5"-0.75" : S160 1.0"-1.5" : XS	52140	Note-1
G2G (518GG)	ASTM A335 Gr.P91 (SMLS) - IBR 0.5"-1.0" : S160 1.5"-1.5" : XXS	ASTM A234Gr.WP91/ A182 Gr.F91 - IBR 0.5"-1.0" : S160 1.5"-1.5" : XXS	52240	Note-1
E5E (51634)	ASTM A335 Gr.P22(SMLS) - H2 0.5"-0.75" : S160 1.0"-1.5" : XS	ASTM A234Gr.WP22Cl.1/ A182 Gr.F22Cl.3 - H2 0.5"-0.75" : BW, S160 1.0"-1.5" : BW, XS	52134	Note-1

Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.	Remarks
A1K (51345), A3K (51345), B1K (51445), D1K (51545)	ASTM A312TP304(SMLS) 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F304 0.5"-1.5" : SW 3000#	52045	
A2K (51346), B2K (51446), D2K (51546)	ASTM A312TP304(SMLS) - CRYO 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F304 - CRYO 0.5"-1.5" : SW 3000#	52046	
B4K (51448), B5K (51448)	ASTM A312TP304H(SMLS) 0.5"-1.5" : 80S	ASTM A182 Gr.F304H 0.5"-1.5" : SW 3000#	52048	
A6K (51350), A11K (51350), B6K (51450)	ASTMA312TP304L(SMLS) 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F304L 0.5"-1.5" : SW 3000#	52050	
A1M (51361), B1M (51461)	ASTM A312 TP316(SMLS) 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F316 0.5"-1.5" : SW 3000#	52061	
B5M (51462)	ASTMA312TP316H(SMLS) - H2 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F316H - H2 0.5"-1.5" : SW 3000#	52062	
B3M (51463)	ASTM A312 TP321(SMLS) 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F321 0.5"-1.5" : SW 3000#	52063	
A1N (51366), B1N (51466)	ASTMA312TP316L(SMLS) 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F316L 0.5"-1.5" : SW 3000#	52066	
B6N (51471)	ASTM A312 TP316L (SMLS) 0.5"-0.75" : 80S 1.0"-1.5" : 40S	ASTM A182 Gr.F316L 0.5"0.5"-1.5" : SW 3000#	52071	

In case specifications for bypass of any specific VMS sheets are not available in the MR, Vendor to obtain the same from EIL and supply strictly in line with specifications.

Notes:

1. All welded joints shall be post weld heat treated. Procedure for Post weld heat treatment shall be in accordance with ASME B31.3.

SPECIAL REQUIREMENTS FOR LOW TEMPERATURE & CRYOGENIC VALVES

1.0 SCOPE

All valves of Low Temperature Carbon Steel (LTCS) and all grades of austenitic SS (CRYO) material are categorized as cryogenic valves. All these valves shall have extended bonnet. The bonnet extension shall be as per VMS sheets (BS 6364/ BS EN ISO 28921-1) except check valves.

2.0 QUALIFICATION CRITERIA

For Limited Enquiries (Non NIT enquiries)

2.1 Vendors who satisfy both the requirements given below shall be considered qualified :

- a. Vendor should be enlisted with EIL for any cryogenic valve irrespective of type, size, rating and metallurgy
- b. Vendors should be enlisted with EIL for the same type, material, size and rating of non-cryogenic/cryogenic valve as the cryogenic valve quoted for

2.2 Qualified Vendors who do not have cryogenic test reports covering the range of Cryogenic valves quoted for, shall conduct cryogenic test per clauses 3.0 within 12 weeks from the date of purchase order.

2.3 Clauses 2.1 and 2.2 of this Annexure shall be read in conjunction.

3.0 CRYOGENIC TEST

3.1 Vendors to furnish copies of cryogenic test certificate for tests as per details given below:

3.1.1 Test shall be as per VMS sheets (BS 6364/ BS EN ISO 28921-2).

3.1.2 Test temperature, unless specifically called for otherwise in the individual MR, shall be -45°C for LTCS and -196°C for all grades of austenitic stainless steel.

3.1.3 Tests carried out on a particular size of one type of valve, pressure rating and material shall qualify all sizes equal to and below the test valve size for the same type, pressure rating and material. In case of austenitic SS any one grade would qualify for all other grades of austenitic SS.

3.1.4 Tests should have been witnessed and certified by any third party inspection agencies like M/s Lloyd, BV, DNV, TUV or EIL/ CEIL.

3.1.5 Test conducted previously and witnessed by inspection agencies listed above shall be considered acceptable and need not be repeated.

3.2 Post Order Testing Procedure

3.2.1. Before conducting post order testing, vendor shall obtain approval for the following from TPIA:

a. Test procedure and Schematic of test rig with complete details as per standard specified in VMS sheet (BS 6364/ BS EN ISO 28921-2).

b. Cross-section drawing of the valve with material of construction.

3.2.2. Test has to be conducted irrespective of the service on largest size for each type of valve and for each material and class rating. Vendor shall offer one, two or three valves for selection of test valve by inspector depending upon whether quantity of largest valve in the order is one, two or three and more than three respectively.

In the event of failure of the test valve to meet the specification requirements, the vendor shall conduct test on two more valves. These two valves which pass test successfully, are of lower size, then the qualification will be valid only to sizes upto which test has been conducted successfully.

3.2.3. In case of non-conductance of cryogenic test(s) within 12 weeks or failure in the test(s) conducted after receipt of order, the owner reserves the right to invoke any of the provisions of the purchase order including cancellation of the purchase order at the risk and cost of vendor.

4.0 Bonnet extension, wherever specified in the valve sheet shall be for "non cold box application" unless otherwise specified in the MR. Even if not called for in VMS, valves indicated as "LT" or "CRYO" shall be supplied with bonnet extension.
If the valves are supplied in accordance with BS EN ISO 28921-1, Bonnet extension in LT service shall be as per values specified for -51 Deg.C to -109 Deg.C.

5.0 Bonnet and Gland extension joints shall be of butt welded/integrally cast construction.

6.0 Repair welding procedure for austenitic stainless steel valves in "CRYO" service shall have to be qualified for impact test as per ASME B31.3. Minimum acceptable impact energy shall be 20 J or lateral expansion of 0.38 mm at temperature of -196°C.

7.0 Wherever impact test of SS studs / nuts is called for in the data sheet, the impact value shall be 27 J at the intended service temperature specified in the data sheets.

SPECIAL REQUIREMENTS FOR HYDROGEN SERVICE

1.0 GENERAL

- 1.1 These requirements are applicable for valves used in Hydrogen service. These are in addition to the requirements described in "Technical Notes for Valves" Spec. No. 6-44-0052, and shall be read in conjunction with this specification.
- 1.2 All cast valve flanges & bodies with flange rating of Class 900 or greater shall be examined in accordance with paragraphs 7.2 through 7.5 of Appendix-VII of ASME SEC-VIII, DIV.1, regardless of casting quality factor.
- 1.3 Body / bonnet / cover joints & stuffing box of all valves shall have low emission. One valve per metallurgy, per rating, per size shall be helium leak tested as per ASME Sec.V, Subsection A, Article 10 (Detector Probe Technique), Appendix IV at a minimum of 25% of the allowable (rated) cold working pressure. Selection of valves for helium leak test shall be at random. Test duration shall be as follows:

Test Duration in Minutes					
Nominal Size	Pressure Class				
	Upto 300	600	800 & 900	1500	2500
Upto 2"	3	6	9	12	12
3" to 6"	6	9	12	15	18
8" to 16"	9	9	12	15	18
18" to 24"	9	12	15	18	21

The valve shall show no leakage. No leakage is defined as a total leakage rate of less than 0.0001 ml/s of helium.

