प्रेशर वेसल्स के सामान्य विनिर्देश

GENERAL SPECIFICATION

FOR

PRESSURE VESSELS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
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Abbreviations:

AI	:	Authorized Inspector
ASME	:	American Society of Mechanical Engineers
DNV	:	Det Norske Veritas
IBR	:	Indian Boiler Regulations
ISO	:	International Organisation for Standardisation
NB	:	Nominal Bore
PESO	:	Petroleum & Explosives Safety Organisation
PWHT	:	Post Weld Heat Treatment

Static Equipment Standards Committee

Convenor: Mr. Nalin Kumar

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Mr. K. Anjaneyulu (Co-Convener)
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Mr. Tarun Khurana (Coordinator)
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1.0 SCOPE

1.1 This specification covers the general requirements for design, fabrication, workmanship, erection, inspection, testing and supply of unfired pressure vessels and is intended to supplement the minimum requirements of the applicable codes.

1.2 Supplementary specification indicating special or additional requirements shall form addenda to this specification and shall govern. Supplementary specification, when made addenda to this specification shall be referred to in the Material Requisition and / or Purchase Order. Following are the supplementary specifications:

a) 6-12-0002 Supplementary specification for carbon steel vessels.
b) 6-12-0003 Supplementary specification for low alloy steel vessels.
c) 6-12-0006 Supplementary specification for austenitic stainless steel vessels.
d) 6-12-0007 Supplementary specification for stainless steel clad vessels.
e) 6-12-0008 Supplementary specification for 3½ %Ni steel pressure vessels.

1.3 In case of conflict, the order of precedence shall be as follows:

a) Statutory Requirement
b) Engineering drawing
c) Specifications and standards
d) Codes

In general, the most stringent requirement out of the above shall govern. However, in such a case, vendor shall promptly refer the conflicts to client / EIL in writing to obtain client / EIL instruction before proceeding with manufacture. Decision of client / EIL shall be binding without any time and cost implication.

2.0 REFERENCES

2.1 Design Codes

The following codes in the edition and addenda referred to in the datasheet shall form the basis for design, fabrication, inspection, testing and acceptance of equipment:

(a) ASME Boiler and Pressure Vessel Code Section VIII Div. 1

(b) ASME Boiler and Pressure Vessel Code Section IX and Sec V.

(c) Indian Boiler Regulations- IBR (whenever applicable).

(d) The Static and Mobile Pressure Vessels (Unfired) Rules 2016 (whenever applicable).

2.2 Material Codes

Material to be used shall conform to:

(a) ASME Boiler and Pressure Vessel Code Sec. II.

(b) Indian Standard specification.

Other specifications of equivalent grade can be used only after written approval from EIL.

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2.3 Regulations

National laws and regulations together with any local by-laws for the country or state wherever the vessels are to be used must be complied with by the fabricator.

3.0 DESIGN

3.1 Design Pressure

3.1.1 Design pressure specified shall be at the top of vertical vessel or at the highest point of horizontal vessel.

3.1.2 The design pressure at any lower point shall be determined by adding the maximum operating liquid head and any pressure gradient within the vessel.

3.2 Corrosion Allowance

3.2.1 Corrosion allowance shall be added to both sides of tray support rings and other fixed internal non-pressure parts.

3.2.2 Removable internal parts (with the exception of trays) which are bolted or clamped in place, shall be provided with extra thickness equal to half the specified corrosion allowance on each surface exposed to vessel contents.

3.2.3 Full corrosion allowance shall be added to the throat thickness necessary for strength or sealing in case of fillet and seal welds on internal attachments.

3.3 During fabrication or shop/site hydro-test conditions in horizontal position, the supports for shell shall be so provided that combined stresses in any shell component (based on corroded thickness for site test) do not exceed the following:

(a) Tensile : 90% of ambient yield

(b) Compressive: Code allowable stress

3.4 All conical reducers shall be designed as tori conical type with knuckle radius at each end as minimum 10% of the adjoining diameter, unless otherwise specified in requisition. 100% radiography shall be carried out for all weld seams of tori cone.

3.5 Statutory Approvals

3.5.1 For vessels coming under the purview of Indian Boiler Regulations, it shall be vendor's responsibility to get approval from IBR authorities pertaining to design, drawings, material of construction, fabrication, inspection and testing etc.

3.5.2 For vessels coming under the purview of Static and Mobile Pressure Vessel rules, it shall be vendor's responsibility to get approval from Petroleum & Explosives Safety Organization (PESO) pertaining to design, drawings, material of construction, fabrication, inspection and testing etc.

3.6 Internals

3.6.1 For support beams, allowable deflection shall be limited to L/325 where L is the length of the beam.

3.6.2 For plates, allowable deflection shall be limited to T/2 where T is the corroded thickness of plate.

3.6.3 Allowable stress at design temperature shall be as per applicable Code.

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4.0 FABRICATION

4.1 Head/Dished Ends

4.1.1 Dished ends shall preferably be of seamless construction. However, dished ends with one chordal weld seam are acceptable. In such cases, the width of chordal plate shall not be less than one third of the blank diameter and chordal seam shall clear nozzle opening. Intermediate heat treatment, if considered necessary, shall be carried out by the fabricator.

4.1.2 Whenever a dished end is made of more than two plates, it must have a seamless crown plate. Whenever a nozzle or a manhole is positioned at the center of the dished end, the crown plate should be larger than the nozzle /manhole reinforcing pad.

4.1.3 Wherever hot forming and subsequent heat treatment is involved, adopted procedure shall not impair the mechanical properties of the material beyond the limits specified in respective material specification.

4.2 Nozzles, Manholes, Handholes and Attachments

4.2.1 Manhole cover shall be provided with a davit or hinge as per EIL standard and Handhole cover shall be provided with suitable lifting handles.

4.2.2 Inside edges of Manholes/Handholes shall be rounded off smooth with a minimum radius of 3mm.

4.2.3 All nozzles shall be set-in type, unless otherwise specified in requisition. Set on type nozzle for size 50 NB and below can be used with prior approval.

4.2.4 Reinforcing pads whenever required as per drawings or Code shall be of the same material or equivalent as the vessel component to which it is welded. All reinforcing pads shall be provided with two 1/8" (3 mm) NPT tapped holes located 180 apart for air soap solution test with a pressure of 1.25 kg/cm2 (g). This test shall also be required to be carried out for slip on flanges. Higher test pressures are not recommended because of accompanying risks and also because the soap bubbles have a chance to blow off. Tell-tale holes in the reinforcing pads shall be plugged with hard grease unless otherwise indicated after the hydro test of the vessel.

4.2.5 Wrapper plates, reinforcing pads, saddle plates or stiffeners of higher thickness than specified can be used provided there is no change in basic dimensions and with the approval from Inspection Agency. No separate deviation permit is required for the same.

4.3 Flanges

4.3.1 When tongue and groove or male and female faced flanges are used, groove or female face shall be in nozzle flange. However, when the nozzle is located in the bottom, the groove or female face shall be in the cover.

4.3.2 Dimensions of flanges shall be as per ASME B16.5 for sizes up to 600 mm NB (24" NB) and as per ASME B 16.47 series 'B' for sizes greater than 600 mm NB (24" NB).

4.4 Fasteners and Gaskets

4.4.1 All bolts/studs shall have ISO threading unless otherwise specified. Studs shall extend beyond nuts at least by 2 threads & studs shall be threaded to full length. Bolts/studs (to be tightened by hydraulic bolt tensioner) shall be longer than normal length by minimum 1 nut diameter.

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Hydraulic bolt tensioner shall be used for following bolt sizes and conditions and shall be supplied by vendor unless otherwise specified in the Requisition:

Nominal Bolt Size	Conditions
All Sizes	When specified by Process Licensor/Project specifications
50 mm and Over	All flange joints
38 mm and to 50 mm	Class 600 and above
	Hydrogen service (Partial Pressure of Hydrogen > 7 Kg/cm2g)
	Design Temperature above 370oC
	Inlet, outlet and quench nozzle flanges of reactors/separators (#)
25 mm to 38 mm	Design Temperature above 370oC
	Inlet, outlet and quench nozzle flanges of reactors/separators (#)

Applicable only for Hydrocracker/DHDT/DHDS/VGO-HDT Reactors and Hot & Cold Separators.

4.4.2 All internal bolts shall be provided with double nuts.

4.4.3 Threads on external bolting shall be lubricated with graphite grease for working temperature up to 200°C and with Molybdenum Di-sulphide for higher temperature.

4.4.4 In addition to stamping of the specifications & manufacturer's symbol as specified in ASME material specifications, size shall be clearly punch marked on one of the ends of the stud. Similarly, the nuts shall have the size punch marked on one of the faces. In case of tapped hole the size shall be punch marked near the hole without disturbing the gasket seating area. Further for all alloy/SS metallurgy bolts & nuts shall also be identified by distinct color marking at the stud end/bolt side face.

4.4.5 Gaskets shall conform to ASME B16.20 and ASME B 16.21.

4.5 Internals and Externals

4.5.1 All removable internals shall pass through the manhole.

4.5.2 Internal baffles, tray support beams or other internals spanning a chord or diameter of the vessel shall be provided with means to allow differential thermal expansion between the part and the vessel shell.

4.5.3 Internal pressure piping shall be seamless and of same specification as the external connected piping. However internal non-pressure piping can be either seamless or welded type.

4.5.4 Internal flanges for pressure piping shall be forged flanges. However internal flanges for non-pressure piping can be fabricated from plate.

4.5.5 Tray/seal pan support rings, downcomer bolting bars and all internals, beam supports welded to the vessel shall be supplied and welded by vessel fabricator in accordance with the details furnished by EIL.

4.5.6 The internal baskets, mesh screens, support grid, distributor/mixing trays, distributor pipes, outlet collector etc. of equipment shall be fitted at shop unless otherwise specified in requisition. Equipment shall be transported along with internals fitted. Temporary wedges (if required) shall be provided for supporting the internals which shall be removed by mechanical contractor at site under vendor's supervision unless otherwise specified. Additionally, manway panels shall be provided for mesh screens, support grids, distributor/mixing trays etc. to ensure accessibility for future inspection, loading/unloading of catalyst/inert balls etc.

In case the internals are to be supplied loose as per requisition, the internal baskets, mesh screens, support grid, distributor/mixing trays, distributor pipes, outlet collector etc. of equipment shall be trial fitted,

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then removed and crated for dispatch with vessel. These items should be tagged for field identification and installation.

4.5.7 All externals shall be supplied and welded by vessel fabricator in accordance with the details furnished by EIL.

4.5.8 Internal perforated plate inside the vessel shall be removable type unless specified otherwise and should be able to pass through nearest manhole.

4.5.9 Unless specified otherwise, Full support rings shall be provided below catalyst bed to support same.

4.6 Name Plate

Each vessel shall be supplied with EIL name plate and manufacturer name plate as per EIL Standards.

4.7 Welding

4.7.1 Flame cut edges shall be ground by the fabricator as required to remove slag, detrimental discoloration and non-uniformity of edges.

4.7.2 All pressure bearing butt welds shall be full penetration, double welded joints. When second side welding is not possible due to inaccessibility, single welded butt joints with root run by Tungsten Inert Gas Process (TIG) can be used to ensure full penetration. Backing strip can be used only after obtaining prior approval from EIL. For sub-zero temperatures, backing strips shall not be used.

4.7.3 Nozzles and Manways and their reinforcement pads shall be attached to vessel with full penetration welds.

4.7.4 Seams in supporting skirt shall be made with full penetration butt welds. Connections between skirt and vessel head shall be made with a smooth flat faced weld unless otherwise indicated in the engineering data sheet. Width of the weld at skirt end shall be equal to the skirt thickness and its height shall at least be twice its width.

4.7.5 All main weld seams shall be clear of nozzles, reinforcement pads, internals, tray support rings, cleats and stiffening rings by 50 mm minimum (weld edge to weld edge). In case the same is unavoidable following requirements shall apply:

a) Nozzles without reinforcing pad

i) Any weld seam having distance (weld edge to weld edge) to nozzles within 50 mm (but not fouling with weld seam) shall be fully radiographed and dye penetrant examined to a length equal to 100 mm on each side measured from nearest point to nozzle edge.

ii) Any weld seam fouling with nozzle opening shall be fully radiographed and dye penetrant examined to a length equal to 3 times of outside diameter of nozzle i.e. 1.5 times of outside diameter of nozzle on each side after installation of nozzles. Nozzle to vessel fillet weld shall be provided with smooth concave radius.

b) Nozzles with reinforcing pad

i) Any weld seam having distance (weld edge to weld edge) to reinforcing pad within 50 mm (but not fouling with weld seam) shall be fully radiographed and dye penetrant examined to a length equal to 100 mm on each side measured from nearest point to reinforcing pad edge.

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ii) Any weld seam not fouling with nozzle opening but coming under reinforcement pad shall be ground flush, fully radiographed and dye penetrant examined to a length equal to portion of weld seam below reinforcement pad + 100 mm on each side.

iii) Any weld seam fouling with nozzle opening shall be ground flush, fully radiographed and dye penetrant examined to a length equal to higher of 3 times of outside diameter of nozzle i.e. 1.5 times of outside diameter of nozzle on each side or length equal to portion of weld seam below reinforcement pad + 100 mm on each side.

In case other attachments like internals, tray support rings, cleats etc. is fouling with weld seam, the weld seam portion coming under the attachment plus 100 mm length on each side shall be ground flush, fully radiographed and dye penetrant examined before welding of any such attachment.

4.7.6 Vendor shall submit welding procedure specification and qualification record to purchaser's inspector or authorized representative for approval as per ASME Boiler and Pressure Vessels Code Section IX.

Previously qualified welding Procedure Qualification Record (PQR) under EIL, CEIL, Lloyds, DNV, TUV and Bureau Veritas shall also be acceptable.

4.7.7 Welding consumables shall be as per ASME Boiler and Pressure Vessel Code Sec. II Part C and shall be indicated in fabrication drawings.

4.7.8 Welding shall not commence unless the concerned procedures are approved.

4.7.9 Only welders who are qualified in the accepted procedure shall be employed for welding.

4.7.10 All internal/external attachments (nozzles, cleats etc.) with fillet welds to the vessel pressure components in case of Hydrogen service, cyclic service and vessels with design temperature (-)29oC and lower, vessels with design temperature 370oC and higher for carbon steel and 425oC and higher for low alloy steel shall be ground smooth and generous concave contour shall be provided.

4.7.11 Minimum shell course width shall be 1 meter. Maximum no. of longitudinal seams shall be as follows:

(a)	vessels up to 2 meter diameter	:	1 seam
(b)	vessels from 2 meter up to 4 meter diameter	:	2 seam
(c)	vessels from 4 meter up to 6 meter diameter	:	3 seam
(d)	vessels beyond 6 meter diameter	:	seam nos. can be proportionately decided

4.8 Post Weld Heat Treatment

4.8.1 Vessels shall be post weld heat treated when specified on the engineering drawings. In no case shall the post weld heat treatment performed be less than that specified in the code.

4.8.2 Vessels shall be post weld heat treated as a complete unit including skirt/support, wherever practicable.

4.8.3 All flange faces shall be suitably protected against oxidation during post weld heat treatment.

4.9 Tolerances

4.9.1 Tolerances shall be as per drawing/standard/code.

4.9.2 For dimensions not provided with tolerances, fabricator shall maintain dimensions as per good engineering practice.

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5.0 INSPECTION & TESTING

5.1 All vessels shall be offered for inspection to purchaser or his authorized inspector.

5.2 Inspectors shall have free access to all workshops of contractors or sub-contractors.

5.3 Inspection shall be carried out both during fabrication and before delivery and also for sub-ordered materials, if any. In addition to final inspection and certification by Inspector, Inspector's written approval shall be obtained by the manufacturer at all stages of fabrication including, but not limited to the following:

a) Raw material identification

b) Edge preparation for welding, including visual check for laminations.

c) Alignment of longitudinal seams.

d) Rolling tolerance on individual sections

e) Alignment of sections

f) Root pass clearing before welding.

g) Nozzle setting.

h) Dimensional check.

i) Radiographic / Ultrasonic Examination.

j) Dye penetrant examination/Magnetic particle examination.

k) Stress relieving.

l) Calibration records of measuring instruments.

m) Pressure Test (Hydrostatic/Pneumatic test).

n) Any other special test such as for leak, corrosion, hardness etc.

o) Surface preparation, primer and painting.

5.4 Radiography

5.4.1 The extent of radiography shall be as specified on the engineering drawings. In no case shall the radiographic examination be less than that specified in the code. However, spot radiography is the minimum requirement for all vessels.

5.4.2 When spot radiography is specified, the following requirements shall supplement the requirements specified in ASME Section VIII Division I:

Each category A or B pressure containing weld shall be spot radiographed in accordance with ASME Section-VIII Division-I, paragraph UW-52 as a minimum requirement. Each Spot radiograph shall be a minimum of six inches (150mm) in length and minimum one spot shall be selected in each circumferential & longitudinal seam. Additionally, at least one T-joint in each circumferential seam shall also be selected. Welds from each welding procedure, welded/welding operator shall be examined. DIA shall be consulted in marking the areas to be radiographed.

5.4.3 All nozzles fabricated from plate, irrespective of thickness of plate, shall be 100% radiographed. When Full radiography is specified due to Service requirement, 100% radiography shall be carried out of all butt welds including nozzle flange to nozzle neck, pipe to pipe and pipe to fitting.

5.4.4 Weld seams of formed ends shall be 100% radiographed after forming and heat treatment, if any.

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5.4.5 The specified radiography of welds may be performed before or after post weld heat treatment (PWHT). If performed before PWHT, an additional radiography or alternatively, ultrasonic examination shall be performed after PWHT.

5.4.6 The technique employed and the weld quality achieved shall meet the requirement of the code.

5.4.7 If vendor intends to carry out radiography by Computed Radiography technique, then demo should be carried out under AI to prove vendor's capability to produce acceptable images meeting the Code requirements.

5.4.8 In case Supplier want to perform UT in lieu of RT based on Code para UW 51 (a) (4), the same is acceptable for Carbon Steel and Low Alloy Steel materials subject to the following:

a) The thickness of weld is greater than 13 mm.

b) The joint is either Category A or Category B joint except shell to hemispherical dished end joint. (Category of joint as defined by Code).

c) Automated recordable UT machine incorporating TOFD and pulse echo probes or TOFD and Phased Array mounted on the same chassis that automatically traverses along the joints to be inspected and displaying both results simultaneously on a single screen may be considered in lieu of RT.

d) Calibration block of similar material & thickness shall be used. Calibration block shall have suitable notches to simulate longitudinal as well as transverse cracks on outside and inside surface. Setup should be capable of detecting defects on outside as well as inside while scanning from one surface only.

e) The system that is proposed to be deployed in lieu of radiography shall be submitted along with the track record prior to use for EIL review. The Supplier shall demonstrate successfully the capability of AUT machine and the defects evaluation in the same screen during the site visit of EIL representative. Based on which, the approval of the parties and their AUT system shall be given.

f) Qualified NDT persons shall be deployed to perform UT.

g) Acceptance criteria shall be as per Code para UW 51.