- 2.0 Only normalized and tempered material shall be used in the following specifications:

Castings : A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12

Forgings : A182 Gr.F11 Cl.2

3.0 CS & AS VALVES

- 3.1 Bend test and Magnetic Particle inspection of the entire surface of body and bonnet casting shall be in accordance with ASTM A217. Supplementary requirement S3 & S4 evaluation of magnetic particle, inspection shall be in accordance with MSS-SP-53 except that no linear discontinuities shall be allowed.
- 3.2 The Brinell hardness of heat treated casting shall not exceed 200 BHN for carbon steel & 225 BHN for alloy steel.
- 3.3 Repair to defective casting shall be outlined in writing to the purchaser before repair starts. Repair method to be approved prior to welding.
- 3.4 Casting shall be preheated to a minimum of 400°F prior to welding and all Chromium-Molybdenum alloys shall be postweld heat treated after welding is complete. Stress relieving is essential for welds.

- 3.5 Carbon steel shall be normalised and alloy steels shall be normalised & tempered.
- 3.6 Dye Penetrant test of welds shall be in accordance with ASTM B165 Procedure B-2, Interpretation as per Appendix-8 of ASME-VIII Div.1.
- 3.7 The tensile stress for AS shall be less than 100,000 psi.
- 3.8 Charpy V-notch impact testing is to be done for valve material (average 20 ft-lb for set of 3 [minimum value 15 ft-lb] at 30°F).
- 3.9 For radiography and acceptance criteria for valve castings, refer Cl. 4.2.
- 4.0 **SS VALVES**
- 4.1 Valve casting shall be in solution heat treated and pickled condition.
- 4.2 Critical body and bonnet casing section typically defined by ASME B16.34 shall be radiographed and shall meet ASTM E446 (upto 2" thick) Category A, B & CA Level 2, Category CB, OC & CD Level 3, Category D, B & F Level 0. For wall thickness 2" to 4.5" comparable plates of ASTM E186 shall be used. ASTM E94 and ASTM E142 shall be used for recommended practice & controlling quality of radiography as guide. The entire surface of all castings shall be dye-penetrant inspected after pickling.
- 4.3 Repair Welds shall be 100% radiographed and evaluated in accordance with paragraph 344.5 of ASME B31.3 with a minimum casting quality factor of 0.95. Dye Penetration test shall be as per ASTM E165 Procedure B-2, Interpretation as per Appendix-8 of ASME-VIII Div.1.

फ्लैजों, स्पैकटेकल ब्लाइंडों एवं
ड्रिप रिंगों के लिए तकनीकी टिप्पणियाँ

**TECHNICAL NOTES FOR FLANGES,
SPECTACLE BLINDS AND DRIP RINGS**

8	15.03.24	REVISED & ISSUED AS STD SPECIFICATION	PK	SH	GB	MN	<i>Brandi</i>
7	16.01.20	REVISED & ISSUED AS STD SPECIFICATION	PK	SH	MI	RKT	
6	25.09.14	REVISED & ISSUED AS STD SPECIFICATION	UK	SH	AK	RN	SC
5	31.12.13	REVISED & ISSUED AS STD SPECIFICATION	UK	SH	AK	RN	SC
4	04.07.08	REVISED & ISSUED AS STD SPECIFICATION	RN	SC	DM	VC	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman	Approved by

Abbreviations:

AARH	:	Arithmetic Average Roughness Height
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
AWWA	:	American Water Works Association
BHN	:	Brinell Hardness Number
HIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
MR	:	Material Requisition
MSS	:	Manufacturer's Standardization Society
NACE MR	:	National Association of Corrosion Engineers : Material Requirement
PMI	:	Positive Material Identification

Piping Standards Committee

Convenor: Mr. G. Balaji

Members : Mr. Udayan Chakravarty
Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
Mr. Rajesh Chitara (SMMS)
Dr. Sudip Paul (Structural)
Mr. Harsh Vardhan (Projects)
Mr. P.K. Rai (Construction)

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1.0 GENERAL

- 1.1 All items, their dimensions, tolerances, chemical composition, physical properties, heat treatment and testing etc. shall conform to the latest codes and standards specified in the requisition. In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted. Post Order Concession/Deviation as mentioned in Cl. 5.17 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

1.2 Testing

- 1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications/ MR. Test reports shall also be furnished for any supplementary tests as specified in the requisition & Clauses 1.11, 1.12 & 1.15.
- 1.2.2 Material test certificates (physical property, chemical composition & heat treatment report including Chart) shall also be furnished for the flanges supplied.
- 1.2.3 Positive Material Identification (PMI) shall be performed as per the scope and procedures as defined in the 'Specification for Positive Material Identification (PMI) at Supplier's Works' (No. 6-81-0001).
- 1.2.4 Refer to specification no. 6-81-0006 for Inspection and Test plans for flanges, spectacle blinds & drip rings.
- 1.3 Ends of weld neck flanges shall be beveled to suit the schedule / thickness of matching pipe, as specified in the requisition.
- 1.4 Bevel end details for welding neck flanges shall be as per ASME B16.25. Contour of bevel end shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

- 1.5 Bore of socket weld flanges & reducing blind flanges shall suit the outside diameter and schedule / thickness of matching pipe.
- 1.6 Bore of slip on flanges shall suit the outside diameter of matching pipe.
- 1.7 Flange face finish shall be normally specified in the requisition as serrated finish, 125 AARH etc. The interpretation for range of face finish shall be as follows:

Stock Finish	:	1000 μ in AARH max.
Serrated Finish/125 AARH	:	Serrations with 125 to 250 μ in AARH
63 AARH	:	32 TO 63 μ in AARH

- 1.8 Galvanized flanges shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A153.
- 1.9 Ends of screwed flanges unless otherwise specified shall have taper threads as per ASME/ANSI B1.20.1.
- 1.10 For ring joint flanges, blinds and spacers the hardness shall be as follows:

Flange Material	Min. Hardness of Groove (BHN)
Carbon Steel	140
1% Cr to 5%, 9% Cr	150
9Cr-1Mo-V	190
Type 304, 316, 321, 347	160
Type 304L, 316L	150
Inconel UNS N06625	220
Incoloy UNS N08825	210
Duplex SS UNS S32205, S31803	250

- 1.11 For ring joint flanges, blinds and spacers, the hardness shall be recorded in the test report.
- 1.12 **NACE/HIC Requirements**
- 1.12.1 Flanges, blinds, drip rings under "NACE" category and those designated as "HIC1" shall meet the requirements given in NACE MR-0103 unless otherwise specified.
- 1.12.2 Flanges, blinds, drip rings made from plates and designated as "HIC1" shall meet the HIC requirements of EIL Specification 6-79-0013 unless otherwise specified.
- 1.13 All austenitic stainless steel flanges shall be supplied in solution annealed condition.
- 1.14 **I.G.C. Test for Stainless Steels:**
- 1.14.1 For all austenitic stainless steel flanges, blinds, drip rings & Fig.8 flanges intergranular corrosion test shall have to be conducted as per following:

ASTM A262 Practice 'B' with acceptance criteria of "60 mils/year (max.)".

OR

ASTM A262 Practice E : The bent specimen shall be examined under 20X magnification. The acceptance criteria is that there will be no crack or fissure in the bent specimen. The bent specimen shall also be subjected to metallographic examination at 250X magnification to ensure no crack or fissure. The photograph of the bent specimen along with comments shall be submitted for review.

- 1.14.2 When specifically asked for in requisition for high temperature application of some grades of austenitic stainless steel (like SS309, 310, 316, 316H etc.) ASTM A262 Practice 'C' with acceptance criteria of "15 mils/year" shall have to be conducted.
- 1.14.3 For the IGC test as described in 1.14.1 & 1.14.2 two sets of samples shall be drawn from each solution treatment lot; one set corresponding to highest carbon content and the other corresponding to the highest rating / thickness.
- 1.15 All types of 321 or 347 stainless steel flanges shall be in a stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to the normal solution annealing. Soaking temperature and holding time for stabilizing heat treatment shall be 900 C and 4 hours respectively.
- 1.16 For dual grades of SS where specified, chemical composition and mechanical properties of both grades specified shall be ensured.
- 1.17 AWWA C207 flanges shall be ring type.
- 1.18 Dimensions for handle projection for Spacers & Blinds shall be as specified in EIL Std. 7-44-0166.
- 1.19 Where ever two sizes have been specified in the MR for flanges, it shall be considered a reducing flange.
- 1.20 All 1Cr-½Mo and 1¼Cr-½Mo flanges shall be normalised and tempered.
- 1.21 Ring Joint Fig-8 Flanges, Spacers & Blinds shall be female type only.
- 1.22 The handle for spacers & blinds for classes 900# & above shall be designed by the vendor. The handle may be integral or attached to the line blank / spacer by welding. In case of attachment by welding heat treatment & welding shall be in accordance with B31.3.
- 1.23 For Hydrogen service following special requirements shall also be met:
- All carbon steel flanges having wall thickness 9.53 mm and above shall be normalised. The normalising heat treatment shall be a separate heat treatment operation and not a part of the hot forming operation.
 - All alloy steel (Cr-Mo) flanges shall be normalised and tempered. The normalising and tempering shall be a separate heat treatment operation and not a part of the hot forming operation.
 - For all carbon steels and alloy steels with wall thickness over 20mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 per heat of material and per heat treating batch. Impact test specimen shall be in accordance with ASTM A370. Impact energies at 0 C shall average greater than 27J (20 ft-lb) per set of 3 specimens, with a minimum of 20J (15ft-lb).

2.0 IBR REQUIREMENTS

2.1 IBR Documentation

- 2.1.1 Flanges coming under the purview of IBR (Indian Boiler Regulations) shall be accompanied with IBR Certificate original in Form III G duly approved and countersigned by IBR authority/ local authority empowered by Central Boiler Board of India. Photocopy of original

certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

- 2.2 For carbon steel flanges under IBR the chemical composition shall conform to the following:
- | | | |
|-------------------|---|-----------------------|
| Carbon (max) | : | 0.25% |
| Others (S, P, Mn) | : | As prescribed in IBR. |

The chemical composition as indicated in this clause is not applicable for flanges other than IBR services.

3.0 ACCEPTABLE DEVIATIONS

- 3.1 Blind Flanges and Spacers & Blinds if specified as plate materials are acceptable in forging materials also in the corresponding material grades.
- 3.2 Flanges/Spectacle Blinds/Drip rings of Grades SS317 of corresponding material are acceptable in place of Grades SS316 or SS316 (2.5Mo min.).
- 3.3 Flanges/Spectacle Blinds/Drip rings of Grades SS317L of corresponding material are acceptable in place of Grades SS316L or SS316L (2.5Mo min.).
- 3.4 Dual Grade SS304/304L conforming to all chemical composition requirements of SS304L and mechanical properties of SS304 is acceptable in place of SS304L or SS304 grades. Any specific additional requirements given in the MR shall also be complied.
- 3.5 Dual Grade SS316/316L conforming to all chemical composition requirements of SS316L and mechanical properties of SS316 is acceptable in place of SS316L or SS316 grades. Any specific additional requirements given in the MR shall also be complied.

4.0 MARKING AND DESPATCH

- 4.1 All items shall be legibly and conspicuously stamped in accordance with the requirements of applicable ASME, API and MSS Standards. In addition, EIL item code, purchase order number & special conditions like "IBR", "CRYO", "NACE" "H2" etc. shall also be stamped.
- 4.2 All items coming under the purview of "IBR", "CRYO", "NACE" & "H2" (hydrogen) shall be painted with one stripe of colour red, light purple brown, canary yellow & white respectively for easy identification. Width of stripe shall be 25mm and it shall be painted longitudinally across the complete thickness of flange other than hub.
- 4.3 Paint or ink for marking shall not contain any harmful metal or metal salts such as zinc, lead or copper which cause corrosive attack on heating.
- 4.4 All items shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.
- 4.5 All items shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.
- 4.6 Rust preventive on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.
- 4.7 Each end of flange shall be protected with the following materials:

Flange face	:	Wood, metal or plastic cover
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Bevelled end	:	Wood, metal or plastic cover
Threaded end	:	Plastic plug
Socket welding end	:	Plastic cover or plug




- 4.8 Each size of flanges, blinds, etc. shall be supplied in separate packagings marked with the purchase order number, item code number, material specification, size and rating.

5.0 REFERENCES

6-81-0001	:	Specification for Positive Material Identification (PMI) at Supplier's Works.
6-81-0006	:	Inspection & test plan for flanges, spectacle blinds & drip rings
6-79-0013	:	Material requirements for carbon steel components used in sour service for petroleum refinery environments
7-44-0162	:	Standard for Spacers & Blinds $\geq 26''$ (150CL, 300CL & 600CL FF)
7-44-0164	:	Standard for Spacers & Blinds $\geq 26''$ (For AWWA Flanges)
7-44-0166	:	Dimensions for Handle projection for Spacers & Blinds $\geq \frac{1}{2}''$ -24''

बट वैल्डेड, साकेट वैल्डेड एवं पेंच
फिटिंगों के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR BUTT WELDED, SOCKET WELDED AND SCREWED FITTINGS

8	18.06.24	REVISED AND ISSUED AS STD SPECN	 PK	 SH	 GB	MN	<i>Handwritten: Manti</i>
7	20.01.20	REVISED AND ISSUED AS STD SPECN	PK	SH	MI	RKT	
6	25.09.14	REVISED AND ISSUED AS STD SPECN	SH	AK	RN	ATD	SC
5	31.12.13	REVISED AND ISSUED AS STD SPECN	UK	SH	AK	RN	SC
4	04.07.08	REVISED AND ISSUED AS STD SPECN	RN	SC	DM	VC	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman	Approved by

Abbreviations:

AARH	:	Arithmetic Average Roughness Height
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
CS	:	Carbon Steel
DP	:	Dye Penetrant
HAZ	:	Heat Affected Zone
IIIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
LT	:	Low Temperature
MP	:	Magnetic Particle
MR	:	Material Requisition
MSS	:	Manufacturer's Standardisation Society
NACE MR	:	National Association of Corrosion Engineers : Material Requirement
NB	:	Nominal Bore
PMI	:	Positive Material Identification
PO	:	Purchase Order
PR	:	Purchase Requisition
SMYS	:	Specified Minimum Yield Strength
SS	:	Stainless Steel

Piping Standards Committee

Convenor: Mr. G. Balaji

Members : Mr. Udayan Chakravarty
Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
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Mr. Harsh Vardhan (Projects)
Mr. P.K. Rai (Construction)

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1.0 GENERAL

- 1.1 Chemical composition, physical properties, tests, dimensions and tolerances, heat treatment and marking shall conform to the applicable latest codes / standards / specifications as specified in the material requisition (MR). In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted. Post Order Concession/Deviation as mentioned in Cl. 5.17 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

1.2 Testing

- 1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications/ MR. Test reports shall also be furnished for any supplementary tests as specified in the MR & Clauses 1.7, 1.8, 1.9, 1.10 & 1.11. Material test certificates (physical properties, chemical composition & heat treatment report including chart) shall also be furnished for fittings supplied.
- 1.2.2 Positive Material Identification (PMI) shall be performed as per scope and procedures defined in the Specification for Positive Material Identification (PMI) at Supplier's Works (6-81-0001).
- 1.2.3 Refer to specification no. 6-81-0005 for Inspection and Test plan for forged, seamless and welded fittings.
- 1.3 All fittings shall be seamless in construction unless otherwise specified. If fittings are specified as welded, the same shall conform to clause 1.7.
- 1.4 Outside diameters and wall thickness (unless otherwise mentioned) of butt welded fittings shall be in accordance with ASME B36.10 and ASME B36.19 as applicable.
- 1.5 For reducing butt weld fittings having different wall thicknesses at each end, the greater wall thickness of the fitting shall be employed and inside bore at each end shall be matched with the specified inside diameter.
- 1.6 Beveled ends for all fittings shall conform to ASME B16.25. Contour of bevel shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

1.7 Welded Fittings

- 1.7.1 All welded fittings shall be double welded. Inside weld projection shall not exceed 1.6 mm. Welds shall be ground smooth at least 25 mm from the ends.
- 1.7.2 For fittings made out of welded pipe, the welded pipe shall be double welded type & shall be manufactured with the addition of filler metal.