5.5 All nozzle to shell welds (Root and Final run) shall be examined by magnetic particle/ Dye- penetrant examination.

5.6 Hydrostatic Test

5.6.1 All necessary precautions shall be taken to guard against the risk of brittle fracture during hydrostatic test in the shop and at site. The temperature of testing medium shall be as per Code. Prior to hydrostatic test, all weld spatter, weld stubs, scale, dirt etc. shall be removed from vessel.

5.6.2 Hydrostatic test shall be conducted at pressures mentioned in engineering drawings after complete fabrication and post weld heat treatment, as applicable. After hydrostatic testing, Equipment shall be completely dried by passing hot air for sufficient time until no further increase in relative humidity of outgoing air is observed. Alternatively vacuum drying of the equipment is also acceptable.

5.6.3 Clean potable water shall be used for hydrotest. Sea water shall not be used.

5.6.4 During hydrotest, care shall be taken to avoid local stresses in shell from exceeding 90 % of the yield strength of the material at the temporary saddle supports.

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5.6.5 Vessels shall not be painted or coated either internally or externally prior to the hydrostatic pressure tested.

5.7 For all weld overlays used in hydrogen or H2S service with design temperature greater than 350oC, Hydrogen disbonding test shall be carried out. The test condition shall be representative of the actual design conditions and the procedure shall be submitted to Inspection Agency for approval. Rate of cooling shall be 100oC/hr (min.) unless specified otherwise in datasheets. Holding time shall be 48 hours unless specified otherwise in datasheets.

5.8 Vendor shall ensure that all alloy steel and stainless steel material are properly identified and finally check tested by a PMI analyzer before dispatch of equipment as per EIL Specification 6-81-0001.

6.0 SUPPLY

6.1 Surface Cleaning and Painting

6.1.1 Surface cleaning and painting shall be as per standard specification for shop and field painting (6-44-0004) or as per job specification as applicable. Paint system shall be selected as per the environments specified on engineering drawing.

6.1.2 All completed equipment shall be cleaned internally and externally to remove scale, dirt, sand, water and foreign matter.

6.1.3 All flanged faces and other machined surfaces shall be greased or protected with rust preventive coating.

6.1.4 Except for machined surfaces, all exterior surfaces of vessels and columns including skirts and integral supports shall be painted to prevent rust, corrosion or damage during transit and storage before erection and final painting.

6.2 Marking

In addition to General purchase conditions, the following requirements shall also be complied with:

6.2.1 All loose components such as studs, nuts, washers, gaskets etc. shall be packed in crates and shall be marked for the project, consignee, consigner, job number, item number, order number, gross and net weight, dimensions etc.

6.2.2 Additional indications such as North/East/South/West along with center of gravity shall be clearly marked with white paint.

6.2.3 Vessels which have been post weld heat treated or have an applied lining, e.g. lead, glass, rubber etc., shall have a suitable warning printed on the visible portion on the outside of vessel.

6.2.4 Specific marking with white paint for slinging shall be provided for all heavy lifts weighing 5 tons and above.

6.2.5 A copy of packing list shall accompany the material enclosed in a water tight envelope fastened inside a shell connection with an identifying arrow sign "Documents" applied with indelible paint.

6.2.6 If it is necessary to separate the unit into different parts for transportation all components and subassemblies shall be carefully identified and match marked to prevent any error in assembly.

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6.3 Packing and Shipment

In addition to General Purchase Conditions, the following requirement shall also be complied with:

6.3.1 Packing

a) Vessels, unless provided with their own steel saddles for entire protection, shall be provided with suitable wooden/steel saddles with steel ties and tension rods. The minimum height of the saddle shall correspond to the maximum projected length of the connected attachments, plus an additional clearance of 45mm. Saddles spacing shall depend on the length of the equipment.

b) Equipment shall be provided with suitable type and adequate number of supports to prevent any deformation during transportation and handling. These supports shall not be removed until the equipment is placed in position at job site.

c) All connections/protrusions shall be suitably protected. Flanges shall be provided with bolts on metal covers (minimum 5 mm thk) using at least four bolts. (Wiring on covers is not acceptable). For ocean shipment, flanged openings shall be additionally covered with heavy plastic bags taped to nozzle. All tell-tale holes shall be plugged with hard grease before dispatch. Tapped orifices shall have threaded plugs.

d) Fragile or machined components shall be especially protected against nature during handling and transit.

e) Pre-fabricated sections shall be protected by temporary stiffeners at each non-supported end. Edges of plates for section to be welded shall also be protected.

6.3.2 Shipment

All dispatches of equipment shall be done in accordance with the relevant terms of the Purchase Order.

7.0 GUARANTEE

Unless otherwise specified in General Purchase conditions regarding guarantee, the following shall govern:

7.1 Manufacturer shall guarantee that all materials used in the equipment are new and have been submitted to regular acceptance procedure and are free from any defect regarding quality, form and appearance.

7.2 Vessel(s) shall be guaranteed for design, raw materials and workmanship for a duration as defined in General Purchase Conditions. When design has been carried out by EIL, the word design shall be excluded from the guarantee clause. The manufacturer shall be completely responsible for any design work carried out by him. EIL's approval of his design will not relieve him of his responsibility to ensure satisfactory performance of such item.

7.3 Approval of work by EIL or release of vessels for shipment shall in no way release or relieve the manufacturer of any responsibility for carrying out all provisions of this specification.

8.0 SITE FABRICATION AND ERECTION

8.1 Where size or shape of vessel makes it impossible to ship it in one piece, the fabricator shall ship number of shop fabricated sections as defined in requisition. Assembly and testing shall be completed by vessel fabricator at site in horizontal position (for erection by others) in strict accordance with the provisions of applicable order/specification.

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8.2 Where size or shape of vessel makes it impossible to erect in single piece, the fabricator shall ship number of shop fabricated sections as defined in requisition. Erection, assembly and testing shall be completed by vessel fabricator at site in vertical position in strict accordance with the provisions of the applicable purchase order/specifications.

8.3 In either of the above two cases, the following additional requirements shall apply:

8.3.1 All pieces shall be shop fit up into sections and each section fit to the adjacent one by the fabricator and all pieces match marked thereafter.

8.3.2 Suitable erection lugs /tailing lugs and locating pins shall be provided by the fabricator to ensure proper fit up & handling of the equipment.

8.3.3 All radiographic requirements for welds completed in the shop shall be made by the fabricator before the part of section leaves the shop.

8.3.4 For equipment requiring PWHT, complete or local PWHT may be carried out at site.

8.4 All lifting lugs/trunnions and tailing lugs shall be designed with an impact factor of minimum 1.5 unless otherwise specified.

9.0 DATA FOLDER

Manufacturer shall complete requisite copies of data folder as required in purchase order. This folder shall contain the following information duly certified by Inspector:

a) Manufacturer's Code Certificate

b) Fabrication drawing of vessel showing 'As Built' dimensions and 'As Built' erection weight.

c) Material Test Certificates with their cast /heat and test numbers

d) Welding procedure qualification reports

e) Welder qualification reports

f) Radiographic results

g) Ultrasonic, Magnetic particle, Dye-penetrant test results (if applicable)

h) Hardness, corrosion and leak test records (if applicable)

i) Record charts showing complete heat treatment cycle (if applicable)

j) Production test coupon results (if applicable)

k) Charpy V notch test results (if applicable)

l) Record chart of pressure test (Hydrostatic and/or pneumatic)

m) Rubbing of name plate

n) Any other documentation as required in the purchase requisition/purchase order.

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कार्बन स्टील वैसल्स के पूरक विनिर्देश

SUPPLEMENTARY SPECIFICATION FOR CARBON STEEL VESSELS

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9	23.11.2023	REVISED AND REISSUED AS STD. SPEC.	PSV	TK	KA/NK	MN
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5	12.04.04	REVISED AND REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG

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Abbreviations:

ASME	:	American Society of Mechanical Engineers
BHN	:	Brinell Hardness Number
HAZ	:	Heat Affected Zone
LWN	:	Long Weld Neck
NB	:	Nominal Bore
PWHT	:	Post Weld Heat Treatment
UTS	:	Ultimate Tensile Strength

Static Equipment Standards Committee

Convenor: Mr. Nalin Kumar

Members: Mr. K. Anjaneyulu
Mr. Tarun Kumar (Emp. No. A328)
Mr. Tarun Khurana (Coordinator)
Mr. Anish Trehan
Mr. P V S Satyanarayana
Mr. Saikat Chakraborty
Mr. Piyush Suryavanshi
Mr. Mittal Kumar Patel
Mr. Srikanth Karanam
Mr. Ayush Mathur (Project)
Mr. Prabhakar Choudhary (SMMS)
Mr. Avdhesh Agarwal (SCM- Inspection)

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1.0 SCOPE

This supplementary specification indicating additional requirements for fusion welded carbon steel vessels shall form addenda to General Specification for Pressure Vessels (6-12-0001) in its latest revision.

2.0 DESIGN

Reinforcement for nozzle openings shall be self reinforced type for equipment where nominal thickness of shell/head exceeds 50 mm. Nozzles of size up to 50 NB LWN can be used in place of self reinforced nozzles.

3.0 ELECTRODES

3.1 Electrodes conforming to following specification shall be used. In case of any deviation, prior approval from EIL shall be obtained.

S. No.	Material to be welded		Electrode Specification
1.	General Structure Welding	:	ASME IIC SFA 5.1 E-6013
2.	Pressure Parts		
a.	Steels with UTS upto 70,000 psi	:	ASME IIC SFA 5.1 E7016/ E7018
b.	Steels with UTS upto 80,000 psi	:	ASME IIC SFA 5.5 E8016-X/ E8018-XX depending upon the alloy element.
c.	Low temperature service		
	Below 0°C and upto (-) 46°C Steels to SA-516 / 516M, SA-537 / 537M, SA-333 / 333M Gr. 6 and SA-350 / 350M LF2	:	ASME IIC SFA 5.1 E 7016-1/ E7018-1

3.2 All electrodes and fluxes shall be properly baked/dried as per manufacturer's recommendation before use.

3.2.1 All bare electrodes and fluxes shall be selected as per ASME IIC .All weld metal shall have equal or better mechanical properties than the parent metal.

3.2.2 Only dry flux shall be used.

4.0 FABRICATION

4.1 Plate Forming

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4.1.1 Forming of shell plates and heads shall be carried out by machine, either hot or cold, in such a way so as to preserve the specified material properties and to produce a regular finish.

4.1.2 Magnetic particle/Dye penetrant examination shall be carried out on the outside and inside surfaces including edges of torispherical or elliptical heads in knuckle zone, after forming, for detection of cracks.

4.2 Edge Preparation

4.2.1 The preparation of edges to be welded shall be done by machining, chipping, grinding, cold shearing, Oxy- acetylene flame cutting or a combination of these.

4.2.2 Chipping shall be followed by grinding to a smooth and regular finish.

4.2.3 Oxy-acetylene flame cutting done in any circumstances, shall be followed by machining or grinding to eliminate any discolouration of material affected.

4.2.4 All welding edges shall be checked by Magnetic particle/Dye penetrant examination for detection of cracks, laminations or segregations.

4.2.5 No welding shall be carried out when ambient temperature is less than 10° Celsius unless preheating is carried out.

4.3 Heat Treatment

4.3.1 Heat treatment of formed parts shall be carried out as per following:

a. Cold formed dished ends or knuckles shall be stress relieved, unless otherwise specified in requisition.

b. Hot formed dished ends or similar parts, which have not been uniformly heated in the normalising range in the final stages of manufacture shall be normalised.

c. When the completed vessel involves post weld heat treatment, heat treatment recommended in (a) above shall not be applicable.

4.3.2 Vessels in Hydrogen/Amine/ Sour (Wet H_2S)/Cyclic/Caustic/HIC service shall be PWHT.

4.4 Production Weld Tests

Production Weld Tests shall be applicable for vessels over 50 mm nominal thickness. The following requirements shall apply:

a. Two production test plate coupons representative of one longitudinal and another circumferential seam shall be provided for each procedure, position and thickness in each vessel shell.

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b. One production test plate representative of the weld seams shall be provided for each procedure, position and thickness for welded dished ends/cones.

c. The production test plate shall be from material of the same heat and thickness as of shell/head/cone as applicable. During and after welding, the test plates shall be subjected to same heat treatment as and together with the course they represent. Extra coupons shall be preserved to take care of eventuality of retests.

d. The tests mentioned below shall be carried out as per methods of testing in governing codes:

i. One transverse tension test

ii. Two side bend tests with weld located in the centre of bend.

iii. Hardness test on production test coupon weld & HAZ (Hardness limitations shall comply with requirement of EIL Spec. 6-15-0091)

iv. Micro & macro examination of welds

v. Charpy V notch tests on weld and HAZ.

a. For low temperature service (0°C & colder) impact test temperature shall be lowest of minimum ambient temperature, design temperature and minimum design metal temperature.

b. For vessel over 50 mm nominal thickness used for warmer service, the test temperature shall be lower of 0°C or lowest ambient temperature of the site.

c. The acceptance criteria for energy absorption shall be as per Table A 2.15 of SA-20 / 20M. In case the acceptance criteria is not available in SA-20, then applicable design code shall be referred unless otherwise specified in requisition.

4.5 Hardness Survey

Hardness Limitation for Vessels, where PWHT is required shall comply with requirement of EIL Spec. 6-15-0091.

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बायलर क्वालिटी कार्बन स्टील प्लेटों का मानक विनिर्देश

STANDARD SPECIFICATION FOR BOILER QUALITY CARBON STEEL PLATES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
9	08.02.2022	REVISED AND REISSUED AS STD. SPEC.	[illegible]K	KA	NK	SM
8	19.01.2017	REVISED & REISSUED AS STD. SPEC.	RNK	SK/KJH	RKT	RN
7	30.06.2010	REVISED & REISSUED AS STD. SPEC.	KA	RKT	AKM/DM	N.DUARI
6	10.09.09	REVISED & REISSUED AS STD. SPEC.	VB	RKG	AKM	N.DUARI
5	16.04.04	REVISED & REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG

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Abbreviations:

ASME	American Society of Mechanical Engineers
EN	European Norm
HIC	Hydrogen Induced Cracking
IBR	Indian Boiler Regulations
SSC	Sulphide Stress Cracking

STANDARDS COMMITTEE

SMED-I (Static Equipment) (Group code 12,13,15,26)

Mr. Nalin Kumar (Convener)
Mr. K. Anjaneyulu
Mr. Tarun Kumar (Emp no. A328) {Coordinator}
Mr. Anish Trehan
Mr. PVS Satyanarayana
Mr. Tarun Khurana
Mr. Saikat Chakraborty
Mr. Srikanth Karanam
Mr. Ayush Mathur (Projects)
Mr. S Ghosal (SMMS)
Mr. Avdhesh Agrawal (SCM)

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1.0 SCOPE

1.1 This specification covers requirements for carbon steel plates intended primarily for pressure vessels/heat exchangers. The steel plates shall meet the requirements of ASME Boiler and Pressure Vessel Code Section II (latest). This is intended to supplement the minimum applicable requirements of the material specification indicated in the material requisition.

1.2 Following codes, standards etc shall be followed in their latest edition and addenda, errata, amendments unless specified otherwise:

1.2.1 ASME Sec VIII Div 1

1.2.2 ASME Sec II part A

1.2.3 EN 10163: Delivery Requirements for Surface Conditions.

1.2.4 EN 10204: metallic products – Types of Inspection Documents.

2.0 GENERAL

2.1 Plates supplied to this specification shall conform to specification SA-20 of ASME sec II part A with additional requirements mentioned herein.

2.2 The tolerance on thickness of steel plates shall be positive only.

2.3 Final Rolling shall be lengthwise.

2.4 The plates shall be free from injurious defects and shall have workmanlike finish. Reconditioning/repair of plates by welding shall not be permitted. Surface conditions shall meet requirements of EN 10163 Class A Subclass 3.

3.0 SUPPLEMENTARY TECHNICAL REQUIREMENTS

3.1 All plates shall be supplied in normalised condition except when the applicable material specifications require supply of plates in quenched and tempered condition.

3.2 a. One product analysis of each heat shall be carried out and reported. Chemical analysis shall be as per applicable specification.

b. The carbon content for plates shall not exceed 0.23%.

Additionally, one of the following requirements for carbon equivalent based on heat analysis, shall be also satisfied:

$$Ceq = C + \frac{Mn}{6} \leq 0.42 \quad \text{.....} \quad \text{(Eqn. - 1)}$$

$$Ceq = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Cu+Ni}{15} \leq 0.43 \quad \text{.....} \quad \text{(Eqn. - 2)}$$

Equation-1 shall be used when applicable material specification specifies C and Mn only.

Equation-2 shall be used when applicable material specifies the above elements or restricted chemical requirements are specified or supplementary requirements S19 and S21 of SA-20 are specified in material requisition.

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For HIC services, these requirements shall be as listed separately.

3.3 Ultrasonic Examination of Plates

a. Plates having thickness 16 mm to 50 mm (both inclusive) shall be examined ultrasonically as per SA-435.

b. For thicknesses above 50mm ultrasonic examination shall be carried out as per SA-578 and shall have acceptance standard of level-B.

c. For quenched and tempered steel plates, ultrasonic examination shall be done after the heat treatment of plates.

3.4 Simulated Heat Treatment of Test Coupons

The following heat treatment shall be conducted on the test coupons representative of heat treated plates before the specified mechanical testing like tensile, bend, impact tests, etc. to meet minimum ASME Sec. II Part - A requirements and these details shall also be recorded on the test certificates.

a. All plates supplied in Normalised condition and intended for hot rolling / hot forming:

Heat Treatment Cycle

One normalising* + One stress relieving as per UCS-56 of ASME Sec. VIII Div.1 complying with UCS-85 of ASME Section VIII Div. 1.

Note: Any other special requirement shall be specified in MR.

b. All plates supplied in Quenched & Tempered condition and intended for hot rolling/ hot forming:

Heat Treatment Cycle

One normalising* + quenched & tempering + One stress relieving as per UCS-56 ASME Section VIII Div.1 complying with UCS-85 of ASME Section VIII Div.1.

Note : Tempering temperature shall be at least 20° C above highest stress relieving temperature.

* Normalising cycle shall be as per Material Test Certificate (MTC).

c. All plates supplied in Quenched & Tempered condition and intended for cold forming:

Heat Treatment Cycle

One stress relieving as per UCS-56 ASME Section VIII Div.1 complying with UCS-85 of ASME Section VIII Div.1.

3.5 Impact test requirements shall be ascertained as per ASME Sec VIII Div.1 or Div.2 as applicable. When required, Impact testing shall be performed as per supplementary requirement of S5 of specification SA-20 and acceptance criteria for energy absorption shall be as per table A2.15 of SA-20.

3.6 If specified in the material requisition, plates shall meet the requirements of Indian Boiler Regulations (IBR).

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3.7 Additional Requirements for High Thickness Plates

Plates above 50mm thickness shall meet following additional requirements:

a. Vacuum Degassing treatment as per the supplementary requirement S1 of specification SA-20. If vacuum degassing is not reported in the test certificates, then through thickness tests as per SA 770 shall be conducted and minimum reduction in area of 35% shall be ensured.

b. Charpy V-notch impact test as per the supplementary requirement S5 of specification SA-20.