- 1.7.3 Welded tees/Lateral Tees shall not be of fabricated (stub-in/stub-on) type unless otherwise specified in the MR.
- 1.7.4 All welded fittings shall be normalized & 100% radiographed by X-ray on all welds made by fitting manufacturers & also welds on the parent materials. Radiography by Gamma rays is also acceptable for thickness 8mm & above.
- 1.7.5 Welded pipes employed for manufacture of fittings shall be made by automatic welding only.
- 1.7.6 Specified heat treatment for carbon steel & alloy steel fittings shall be carried out again after weld repairs.
- 1.7.7 Irrespective of the material code requirement, all welded fittings indicated in the MR as "Cryo"& "LT" shall meet impact test requirements of ASME B31.3. The impact test temperature shall be -196°C & -45°C for stainless steel & carbon steel respectively unless specifically mentioned otherwise in the MR.
- 1.7.8 For welded Carbon steel fittings wherever heat treatment is specified, hardness of weld and HAZ shall be 200 BHN (max.). For welded Alloy steel fittings, hardness after heat treatment shall be as per relevant ASTM material specification unless otherwise specified.

1.8 Stainless Steel Fittings

- 1.8.1 All stainless steel fittings shall be supplied in solution heat treated condition.
- 1.8.2 Solution annealing for stainless steel fittings shall be carried out again after weld repairs.
- 1.8.3 For all stainless steel fittings Inter Granular Corrosion (IGC) test shall have to be conducted as per the following:
ASTM A 262 Practice "B" with acceptance criteria of "60 mils/year (max.)".
Or
ASTM A262 Practice E : The bent specimen shall be examined under 20X magnification. The acceptance criteria is that there will be no crack or fissure in the bent specimen. The bent specimen shall also be subjected to metallographic examination at 250X magnification to ensure no crack or fissure.
- 1.8.4 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg. SS309, 310,316,316H etc.) ASTM A 262 Practice "C" with acceptance criteria of "15 mils/year" shall have to be conducted.
- 1.8.5 For the IGC test as described in Clauses 1.8.3 & 1.8.4, two sets of samples shall be drawn from each solution treatment lot, one set corresponding to the highest carbon content and other set to the highest fitting thickness. When testing is conducted as per ASTM A 262 Practice "E", the photograph of the bent specimen along with comments shall be submitted for review.
- 1.8.6 For dual grades of SS where specified, chemical composition and mechanical properties of both grades specified shall be ensured.

1.9 NACE/HIC Requirements

- 1.9.1 Fittings under "NACE" category or those designated as "HIC1" shall meet the requirements of NACE MR-0103 unless otherwise specified.

- 1.9.2 Fittings made from plates and designated as "HIC1" shall meet the HIC requirements of EIL specification 6-79-0013 unless otherwise specified.
- 1.10 Thickness/schedule lower or higher than specified for the finished product shall not be accepted.
- 1.11 The gasket contact surfaces of stub ends shall be flat with face finish specified in the requisition. Interpretation on the specified face finish is as follows:
125 AARH : Serrations with 125 to 250 μ in AARH
- 1.12 Seamless stub ends shall not have any welds on the body. Stub ends shall be long pattern type.
- 1.13 Galvanized fittings shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A153.
- 1.14 Threaded ends shall have NPT taper threads in accordance with ASME/ANSI B1.20.1 up to 1.5" NB & IS 554 from 2" to 6" NB.
- 1.15 Unless and otherwise specified in the MR, all socket welded and screwed fittings shall be in accordance with ASME B16.11 to the extent covered in the specification except for unions which shall be in accordance with MSS-SP-83.
- 1.16 Special fittings like weldolet, sockolet, sweepolet, latrolet, elbolet etc., the dimensions of which are not covered in ASME, MSS-SP & EIL Standards, shall be as per manufacturer's std. Contours of these fittings shall meet the requirements of ASME B31.3. Manufacturer shall submit drawings / catalogues of these items for records after acceptance of offer.
- 1.17 Length of all long half couplings shall be 100 mm unless otherwise specified in the MR.
- 1.18 For reducers to manufacturers' standard, length of reducer shall not be less than 0.7D where D is the outside diameter of the larger end.
- 1.19 All seamless pipes employed for manufacturing of fittings shall be required to have undergone hydrostatic test to ASTM A 530. Welded pipes employed for manufacture of fittings shall be tested as given below :

Welded Pipe Employed For Manufacture Of Welded Fittings.	Test Criteria
ASTM A671 Gr. C65,70 (Cl.32) ASTM A672 Gr. C60,65,70 (Cl.12, 22) ASTM A671 Gr. CF60,65,70,66 (Cl.32) ASTM A691 Gr. 1/2Cr, 1Cr, 1 1/4Cr, 2 1/4Cr, 5Cr, 9Cr (Cl.42), 91 (Cl.42)	P = 2ST / D S = 90% of SMYS. T = Nom. Wall Thickness D = 0.D. of Pipe.
API 5L ASTM A358 TP 304, 304L, 304H, 318, 318L, 318H, 321, 347 (Cl.1, 3, 4)	P = 2ST / D S = 85% of SMYS. T = Nom. Wall Thickness D = 0.D. of Pipe.
ASTM B725	ASTM B725
ASTM B517	ASTM B517
ASTM B514	ASTM B514

- 1.20 The bevel ends of all butt weld fittings shall undergo 100% MP / DP test.

- 1.21 Abbreviations for ends of swages and nipples shall be as follows:
- | | | |
|-----|---|--------------------|
| PBE | : | Plain Both Ends |
| TBE | : | Threaded Both Ends |
| TOE | : | Threaded One End |
| TSE | : | Threaded Small End |
| TLE | : | Threaded Large End |
- 1.22 All types of SS321 or SS347 fittings shall be in stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to normal solution annealing. Soaking temperature and holding time for stabilizing heat treatment shall be 900°C and 4 hours respectively.
- 1.23 For Hydrogen service fittings following special requirements shall also be met:
- All carbon steel fittings having wall thickness 9.53 mm (0.375") and above shall be normalised. Cold drawn fittings shall be normalised after the final cold draw pass for all thicknesses. In addition, fittings made from forgings shall have Carbon- 0.35 % max, and Silicon- 0.35 % max. The normalising heat treatment shall be a separate heating operation and not a part of the hot forming operation
 - All alloy steel (Cr-Mo) fittings shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psi.
 - For carbon steel fittings, hardness of weld and HAZ shall be 200 BHN (max.). For alloy steel fittings, hardness of weld and HAZ shall be 225 BHN (max.).
 - For all Carbon steel and Alloy steel fittings with wall thickness over 20 mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°Celsius shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 20J(15 ft-lb).
- 1.24 For all welded alloy steel fittings with mandatory requirements of heat treatment and radiography, radiography shall be performed after heat treatment.
- 1.25 All 1Cr-0.5Mo & 1.25Cr-0.5Mo fittings shall be normalized and tempered. All 2.25Cr-1Mo, 5Cr-0.5Mo, 9Cr- 1 Mo & 9Cr-1Mo-V welded fittings shall be normalized and tempered.
- 1.26 Fitting material as per ASTM A234 Gr. WP11/WP22/ WP5/WP9/WP91, wherever specified, shall be as per 'Cl.1', unless otherwise specified.
- 1.27 Materials designated as structural steel grades like IS 2062, SA 36 etc. or similar specification are not permitted for manufacture of fittings.
- 1.28 **Pipe Bends (Other than Elbows)**
- Bending shall be as per ASME B31.3 except that corrugated or creased bends shall not be used. Final Wall thickness after bending process shall not be less than 87.5% of the thickness specified. All other tolerances shall be as per PFI ES-24.