Material meant to be used for design temperature warmer than 0°C, impact test shall be carried out at 0°C or MDMT whichever is lower and acceptance criteria for energy absorption shall be as per Table A2.15 of SA-20. Incase the acceptance criteria is not available in SA-20, then applicable design code shall be referred unless otherwise specified in material requisition.

c. Simulated heat treatment of test coupons for all plates as per Clause 3.4 mentioned above.

4.0 CERTIFIED DOCUMENTS

The supplier shall furnish certificates/documents (number of copies as specified in requisition) inclusive of all the following tests required as per specification duly certified by the Inspecting Authority before shipment of plates. The actual values obtained shall be recorded in the test certificates/documents. Material certificates shall conform to EN 10204 Type 3.1/3.2 as specified.

a. Chemical Analysis

b. Mechanical Tests

c. Data of heat treatment i.e. initial temperature, heating rate, soaking temperature, cooling rate, etc.

d. Simulated Heat Treatment of Mechanical Test coupons (S3 of SA-20) at indicated Heat Treatment Cycle (if specified in the requisition or whenever applicable)

e. Ultrasonic Examination (S8 or S12 of SA-20)

f. Charpy V-notch impact tests (S5 of SA-20 if specified in the requisition or whenever applicable)

g. Certification as per IBR (if specified in the requisition)

h. SSC and/or HIC tests (if specified in material requisition)

i Additional tests (if specified in requisition).

5.0 PAINTING AND COATING

No painting/coating of any kind is permitted on the steel plates, except stencil marking. However steel plates shall be carefully protected and packed against any damage during transit and shall be of sea worthy condition.

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6.0 INSPECTION AUTHORITY

Material test certificates, duly certified by Mill's Quality Assurance Department are acceptable i.e. 3.1 certification as per EN 10204. However, if third party inspection is required specifically for plates in material requisition, all test certificates and documents shall be duly certified by the third party. i.e. 3.2 certification as per EN 10204.

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भंडारण टैंक एवं वैसल के लिये वेल्डिंग योग्य स्ट्रक्चरल क्वालिटी स्टील प्लेटों का मानक विनिर्देश

STANDARD SPECIFICATION FOR WELDABLE STRUCTURAL QUALITY STEEL PLATES FOR STORAGE TANKS AND VESSELS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	27.03.2023	REVISED AND REISSUED AS STD. SPEC.	NSK	TK	NK	SM
6	22.09.2017	REVISED AND REISSUED AS STD. SPEC.	SK	KJH	RKT	RN
5	30.06.2010	REVISED AND REISSUED AS STD. SPEC.	KA	RKT	AKM/DM	N.DUARI
4	15.09.09	REVISED & REISSUED AS STD. SPEC.	VB	RKG	AKM,	N.DUARI
3	08.04.04	REVISED & REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG

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Abbreviations:

EN	:	European Norm
IS	:	Indian Standard

Static Equipment Standards Committee

Convenor : Mr. Nalin Kumar

Members :

Mr. K. Anjaneyulu
Mr. Tarun Kumar (Emp. No. A328)
Mr. Tarun Khurana (Coordinator)
Mr. Anish Trehan
Mr. P V Satyanarayana
Mr. Saikat Chakraborty
Mr. Piyush Suryavanshi
Mr. Mittal Kumar Patel
Mr. Srikanth Karnam
Mr. Ayush Mathur (Project)
Mr. Prabhakar Choudhary (SMMS)
Mr. Avdhesh Agarwal (SCM-Inspection)

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1.0 SCOPE

1.1 This specification covers additional and supplementary requirements for weldable structural quality Steel Plates to IS: 2062 (latest), intended primarily for storage tanks and vessels.

1.2 Following Codes, standards etc. shall be followed in their latest edition and addenda, errata, amendments unless specified otherwise:

1.3 IS:2062, IS:1852, IS:10842 (All Parts)

1.4 EN 10163 (All Parts): Delivery for Surface Condition.

1.5 EN 10204: Metallic products – Types of Inspection Documents.

2.0 GENERAL

2.1 The maximum under tolerance permissible on the thickness of plate shall be 0.25 mm. Tolerances on other dimensions of plates shall be as per IS: 1852.

2.2 Direction of final rolling shall be lengthwise.

2.3 Reconditioning/Repair of plates by welding shall not be permitted. Surface finish shall be ground/flush smooth and shall be free from any surface imperfection.

3.0 SUPPLEMENTARY TECHNICAL REQUIREMENTS

3.1 Heat analysis and product analysis shall be carried out for each heat and chemical composition shall meet the limits as specified in IS: 2062.

3.2 Y-groove weld crackability test as per IS: 10842 shall be carried out for plates conforming to Gr. E250 C having thickness 12mm and above.

3.3 Charpy impact test shall be carried out on the plates having thickness greater than 12 mm conforming to Grade E250 BR, E250 B0 & E250 C. Test temperature and acceptance criteria for energy absorption shall be as mentioned in Table-2 of the specification IS: 2062.
For Thickness less than 12 mm (for materials E250 Gr.B0 & E250 Gr.C), if required, the minimum impact energy values of reduced sizes shall be as per Fig. 2 of the specification IS: 2062.

4.0 CERTIFIED DOCUMENTS

The supplier shall furnish certificates/documents (number of copies as specified in requisition) inclusive of all the following tests required as per specification, duly certified by the Inspecting Authority before shipment of plates. The actual values obtained during tests shall be recorded in the test certificates/documents. Material certificates shall conform to EN 10204 Type 3.1/3.2 as required.

a. Chemical Analysis
b. Mechanical Tests
c. Data of heat treatment
d. Charpy V-notch impact tests
e. Y- groove crackability test

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5.0 PAINTING AND COATING

No painting/coating of any kind is permitted on the steel plates except stencil marking. However steel plates shall be carefully protected and packed against any damage during transit and shall be of sea worthy conditions.

6.0 INSPECTION AUTHORITY

Material test certificates, duly certified by Mill's Quality Assurance Department are acceptable i.e. 3.1 certification as per EN 10204. However, if third party inspection is required specially for plates in requisition, all test certificates and documents shall be duly certified by the third party. i.e. 3.2 certification as per EN 10204.

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पैकेज मदों हेतु प्रैशर वैसल्स का मानक विनिर्देश

STANDARD SPECIFICATION OF PRESSURE VESSELS FOR PACKAGE ITEMS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
9	02.04.2024	REVISED AND REISSUED AS STD.SPEC.	MKP	TKh	KA/NK	MN
8	28.08.2018	REVISED & REISSUED AS STD. SPEC.	SK	TK	KJH	RKT
7	21.10.2009	REVISED & REISSUED AS STD. SPEC.	VB	RKG	AKM	N. DUARI
6	31.03.2004	REAFFIRMED & REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG
5	31.05.2002	REVISED & REISSUED AS STD. SPEC.	VMP	RKG	AKM	GRR
4	09.01.1997	REVISED & REISSUED AS STD. SPEC.	KPS	AKM	CRMN	AS

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Abbreviations:

API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
CD	:	Compact Disc
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
EN	:	European Standards
FRP	:	Fibre Glass Reinforced Plastic
HIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standards
MT	:	Metric Ton
NB	:	Nominal Bore
RTJ	:	Ring Type Joint
SS	:	Stainless Steel

Static Equipment Standards Committee

Convenor: Mr. Nalin Kumar
Co-Convenor: Mr. K. Anjaneyulu

Members:

Mr. Tarun Kumar (Emp. No. A328)
Mr. Tarun Khurana (Coordinator)
Mr. P V Satyanarayana
Mr. Anish Trehan
Mr. P Barik
Mr. Saikat Chakraborty
Mr. Piyush Suryavanshi
Mr. Mittal Kumar Patel
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Mr. Aasheesh Handa (Projects)
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1.0 SCOPE

1.1 This Specification covers general requirements for material, design, fabrication, erection and testing of pressure vessels.

1.2 Vessel Sizing/Design shall be in vendor's scope, unless otherwise specified. Vendor shall submit all design parameters of vessels as per Annexure-I.

2.0 CODES, SPECIFICATIONS AND REGULATIONS

2.1 Design Codes

a) Vessels with design pressure greater than or equal to 1.0 Kg/Cm^2(g) and less than 210 Kg/cm^2(g) shall be designed, fabricated, inspected and tested as per ASME Code Sec. VIII Div.1 (latest).

b) All vessels with design pressure greater than or equal to 210 Kg/cm^2(g) shall be designed, fabricated, inspected and tested as per ASME Code Sec. VIII Div.2 (latest).

c) Vessels full of liquid and/or with design pressure < 1.0 Kg/cm^2(g) shall be designed, fabricated, inspected and tested as per ASME Code Sec. VIII Div.1 - Practice.

d) Mechanical design of self-supporting tall column shall be carried out as per guidelines given in Annexure-III.

2.2 Material Specifications

Materials to be used shall conform to:

a) ASME Section II.

b) Indian Standard Specification of equivalent grade.

2.3 Statutory Regulations

a) National laws & regulations together with local bye-laws for the country or state where vessel(s) is (are) to be erected must be complied with. Approval of design and drawings from statutory authorities shall be Vendor's responsibility.

b) Wind and earthquake loads shall be calculated in accordance with relevant Indian Standards unless otherwise specified.

3.0 DESIGN BASIS

3.1 Minimum Wall Thickness

Vessel shell and heads shall have minimum wall thicknesses calculated with design pressure and temperature, in accordance with codes, but in no case, shall the thickness be less than that determined by following formulae:

a) For carbon/Low alloy steel vessel & column* – 6 mm & 8 mm respectively (including corrosion allowance not exceeding 3.0 mm), but not less than that calculated as per following:

FOR DIAMETERS LESS THAN 2400 mm

$$\text{Wall thickness} = \frac{\text{Dia.}}{1000} + 1.5 + \text{Corrosion Allowance}$$

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FOR DIAMETERS 2400 mm AND ABOVE

$$\text{Wall thickness} = \frac{\text{Dia.}}{1000} + 2.5 + \text{Corrosion Allowance}$$

All dimensions are in mm.

b) For Stainless steel/High alloy steel vessel & column* – 3 mm & 5 mm respectively, but not less than that calculated as per following for diameter more than 1500 mm.

$$\text{Wall thickness (mm)} = \frac{\text{Dia.}}{1000} + 2.5$$

Corrosion allowance, if any, shall be added to minimum thickness.

* If the vessel height (H) from base of skirt to top tangent line is greater than 5 times diameter (D) then it shall be considered as column and shall be designed accordingly.

3.2 Design Pressure

a) Design pressure shall be calculated considering higher of the following:

i) For operating pressures above 70 kg/cm²g, mechanical design pressure shall be as per designer, subject to a minimum of 77 kg/cm²g.

ii) For operating pressure up to and including 70 kg/cm²g, design pressure shall be the highest of the following:

a) Maximum operating pressure (kg/cm²g) x 1.1
b) Maximum operating pressure + 2.0 kg/cm²
c) 3.5 kg/cm²g

b) Design pressure at any lower point is to be determined by adding the maximum operating liquid head and any gradient within the equipment.

c) Equipment operating under vacuum (or partial vacuum) shall be designed for differential external pressure of 1.055 Kg/cm^2.

3.3 Design Temperature

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

a) For equipment operating at or above 0°C, the mechanical design temperature shall be the higher of the following:

T (des) = 65 °C
T (des) = T (max) + 15 °C
T (des) = T (relief), excluding fire relief temperatures

where,

T (max) = Maximum operating temperature expected considering different possible operations for the equipment or system, including air drying or gas drying conditions.

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T (relief) = Temperature corresponding to pressure relief conditions for an operational failure case (specifically excluding fire relief case).

b) For equipment operating below 0 °C, the mechanical design temperature shall be equal to the lowest anticipated operating temperature.

c) Minimum Design Metal Temperature (MDMT) shall be lower of minimum atmospheric temperature and minimum temperature envisaged during operation.

3.4 Corrosion Allowance

Minimum corrosion allowance for carbon steel and low alloy steel vessels shall be 3.0 mm and 1.5 mm respectively, unless otherwise specified elsewhere in the package.

3.5 Allowable Stresses

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

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

3.6 Wind and Seismic Loads

3.6.1 Wind load shall be calculated as per Indian Standard IS-875 and Site-specific wind data if attached with the bid package.

3.6.2 Earthquake forces shall be calculated in accordance with Site-specific spectra (along with IS-1893 procedure) provided elsewhere in the bid package. Otherwise, the same shall be as per Indian Standard IS: 1893.

4.0 MATERIALS

Unless otherwise specified, Materials of various parts of equipment shall be selected as per Table given in Annexure - II for general industrial condition/services.

4.1 Specifications of Carbon Steel Plates

4.1.1 Chemical Analysis

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

a) Only normalised 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.

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

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

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

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

4.1.2 **Ultrasonic Examinations of Plates**

a) Plates having thickness 16 mm to 50 mm (both inclusive) shall be examined ultrasonically as per specification SA-435.

b) For thickness above 50 mm, ultrasonic examinations shall be carried out as per specification SA-578 and shall have acceptance standard of level-B.

c) For quenched and tempered steel plates, ultrasonic examination shall be carried out after the specified heat treatment.

4.1.3 **Simulated Heat Treatment of Test Coupons**

The following heat treatment shall be conducted on the test coupons representative of heat treated plates before the specified mechanical testing like tensile, bend, impact tests, etc. to meet minimum ASME Sec. **II** Part - A requirements and these details shall also be recorded on the test certificates.

a. All plates supplied in Normalised condition and intended for hot rolling / hot forming:

Heat Treatment Cycle

One normalising* + One stress relieving as per UCS-56 of ASME Sec. VIII Div.1 complying with UCS-85 of ASME Section **VIII** Div. 1.

Note: Any other special requirement shall be specified in MR.

b. All plates supplied in Quenched & Tempered condition and intended for hot rolling/ hot forming:

Heat Treatment Cycle

One normalising* + quenched & tempering + One stress relieving as per UCS-56 ASME Section **VIII** Div.1 complying with UCS-85 of ASME Section **VIII** Div.1.

Note: Tempering temperature shall be at least 20° C above highest stress relieving temperature.

* Normalising cycle shall be as per Material Test Certificate (MTC).

c. All plates supplied in Quenched & Tempered condition and intended for cold forming:

Heat Treatment Cycle

One stress relieving as per UCS-56 ASME Section **VIII** Div.1 complying with UCS-85 of ASME Section **VIII** Div.1.

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

4.1.5 Plates needed for IBR vessels shall meet the requirements of IBR (Indian Boiler Regulations).

4.1.6 Plates above 50 mm in thickness shall meet following additional requirements:

a. Vacuum Degassing treatment as per the supplementary requirement S1 of specification SA-20. If vacuum degassing is not reported in the test certificates, then through thickness tests as per SA 770 shall be conducted and minimum reduction in area of 35% shall be ensured.

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b. Charpy V-notch impact test as per the supplementary requirement S5 of specification SA-20. Material meant to be used for design temperature warmer than 0°C, impact test shall be carried out at 0°C or MDMT, whichever is lower, and acceptance criteria for energy absorption shall be as per Table A2.15 of SA-20. In case the acceptance criteria is not available in SA-20, then applicable design code shall be referred, unless otherwise specified in material requisition.

c. Simulated heat treatment of test coupons for all plates as per Clause 4.1.3 mentioned above.

4.2 Specification of Stainless Steel Plates/Pipe/Forging

Plates used shall conform to latest issue of specification SA-480 with additional requirements mentioned herein.

a) All plates shall be hot rolled, annealed, pickled and shall have No.1 finish on both sides with reference to specification SA-480. In addition, all stabilized grade of SS (SS 321, SS 347 etc.) shall be given stabilization heat treatment.

b) Unless otherwise specified plates, pipes, forgings and fittings representative of each heat shall be subjected to inter granular corrosion tests as per ASTM A 262 practice E for all the 300 series material. The bend test specimen shall be examined at a magnification of 200 x.

c) Plates having thickness 16mm to 50mm (both inclusive) shall be examined ultrasonically as per specification SA-435.

d) For thickness above 50 mm, ultrasonic examinations shall be carried out as per specification SA-578 and shall have acceptance standard of level-B.

4.3 Applicable certificates and documents of all tests required here, duly certified by inspecting authority shall be submitted to EIL inspector before fabrication of vessel. Material Certificates shall conform to EN 10204 Type 3.1.

4.4 Material for Internal Lining/Painting

4.4.1 **FRP Lining**

i) Wherever FRP lining on inside of equipment is specified the resin used shall be vinyl ester, equivalent or better to suit the intended service.

ii) The steel surface shall be abrasive blasted as per SSPC-SP-10 and anchor profile of surface shall be 38 to 75 microns. Primer coat of polyamide cured epoxy (25 to 75 microns DFT) shall be immediately applied after cleaning to prevent rust formation before application of FRP lining.

4.4.2 **Rubber Lining**

Application of rubber lining on inside of vessels, shall be done as per Part-1, IS 4682.

4.4.3 **Painting on Internal Surface**

Surface preparation and application of Primer and Painting shall be in accordance with EIL Specification for surface preparation and protective coating.

5.0 HEADS

a) FOR CS METALLURGY:

Heat treatment of formed parts shall be carried out as per following:

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1. Cold formed dished ends or knuckles shall be stress relieved, unless otherwise specified in requisition.

2. Hot formed dished ends or similar parts, which have not been uniformly heated in the normalising range in the final stages of manufacture shall be normalised.

3. When the completed vessel involves post weld heat treatment, heat treatment recommended in (1) above shall not be applicable.

b) FOR SS METALLURGY:

1. Cold formed dished ends of SS Vessels shall not be solution annealed unless any of the following conditions exists:

i) Specifically called for particular equipment/service.

ii) Hardness value after forming exceeds 235 BHN.

iii) Nominal thickness of plate is 16mm or above.

2. Hot formed dished ends of SS Vessels shall be solution annealed.

6.0 MANHOLES/HANDHOLES AND NOZZLES

a) Manholes shall be minimum 450 mm NB unless otherwise specified.

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

c) Small vessels shall be provided with two 150 NB hand holes for inspection. Vessels less than or equal to 300 NB shall be provided with 2 nos.100 NB hand holes for inspection.

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

e) As a general rule all nozzles attachment to shell/head shall be set-in type.

f) Reinforcement for nozzle openings shall be self-reinforced type for equipment where nominal thickness of shell/ head exceeds 50 mm. Nozzles of size up to 50 NB LWN can be used in place of self-reinforced nozzles.

g) Nozzles up to 50 mm NB size shall be stiffened with 2 number of 40 mm wide x 6 mm thick stiffeners welded at 90 apart.

h) Nozzle connections used for vessels shall not be less than 40 mm NB.

7.0 FLANGES

a) Dimensions for flanges shall be as per ASME B16.5 for size up to 600 NB and to ASME B-16.47 (Series B) for size above 600 NB.

b) All flanges shall be of weld neck type. Slip on flanges are not permitted.

c) All flanges of class 900 and above shall have gasket surfaces for RTJ unless otherwise specified.

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8.0 INSPECTION

All vessels shall be offered for stage-wise as well as for final inspection to Purchaser or his authorised inspector.

Inspector shall have free access to all workshops of vendor or his sub-vendors.