2.0 IBR REQUIREMENTS

2.1 IBR Documentation Required

2.1.1 Fittings under the purview of "IBR" (Indian Boiler Regulations) shall be accompanied with original IBR certificate in Form III-C duly approved and countersigned by IBR authority / local authority empowered by Central Boiler Board of India. Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

2.1.2 For materials 1¼Cr - ½Mo (ASTM A 234Gr.WP11 Cl.1 & ASTM A234 Gr.WP11W Cl.1) & 2¼Cr - 1Mo (ASTM A 234 Gr.WP22 Cl.1 & ASTM A234 Gr. WP22W Cl.1) & 9Cr-1Mo-V (A234 Gr.WP91/A234Gr.WP91W), where fittings are manufactured from pipe, Form III-C approved by IBR shall include the tabulation of E_t , S_c , & S_r values for the entire temperature range given below. E_t , S_c , & S_r values shall be such that throughout the temperature range

$$\begin{array}{l} E_t / 1.5 \\ S_r / 1.5 \\ S_c \end{array} \geq S_A$$

- S_A : Allowable stress at the working metal temperature.
 E_t : Yield point (0.2% proof stress at the working metal temperature)
 S_c : The average stress to produce elongation of 1%(creep) in 100000 hrs at the working metal temperature.
 S_r : The average stress to produce rupture in 100000 hrs at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

Temp(F) Material	S_A (psi)											
	500	600	650	700	750	800	850	900	950	1000	1050	1100
A234Gr.WP11 Cl.1/ A234Gr.WP11W Cl.1	16200	15700	15400	15100	14800	14400	14000	13600	9300	6300	4200	2800
A234Gr.WP22 Cl.1/ A234Gr.WP22W Cl.1	17900	17900	17900	17900	17900	17700	17100	13600	10800	8000	5700	3800
A234Gr.WP91/ A234Gr.WP91W	28100	27700	27300	26700	25900	24900	23700	22300	20700	18000	14000	10300

Note : S_A values shall be as per the latest edition of ASME B31.3 prevailing.

2.2 For carbon steel Fittings under IBR the chemical composition shall conform to the following:

- Carbon (max) : 0.25%
 Others (S, P, Mn) : As prescribed in IBR.

The chemical composition as indicated in this clause is not applicable for fittings other than IBR services.

3.0 ACCEPTABLE DEVIATIONS

- 3.1 Seamless fittings are acceptable in place of welded fittings, however, welded fittings are not acceptable in place of seamless fittings. Forged fittings are acceptable in place of wrought fittings. However, wrought seamless fittings are acceptable in place of forgings only in case of swages.
- 3.2 Fittings of Grades SS317 of corresponding material are acceptable in place of Grades SS316 or SS316(2.5Mo min.).
- 3.3 Fittings of Grades SS317L of corresponding material are acceptable in place of Grades SS316L or SS316L(2.5Mo min.).
- 3.4 Dual Grade SS304/304L conforming to all chemical composition requirements of SS304L and mechanical properties of SS304 is acceptable in place of SS304L or SS304 grades. Any specific additional requirements given in the MR shall also be complied.
- 3.5 Dual Grade SS316/316L conforming to all chemical composition requirements of SS316L and mechanical properties of SS316 is acceptable in place of SS316L or SS316 grades. Any specific additional requirements given in the MR shall also be complied.

4.0 MARKING AND DESPATCH




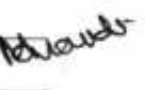
- 4.1 Each fitting shall be legibly and conspicuously stamped in accordance with the requirements of applicable standards along with special condition like "IBR", "Cryo", "NACE" and "H2" etc.
- 4.2 Steel die marking with round bottom punch may be permitted on body of butt weld CS & lower alloy steel fittings, but for SS & higher alloy steel fittings, the same should be marked by electro-etching only.
- 4.3 Paint or ink for marking shall not contain any harmful metals or metal salts such as Zinc, Lead or Copper which causes corrosive attack on heating.
- 4.4 Fittings shall be dry, clean and free of moisture, dirt and loose foreign materials of any kind.
- 4.5 Fittings shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.
- 4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.
- 4.7 Fittings coming under the purview of "IBR", "CRYO", "NACE" & "H2"(hydrogen) shall be painted with one circumferential stripe of colour red, light purple brown, canary yellow & white respectively for easy identification. Width of stripe shall be 12mm for sizes less than 3" and 25mm for sizes 3" and above. Stripe shall be located centrally for elbows, diagonally for caps, at the larger end for reducing fittings, longitudinally for couplings and at one end near to the bevel/socket/screwed end for other fittings.
- 4.8 Each end of fitting shall be protected with a wood, metal or plastic cover.
- 4.9 Each size of fitting shall be supplied in separate packaging marked with the purchase order number, item code number, material specification, size and schedule / thickness / rating. For small quantities, fittings of different sizes may be packed in separate packing size-wise and these packing may be packed in a bigger package/ container clearly identifying the contents.

5.0 REFERENCES

- 6-81-0001 : Specification for Positive Material Identification (PMI) at Supplier's Works
- 6-81-0005 : Inspection & test plan for forged, seamless and welded fittings
- 6-79-0013 : Material requirements for carbon steel components used in sour service for petroleum refinery environments

गास्केट्स के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR GASKETS

7	15.03.24	REVISED & ISSUED AS STANDARD SPECIFICATION	 PK	 SH	 GB	MN 
6	11.08.21	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM
5	30.03.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
4	21.03.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN	ATD DM
3	23.07.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
						Approved by

Abbreviations:

AARH :	Average Arithmetic Root Height
BHN :	Brinell Hardness Number
CS :	Carbon Steel
MR :	Material Requisition
PMI :	Positive Material Identification
RTJ :	Ring Type Joint

Piping Standards Committee

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Members : Mr. Udayan Chakravarty
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Mr. P.K. Rai (Construction)

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1.0 GENERAL

1.1 All gaskets shall conform to the codes/standards and specifications given in the requisition. In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted.

1.2 Process of manufacture, dimensions and tolerances not specified in requisition shall be in accordance with the requirements of the manufacturer's standards.

1.3 Testing

1.3.1 Test reports shall be supplied for all mandatory tests for gaskets as per the standards specified in the requisition.

1.3.2 Chemical composition and hardness of RTJ gaskets shall also be furnished in the form of test reports on samples.

1.3.3 For Spiral wound material following shall be furnished:

a. Manufacturer's test certificate for filler material and spiral material as per the relevant material specifications/ MR.

b. Manufacturer's test certificate for raw materials and tests for compressibility/ sealability & recovery as per the relevant material specifications/ MR.

1.3.4 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Supplier's Works (6-81-0001) for ring type joint gaskets.

1.3.5 Refer Specification no 6-81-0008 for 'Inspection & Test Plan for Gaskets'.

1.4 Full face gaskets shall have bolt holes punched out.

1.5 Filler material for spiral wound gaskets shall not have any colour or dye.

1.6 All spiral wound gaskets shall be supplied with Outer ring. Material of the outer ring shall be CS unless otherwise specified in the MR.

1.7 Inner rings shall be provided for all Spiral Wound Gaskets. For spiral wound gaskets, material of Inner Compression ring shall be same as Spiral Strip material.

1.8 Hardness of metallic RTJ gaskets shall not exceed the values specified below unless otherwise specified in MR:

Ring Gasket Material	Maximum Hardness (BHN)
Soft Iron	90
Carbon steel	120
5 Cr. ½ Mo	130
Type 304, 316, 321, 347	140

Type 304L, 316L	135
Inconel UNS N06625	200
Incoloy UNS N08825	190
Duplex SS UNS S32205, S31803	230


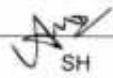

- 1.9** Face finish of metallic RTJ gaskets shall be 32 to 63 AARH.
- 1.10** Gaskets of different types and sizes shall be placed in separate shipping containers and each container clearly marked with the size, rating, material specification and item code.
- 1.11** All items shall be inspected and approved by EIL Inspector or any other agency authorized by EIL.
- 1.12** Any additional requirements specified in the requisition, shall be fully complied with.
- 1.13** Non-metallic ring gaskets as per ASME B16.21 shall match flanges to ASME B16.5 upto 24" and to ASME B16.47B above 24" unless specified otherwise.
- 1.14** Spiral wound gasket as per ASME B16.20 shall match flanges to ASME B16.5 upto 24" and to ASME B16.47B above 24" unless specifically mentioned otherwise.
- 1.15** The following abbreviations have been used in the Material Requisition for Spiral Wound Gaskets :
- | | | |
|--------|---|----------------|
| (I) | : | Inner Ring |
| (O) | : | Outer Ring |
| GRAFIL | : | Grafoil Filler |
- 1.16** Specialties mentioned in item description like "IBR", "LT", "HIC1", "H2", "CRYO" etc. shall be ignored.

2.0 REFERENCES

6-81-0001	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0008	Inspection & Test Plan for Gaskets
6-78-0001	Specification for Quality Management System Requirements from Bidders

बोल्ट्स एवम नट्स के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR BOLTS AND NUTS

7	15.03.24	REVISED & ISSUED AS STANDARD SPECIFICATION	 PK	 SH	 GB	MN	<i>Khandi</i>
6	28.03.23	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM	
5	30.03.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN	
4	21.03.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN	ATD	DM
3	23.07.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman	Approved by

Abbreviations:

ASME :	The American Society of Mechanical Engineers
ASTM :	The American Society for Testing and Materials
GALV :	Galvanized
HDG :	Hot Dip Galvanized
MR :	Material Requisition
PMI :	Positive Material Identification
SS :	Stainless Steel

Piping Standards Committee

Convenor: Mr. G. Balaji

Members : Mr. Udayan Chakravarty
Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
Mr. Rajesh Chitara (SMMS)
Dr. Sudip Paul (Structural)
Mr. Harsh Vardhan (Projects)
Mr. P.K. Rai (Construction)

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1.0 GENERAL

1.1 The process of manufacture, heat treatment, chemical & mechanical requirements and marking for all stud bolts, m/c bolts, jack screws & nuts shall be in accordance with the codes/standards and specifications given in the requisition. Supplier shall strictly comply with MR stipulations and no deviations shall be permitted. In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

All codes and standards for manufacture, testing, inspection etc. shall be of latest editions as on issue date of RFQ.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications/ MR.

1.2.2 Material test certificate shall also be furnished. (Heat Analysis, Product Analysis, Mechanical Requirement and any other testing as per MR).

1.2.3 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Supplier's Works (6-81-0001).

1.2.4 Stress Rupture Test as detailed in ASTM A453 shall be carried out for all ASTM A453 bolting material irrespective of the temperature.

1.2.5 Refer Specification no 6-81-0007 for 'Inspection & Test Plan for Bolting Material'.

1.3 All bolting shall be as per ASME B 18.2.1 for studs, M/c bolts and jackscrews and ASME B18.2.2 for nuts.

1.4 Threads shall be unified (UNC for up to 1" dia and 8UN for > 1" dia) as per ASME B1.1 with class 2A fit for studs, M/c bolts and jackscrews and class 2B fit for nuts.

1.5 Stud bolts shall be threaded full length with two heavy hexagonal nuts unless otherwise specified. Length tolerance shall be in accordance with the requirement of ASME B 16.5.

1.6 The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process and stamped as per respective material specification.

1.7 Heads of jackscrews and m/c bolts shall be heavy hexagonal type. Jackscrew end shall be rounded.

1.8 All items shall be inspected and approved (stage-wise) by EIL inspector or any other agency authorized by EIL.

1.9 The heat treatment for stud bolts & nuts shall be as per code unless mentioned otherwise.

1.10 All austenitic stainless steel bolts, nuts, screws shall be supplied in solution annealed condition unless specified otherwise in the material specification.

1.11 Any additional requirements specified in the requisition shall be fully complied with.

- 1.12 Stud bolts, nuts & jackscrews shall be impact tested wherever specified in the material specification and also where the material specification is indicated as "CRYO". For S.S. nuts and bolts minimum impact energy absorption shall be 27 Joules and test temperature shall be -196°C unless mentioned otherwise. For other materials impact energy and test shall be as per respective code.
- 1.13 Bolts/nuts of material of construction B7M/2HM shall be 100% Hardness tested as per supplementary requirement S3 of ASTM A193.
- 1.14 When specified as "GALV.", the studs, M/C bolts and nuts shall be 'hot dip zinc coated' in accordance with requirements of 'class C' of 'ASTM A 153'. As an alternative, electro-galvanizing as per IS 1573, 'Service Grade Number 2' is also acceptable. However, for bolting where "HDG" has been specified, only 'hot dip zinc coating' in accordance with requirements of 'class C' of 'ASTM A 153' is acceptable.
- 1.15 All Stud Bolts of Bolt diameter size 1" and above shall be provided with three nuts irrespective of whatever has been specified elsewhere in the MR.
- 1.16 For stud bolt diameters not covered in ASTM A320, mechanical properties shall match the values specified for the matching grades and stud bolt diameters in ASTM A193.
- 1.17 In cases where the lengths of Stud/Machine bolts specified in the MR are not multiples of 0.25", the length supplied shall be equal to the specified length rounded up to the next higher 0.25".
- 1.18 All Specialties mentioned in item description like "IBR", "LT", "H2", etc. other than "CRYO"& "NACE" shall be ignored.
- 1.19 'Nuts' to ASTM A194Gr.7 to be supplied wherever ASTM A194Gr.4 is specified in the MR/PR.

2.0 ACCEPTABLE DEVIATIONS

- 2.1 Stud Bolts to ASTM A453 Gr.660 Cl.B are acceptable in lieu of ASTM A453 Gr. 660 Cl.A and vice versa.
- 2.2 In case of ASTM A453 Gr.660, Nuts machined from raw material duly heat treated & tested (including stress rupture test) as per relevant material specifications are acceptable. However, all tests required as per MR shall be repeated on finished product.

3.0 MARKING AND DESPATCH





- 3.1 Bolting shall be protected by non-corrosive oil or grease before dispatch to prevent rusting.
- 3.2 The applicable identification symbol in accordance with the material specification shall be stamped on each bolt and nut.
- 3.3 Each size of studs & m/c bolts with nuts and jackscrews shall be supplied in assembled condition in separate containers. Each container shall be clearly marked with the size, material specification, and item code. 'CRYO' shall be marked additionally in case 'CRYO' is specified in the requisition. Packing of studs/bolts and nuts separately are not acceptable.

4.0 REFERENCES

- | | |
|------------|--|
| 6-81-0001 | Specification for Positive Material Identification (PMI) at Supplier's Works |
| 6-81-0007 | Inspection & Test Plan for Bolting Material |
| 6-78-0001 | Specification for Quality Management System Requirements from Bidders |
| 6-78-0003: | Specification for documentation requirements from suppliers |

हौज एवं हौज कपलिंग के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR HOSES & HOSE COUPLINGS

3	28.03.23	REVISED & ISSUED AS STANDARD SPECIFICATION	 PK	 SH	 MI	 RN
2	30.03.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
1	28.03.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN	ATD DM
0	29.06.09	ISSUED AS STANDARD SPECIFICATION	PK	RN	SC	ND
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	

Abbreviations:

AARH	:	Arithmetic Average Roughness Height
ASME	:	American Society of Mechanical Engineers
CS	:	Carbon Steel
eDMS	:	Electronic Document Management System
MR	:	Material Requisition
PMI	:	Positive Material Identification

Piping Standards Committee

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1.0 PURPOSE & SCOPE

These Technical Notes shall form part of Material Requisition as well as the Purchase Requisition for Hoses & Hose couplings. These shall also serve as reference for Materials Engineer and Inspection. These notes cover the technical requirements, documentation, inspection, testing, marking and dispatch requirements for hoses and hose couplings. Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted.

All codes and standards for manufacture, testing, inspection etc. shall be of latest editions as on issue date of RFQ.