9.0 PRESSURE TESTING

All vessels shall be hydrostatically or pneumatically tested as per the code. In order to safeguard against the risk of brittle fracture during hydrostatic test, temperature of test fluid shall meet the requirements of UG-99 of ASME Sec. VIII Div.1 and shall preferably not be less than 16° C.

10.0 WELDING

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

11.0 POST WELD HEAT TREATMENT

a) Vessels shall be heat-treated whenever it is required due to service requirement or due to code requirements. Vessels shall be post weld-heat treated as a complete unit and no welding shall be permitted once post weld heat treatment is performed. CS/LAS Vessels in Hydrogen/ Amine/ Sour (Wet H2S)/ Cyclic/ Caustic/ H1C service shall be mandatorily PWHT.

b) Wherever heat treatment on stainless steel is carried out, it shall be followed by micro etching test and IGC test as per ASTM A 262 Practice E unless otherwise specified to ascertain suitability and effectiveness of solution annealing. The bend test specimen shall be examined at a magnification of 200 x.

12.0 RADIOGRAPHY/ NON-DESTRUCTIVE TESTING

12.1 The extent of radiography shall be as specified in the package. In no case shall the radiographic examination be less than that specified in the code. However, spot radiography is the minimum requirement for all vessels.

12.2 Each category A or B pressure containing weld shall be spot radiographed in accordance with ASME Section-VIII Division-I, paragraph UW-52 as a minimum requirement. Each Spot radiograph shall be a minimum of six inches (150mm) in length and minimum one spot shall be selected in each circumferential & longitudinal seam. Additionally, at least one T-joint in each circumferential seam shall also be selected. Welds from each welding procedure, welded/welding operator shall be examined.

12.3 All nozzles fabricated from plate, irrespective of thickness, shall be 100% radiographed.

12.4 Weld seams of formed ends shall be 100% radiographed after forming and heat treatment, if any.

12.5 The technique employed and the weld quality achieved shall meet the requirement of the code.

12.6 All nozzle to shell welds (Root and Final run) shall be examined by magnetic particle/Dye penetrant test.

12.7 In case Supplier want to perform UT in lieu of RT based on Code para-UW 51 (a) (4), the same is acceptable subject to the following:

a) Material of construction is either CS or LAS.

b) The thickness of weld is greater than 13 mm.

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c) The joint is either Category A or Category B joint except shell to hemispherical dished end joint. (Category of joint as defined by Code).

d) Automated UT incorporating TOFD and pulse echo probes or TOFD and Phased Array mounted on the same chassis that automatically traverses along the joints to be inspected and displaying both results simultaneously on a single screen may be considered in lieu of RT.

e) Calibration block of similar material/thickness shall be used. Calibration block shall have suitable notches to simulate longitudinal as well as transverse cracks on outside and inside surface. Setup should be capable of detecting defects on outside as well as inside while scanning from one surface only.

f) The system that is proposed to be deployed in lieu of radiography shall be submitted along with the track record prior to use for EIL review. The Supplier shall demonstrate successfully the capability of AUT machine and the defects evaluation in the same screen during the site visit of EIL representative. Based on which, the approval of the parties and their AUT system shall be given.

g) Qualified NDT persons shall be deployed to perform UT.

h) Acceptance criteria shall be as per Code para-UW 51.

13.0 FIRE PROOFING AND INSULATION

Vessels requiring insulation and/or fire proofing shall be provided with supports as per EIL standard referred in this specification.

14.0 CLEANING AND PAINTING

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

b) Stainless steel surfaces both inside and outside shall be pickled and passivated in accordance with specification ASTM-A380 after hydrotest, unless otherwise specified.

c) All external surfaces shall be cleaned, primed and painted in accordance with applicable EIL Specification for surface preparation and protective coating.

15.0 GENERAL

15.1 Vessel weighing more than 5.0 MT shall be provided with lifting lugs. Skirt supported vessels shall be provided with tailing lugs, if necessary.

15.2 Unless otherwise elsewhere specified, Manufacturer shall supply Mandatory spares as given below:

Gaskets	:	Two sets for each installed gasket.
Fasteners	:	10% (minimum two in each size) of installed fasteners.
Sight/Light glass:		4 Sets for each installed glass.

15.3 Fabrication tolerances indicated in EIL Standards/Specifications shall be adhered to.

15.4 Vessel diameter 300 mm NB and below shall be made from seamless pipe only.

15.5 Rolling direction of plate for shell shall be lengthwise.

15.6 Guarantee, packing, marking on vessels and shipment, etc. to be as per package specifications.

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16.0 LIST OF ATTACHMENTS

TITLE	DOCUMENT NO.
Vessel Tolerances	7-12-0001
Support for Horizontal Vessel	7-12-0002
Skirt Base Details	7-12-0004
Angle Leg Support	7-12-0006
Pipe Leg Support	7-12-0007
Bracket Support for Vertical Vessel	7-12-0008
Manhole with Hinge Cover	7-12-0009
Manhole with Davit	7-12-0010
Standard Bolt Hole Orientation	7-12-0015
Internal Flanges	7-12-0018
Fire-Proofing and Insulation Supports	7-12-0025
Internal Feed Pipe Support	7-12-0032
EIL Specification for Surface Preparation and Protective Coating	EIL specification (as applicable)

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ANNEXURE - I

DATA SHEET FOR PRESSURE VESSEL

(To be filled in by the Vendor)

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

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ANNEXURE - II

MATERIAL SELECTION

The following table gives general guidelines for material selection for various Pressure /Non-Pressure Parts of the equipment based on design temperature wherever material of construction is not specified by the process licensor.

PRESSURE PARTS						NON PRESSURE PARTS			
DESIGN TEMP.°C	PLATE	PIPE	TUBES, SPACERS (SEE NOTE-11)	FORGING (SEE NOTE 12)	BOLTS/STUDS/ NUTS EXTERNAL (SEE NOTE 8)	STRUCTURAL ATTACHMENT WELDED TO PRESSURE PARTS, BAFFELS, SUPPORTS, TIE RODS, SEALING, SLIDING STRIPS ETC.	INTERNAL PIPES	STUDS BOLTS NUTS INTERNAL (Note 8)	TIE RODS
CRYOGENIC									
COLDER THAN (-) 196 UPTO (-) 254	SA 240 GR.304L,304, 316,316L 347 (IMPACT TESTED)	SA 312 TYPE 304 304L,316, 316L,347	SA 213 TYPE 304 304L,316, 316L,347	SA 182, GR F 304,304L,316 347,316L	SA 320 GR B8,8C,8T STRAIN HARDENED	SAME AS PRESSURE PARTS			SS GRADE SAME AS TUBES
COLDER THAN (-) 80 UPTO (-) 196	SA 240 GR.304L,304, 316,316L 321,347 SA 353/553 GR.A	SA 312 TYPE 304 304L,316, 316L,321, 347 SA 333 GR.8	SA 213 TYPE 304 304L,316, 316L,321, 347 SA 334 GR.8	SA 182, GR F 304, F304L, F316L,316 321,347, SA 522	SA 194 GR.8, 8C,8T				
LOW TEMPERATURE									
COLDER THAN (-) 60 UPTO (-) 80	SA 203 GR E IMPACT TESTED (SEE NOTE-1)	SA 333 GR.3	SA 334 GR.3	SA 350 GR.LF3	SA 320 L7 SA 194 GR 7	SA 203 GR E	SA 333 GR.3	SA 193 GR.B8 SA 194 GR.8	CS KILLED
COLDER THAN (-) 46 UPTO (-) 60	SA 537 CL.1 IMPACT TESTED (SEE NOTE-1)	SA 333 GR.3	SA 334 GR.3	SA 350 GR.LF3	SA 320 L7 SA 194 GR 7	SA 537 CL.I	SA 333 GR.3	SA 193 GR.B8 SA 194 GR.8	CS KILLED
COLDER THAN (-) 29 UPTO (-) 46	SA 516 (ALL GRADES) IMPACT TESTED (SEE NOTE-1)	SA 333 GR.6 OR GR I	SA 334 GR.6 OR GR I	SA 350 GR LF2	SA 320 L7 SA 194 GR 7	SA-516 (IN ALL GRADES)	SA 333 GR.6	SA 193 GR.B8 SA 194 GR.8	CS KILLED
0 (ZERO) OR COLDER UPTO (-) 29	SA 516 (ALL GRADES) (SEE NOTE-3)	SA 106 GR.B (SEE NOTE 3)	SA 334 GR.6 OR 1 (SEE NOTE 3)	SA 105/ SA 266 (SEE NOTE 3)	SA-193 GR B7 SA-194 GR 2H	SA-516 (IN ALL GRADES)	SA 106 GR.B	SA-193 GR.B8 SA-194 GR.8	CS KILLED
INTERMEDIATE TEMPERATURE									
ABOVE 0 UPTO 427	SA 516 (ALL GRADES)	SA 106 GR.B	SA 179	SA-105 SA-266	SA-193 B7 SA-194 GR 2H	IS-2062/ SAME AS PRESSURE PARTS **(NOTE 13)**	SA 106 GR.B	SA-193 GR.B8 SA-194 GR 8	IS- 2062 (WELDABLE QUALITY) **(NOTE 13)**
	SA 387 GR.11 CL.1/CL.2	SA 335 GR.P11	SA 213 GR.T11	SA 182 GR.F11	SA 193 GR.B7 SA 194 GR 7	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SA-193 GR.B8 SA 194 GR.8	1¼ Cr.½ Mo (COMML. QLTY)
	SA 240 TYPE 304L,316L, 321 (SEE NOTE 4)	SA-312 TP 304L 316L,321 SA-376 TP 321	SA-213 TP 304L 316L, 321	SA 182 F 304L,316 L, 321	SA-193 B7 SA-194 GR 2H	SAME AS PRESSURE PARTS	SA 106 GR.B	SA-193GR.B8 SA-194 GR.8	SAME GRADE AS PRESSURE PARTS
ELEVATED TEMPERATURE									
ABOVE 427 UPTO 538	SA 387 GR.11 CL.1/CL.2 SA 387 GR.12 CL.I/CL.2	SA 335 P11 SA 335 P12	SA 213 T11 SA 213 T12	SA 182 GR F11 SA 182 GR.F12	SA 193 GR.B16 SA 194 GR7	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SA-193 GR.B8 SA 194 GR.8	1¼Cr-½Mo (COMML. QTLY)
ABOVE 427 UPTO 500	SA 240 TYPE 304,316,321 (SEE NOTE 4)	SA 312/ SA 376 TYPE 304,316, 321	SA 213 TP 304,316, 321	SA 182F 304, 316, 321	SA 193 GR.B16 SA 194 GR 7	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SA-193 GR.B8 SA 194 GR.8	SA 479 Gr. 304L,316L, 321
ABOVE 538 UPTO 593	SA 387 GR.22 CL.1/CL.2 SA 387 GR.21 CL.1/CL.2	SA 335 P22	SA 213 T22	SA 182 GR F22 SA 336 GR F22	SA 193 GR B5 SA 194 GR.3	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	2¼ Cr.1 Mo (COMML. QLTY)
ABOVE 500 UPTO 815	SA 240 GR.304H, 316H 321H,	SA 312/ SA 376 TYPE 304H, 316H, 321H	SA 213 TYPE 304H, 316H, 321H	SA 182 GRADES 304H, 316H,321H	SA 193 GRB8 SA 194 GR.8 (STRAIN HARDENED)	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS (Note 8)	SA 479 Gr. 304H, 316 H, 321 H.

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NOTES:

1. Plates are purchased to the requirement of the standard ASME SA-20, which requires testing of individual plates for low temperature service. Carbon steel material is ordered to meet the impact requirements of supplement S5, of standard ASME SA 20.

   For example, typical material specification would be as follows:

   SA 516 Gr.70: 20 mm thick Normalised with impact test requirements per supplement S5 of SA 20 at minus (-) 46 ºC.

2. All permanent attachments welded directly to 9% nickel steel should be of the same material or of an austenitic stainless steel type, which cannot be hardened by heat treatment.

3. Check for impact testing requirement as per UCS-66, for coincident temperature and part thickness.

4. Selection of stainless steel material shall be based on process recommendation / process licensor.

5. This table is not applicable for atmospheric/low pressure storage tanks. Materials shall be selected as per API 650/API 620 as applicable.

6. Materials for caustic service, sour service or sour service + HIC shall be selected based on specific recommendation of process licensor.

7. Material for pressure vessels designed according to ASME Section VIII Division 2 shall be given special consideration as per code.

8. For Exchangers, Internal bolting shall be selected on the basis of shell side material solid or clad as follows:

SHELL MATERIAL	STUD	NUTS
Carbon steel & up to 1% Cr.	ASTM A 193 GR.B7M	ASTM A 194 GR. 2HM
5% Chrome	A 193 Gr. B5	A 194 Gr. 3
13% Chrome	A 193 Gr. B6 X	A 194 Gr. 6
Stainless Steel	A 193 Gr.*	A 194 Gr.*

   For low temperatures, min. quality of bolting material shall be as specified for external bolting and shall be improved if shell side materials are better.

   * Compatible / same grade of SS.

9. Non-ferrous material and super alloys are not covered above and shall be selected based on specific recommendation.

10. Material for vessel / column skirt shall be the same material as of vessel / column shell for the upper part with a minimum of 1000mm.

11. All tubes shall be of seamless construction.

12. SA 965 shall be used for Heat Exchanger non-standard SS/LAS forgings.

13. IS 2062 GR E250 Quality BR/B0 shall be used for attachments not welded to pressure parts up to temperature of 300 Deg. C maximum. In all other cases, attachments should be same as pressure parts.

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ANNEXURE - III

DESIGN PHILOSOPHY OF TALL COLUMNS

Mechanical design of self-supporting tall column and its anchorage block shall be carried out considering combination of various loads.

1.0 Loadings

The loadings to be considered in designing a self-supporting tall column/tower shall include:

1.1 Internal and/ or external design pressure specified on process data sheets.

1.2 Self weight of column inclusive of piping, platforms, ladders, manholes, nozzles, trays/packed beds (including liquid hold-up) and other internals, welded and removable attachments, insulation, fire-proofing and operating liquid etc. The weight of attachments to be considered shall be as per Table-1 enclosed.

Other loadings as specified in UG-22 of ASME Code Sec. VIII Div.1, wherever applicable.

1.3 Seismic forces and moments shall be computed in accordance with IS 1893 (latest edition) or it shall be based on meteorological and seismic data of the site, if attached with the bid package. Unless otherwise specified, importance factor and damping coefficient shall be considered as 2 and 2% respectively.

1.4 Basic wind pressure and wind velocity (including that due to winds of short duration as in squalls) for the computation of forces/moments and dynamic analysis respectively shall be in accordance with IS 875 Part-3 (latest edition) or site-specific wind data if attached with the bid package. Additional wind loading on column due to external attachments like platforms, ladders, piping and attached equipment should be given due consideration.

1.5 Loadings resulting in localised and gross stresses due to attachment or mounting of reflux/reboiler, condenser, etc.

2.0 Loading Condition

Analysis shall be carried out for following conditions:

2.1 Erection Condition : Column (uncorroded) erected on foundation, without insulation, platforms, trays etc. but with welded attachments plus full wind on column.

2.2 Operating Condition : Column (in corroded condition) under design pressure, including welded items, trays, removable internals, piping, platforms, ladder, reboiler mounted on column, insulation and operating liquid etc. plus full wind, on insulated column with all other projections open to wind, or earthquake forces.

2.3 Test Condition : Column (in corroded condition) under test pressure, filled with water plus 33% of specified wind load on un-insulated column including all attachments shall be considered.

2.4 Earthquake and wind shall be considered not acting concurrently.

3.0 Deflection of Column

Maximum allowable deflection at top of column shall be equal to height of the column divided by 200 limited to 300mm maximum.

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3.1 If the deflection of column exceeds the above allowable limit, the thickness of skirt shall be increased as first trial up to a maximum value equal to the column thickness and this exercise shall be stopped if the deflection falls within allowable limit.

3.2 If the above step is inadequate, skirt shall be gradually flared to reduce the deflection. Flaring of skirt shall be stopped if the deflection falls within limits or half angle of cone reaches maximum limit of 9 degree.

3.3 If the above two steps prove inadequate in limiting the deflection within allowable limits, the thickness of shell courses shall be increased one by one starting from bottom course above skirt and proceeding upwards till the deflection falls within allowable limits.

4.0 Stress Limits

The stresses due to pressure, weight, wind/seismic loads shall be combined using maximum principal stress theory for ASME Section VIII Div I. Thicknesses are accordingly chosen to keep the stresses within limits as per Table-2.

5.0 Skirt Support Base

Base supporting including base plate, anchor chairs, compression ring, foundation bolting etc. shall be designed based on over-turning moment (greater of seismic or wind). A minimum number of 8 foundation bolts shall be provided. Nos. of foundation bolts shall be in multiple of four.

6.0 Minimum Hydrotest Pressure

Minimum Hydrotest Pressure shall be equal to 1.3 x design pressure x temperature correction factor, as specified in ASME Code Section VIII Div I (Clause UG-99). The term test pressure shall apply to the pressure measured at the highest point of vessel in its operating position and shall be applied to the highest point in its test position.

7.0 Dynamic Analysis of Column

Dynamic analysis of each column shall be carried out for stability under transverse wind induced vibrations as per standard design practice and calculations for each column shall be submitted to EIL for approval. The recommended magnification factor for unlined towers/column shall be taken as 70 and allowable dynamic amplitude shall be limited to tower diameter divided by five.

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TABLE-1

DETAILS AND WEIGHT OF COLUMN AND VESSEL WITH SKIRT ATTACHMENT

These loads/weights are minimum to be adopted in design based on their applicability. However, in case actual loads/ weights are more the same shall be considered in design.

1.	Shape factor for shell (for wind force calculation)	0.7 (minimum)
2.	Weight of trays (with liquid) to be considered, as applicable	120 Kg/m^2 (minimum)
3.	Weight of plain Ladder	15 Kg/m
4.	Weight of caged ladder	37 Kg/m
5.	Equivalent projection to be considered for wind load on caged ladder	300 mm
6.	Distance of platform below each manhole	Approx. 1000 mm
7.	Maximum distance between consecutive platforms	4000 mm
8.	Projection of Platform	900 mm up to 1 meter dia. column and 1200 mm for column dia. > 1 meter, from column insulation surface.
9.	Equivalent height of platform (for wind load computation)	1000 mm
10.	Weight of platforms	170 Kg/m^2.
11.	Platform shall be considered all around	

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TABLE-2

ALLOWABLE STRESSES FOR COMBINED LOADING

VESSEL CONDITION/TEMP. TYPE OF STRESSES	CONDITIONS		
	ERECTION	OPERATING	TEST
NEW OR CORRODED	NEW	CORRODED	CORRODED
TEMPERATURE	AMBIENT	DESIGN	AMBIENT
LONGITUDINAL TENSILE STRESS	KxSxE	KxSxE	0.90xYPxE
LONGITUDINAL COMPRESSIVE STRESS	KxB	KxB	B
CIRCUMPERENTIAL TENSILE STRESS	-	KxSxE	0.90xYPxE

Where,

S = Basic allowable Tensile Stress as per Clause UG 23(a) of ASME Code Sec. VIII Div.1.

B = 'B' value calculated as per Clause UG-23(b).

E = Weld joint efficiency of circumferential weld, depending on extent of radiography.