2.0 TECHNICAL REQUIREMENTS

2.1 Hose material and Ends thereof shall be as per Material Requisition (MR).

2.1.1 The material composition, physical properties, heat treatment, mandatory tests, dimensions and tolerances and marking shall conform to the applicable codes/standards/specifications.

2.2 Hoses shall be suitable for outdoor installation in an atmosphere containing hydrocarbon vapour, steam etc. The outer cover shall be resistant to ageing, abrasion & weather effects etc.

2.3 Flanges for flanged hoses shall be in accordance with ASME B16.5 unless specified otherwise in the requisition. Flange finish shall be as specified in the requisition. The interpretation for range of face finish shall be as follows:

Serrated/Smooth/125AARH: 125 to 250 micro inch AARH.

2.4 Hose end connections shall be supplied as per MR.

2.5 CS Fittings (hose couplings, clamps, claws, nozzles etc.) shall be cadmium chromium Plated.

2.6 Manufacturer shall guarantee suitability of hoses for the service and working conditions (design pressure, design temperature) as specified in Data sheet of hoses and hose couplings.

3.0 DOCUMENTATION

3.1 No documents shall be submitted along with the offer. However, vendor shall submit the following documents for records through EIL eDMS:

- Duly signed and stamped data sheet for hoses & hose couplings.
- Vendor's catalogue/ drawings showing detailed dimensions along with material for different parts.
- Material test certificates as applicable; test reports of mandatory tests, hydrotest and special tests as per applicable specifications and standards.

3.2 In addition to submissions through eDMS, the following documents shall be submitted in hard copies (6 sets) and soft copies (2 CDs/DVDs) along with the delivery of respective items:

- Vendor's catalogue/ drawings showing detailed dimensions along with material for different parts.

4.0 TESTING & INSPECTION

4.1 All hoses shall be tested at 2 times the design Pressure along with end connections.

4.2 Steam resistance test, vacuum test and electrical continuity test shall be carried out as applicable in Clauses 4.2.1 & 4.2.2 and shall fulfill the requirements of the applicable design codes mentioned in MR. In cases where these are not specified, tests shall be as per specifications followed by the manufacturer.

4.2.1 Electrical continuity test shall be conducted on all individual non-metallic hoses.

4.2.2 Vacuum test shall be conducted on all individual metallic and rubber hoses intended for steam service. For rubber hoses intended for steam service, steam resistance test shall also be conducted.

4.3 Flanges shall be so aligned so that the deviations measured in any direction do not exceed 0.5°.

4.4 The length of the finished hose assembly shall not differ from the specified length by more than ±1%. Hose assembly shall be measured after being subjected to the various tests. Tolerances shall be as per specified design code.

4.5 Positive Material Identification (PMI) shall be performed as per the scope and procedures as defined in the 'Specification for Positive Material Identification (PMI) at Supplier's Works (No. 6-81-0001).

4.6 Refer Specification no 6-81-0135 for 'Inspection & Test Plan for Hose Pipes and Couplings'.

5.0 MARKING & DESPATCH

5.1 All hoses along with their couplings shall be dry, clean and free from moisture, dirt and loose foreign material of any kind. All hoses shall be suitably packed and protected to avoid damage during transportation, shipment and storage.

5.2 Each hose shall have a weatherproof tag attached with a corrosion resistant metal wire. The weatherproof tag shall be embossed with item code, size of hose and length of hose. In addition, all hoses shall be clearly marked with service and maximum working pressure at both ends.

6.0 ATTACHMENTS

6-44-0064-A1 : Sketches for hoses and hose couplings (End details)

7.0 ATTACHMENTS FOR MR

Format No.3-1643-0095: Data sheet for hoses and hose couplings

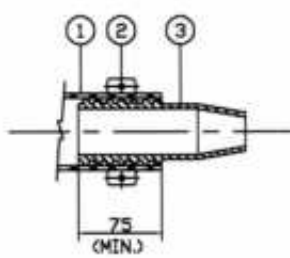
8.0 REFERENCES

6-81-0001 Specification for Positive Material Identification (PMI) at Supplier's Works

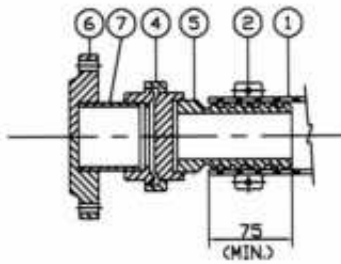
6-81-0135 Inspection & Test Plan for Hose Pipes and Couplings

6-78-0001 Specification for Quality Management System Requirements from Bidders

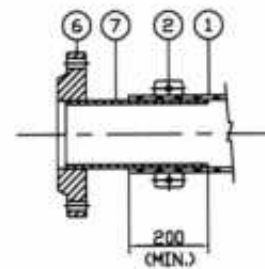
6-78-0003: Specification for documentation requirements from suppliers



TYPE-1

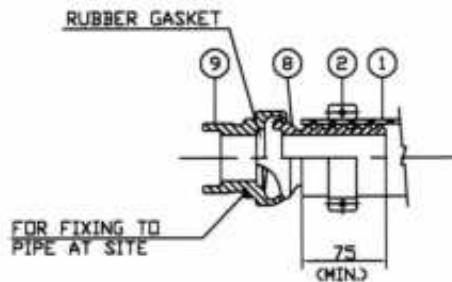


TYPE-2

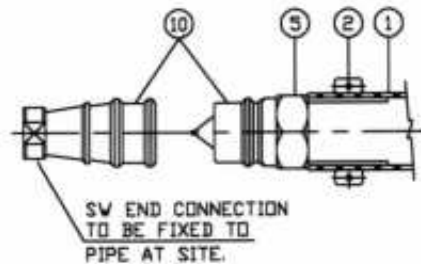


TYPE-3A & 3B

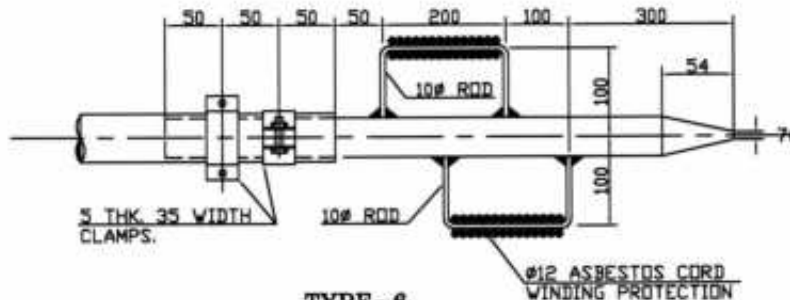
NOTE: FOR TYPE 3B HOSE TO BE FULLY
VULCANIZED OVER NIPPLE & NO CLAMP



TYPE-4



TYPE-5



TYPE-6

(FOR STEAM HOSE CONNECTION)
PIPE OD 33.4 & 4.5 THK.

ITEM No.	DESCRIPTION
1	HOSE PIPE AS SPECIFIED
2	HOSE PIPE CLAMP WITH BOLTS MINIMUM 6mm THK. STEEL PLATE (IS2062) IN TWO PARTS BOLT/ NUTS A307 GR'B'
3	PIPE NIPPLE MATERIAL AS SPECIFIED (SEAMLESS)
4	3000 LB SW UNION, ENDS TO SUIT ITEM (5) AND (7), MATERIAL AS SPECIFIED
5	SEAMLESS PIPE NIPPLE WITH SERRATIONS TO SUIT ITEMS (1) AND (4), MATERIAL AS SPECIFIED
6	END FLANGE MATERIAL AND DETAIL AS SPECIFIED
7	PIPE MATERIAL AS SPECIFIED WITH SERRATIONS
8	QUICK CLAW COUPLING (HOSE END) MATERIAL AS SPECIFIED BOTH COUPLINGS TO BE SUPPLIED IN TYPE 4
9	QUICK CLAW COUPLING WITH SOCKET WELD PIPE END, MATERIAL AS SPECIFIED
10	QUICK ACTING, QUICK RELEASE COUPLER/ ADAPTOR ASSEMBLY WITH BUILT IN CHECK VALVE BOTH COUPLER AND ADAPTOR SHALL BE SUPPLIED IN TYPE 5.