K = Factor for increasing basic allowable value when wind or seismic load is present.

YP = Yield strength of shell material

Note: Allowable stresses in skirt to shell joint shall be as per following:

a) 0.49S, if joint is shear type.

b) 0.70S, if joint is compression type

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भंडारण टैंकों का मानक विनिर्देश

STANDARD SPECIFICATION FOR STORAGE TANKS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	02.04.24	REVISED & REISSUED AS STD. SPEC.	SC	TKh	KA/NK	MN
7	30.08.18	REVISED & REISSUED AS STD. SPEC.	RKK	TK	KJH	RKT
6	30.07.10	REVISED & REISSUED AS STD. SPEC.	KA	RKT	AKM	ND
5	12.03.10	REVISED & REISSUED AS STD. SPEC.	TK	RKT	AKM	ND
4	23.03.04	REVISED & REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG
3	09.01.97	REVISED & ISSUED AS STD. SPEC.	A. KUMAR	AKM	CRMN	A.SONI

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Abbreviations:

API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
ATF	:	Aviation Turbine Fuel
AWS	:	American Welding Society
CI	:	Cast Iron
EFR	:	External Floating Roof
FR	:	Floating Roof
GA	:	General Arrangement
IBR	:	Indian Boiler Regulations
IFR	:	Internal Floating Roof
IS	:	Indian Standards
NACE	:	National Association of Corrosion Engineers
NB	:	Nominal Bore
NBR	:	Nitrile Butadine Rubber
OISD	:	Oil Industry Safety Directorate
SS	:	Stainless Steel
UTS	:	Ultimate Tensile Strength

Static Equipment Standards Committee

Convenor : Mr. Nalin Kumar
Co-Convenor : Mr. K. Anjaneyulu

Members :

Mr. Tarun Kumar (Emp. No. A328)
Mr. Tarun Khurana (Co-Ordinator)
Mr. P V Satyanarayana
Mr. Anish Trehan
Mr. P Barik
Mr. Saikat Chakraborty
Mr. Piyush Suryavanshi
Mr. Mittal Kumar Patel
Mr. Srikanth Karnam
Mr. Aasheesh K Handa (Projects)
Mr. Prabhakar Choudhary (SMMS)
Mr. Avdhesh Agrawal (SCM-Inspection)

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1.0 SCOPE

1.1 This specification covers the general requirements for design, fabrication, workmanship, erection, inspection, testing and supply of storage tanks and is intended to supplement the minimum requirements of the applicable codes.

1.2 Supplementary specification indicating special or additional requirements shall form addenda to this specification and shall govern. Supplementary specification, when made addenda to this specification shall be referred to in the Bid Document.

1.3 In case of conflict, the order of preference shall be as follows:

a) Engineering drawing

b) Specifications

c) Codes

As a general rule, the most stringent requirements shall govern.

1.4 For bought out items / Components EIL recommended vendors list is provided elsewhere in the Tender. In case, Contractor proposes any other vendor for bought out items/ Components, then the proposed supplier shall be a reputed manufacturer. Contractor shall submit for Client/EIL approval the necessary documents regarding Proven Track Record (PTR) of the proposed supplier w.r.t the bought out item / Components. As a minimum, two (02) sets of items shall have been supplied for tankage applications and out of these one (01) set shall have been successfully commissioned within the last ten years from bid due date. Contractor shall place the order on the proposed supplier only after obtaining approval from Client/EIL. There shall be no cost/time implication on this account.

2.0 REFERENCES

2.1 Design Codes

The following codes in their latest edition shall form the basis for design, fabrication, inspection, testing and acceptance of storage tanks:

API Standard: 650	:	Welded steel tanks for oil storage. (Items not covered by API-650 shall be as per IS-803.)
IS: 803	:	Code of practice for design fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
API Standard: 620	:	Design and construction of large welded low pressure storage tanks.
IS: 875 (Part 3)	:	Code of practice for design loads Wind Loads (other than earthquake) for building and structures.
IS: 1893/Site Spectra	:	Criteria for Earthquake resistant design of structures.
API STD: 2000	:	Venting atmospheric and low pressure storage tanks.
IS: 2007	:	Method for Calibration of Vertical Oil Storage tanks
IS: 2008	:	Method for Computation of capacity tables for Vertical Oil Storage Tanks.

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API: RP 2003	:	Protection against ignitions arising out of static, lightning and stray currents.
API: RP 545	:	Recommended Practice for Lightening Protection of Above Ground Storage Tanks for flammable or Combustible Liquids.

2.2 Material Codes

Material to be used shall conform to:

a) ASME Boiler and Pressure Vessel Code Section II
b) Indian Standard Specification.
c) API Standard 650 & 620.

2.3 Regulations

National laws and regulations together with local bye-laws for the country or state wherever the tanks are to be erected must be complied with by the fabricator.

3.0 SELECTION OF MATERIALS

3.1 All materials shall be as per EIL Engineering Data Sheet, EIL Specifications and applicable Codes.

3.2 Manhole necks, nozzle necks 250 mm NB and above may be fabricated from same plate material as used for shell.

3.3 All nozzles except manhole shall be fitted with forged flanges.

3.4 Heating coil pipes shall be of seamless quality.

3.5 All clips and attachments shall be fabricated from carbon steel plates of weldable quality.

3.6 Gaskets for manholes shall be 3mm thick compressed non asbestos.

3.7 Bolts and nuts for all nozzles fitted with blind flanges shall conform to ASTM A-193 Gr. B-7, A-194 Gr. 2H. Bolts and nuts for all structurals shall conform to IS: 1363. Bolt and nuts for Manholes shall conform to ASTM A 307 Gr. B or IS 1367 Cl. 4.6/ Cl.4.0.

3.8 Floating roof pipe supports and pipe sleeves shall be of carbon steel conforming to seamless ASTM A-106, A-53, API.5L, IS:1978 or equivalent.

3.9 For all Material of Construction, requirement of Impact Testing shall be complied with as per API 650.

4.0 DRAWINGS AND DOCUMENTS

4.1 All individual tank data sheets shall have dimensional/design data as well as material specification. Final drawing with revisions, if any, shall be issued after award of contract/purchase order.

4.2 Contractor shall submit the detailed design calculation for floating roof (FR), wherever called for in the tender document for EIL's review.

4.3 Contractor shall prepare all design calculations and fabrication drawings based on the drawings issued on award of contract/purchase order and shall include the Documents and Fabrications Drawings as per Annexure-III, which shall be considered as a minimum in general. For detailed Vendor Data Requirements refer contract / purchase order.

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5.0 FABRICATION AND ERECTION

During fabrication, contractor shall provide guy-ropes and other means to secure semi-finished storage tanks against damage due to wind. A scheme shall be submitted to Engineer-in-Charge for review. Wind girders and roof shall be welded to tanks at the earliest. Before commencement of erection, contractor shall submit detailed erection scheme to Engineer-in-Charge for approval.

5.1 Plates

a) Plate edges shall preferably be sheared or machine cut as per code. All machined parts shall be suitably protected before assembly.

b) Gas cut plates shall be ground to the satisfaction of the Engineer-in-Charge.

c) All formed plates shall be match marked with paint on the concave side with numbers as shown on erection drawings.

5.2 Structure

a) Structural steel fabrication shall be carried out to the required shapes for making the structure. Electro-forged type of grating shall be provided.

b) A pre-assembly of a sufficient part of roof structure may be called for by the Engineer-in-Charge to assess the correct workmanship.

5.3 Bottom

a) Bottom slope shall be as indicated in the respective tank drawings.

b) All ATF (Aviation Turbine Fuel) floating roof storage tanks shall be provided with Apex-down bottom with central sump. All other storage tanks shall have apex-up bottom unless otherwise shown in engineering drawing.

c) Overlaps shall be properly cleaned with steel wire brush before welding.

d) Single pass welds are not permitted.

e) Arrange the laps to shed the water towards the drain.

f) Bearing plate under each leg support for floating roof tanks shall be centred and welded to the bottom plate by a continuous fillet weld of size equivalent to bottom plate thickness. Plates shall be 600 mm round or square and 10 mm thick (minimum). If bearing plate is coming on overlap, shim plates shall be used. Prior to welding of bearing plates area of bottom plate beneath the bearing plate and also underside of bearing plate shall be painted as per painting specification.

5.4 Shell

a) All vertical and horizontal shell joints shall be full penetration and full fusion welds using any one of the edge preparations permitted by the Code.

b) Top curb angle shall be lap or butt welded to the top course with flange turned outside.

c) Drain holes of 20 mm diameter suitably staggered shall be provided on the horizontal plates of the stiffening ring (wind girder).

d) Hand railing shall be provided all around top wind girder when it is used as walkway for floating roof tank.

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e) Hand railing shall be provided all around for all fixed roofs.

f) Curb angle joints and stiffening ring joints shall not coincide with the vertical shell plate welds.

g) Vertical weld joints shall be offset by at least 1000 mm.

h) Holes shall not be made in shell plates for erection purposes.

i) Shell plate alignment shall be within the limits specified in code and as approved by EIL.

j) For floating roof tanks, internal surfaces of all shell courses shall be flushed and internal diameter shall be maintained in all shell courses.

k) After completion, the inside surface of floating roof tank walls shall be ground to remove any roughness liable to impair the seal.

5.5 Fixed Roof

a) The roof plate shall rest on self-supported structures as indicated in the drawing/standard.

b) All supporting structures shall be designed to carry the minimum loads as specified in codes, if the same is included in contractor's scope of work. While designing, contractor shall also consider lateral loads caused by one bay loaded and the other bay not loaded.

c) Laps in roof plate shall be 25 mm minimum. Laps shall be arranged with upper edge of the lower plate underneath the lower edge of the upper plate.

d) Roof shall be joined to the shell by means of continuous fillet (5 mm max.) weld on the curb angle. Roof to shell joint shall be frangible type, otherwise suitable emergency venting shall be provided as per API 2000 for Fire Case for Oil Tanks.

e) Roof plates shall not be welded to the supporting structure. The same shall rest on the structure.

f) Wherever corrosion allowance is more than 1mm for roof, external roof structure shall be provided. Central drum, curb angle shall be suitably modified etc. EIL standards shall be used for guidance only. However, if any protective coating like epoxy etc. is provided then roof structure may be provided inside the tank as per EIL standards.

5.6 Floating Roof

5.6.1 General

a) Floating roof of tanks less than or equal to 12m or more than 60 m in diameter shall be of double deck type construction.

b) Tanks having diameter greater than 12 m but less than or equal to 60 m, shall be of single deck annular pontoon type construction with or without buoys.

c) When floating roof is in the highest position, tank shall be capable of holding its design capacity.

d) Floating roof deck shall always be in contact with the liquid at all positions during operating conditions.

e) Floating roof shall be designed by Contractor considering design data given on each Tank drawing of tender specification.

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f) Single deck annular pontoon type floating roofs of diameter more than 46 m shall be designed for elastic stability against "gross out of plane" buckling and local buckling of the outer pontoon due to radial load imposed by deflection of the centre deck. This radial load shall be the higher of the following (i) water (10" rain water in case of external floating roof & 3" fire water in case of internal floating roof) (ii) when deck is punctured.

g) Central deck of the floating roof shall be provided with at least one manhole of 750 NB in addition to the number and size of manholes required as per code. This manhole shall be provided with a ladder for stepping down to bottom when the roof is in the lowest position.

h) Deck shall have level surface with a slope towards the drain sump to avoid stagnation of foam / fire water / rainwater while floating in the product or when the floating roof is at lowest standout position.

i) Each compartment of the floating roof shall be provided with a 500 NB manhole with cover.

j) Each buoy, if provided, shall have 150 NB inspection opening with cover and bolting.

k) Central deck and pontoon shall be suitably stiffened, if required, and calculations for the structural integrity of the floating roof shall be submitted to EIL for approval.

l) Contractor shall decide the dimensions of the pontoons of the floating roof such that when it is floating on the product (of specific gravity 0.7 or the specific gravity of the stored product, whichever is lower) the maximum submergence shall be within 95% of the rim height under conditions as listed below:

   i) For single deck annular pontoon type external floating roofs

      - The submergence of outer rim when 254 mm rain water is accumulated on the roof.

      - The submergence of inner and outer rim near the punctured compartments when deck and two adjacent pontoon compartments are punctured.

   ii) For single deck annular pontoon type internal floating roofs.

      - The submergence of outer rim for fire water accumulation equivalent to 75 mm water.

      - The submergence of inner and outer rim near the punctured compartments when deck and two adjacent pontoon compartments are punctured.

   iii) For double deck floating roof tanks

      - The submergence of outer rim shall be calculated with maximum amount of water that can be accumulated on the double deck.

      - The submergence of inner and outer rim near the punctured compartments when deck and two adjacent pontoon compartments are punctured

m) Contractor shall carry out buoyancy (including tilting) calculations of the floating roof for all the conditions of (l) mentioned above when it is floating on test water. Maximum submergence in water shall be clearly specified in fabrication drawing while taking care of actual floating scenario with product (of specific gravity 0.7 or the specific gravity of the stored product, whichever is lower) & the same shall be compared with actual submergence measured during floatation test as mentioned in Cl. No. 7.2.4 of this Specification.

n) Contractor shall submit design calculations for external floating roofs for

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i) Buoyancy, including tilting for punctured condition, leg supports, bleeder-vent, emergency drain (if required as per datasheet / specifications for single deck) & primary drains.

ii) Deflection of deck and structural integrity of floating roof for annular pontoon type floating roofs.

iii) Deflection of deck and stresses in decks for double deck floating roof.

o) For internal floating roofs all above calculations except emergency drain are to be submitted.

5.6.2 **Seal**

a) All internal and external floating roofs, unless otherwise shown in engineering drawing, shall be provided with liquid mounted foam seal for external floating roof & vapour mounted foam seal for internal floating roof as primary seal. In addition, secondary seal shall be provided for both external & internal floating roof.

b) Liquid mounted foam seal shall have minimum 100 mm immersion in the stored product.

c) Details of foam seal and secondary seals shall be as per Annexure-1 to this specification.

5.6.3 **Floating Roof Supports**

a) Supports shall be adjustable to two positions

i) The lower position shall permit the roof to go as low as possible without interference with any internal accessories and roof seal mechanism.

ii) The upper position (for cleaning) shall provide a clearance of 2000 mm between the pontoon/double deck edges and bottom.

b) The number of leg supports shall be determined to ensure that while resting they do not deform the tank bottom and roof. For ascertaining compressive capability, the effective length of the pipe support should be taken as 1.5 times of actual length of the pipe support in clean-out position.

c) Pipe sleeves shall project sufficiently above the roof to take care of rain-water/foam flooded condition of roof and extend sufficiently below the roof to prevent escape of vapour (minimum 200 mm).

d) Pipe support length shall be readjusted after hydraulic testing of tank so as to take care of the initial settlement of the tank bottom.

5.6.4 For EFR, Rolling ladder and track shall be provided as per EIL Standard. Electro-forged type of grating shall be provided.

5.6.5 **Roof Drains**

a) Unless otherwise specified, Primary Roof drains shall be either of two types mentioned below:

i) Flexible Drain Pipe System (Stainless steel armoured clad flexible hose or the flexible hose with stainless steel carcass).

ii) Articulated Steel Pipe with Flexible Joint (Swivel type joint is not acceptable).

b) Flexible drain pipe system shall have following features:

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i) Full length of the pipe shall be in single continuous length without any intermediate joints in between two end flanges. It shall have stainless steel armoured clad flexible hose or the flexible hose with stainless steel carcass.

ii) Flexible pipe must provide repetitive lay pattern without any external support of accessories like tethered assemblies, ballasting chain etc. during its full operational life. No kinking of flexible pipe shall take place during movement of the roof.

iii) As the roof starts its descent, pipe shall start forming the coil and should not slide on the tank floor.

c) Articulated Steel Pipe with Flexible Joint: Flexible joints joined with steel pipe drain system in a straight line design. Swivel joints are not acceptable. Steel pipe shall be Seamless, Schedule 40 pipes minimum.

d) The primary roof drain for EFR tanks shall be designed for complete water drainage equivalent to maximum recorded rainfall per hour for given site without allowing any accumulation of water, the deck being at the lowest operating level as indicated in Engineering Drawing.

e) The primary roof drain for IFR tanks shall be designed for complete water/foam drainage equivalent to 75 mm per hour for given site without allowing any accumulation of water, the deck being at the lowest operating level as indicated in Engineering Drawing.

f) When storage tanks are provided with heating coils, suitable isolation of flexible roof pipe drains from heating coils shall be provided as recommended by drain supplier.

g) Swing check non return valve with CI body and brass/bronze valve and seat shall be provided at the entry point of the primary drain.

h) Primary roof drain system shall have minimum guarantee/warranty period of 3 years from the date of commissioning.

i) If specifically mentioned, emergency drain shall be provided to take care of primary roof drain failure. These drains shall be equipped with water seal sump inside the roof to prevent back flow of the stored product. It should start functioning after accumulation of 125 mm of rain fall on deck.

5.6.6 Vents

a) Roof shall be provided with automatic bleeder vents designed to open before the roof reaches its lowest position and to close when the roof rises above this point. Also, same operation should follow in the clean-out position.

b) Rim vents of 150 NB at about 30 metres peripheral spacing (minimum two nos.) shall be provided for venting the dead space between stored liquid and seal where vapour mounted primary seal is installed. They shall be provided with pressure relief valve of approved make (Refer Annexure-II) set at 20 mm water column above Operating Pressure.

c) No rim vent is required where liquid mounted primary seal is installed.

5.6.7 Gauge Well/Anti-rotational Device

Gauge hatch with well pipe (including slots) shall be provided for all types of tanks. This should have continuous contact by means of strips with bottom plate of the tank. Gauge hatch size shall be as indicated in the drawing and it shall have a quick opening cover. Gauge hatch shall be spark proof type. This shall also act as anti-rotational device for floating roof tanks wherein no additional anti-rotational device is suggested. For pressurized tank, slot dipping device shall be provided.

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5.6.8 **Earthing of Floating Roof**

a) Wire cables shall be provided between ladder and track and also between ladder and shell. Two such independent connection should exist in parallel.

b) Adequate number of earthing shunts shall be provided for the seal.

5.7 Post Weld Heat Treatment (PWHT)

Tanks in amine service, sour water service, caustic service (wherever required) or wherever indicated in engineering drawings shall be PWHT as per Code requirements. PWHT shall meet the requirement of UCS 56 of ASME Sec. VIII Division 1.

Necessary provisions (slots) shall be kept in anchor chairs and tank bottom plate to take care of the expansion during stress relieving. Foundation and tank bottom shall be properly sealed after PWHT to prevent ingress of water.

6.0 APPURTENANCES

6.1 Nozzles & Accessories

a) All appurtenances and accessories as shown in the respective tank drawings shall be supplied by the Contractor.

b) Manhole and nozzles with blind flanges shall be provided with gaskets and boltings.

c) Nozzle and manholes may be shop assembled.

d) Flange faces shall be varnished and protected by wooden discs using at least three bolts.

e) Suction heaters and mixer nozzles shall be provided with stiffeners.

f) All nozzles and accessories shall be prefabricated and attached to the shell plate. The prefabricated assembly shall be stress relieved prior to installation, wherever required as per code and applicable appendices.

6.2 Heating Coils

Coils shall be supported from tank bottom. Coil supports shall not be welded to tank bottom. No screwed or flanged connections shall be used inside the tank. Heating coil layout shall clear leg supports of floating roof and primary roof drain lay area.

Allowable flattening due to bending shall be as per ASME B 31.3.

6.3 Stairways, Roof Access and Handrailing

Each tank shall be provided with stairway and roof access. Handrailing, if not indicated otherwise on tank drawings, shall be provided all around. Walkway with handrails & gratings on the roof of the tank should be provided to facilitate inspection/checking of vents / flame arrestor etc. so that movement of personnel on roof is safer.

6.4 Settling Marker

Markers shall be provided on the shell, 500mm from the bottom to check tank settlement. Marker, 100 mm long of 50x50x5 mm angle shall be welded around the tank shell. The distance between settling marker is approximately 5 metres. (Minimum 8 numbers).

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Shell settlement measurements shall be made after tank erection, prior to hydrotesting and during water filling at 1000 mm intervals upto maximum filling height of tank.

While taking measurement on settling markers, rim space (distance between shell and outer rim) shall also be measured at location corresponding to settling markers, for floating roof tanks.

Bottom internal measurements shall be made after hydrotesting, such measurement shall be made at all pipe support location. Additional measurements shall be made in annular plate region at 5 metre intervals around the tank shell.

7.0 INSPECTION AND TESTING

Inspection shall be co-ordinated by Engineer-in-Charge at all stages. It shall be the responsibility of Contractor to prepare a detailed inspection and test plan as per applicable code and specifications and get the same reviewed by Engineer-in-Charge prior to execution of work.

7.1 Inspection

a) All tanks shall be offered for inspection at all stages, as desired by Engineer-in-Charge.

b) Inspector or Owner's representatives shall have free access to all the contractor's shops as well as to worksite.

c) The contractor shall provide all facilities, such as access ladder, lighting, tools and tackles, instruments etc. and personnel to inspectors, for proper execution of their inspection.

d) All the inspection shall be carried out in accordance with the relevant codes and requirements of drawings and specifications.

e) Approval of the Inspector shall in no way relieve the contractor of his responsibilities for proper execution of work.

7.1.1 Welding Electrodes

Following classifications of electrodes are recommended for welding. However, minimum requirements of applicable codes and appendices shall be adhered to:

a) Low hydrogen electrodes shall be used for all manual metal-arc welds of carbon steel shell courses having a thickness of 12mm or more and for attachment of shell course to bottom or annular plates.

b) High cellulose/rutile type electrodes as per the AWS classification SFA 5.1 are acceptable for all other structural welding.

Based on above, fabricator shall furnish brand names of welding consumables to Engineer-in-Charge for approval.

7.1.2 Welding Procedure

a) Welding procedure qualification shall be carried out as per ASME Boiler and Pressure Vessel Code Section IX.

b) No welding shall be undertaken without approval of the welding procedure and welder qualification test by the Engineer-in-Charge.

7.1.3 Radiography and Inspection of Welds

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a) All welds shall be inspected and tested as per Code and this specification.

b) All long seams of fabricated nozzles shall be fully radiographed.

c) Weld areas to be radiographed shall be designated by the Engineer-in-Charge.

d) Radiographs shall be taken as soon as welding of the Joint is completed. If repairs are required, these shall be carried out before starting other welds. New radiography examination of such repairs shall also be carried out by the Contractor at his own cost.

e) For heating coils, number of joints to be radiographed shall be 25% and interpretation of radiography shall be as per ASME B 31.3. Approval, from IBR, wherever required shall be contractor's responsibility.

7.1.4 Liquid Penetrant/Magnetic Particle Examination / Ultrasonic Examination

Whenever specified in drawing/code, liquid penetrant/magnetic particle/ultrasonic examination shall be carried out as per ASME Boiler and Pressure Vessel Code Section V and acceptance criteria shall be as per Section VIII Div. I.

7.2 Testing

All equipment required for testing shall be supplied by the contractor.

Openings other than those used for hydrostatic test or any other test shall be closed by plugs and blind flanges supplied by the contractor.

7.2.1 Bottom Test

a) A detailed description of the proposed test method shall be first submitted for approval to the Engineer-in-Charge.

b) Vacuum box testing shall be carried out for detection of leaks in the bottom.

c) The weld joints under the shell periphery shall be tested before erection and welding of first shell course.

d) Contractor shall test the tank bottom for the entire weld length in the presence of the Engineer-in-Charge and test reports shall be issued accordingly.

7.2.2 Shell Test

a) Bottom to shell joints shall be tested as follows:

i) Inner fillet weld shall be inspected and tested prior to welding the outside fillet weld. Leak test shall be performed with penetrating oil after removal of slag. Oil shall be removed before, welding the outer fillet.

ii) Examination for inner fillet to detect cracks shall be performed using either the liquid penetrant or magnetic particle method.

b) All welded lugs and brackets used for erection purpose shall be carefully removed from inside and outside surface of the tank to the satisfaction of the Engineer-in-Charge.

c) Contractor shall perform the hydrostatic test in the presence of Engineer-in-Charge on each tank after complete erection. Any defects observed during the test shall be repaired by the Contractor.

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d) The filling height, in case of fixed roof or open roof tanks, shall be upto the curb angle and in case of floating roof tanks shall be restricted to the maximum height so that weather shield or secondary seal does not go beyond curb angle.

e) If sea water is used for testing and is to remain in tank for more than 30 days, an oxygen scavenger and corrosion inhibitor shall be added. After testing the tank, water shall be drained and tank shall be thoroughly flushed with clean fresh water. Standing water silt or other dirt left in the tank after hydrostatic testing shall be thoroughly cleaned.

f) Filling of the tank may be restricted by the Engineer-in-Charge for preloading of foundation and hydrostatic test may be extended over a period of 4 weeks or more to ensure proper settlement of the tanks.

g) On completion of tank and after cleaning, the tank shall be filled with water as follows, unless otherwise specified in the tender documents.

Filling shall be in 4 stages, 25%, 50%, 75% and 100%. After each stage a load stabilization period shall be observed:

- 24 hours between each stage for tanks with a capacity equal or more than 10,000 m^3.
- 12 hours between each stage for tanks with a capacity under 10,000 m^3.

Filling rate shall not exceed 5 meters per day.

h) When the tank is full all the welded joints shall be hammered by contractor in the presence of Engineer-in-Charge. In case of any defect, it shall be repaired and retested by the Contractor as per the instructions of Engineer-in-Charge.

i) Tank shall be emptied at a maximum water level variation rate of 5 meters per day or as per instruction of Engineer-in-Charge.

j) All weld repairs shall be done with water level minimum 300mm below the joint being repaired.

7.2.3 Fixed Roof Test

a) After filling the tank upto curb angle, all openings in the roof shall be closed and internal air pressure shall be applied equivalent to the weight of roof plates. All welded joints in roof shall be checked with soap-suds for detection of leaks.

b) Pressure testing of roof for leak detection shall be carried out as per code.

c) For vacuum test the tank shall be emptied upto 1 meter level from the bottom. The openings shall be closed and draining continued with care until the vacuum of 25mm water gauge or the design vacuum whichever is higher is obtained and checked by vacuum gauge. However, for tanks having diameter 20 m and above, design check for vacuum shall be made before proceeding with the test.

7.2.4 Floating Roof Test

Floating roof test shall be as recommended in API Standard 650 Appendix C or Appendix H and also as given below:

a) During floatation test of roof, contractor shall carry out the proof test as follows on each size of the tank selected by Engineer-in-Charge who shall also witness the test check.

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i) For annular pontoon type external floating roofs, with primary drains closed, water equivalent to 10" of rainfall over the tank area shall be poured on the deck and in the stabilized state submergence of outer rim shall not exceed allowable limit as stated in Sl. No. (iv) below.

ii) For annular pontoon type external as well as internal floating roofs the condition of deck and two adjacent pontoon compartments punctured shall be simulated and the submergence of inner rim and outer rim at the punctured pontoon shall not exceed allowable limit as stated in Sl. No. (iv) below.

iii) For double deck tanks puncture condition for 2 adjacent compartments which shall cause maximum tilting as established in the design calculation shall be simulated, and the submergence of outer rim at the punctured compartment shall not exceed allowable limit as stated in Sl. No. (iv) below.

iv) The allowable limit of submergence shall be considered as 65% of rim height at any point, for tanks having stored product of specific gravity more than equal to 0.7. For stored product having specific gravity less than 0.7, the allowable limit of submergence shall be considered as 95% multiplying the specific gravity of the stored product but in no case, the same shall be more than 65% as stated above.

v) Failing to meet the above requirements contractor shall rectify the floating roof and retest at his cost till the above requirements are satisfied.

b) All compartments including buoys shall be tested for liquid tightness.

c) Sealing device shall be installed after floatation test.

7.2.5 Heating Coils

Heating coils shall be pressure tested as per engineering drawing.

7.2.6 Nozzle Reinforcing Plates

Nozzle reinforcing plates shall be pneumatically tested at 1.05 kg/cm^{2}g with soap solution. This test shall be carried out before filling the tank for hydrostatic testing.

7.2.7 Primary Drains

Drain pipes in floating roof tanks shall be pressure tested with water at 3.5 kg/cm^{2}g. During the flotation test, the roof drain valve shall be kept open and observed for leakage of the tank contents into pipe drain.

8.0 CALIBRATION

Strapping and Calibration of all tanks shall be done in accordance with IS:2007 & 2008 (Latest editions).

9.0 PAINTING

For details of primer and painting both internal & external including soil side of bottom plates, Painting specification shall be referred to.

10.0 DIMENSIONAL TOLERANCES

10.1 Shell

For tanks to have acceptable appearance and to permit proper functioning of floating roof, they shall have tolerances strictly as specified in applicable codes.

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10.2 Floating Roof Tolerances

Tolerances allowed on the annular clearance between shell and floating roof shall be compatible with the requirement specified by seal manufacturer. However, the difference in gap between the shell and the periphery of the roof on completion of erection of the roof shall not exceed ± 13 mm from the nominal gap.

11.0 IDENTIFICATION, PACKING AND TRANSPORTATION

11.1 Identification

Each plate and structural member shall be clearly marked with the specification number, drawing number and assembly number.

11.2 Packing and Transportation

a) All plates shall be transported in tractor or trailor and shall not be dragged.

b) All rolled shell plates shall be packed properly to retain the shape and shall be handled carefully to avoid damage during transit.

c) Contractor shall be responsible for transportation of material fabricated in his workshop or worksite.

12.0 GUARANTEE

Guarantee, if not covered by the General Conditions of contract, shall be as following:

12.1 All equipment shall be guaranteed in accordance with conditions given in the "Special Conditions of Contract".

12.2 Any part of tank found detective within 18 months of completion or during 12 months operation and not having been subjected to faulty operations or incorrect service conditions shall be promptly replaced/repaired and reassembled by the contractor at his own cost, failing which owner has the right to get the same replaced/repaired by others and charge the cost incurred to the contractor.

12.3 Guarantee/warranty for seals and primary roof drain system for floating roof tanks shall be as per Annexure-I and Clause 5.6.5 (f) respectively.

13.0 ANNEXURES

ANNEXURE-I	:	SEALS FOR FLOATING ROOF TANKS
ANNEXURE-II	:	LIST OF RECOMMENDED MAKES FOR PRESSURE RELIEF VALVES & SLOT DIPPING DEVICE
ANNEXURE-III	:	LIST OF DOCUMENTS & DETAILS OF FABRICATION, TO BE SUBMITTED BY TANK FABRICATOR.

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14.0 ANNEXURE - I

SEALS FOR FLOATING ROOF TANKS

1.0 GENERAL

This Annexure cover requirements that shall be met as a minimum for core foam and casing for primary seals for floating roof tanks. Requirement for secondary seals are also covered.

2.0 CORE FOAM

2.1 Core foam shall be of prime quality solid polyurethane foam and of octagon shape. Foam shall be of light weight having appropriate elasticity, little permanent compressive strain and shall have excellent resistance to oil and chemicals.

2.2 Core foam shall have the following properties in accordance with ASTM D-3574.

i)	Specific Gravity	0.018 to 0.022
ii)	Permanent Strain due to compression	Not to exceed 10%
iii)	Load at 25% deflection	RMA value 6.81 $\pm$ 1.36 Kgs.

2.3 Rim space of 200 mm shall be provided. Foam shall be of octagonal shape and of size 305 mm (across flat ends).

3.0 FOAM CASING

3.1 The casing material shall be oil and water resistant and compatible with stored product.

3.2 Material for foam casing shall be Nylon Fabric (1 mm thickness) equally coated on both sides with polyurethane for both liquid and vapour mounted seals.

3.3 Contractor shall furnish following characteristics of casing material post-order:

a) Original adhesion

b) Adhesion after Fuel ageing (*)

c) Original tensile strength

d) Tensile strength after Fuel ageing (*)

e) Tensile strength after 50,000 flexes

f) Volumetric swelling (*)

g) Vapour permeability

(*) Ageing in both 100% Toulene and also in 75% Toluene with 25% Iso-octane for 7 days at 25 degree centigrade.

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4.0 FABRICATION OF SEAL

4.1 Tests as specified above shall be carried out in a reputed laboratory and the results shall be furnished for review/approval.

4.2 Contractor shall use proper adhesive of approved quality. Contractor shall give complete procedure for joining the pieces. The entire work shall be carried out in a clean, dry area, free of heat, sparks of flame.

4.3 Minimum length of foam and casing for foam seal shall not be less than 3 meters. Total circumferential length of foam seal shall be such that a compression of 150 mm is achieved for every 3 meters length of foam seal when installed.

4.4 Maximum seal gap width will be 4 cm and maximum gap area will be 200 cm^2/m of tank diameter.

5.0 SECONDARY SEAL

5.1 Secondary seal shall have synthetic rubber wiper seal, continuous vapour barrier membrane, galvanized compression plate of 16G thickness, SS electric shunt and all necessary hardware for installing on rim of external floating roof. Vapour barrier membrane shall have polyurethene coating on both sides of nylon fabric. Minimum thickness of vapour barrier shall be 0.4 mm. Maximum seal gap width will be 1.3 cm and maximum gap area will be 20 cm^2/m of tank diameter.

5.2 Recommended models and makes of secondary seals shall be as per EIL approved Vendor list.

6.0 GUARANTEE

The primary and secondary seals shall have guarantee/warranty for its durability and satisfactory performance for a minimum period of five years from the date of commissioning.

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15.0 ANNEXURE - II

A : LIST OF RECOMMENDED MAKES FOR PRESSURE RELIEF VALVE SHALL BE AS PER EIL LIST.

B : SLOT DIPPING DEVICE SHALL BE OF REPUTED MAKE.

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16.0 ANNEXURE - III

VENDOR DATA REQUIREMENTS

SL. NO.	DESCRIPTION	NO. OF SETS (WITH THE BIDS)	NO. OF SETS (AFTER PLACEMENT OF ORDER)	
			COMPACT DISC./ELECTRONIC FORM	PRINTS
1.	Document/Drawing Index along with Schedule of Submission.	-	2	
2.	Proposed Heat Treatment Procedure	-	2	
3.	GA drawing covering all details shown in EIL data sheets like list of appurtenances, lists of standards and specifications, material of construction, Tank design data, General Notes including details of test to be conducted on tank, specification and brand-name of welding electrodes to be used etc	-	2	
4.	Details of shell, bottom and roof & roof structure showing their welds, nozzles and manhole connections, internals etc.	-	2	
5.	Development, details of welding for shell showing location of nozzles, pipe support cleats & travel of stairway on developed shell	-	2	
6.	Details of spiral stairway, platforms, landings, handrails and other accessories with bill of material	-	2	
7.	Details of wind girders	-	2	
8.	Details of rolling ladder and track and Earthing connection for EFR tanks	-	2	
9.	Details of Roof Supporting Structure for fixed roof tanks	-	2	
10.	Details of shell nozzles and shell earthing cleats	-	2	
11.	Details of Seal(s) and weather shield and details of earthing shunts for FR Tanks	-	2	
12.	Details of floating roof appurtenances, roof stopper and leg supports for floating roof	-	2	
13.	Orientation of floating roof appurtenances, leg supports, plate joints, rolling ladder track etc. for FR Tanks	-	2	
14.	Details of still-wells and Bill of Material	-	2	
15.	Details of heating coil showing coil layout, details of supports and details of pipe joints, including Bill of Material	-	2	
16.	Details of insulation supports	-	2	
17.	Details of Foam System	-	2	

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18.	Details of Cooling System	-	2	
19.	Plate cutting diagrams for all free issue material	-	2	
20.	Plate reconciliation statement for free issue material	-	2	
21.	Quality Control Procedure	-	2	
22.	Design calculations for floating roofs for 1) Buoyancy, including tilting for punctured condition, leg supports, bleeder vent, emergency drain & primary drains 2) Deflection of deck and structural integrity of floating roof for annular pontoon type floating roofs. 3) Deflection of deck and stresses in decks for double deck floating roof	-	2	
23.	Material test certificates for plates, pipes and flanges.	-	2	
24.	Welding procedure and welder's qualification reports	-	2	
25.	Radiographic test reports (films to be stored for 5 years)	-	2	
26.	Heat Treatment Report	-	2	
27.	Procedure & Report of Internal Liner / Coating	-	2	
28.	Final Inspection Certificate and hydrostatic test certificate	-	2	
29.	Final as built drawings for information.	-	2	

Note
1. Above drawings shall also include Bill of Material.
2. Items at Sl. No. 1 to 20 & 29 are required for review by EIL.
3. Items at Sl. No. 21 to 28 are required for review by EIL.
4. All drawings shall be drawn in AutoCAD R-14 or above. No hand drawings shall be accepted. All calculations shall be computerized.
5. Documents and letters shall be furnished in electronic format. The software used shall be as follows:
   a) MS OFFICE 2007 OR ABOVE
   b) ADOBE ACROBAT 9.0 OR ABOVE.
6. Number of sets with Bids or after placement of order shall be as per Tender or Requisition

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मेकैनिकल एजिटेटर का मानक विनिर्देश

STANDARD SPECIFICATION FOR MECHANICAL AGITATORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	14.05.2024	REVISED AND REISSUED AS STD. SPEC.	MKP	TKh	NK	MN
4	24.08.2018	REVISED AND REISSUED AS STD. SPEC.	SA	AT	KJH	RKT
3	22.03.2010	REVISED AND REISSUED AS STD. SPEC.	TK	RKT	AKM	DM/ND
2.	15.06.2004	REVISED AND REISSUED AS STD. SPEC.	M.ASHOK	AM	SSA	MG
1	04.01.1999	REVISED AND REISSUED AS STD. SPEC.		USG	CRMN	A.SONI
0	07.04.1986	ISSUED AS STANDARD SPECIFICATION	A.RAO	RSC	SCG	AK

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Abbreviations:

AGMA	:	American Gear Manufacturer's Association
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
BKW	:	Brake Kilowatts
BS	:	British Standards
dBA	:	Decibels
GPC	:	General Purchase Conditions
IS	:	Indian Standards
KW	:	Kilowatts
NB	:	Nominal Bore
PTFE	:	Poly Tetra Flouro Ethylene
RPM	:	Revolutions Per Minute

Static Equipment Standards Committee

Convenor: Mr. Nalin Kumar
(Co-Convener): Mr. K. Anjaneyulu

Members:
Mr. Tarun Kumar (8906) – Special Invitee
Mr. Tarun Kumar (Emp. No. A328)
Mr. Tarun Khurana (Coordinator)
Mr. P V S Satyanarayana
Mr. Anish Trehan
Mr. P Barik
Mr. Saikat Chakraborty
Mr. Piyush Suryavanshi
Mr. Mittal Kumar Patel
Mr. Srikanth Karanam
Mr. Aasheesh Handa (Projects)
Mr. Prabhakar Choudhary (SMMS)
Mr. Avdhesh Agrawal (SCM-Inspection)

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1.0 SCOPE

1.1 This specification covers minimum requirements for design, supply, inspection and testing of mechanical agitators, their auxiliaries and accessories.