NOTE:-

ALL DIMENSIONS ARE IN MM.

Abbreviations:

AARH :	Arithmetic Average Roughness Height
AISI :	American Iron and Steel Institute
ASME :	American Society of Mechanical Engineers
ASTM :	American Society for Testing and Materials
BHN :	Brinell Hardness Number
BW :	Butt Weld
DP :	Dye Penetrant
IBR :	Indian Boiler Regulations
MOC :	Material of Construction
MP :	Magnetic Particle
PMI :	Positive Material Identification
Re :	Rockwell C Hardness
SCRD :	Screwed
SS :	Stainless Steel
SW :	Socket Weld
WN :	Weld Neck
eDMS :	Electronic Document Management System

Piping Standards Committee

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1.0 PURPOSE & SCOPE

This specification covers the design and construction, IBR requirements, documentation, testing, inspection, marking and dispatch requirements for Traps, Compact Steam Trap Assemblies (CSTAs) and Steam Supply (SS)/Condensate return(CR) manifolds. Vendor shall supply Traps, CSTAs and SS/CR manifolds in accordance with the technical notes and details specified in the data sheet for steam/air traps, CSTAs & SS/CR Manifolds. Supplier shall strictly comply with MR stipulations and no deviations shall be permitted. In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Post order Concession/ Deviation as mentioned in Cl. 5.17 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

2.0 DESIGN AND CONSTRUCTION

- 2.1 All Codes and Standards for manufacture, testing and inspection etc. shall be of latest editions.
- 2.2 The material of construction shall be as per the data sheet; for parts not mentioned in the datasheet, vendor shall guarantee the material used for the service conditions specified. For flanged traps, MOC of end flanges shall correspond to the material specified in the data sheet.
- For welding of dissimilar materials required for trap assembly, welder qualification procedure shall be done prior to welding.
- 2.3 The material composition, physical properties, heat treatment & mandatory test reports, dimensions and tolerances shall conform to the applicable codes/standards/specifications as specified in the requisition.
- 2.4 All traps shall be designed with back pressure upto 80% of upstream pressure unless otherwise specified in the datasheet.
- 2.5 All traps shall have an integral strainer which can be serviced and its material shall be SS304/SS316. However, Ball Float and Inverted Bucket traps may be supplied with separate strainer of trap or line size, but vendor should quote composite price for the same. Trap and strainer shall be supplied in assembled condition having strainer in the upstream. This strainer shall be of Y-type having 40mesh size and material of construction for body and internals shall be same as that of trap.
- 2.6 Thermodynamic traps shall have seat integral or seal-welded to the body & central entry with respect to the disc. The seat and disc shall be differentially hardened to Rc 45-50 and Rc 40-45 respectively maintaining a minimum difference of Rc 5 to ensure wear on the disc.
- 2.7 Thermostatic traps shall be designed with subcool temperature setting as per data sheet. If nothing is specified in data sheet, subcooling of 10 Deg C should be considered by default.
- 2.8 Upto 300 Class rating, Composite Impulse cum Thermodynamic type steam trap with two integral strainers in place of Thermodynamic and Thermostatic trap is also acceptable.
- 2.9 Inverted bucket steam trap shall be of horizontal entry & exit type.
- 2.10 For flanged end traps, weld-on flanges are also acceptable. However, the type of flange shall be WN.

2.11 Ends shall be as specified in the data sheet. The applicable dimension standards are:

Flanged ends	:	ASME B16.5
SW ends	:	ASME B16.11
SCRD ends	:	ASME B16.11
BW ends	:	ASME B16.25

2.12 Bevel end details for BW steam traps shall be as per ASME B16.25. Contour of bevel end shall be as follows :

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

2.13 Flanged end face finish shall be normally specified in the data sheet. The interpretation for range of face finish shall be as follows:

Stock Finish	:	1000 μ in AARH max.
Serrated/Smooth Finish/125 AARH	:	Serrations with 125 to 250 μ in AARH
Extra Smooth/63 AARH	:	32 TO 63 μ in AARH

2.14 For traps with ring joint type flanged ends the hardness shall be as follows :

Flange Material	Min. Hardness of Flange Groove (BHN)	Max. Gasket Hardness (BHN)
Carbon Steel	140	90
1% Cr to 5% Cr, 9Cr	150	130
Type 304, 316, 321, 347	160	140
Type 304L, 316L	150	135
9Cr-1Mo-V	190	130

2.15 For traps with flanged ring type joint ends, the hardness shall be recorded in the test report.

2.16 All 1Cr-0.5Mo & 1.25Cr-0.5Mo traps shall be normalized and tempered.

2.17 All piping components like pipes, reducers, elbows, etc. used for fabrication of steam trap assembly shall be of metallurgy equivalent to trap body and of seamless construction.

2.18 CSTAs & SS/CR Manifolds shall be supplied in single piece construction. If SS/CR manifolds are multi piece construction, the individual sections of min. 4 nos. connection shall be butt-welded/socket-welded to form the manifold. All these butt-weld joints shall be 100% radiographed and socket weld joints shall be 100% DP/MP tested.

2.19 CSTAs and CR Manifolds shall be supplied with a provision for depressurisation of steam trap.

- 2.20** CSTAs & SS/CR Manifolds shall also meet applicable requirements of "Technical notes for Butt welded, socket welded and screwed fittings", Document No. 6-44-0054 and "Technical notes for valves", Document No. 6-44-0052.
- 2.21** SS/CR Manifolds shall be supplied with threaded supporting bosses at least at two locations for Manifolds with 4 no. of connections and at least four locations for manifolds with 8/12 no. of connections. The bosses having provisions for screwing in M12 studs shall be bolted with support member with a suitable spacer between manifold and support member. Sufficient play shall be provided in Bolt holes to account for expansion of manifolds in design condition. Suitable support member as per 6-44-0066-A1 shall be provided in assembled condition with manifold.
- 2.22** All open outlet connections of CSTAs & CR manifolds (from depressurization/test valves) shall be supplied with suitable 0.5" SS tubing (minimum 100mm length) pointing away from operating personnel for safe operation. In case of manifolds, all bypass outlet connections on each side of manifold shall be joined in a separate common pipe header equivalent to manifold material.
- 2.23** Wherever back pressure is specified in MR, Functionality test is to be performed on each model, metallurgy and size for intended back pressure specified in MR. For the same model, with equal or higher back pressure, earlier successfully performed functionality test reports shall also be acceptable.

3.0 IBR REQUIREMENTS

3.1 IBR Documentation

- 3.1.1** Traps coming under the purview of IBR (Indian Boiler Regulations) shall be accompanied with IBR Certificate original in Form III C duly approved and countersigned by IBR authority / local authority empowered by Central Boiler Board of India. Photocopy of original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.
- 3.1.2** For carbon steel traps described as "IBR", chemical composition for all carbon steel components shall conform to the following :

Carbon (max.)	:	0.25% (C=0.30% for A182 Gr. F1)
Others (S, P, Mn)	:	As prescribed in IBR Regulation

4.0 ACCEPTABLE DEVIATIONS

- 4.1** Following alternative body materials are acceptable :
- AISI 420/AISI 410/A743 Gr.CA40/A743 Gr.CA15 in lieu of ASTM A105.
 - A182 F22 in lieu of A182 F11.
 - AISI 420/A182 F11 in lieu of A182 F1.
- 4.2** Cast traps including strainer with integrally cast flanges are also acceptable in lieu of equivalent forged material. All castings offered in place of forgings shall be radiographed.
- 4.3** Forgings of equivalent material shall be acceptable in place of castings.
- 4.4** For traps where capacity has been specified in the datasheet, and if the trap meets the capacity requirement, in these cases trap of same type but of lower size is also acceptable. End connection size and type shall be same as that specified in datasheet.