1.2 No deviation or exception from this specification shall be permitted without the written approval of the purchaser. Intended deviations shall be separately listed by the vendor and supported by reasons for consideration of the Purchaser.

1.3 Compliance with this specification shall not relieve vendor of the responsibility of furnishing equipment and accessories of proper design, materials and workmanship to meet the specified operating conditions.

1.4 This general specification supplements the specific requirements contained in the job specifications, if any, and the equipment data sheets. In the event of any contradiction between the information contained in various attached documents, the following order of precedence shall govern:

i) Data sheets.
ii) Job Specification.
iii) This Specification.
iv) Various reference specifications.

2.0 BASIC DESIGN

2.1 General

2.1.1 Agitators, gears and auxiliary equipment shall be designed and constructed for operation at continuous full load duty. Units shall be of a proven design for the intended service. The agitator vendor shall be wholly responsible for satisfactory hydraulic, mechanical and overall performance of the equipment and all connected subassemblies. CFD analysis, if required, shall be carried out for the agitator.

2.1.2 Unless otherwise specified elsewhere, the following experience criteria shall be applied for acceptance of the offered agitator model.

i) The vendor shall be an established agitator manufacturer having engineering, manufacturing and testing facilities.

ii) Agitator offered shall be from existing manufacturing range of vendor. (Prototypes are not acceptable).

iii) Proposed agitator shall be identical in model number/ Frame and similar in terms of power rating & mechanical design (e.g. overall shaft length, shaft diameter, operating speed, number/ type of impellers, type of sealing & sealing system etc.) to at least one unit designed, manufactured, tested and supplied from the proposed manufacturing plant and the unit shall have completed 1 year of operation at job site on bid due date. As an alternative, vendor may show to the satisfaction of the purchaser that the equipment offered is comprised of standard subassemblies which individually satisfy the above requirements.

iv) The above acceptance criteria shall also be applicable for bought out auxiliaries like Gearbox, seals, sealing system etc.

v) Vendor shall furnish record of his past experience to justify the proven-ness of the offered equipment.

2.1.3 In cases where the impeller geometry, absorbed power and speeds are specified by the buyer, the Supplier shall review the same and confirm the adequacy for the overall satisfactory performance of the equipment for their specified service conditions. Any deviations or changes required to these Buyer's requirements shall be clearly highlighted by supplier in the technical bid with proper justification.

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The supplier shall in all cases satisfy himself that the materials and/or design features indicated by Buyer (including process licensor) are adequate for the design, design duty, test conditions and methods of manufacture and handling to be encountered. In the case of any doubt, the Supplier shall consult Buyer before commencing with work of fabrication.

2.1.4 The agitator shall be designed for mounting and operating in purchaser's vessel/tank whose drawing is annexed with the enquiry specification. The agitator vendor shall, within one month of receipt of order, review and comment on the Purchaser's vessel drawing for number and size of baffles, sparger locations, mounting nozzle details etc.

2.1.5 Agitator shall be designed for complete operational range of vessel liquid level inclusive of full/maximum & minimum liquid level, as specified.

2.1.6 Unless otherwise specified, for small diameter impeller, it shall be possible to remove the complete Agitator assembly without dismantling through the opening provided on the vessel/tank. For large diameter impeller, blades shall be of removable construction for ease of removal. Vendor shall also furnish the headroom required for taking out the agitator as above.

2.1.7 All equipment furnished by vendor shall be suitable for the area classification specified in the data sheets.

2.1.8 The noise level of unit when measured at 1 meter distance shall not exceed 85 dBA. The supplier shall submit noise emission data for the proposed unit post award.

2.1.9 Pressure containing parts and mounting flanges shall be designed, fabricated, tested and inspected in accordance with the ASME codes, unless specified otherwise on the data sheets.

2.1.10 Pressure containing parts of carbon steel shall have a minimum corrosion allowance of 3mm, unless otherwise specified on the data sheets. Carbon steel shaft shall have corrosion allowance of 6 mm on its diameter unless otherwise specified. On other non pressure carbon steel parts a corrosion of 3 mm shall be considered on each surface.

2.1.11 Lifting eye bolts shall be provided for driver, gear box, mounting plate etc. for ease of lifting and shall be located at the centre of gravity of that component.

2.1.12 Vendor shall provide proper dowelling between motor and base plate, gear box and mounting stool/base plate for ease of assembly of the agitator unit. Tapered dowels shall be provided.

2.1.13 Vendor shall provide suitable arrangement for supporting the agitator shaft with impellers during removal of gear box for maintenance and details of such arrangement shall be furnished.

2.2 Electric Drives

2.2.1 Unless stated otherwise, the driver shall be in the scope of agitator vendor. The driver shall conform to the corresponding specifications listed in the enquiry document.

2.2.2 Electric motors shall have a minimum power rating in accordance with the following table:

Agitator BKW at input shaft of gear box (Including Gear &Transmission losses)	Motor rating (% of Agitator Rated BKW)
Less than 22 KW	125%
22 - 55 KW	115%
Higher than 55 KW	110 %

The electric motor shall be suitable for the electrical area classification indicated in the electrical specification/data sheets.

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2.3 Gear Units

2.3.1 In case where speed reduction is required, the vendor shall incorporate helical or worm gear reduction unit. Use of V-belt/Chain drive (antistatic type) is permitted for swivel type side entry agitators. Use of V-belt / Chain drive for any other agitator configuration (i.e. top/bottom entry or fixed type side entry) shall require purchaser's approval, unless otherwise specified in data sheet. Minimum design life of V-belt shall be 25000 hrs.

2.3.2 The gear box rating shall be selected based on minimum gear service factor of 1.5 over the driver's name plate rating. The gear box shall be of heavy-duty type and the bearings shall be capable of withstanding maximum radial cum thrust loading which may occur during startup/ transient & normal operation including initial whirling motion.

2.3.3 The speed reduction unit shall be procured from a reputed gearbox manufacturer and shall conform to DIN/ ISO/ AGMA or equivalent specification.

2.3.4 Where shut off and retracting arrangements are required, the vendor shall provide a gear reduction unit having a hollow output shaft.

2.3.5 The gear reduction unit shall always be provided with an oil drain, a breather and oil level gauge. The lubrication must be designed keeping in view that temperature within bearings should not exceed 85°C.

2.4 Couplings

2.4.1 The vendor shall use the following nomenclature.

i) High Speed Coupling

Coupling used between the motor and gear reducer. It shall be of flexible type and shall be provided with a non-sparking guard.

ii) Low Speed Coupling:

Coupling used between the output shaft of the gear reducer or driver, and the agitator shaft. It shall be of the flexible or rigid type with spacer.

iii) Auxiliary coupling:

Coupling provided to sectionalize the agitator shaft inside the tank/vessel.

2.4.2 Flexible couplings shall be selected with a minimum service factor of 2 over the driver nameplate rating and shall be capable of continuous operation at the maximum anticipated misalignment.

2.4.3 Rigid couplings wherever used, shall have tapered bores with key and nut arrangement. All rigid couplings shall be manufactured from cast steel as per IS: 1030 Gr. II or forged steel as per IS : 2004 Cl. 3 or cast iron as per IS : 210 Cl. 30. Rigid couplings in forged steel may be welded to the shaft for atmospheric tanks.

2.4.4 All necessary instructions for assembly of coupling shall be furnished by the Vendor.

2.5 Mounting stool & Flanges

2.5.1 Wherever required, the vendor shall provide a mounting stool for the agitator unit. It shall house the shaft coupling, the bearing housing, the seal and the auxiliary coupling as applicable.

2.5.2 The lantern stool shall be designed to provide adequate accessibility for ease of erection and maintenance. The stool shall be either in standard ERW pipe construction as per IS: 1978 or shall be fabricated from

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IS :2062 E250 Grade B plate. Plugged holes shall be provided at proper locations to drain the oil which may get collected in the stool due to improper functioning of gear box, oil seal, etc.

2.5.3 Mounting flange dimensions shall be as per ASME B16.5 up to 600 NB, ASME B16.47 Series B for more than 600 NB or as specified in the data sheets. Material of construction shall be as specified in the data sheet of agitator/ vessel/tank.

2.6 Agitator Shaft

2.6.1 Unless otherwise specified, the bottom shaft of top mounted agitators shall be one piece. Constant diameter solid/hollow shaft of cantilever design suitable for 20 yrs. of service life shall be furnished. Larger lengths shaft may be divided.

2.6.2 The selection of the shaft diameter shall be done to satisfy the following criteria:

a) Shaft shall be suitable for transmitting full rated (pull out) torque as mentioned in driver's name plate.

b) Shaft shall be suitable for jamming conditions considering that impeller is jammed at a point 0.75R from the centre (R=radius of impeller). Unless otherwise specified a safety factor of 1.5 shall be taken on motor rating to work out pull out torque for calculating the stresses as per maximum shear strain energy theory. The maximum stress thus calculated shall be limited to yield stress of the shaft material at vessel design temperature.

c) Shaft runout shall be limited to a maximum value of 0.05 mm at the face of the stuffing box/seal.

d) Dynamic shaft deflection at the mechanical seal (cartridge) face shall be limited to the value specified by mechanical seal manufacturer or 0.07mm whichever is less.

e) Shaft diameter shall also take into account factors of straightness and runout at shaft end. In the assembled condition, the maximum shaft runout at the free end shall be limited to 1.0 mm per meter (on each side) of overhung length of shaft (measured from nearest bearing/seal face end).

f) There shall be a separation margin of minimum 20% between the critical speed (dry/wet) and any operating speed.

2.7 Impellers

2.7.1 Impellers with small diameter shall be of one-piece construction. Impellers with large diameter blades shall be of bolted construction.

2.7.2 Discs and stabilizers may be split to permit removal through manhole openings.

2.7.3 Wherever possible the impellers shall be mounted on the taper bore of the shaft by means of key. Care shall be taken that both tapers match each other. A lock nut with cotter pin shall be provided to safeguard against loosening during operation.

2.7.4 All impellers shall be dynamically balanced for operating speed above 300 rpm.

2.8 Seals

2.8.1 The type of seal required shall be as specified in the data sheets.

2.8.2 Seals, when specified shall be of standard manufacturing range and shall be procured from EIL approved makes for Mechanical Seals.

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2.8.3 Gland packings, if specified, shall be designed for ease of maintenance and shall not require auxiliary coupling for the same. The design shall incorporate:

a) Gland in two halves.

b) individual packing rings of PTFE or PTFE impregnated asbestos.

c) Spacer ring in two halves between two packing rings.

d) Lantern ring in two halves, if lubrication is required.

Equipment (if any) necessary for lubrication of packing shall be supplied by the vendor and a detailed drawing for the same shall be submitted as per vendor data requirement.

2.8.4 Mechanical seal assemblies shall be of cartridge type and shall be removable without dismantling the agitator drive unit.

Seal cartridges shall be self-venting through circulation return line. Cartridge shall have leak detection ports.

(a) Hydraulically balanced Mechanical Seals shall be used for agitator sealing.

(b) Seal housing & Mechanical Seal shall be designed taking into consideration the vessel design pressure & temperature under static conditions. All parts of seal housing in contact with the process fluid shall be constructed in the same or superior material of vessel.

(c) Inboard seal of all double Mechanical Seals shall have reverse pressure capability.

(d) Pressure double Mechanical Seals shall have barrier fluid inlet adjacent to the inboard seal & outlet adjacent to the above outboard seal.

(e) If dual Mechanical seal is specified, the same shall be provided with modified Plan 53B as per details attached in Annexure-I.

2.8.5 The seal model/type/material code etc. shall be suitable for the specified operating media and shall be as per the seal manufacturer's recommendations. The seal design pressure shall be 1.1 times the vessel design pressure.

2.8.6 The equipment & piping seal for flushing/quenching system, if specified shall be in the agitator vendor's scope of supply.

2.9 Bearing Housing and Bearings

2.9.1 The bearing housing shall be designed with a span suitable for the maximum radial cum thrust loadings used for the design of the shaft. The housing shall be either integral with mounting stool or bolted to the mounting stool and be provided with a precision machined step facing to make a corresponding facing on the stool for the purpose of maintaining alignment and interchangeability.

2.9.2 All bearings shall be designed for the maximum radial cum thrust loadings and any shock loadings expected during operation. The bearings shall have a trouble-free operating life of 30,000 hours minimum.

2.10 Steady Bearings & Baffles

2.10.1 Unless otherwise agreed upon, the design of the agitator shall not incorporate the use of a steady bearing at the shaft end. However, if the use of such a bearing is imperative, the design shall be such that the bearing is of self aligning type and is product lubricated. Vendor shall highlight the same in proposal.

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2.10.2 The steady bearing and its support arrangement for top mounted agitator shall be in the scope of agitator vendor. The vendor shall supply necessary drawings/specifications to purchaser for making arrangement in the vessel/tank for mounting the steady bearing and its support. The pads welded to the equipment shall be supplied by the vessel fabricator.

2.10.3 If antivortex-baffles are required, vendor shall design and furnish the complete details (in terms of dimensions, number, location, orientation) including its supports.

2.11 Piping Connections

2.11.1 Threaded and plugged connections for seal flushing, vents and lubrication shall be ½ inch NB minimum size.

2.11.2 Flanged connections shall be used for sizes 1 inch NB and above and shall conform to ASME B 16.5.

2.12 Special Tools and Tackles

If required, Vendor shall supply a set of special tools and tackles required for erection, as well as operation & maintenance of the agitator units. A list of such tools shall be submitted along with the offer.

3.0 MATERIALS

3.1 Vendor shall indicate the materials of construction for the various parts on the data sheet. However, the vendor shall adhere to the materials as specified by the purchaser in the data sheets or elsewhere in specification and shall quote accordingly. IS/BS/ANSI/ASTM or other international standards shall be used to specify exact material designations.

3.2 Castings used for any part of agitator assembly ordered under these specifications shall be sound and free of shrink or blow holes, scale, blisters and other similar casting defects.

3.3 Unless otherwise specified in the data sheets, material test certificates (chemical analysis and mechanical properties) shall be supplied for impeller, shaft, mounting flange and coupling, after award.

4.0 INSPECTION & TESTING

4.1 General

4.1.1 Unless otherwise specified all agitator units shall be tested at vendor's shop in accordance with Clause 4.2 to 4.4 of this specification.

4.1.2 The tests to be witnessed by the Purchaser shall be as indicated in the data sheets / approved vendor quality assurance plan.

4.1.3 The vendor shall notify the purchaser not less than 10 days prior to the date of inspection or test.

4.1.4 Acceptance of shop tests shall neither be considered a waiver of requirements to meet field tests under specified operating conditions nor does inspection relieve the manufacturer of his responsibilities in any way whatsoever.

4.1.5 The inspector representing the purchaser shall have entry to the plants including sub-vendor plants where work or testing of the equipment is being performed.

4.1.6 Vendor shall furnish the inspector with all necessary material certificates, shop test data for verifying the vendor's compliance with the specifications on the agitator and all auxiliaries furnished by sub vendors

4.1.7 No surfaces or parts are to be painted until the inspection is completed.

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4.2 Hydrostatic Test

Each pressure part like stuffing box jacket or seal reservoir of a unpressurized/ pressurized sealing lubrication system, etc., shall be hydrostatically tested with water at a pressure not less than one and a half time the maximum operating pressure. The duration of the test shall be 30 minutes. Criteria of acceptance shall be no leaks.

4.3 Mechanical Run Test (in air)

Each agitator unit shall be given a 4 hours mechanical run test in air at vendor's shop. Agitator unit shall be mounted in the same orientation as it will operate in the field. During this test, the record shall be made of:

a) Shaft run out at the free end.

b) Dynamic shaft deflection adjacent to the mechanical seal/packing/vapor seal.

c) Gear box oil temperature and temperature of bearing housing in stool.

The temperature of gear box oil shall not exceed ambient plus 40°C and that of bearing housing shall not exceed room temperature plus 20°C after the temperatures have stabilized.

d) Bearing housing vibration check shall be carried out. The maximum acceptable vibration velocity shall be 6 mm/sec.

e) Noise levels shall be checked and shall be as per clause 2.1.7

f) Agitator shaft RPM and motor RPM.

g) Check of satisfactory operation of shut off and retracting arrangement.

4.4 Mechanical Run Test (in water)

If specified in the data sheets, the agitator unit shall be given a load test in water at the vendor's shop. The duration of this test shall be 4 hours unless agreed otherwise between the Purchaser and the vendor. The following parameters shall be recorded during the test:

a) Dynamic shaft deflection adjacent to the mechanical seal/packing/vapor seal.

b) Gear box bearing oil temperature and temperature of bearing housing in stool. The temperature of gear box oil shall not exceed ambient plus 40°C and that of bearing housing shall not exceed room temperature plus 20°C after the temperatures have stabilized.

c) Bearing housing vibrations. Maximum acceptable vibration velocity is 6 mm/sec.

d) Noise levels shall be checked and shall be as per clause. 2.1.7

e) Electrical power input to the motor.

f) Agitator shaft RPM and motor RPM.

g) Check of satisfactory operation of shut off and retracting arrangement.

4.5 Acceptance Test at Site (if specified)

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After the agitator has been installed at site and is ready for test, vendor shall depute his representative to supervise the site acceptance test. All measurements and record of readings shall be done in accordance with para 4.4 above.

5.0 PREPARATION FOR SHIPMENT

5.1 After completion of inspection and tests all exposed machined surfaces and all internal parts shall be thoroughly coated with rust preventive. All exterior parts of the unit, except machined surfaces, shall receive one coat of primer and one coat of synthetic enamel of approved make.

5.2 All untapped openings shall be provided with 4mm thick metal closures with full rubber gaskets and bolted with not less than 4 bolts. Tapped openings not otherwise closed shall be plugged. The end of small piping may be closed with tape.

5.3 The agitator shall be supplied with a name plate containing the following information:

- Manufacturer's Name
- Type and Serial Number of Unit
- Rotational Speed
- Direction of Rotation
- KW Rating
- Tag number of equipment
- P.O. Number

The name plate shall be of stainless steel and relevant information shall be punched onto the same.

5.4 The equipment and spare parts shall be suitably packed, fastened to avoid damage during transit and crated for shipment and outdoor storage for a period of 6 months. 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 clearly identify the equipment contained therein.

6.0 VENDOR DATA

6.1 The Vendor shall submit the mechanical calculations for EIL review. EIL's review of calculation shall not relieve the Vendor of his responsibility in any manner. The fabrication drawings and other documents shall also be submitted in accordance with the requisition/bid document.

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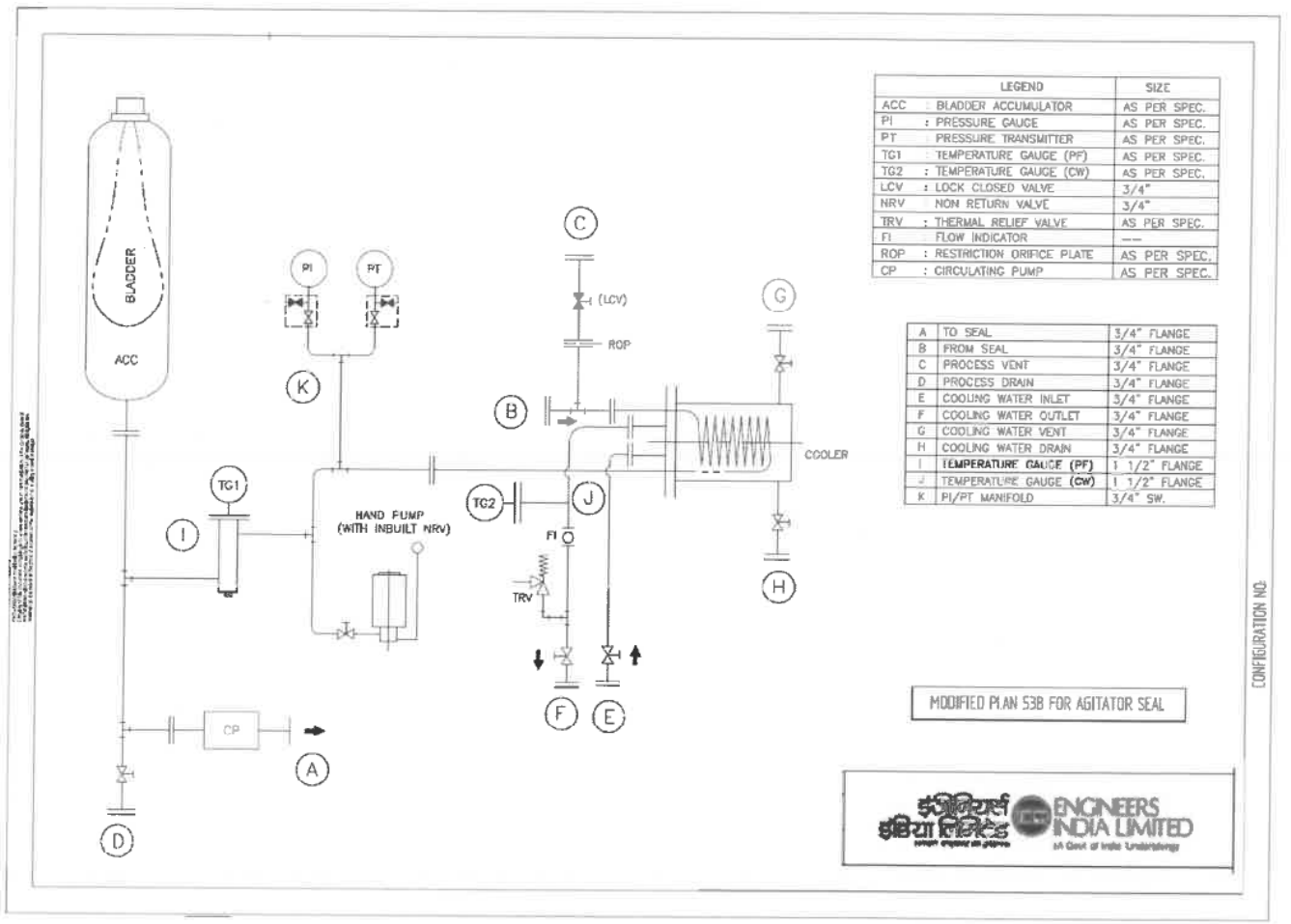
ANNEXURE – I (Modified Plan 53B)



	LEGEND	SIZE
ACC	: BLADDER ACCUMULATOR	AS PER SPEC.
PI	: PRESSURE GAUGE	AS PER SPEC.
PT	: PRESSURE TRANSMITTER	AS PER SPEC.
TG1	: TEMPERATURE GAUGE (PF)	AS PER SPEC.
TG2	: TEMPERATURE GAUGE (CW)	AS PER SPEC.
LCV	: LOCK CLOSED VALVE	3/4"
NRV	: NON RETURN VALVE	3/4"
TRV	: THERMAL RELIEF VALVE	AS PER SPEC.
FI	: FLOW INDICATOR	---
ROP	: RESTRICTION ORIFICE PLATE	AS PER SPEC.
CP	: CIRCULATING PUMP	AS PER SPEC.

A	TO SEAL	3/4" FLANGE
B	FROM SEAL	3/4" FLANGE
C	PROCESS VENT	3/4" FLANGE
D	PROCESS DRAIN	3/4" FLANGE
E	COOLING WATER INLET	3/4" FLANGE
F	COOLING WATER OUTLET	3/4" FLANGE
G	COOLING WATER VENT	3/4" FLANGE
H	COOLING WATER DRAIN	3/4" FLANGE
I	TEMPERATURE GAUGE (PF)	1 1/2" FLANGE
J	TEMPERATURE GAUGE (CW)	1 1/2" FLANGE
K	PI/PT MANIFOLD	3/4" SW.

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उपकेन्द्रीय पम्पों के लिए मानक विनिर्देश (सामान्य प्रयोजन)

STANDARD SPECIFICATION FOR CENTRIFUGAL PUMPS (GENERAL PURPOSE)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	02.12.24	REVISED & ISSUED AS STANDARD SPECIFICATION	AK	JSD/TK	NK	MN
5	09.01.20	REVISED & ISSUED AS STANDARD SPECIFICATION	NGAS	NK	SM	RKT
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2	29.08.03	REVISED & ISSUED AS STANDARD SPECIFICATION	PS	KDS	RK	SKG

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Abbreviations:

ANSI	:	American National Standards Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
DCI	:	Document Control Index
DMW	:	De-Mineralized Water
EC	:	Experience Criteria
engDMS	:	Engineering Electronic Document Management System
ETP	:	Effluent Treatment Plant
GA	:	General Arrangement
HI	:	Hydraulic Institute
IC	:	Internal Combustion
ISA	:	Instruments Society of America
ISO	:	International Organization for Standardization
MAWP	:	Maximum Allowable Working Pressure
MCF	:	Minimum Continuous Flow
MCR	:	Maximum Continuous Rating
MCS	:	Maximum Continuous Speed
NPS	:	Nominal Pipe Size
NPSH	:	Net Positive Suction Head
NPSHA	:	Net Positive Suction Head Available
NPSHR	:	Net Positive Suction Head Required
OD	:	Outside Diameter
P&ID	:	Piping and Instrumentation Diagram
PTR	:	Proven Track Record
RWTP	:	Raw Water Treatment Plant
VDM	:	Vendor Document Management
VDR	:	Vendor Data Requirements

Rotating Equipment Standards Committee

Convenor: Mr. Nalin Kumar

Members:
Mr. Tarun Kumar
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SECTION 1 - GENERAL

1.1 SCOPE

i. This specification together with the attendant Data Sheets and other specifications/attachments to inquiry / order defines the minimum requirements for vertical and horizontal centrifugal pumps and their accessories / auxiliaries for general purpose services [i.e. non-process services & utility services such as De-mineralised Water (DMW) plants, Raw Water Treatment Plants (RWTP), Effluent Treatment Plants (ETP), etc.]. Specifically intended are centrifugal pumps for general purpose which are classified as pumps for applications where maximum pressure by all considerations does not exceed 16.0 kg/cm²g, maximum suction pressure does not exceed 5 kg/cm²g, pumping temperature remains within –29°C to 150°C, Specific gravity is not less than 0.7 at the specified operating conditions or when dual pressurised / un-pressurised mechanical seals are not required/specified. Non-metallic pumps are not covered by this specification.

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 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.

1.3 DEFINITION OF TERMS

1.3.1 The **Normal operating point** is the point at which usual operation is expected.

1.3.2 The **Rated operating point** is the point at which the vendor certifies that performance is within the tolerances stated in this specification.

1.3.3 **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 the equipment is operating at the maximum allowable temperature.

1.3.4 **Maximum allowable temperature** is the maximum continuous temperature for which the

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manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified liquid at the specified pressure.

1.3.5 **Minimum continuous flow (MCF) stable** is the lowest flow at which the pump can operate continuously without exceeding the noise and vibration limits imposed by this specification.

1.3.6 **Minimum continuous flow (MCF) thermal** is the lowest flow at which the pump can operate without its operation being impaired by the temperature rise of the pumped fluid.

1.3.7 The **Pressure casing** is the composite of all stationary pressure containing parts of the unit, including all nozzles, glands and other attached parts.

1.3.8 Unless otherwise specified, **Supplier / Vendor** shall be a manufacturer of centrifugal pumps (general purpose) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete centrifugal pumps (general purpose) package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed centrifugal pumps (general purpose).

1.3.9 **Net positive suction head (NPSH)** is the total absolute suction head, in meters of liquid, determined at the suction nozzle and referred to the datum elevation minus the vapour pressure of the liquid in meters absolute. The datum elevation is the shaft centreline for horizontal pumps, the suction nozzle centreline for vertical in-line pumps and the top of foundation for other vertical pumps.

1.3.10 **Net positive suction head available** (NPSHA) is the NPSH in meters of liquid, determined by purchaser for pumping system with the liquid at the rated flow and normal pumping temperature.

1.3.11 **Net positive suction head required** (NPSHR) is the NPSH in meters, determined by vendor while conducting tests with water. NPSHR is measured at the suction flange and corrected to the datum elevation. NPSHR at rated and other capacities is equal to the NPSH that produces a 3 percent head drop (first stage head in multistage pumps) due to cavitation within the pump.

1.3.12 **Minimum Submergence required** is the liquid level with respect to pump suction flange face, in millimetres, determined by the vendor when testing with water for vertical pumps. This is the level required to prevent vortex formation/ingress of air/vapour into the pump suction resulting in loss of flow/head.

1.3.13 **Rated Speed** is the number of revolutions per minute of the pump required to meet the rated operating conditions. (It should be noted that induction motors will operate at a speed that is a function of the load imposed)

1.3.14 **Critical Speed** is the rotative speed corresponding to a lateral natural frequency of a rotor.

1.3.15 **Maximum Continuous Speed (MCS)** is the speed at least equal to 105% of the highest speed required by any of the specified operating conditions.

1.3.16 **Trip Speed** is the speed at which the independent emergency over-speed device operates to shut down a prime mover.

1.4 REFERENCED PUBLICATIONS

Unless otherwise specified, the editions of the following standards, codes and specifications that are in effect at the time of issue of the inquiry shall, to the extent specified herein form a part of this specification:

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ASME	**American Society of Mechanical Engineers**
B73.1	Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process.
B 16.1	Cast Iron Pipe flanges and flanged fittings
B 16.5	Pipe flanges and Flange fittings (Steel) [(up to NPS 24)]
B 16.47	Large Diameter Steel Flanges [NPS 26 Through NPS 60]
B 16.11	Forged steel fittings, Socket-welding and Threaded
BIS	**Bureau of Indian Standards**
IS:5120	Technical Requirements for Rotodynamic Special Purpose Pumps
HI	The codes, standards, and specifications of the **Hydraulic Institute** (Centrifugal pump section)
ISO	**International Organisation for Standardisation**
ISO:1940	Mechanical Vibration – Balance Quality requirements of Rigid Rotors Part-1: Determination of Permissible Residual Unbalance Part-2: Balance Errors
ISO:5199	Technical specifications for centrifugal pumps Class II.

1.5 EXPERIENCE CRITERIA

1.5.1 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 NPSHR) for the complete range of operation of the offered model shall have been established in the shop test. (Details to be furnished, if required).

The offered pump model with identical hydraulics and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions, bearing span / column length, 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, bearing span / column length would mean approx. 80% or higher)

Multiple references can be furnished to justify the above.

1.5.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump meets the above criteria by furnishing references of flow, head, pressure & temperature, viscosity, driver rating & speed, number of stages (as applicable), bearing span / column length (as applicable), efficiencies, material of construction, bearing design & lubrication. In addition, manufacturer's catalogue and general reference list for centrifugal pump (general purpose) to be furnished along with the proposal.

SECTION 2 - BASIC DESIGN

2.1 GENERAL

2.1.1 The vendor shall have UNIT RESPONSIBILITY of complete centrifugal 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

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drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.

2.1.2 Pumps with constant speed drivers shall be capable of at-least 5 percent head increase at rated condition and pump rated speed by replacing with a new impeller or impellers. Offered impeller shall in no case be less than the minimum diameter impeller.

2.1.3 Horizontal pumps of the close-coupled, the two stage overhung, or the single stage double suction overhung, type shall not be furnished.

2.1.4 Unless otherwise specified, Pumps where difference between NPSHA and NPSHR is 0.6 meter or less are not acceptable. The said NPSHR value shall correspond to the maximum value of NPSHR from rated flow down to the recommended minimum continuous stable flow specified by the vendor. However, for pumps having pump rated BKW up to 55 kW, pumps with margin between NPSHA & NPSHR less than or equal to 1 m are not acceptable.
For Pumps with open discharge valve/auto-start condition, the NPSHR at the 120% of Best Efficiency Point (BEP) flow shall not exceed the NPSHA.
Note: Actual datum for NPSHA (i.e. grade level, top of foundation level or any other level as defined in enquiry) shall be referred from the data sheets forming part of enquiry document.

Pumps fitted with inducers for reducing NPSHR are not acceptable.

2.1.5 Pumps shall have stable head/capacity curves (continuous head rise to shut-off). When parallel operation is specified, the head rise to shut-off from rated point shall be at least 10%. Unless otherwise specified, discharge orifice shall not be used to achieve required head rise to shut off, even in the case of parallel operation.

2.1.6 Pumps that handle liquids more viscous than water, shall have their performance corrected with Performance Correction Chart / Performance Correction formulae of Hydraulic Institute Standard. Correction factors as applicable shall be indicated by the manufacturer on the filled-in data sheet.

2.1.7 The best efficiency point for the furnished impeller is preferred between the rated point and the normal point. However the rated point shall be between 70% to 110% of the best efficiency point of the rated impeller except for intermittent duty applications and pump BKW upto 22 KW.

2.1.8 Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (pump + driver) train shall not exceed 85 dBA measured at 1 meter from pump surface in any direction for the recommended range of operation at site.

2.1.9 The setting depth of vertical submerged pumps shall be worked out to ensure that minimum submergence of the pump is within the boot of vessel / pit.

2.1.10 For vertical pumps, not provided with non-reverse ratchet, vendor shall describe the precaution taken, to prevent damage due to reverse rotation. Vertical pumps shall be provided with their own thrust bearing designed to carry rotor weight and pump generated axial forces and shall not transmit any thrust to the bearings of driver.

2.1.11 Pump-Driver train shall be designed to be suitable for outdoor installation without roof.

2.1.12 Typical cooling plans shall be as per Annexure-A. Piping shall extend upto the edge of base plate. Gate Valve shall be provided in the inlet line. Globe valve along with sight flow glass shall be provided in the outlet line. A thermal relief valve shall also be provided in each isolatable cooling water circuit.

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2.1.13 Oil reservoirs and housings that enclose moving lubricated parts (such as bearings, shaft seals, highly polished parts, instruments and control elements) shall be designed to minimise contamination by moisture, dust and other foreign matter during periods of operation & idleness.

2.1.14 Unless otherwise specified, cooling water systems shall be designed for the conditions specified in Table-1. Provision shall be made for complete venting and draining.

Table-1: Design Conditions for Cooling Water System

Velocity over heat exchanger surface	:	1.5 - 2.5 m/sec.
Maximum Allowable Working Pressure	:	$\geq$ 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

2.1.15 All equipment shall be designed to permit rapid and economical maintenance. Major parts such as casing components and bearing housings shall be designed (shouldered or doweled) to ensure accurate alignment on reassembly.

2.1.16 Lifting lugs/eye hooks shall be provided for ease of lifting of complete pump as well as the heavy maintenance components of the pump.

2.1.17 Pumps with variable speed drivers shall be capable of operating continuously upto 105 percent of rated speed as well as operating briefly upto driver trip speed.

2.1.18 Casing vents alongwith vent valves, as per manufacturer standards, for all pumps shall be provided. For all horizontal pumps, casing drain with isolation valve and flanged piping terminated at the skid edge shall be provided. Baseplate shall also be provided with flanged drain connection.

2.2 PRESSURE CASINGS

2.2.1 MAWP for all pressure containing parts e.g. casing, bowl, discharge head, discharge pipe, column pipe (in case of vertical turbine type pump), stuffing box etc. shall in no case be less than the maximum discharge pressure produced by the pump at shut-off (including tolerances) considering maximum specific gravity, at the maximum suction pressure, for the rated impeller diameter and the maximum continuous speed.
Note: Shut-off pressure for vertical pumps shall be calculated at the delivery flange at the top of mounting plate in the same way bowl head is calculated, since the shut-off head corresponds to the rated impeller, at the Pump casing discharge flange.
MAWP shall also not be less than the specified downstream design pressure.
These pressure-containing parts shall be suitable for hydrostatic test pressure of 1.5 times the MAWP.
MAWP shall also not be less than pressure temperature rating of ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24) Class 150 flanges for the material used.
Note: In any case, MAWP shall not be less than 16 kg/cm^{2}G for pumps with 150# flanges (i.e. with Carbon Steel or Alloy Steel casing).

2.2.2 Flanged nozzle connections shall be offered for all sizes and all applications (all vertical & horizontal single & two stage pumps shall have suction flanges designed for the same

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pressure as discharge flanges). Unless otherwise stated, flanges shall be machined and drilled conforming to ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24).

2.2.3 Cavities of the Pressure Casing that are not self venting type, shall be equipped with a vent connection of ½" size as a minimum.

2.2.4 Pump Casing shall be provided with low point casing drain with minimum drain size of ¾", piped up to the end of baseplate with block valve & blind flange.

Casing shall be provided with drain connection with nipple, threaded and seal welded and provided with a socket welded gate valve terminated at edge of the base plate. Gate valve shall be of 800# rating with material of construction equal or superior to the pump casing. Unless made self venting casing design, vent connections shall be provided with a nipple, threaded and seal welded and terminated with a gate valve. Pressure gauge connection shall not be provided unless specifically required in the inquiry.

Note: In case threaded/seal welded connections for drain and vent are not possible as per manufacturer's standard design, bolted connections for drain and vent may be provided subject to field proven past supplies.

2.2.5 Radially split casings shall have gaskets (including mechanical seal plate gaskets) externally confined. Radially split casing pumps shall be designed to permit removal of the impeller(s), shaft, bearings without disassembling the suction or discharge piping.

2.2.6 In the event that nozzle sizes of 32 mm (1¼ 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 raised face (RF) along with gaskets & fasteners shall be supplied with the pumps. The metallurgy of the companion flanges shall be same as casing metallurgy or superior.

2.2.7 Vendor shall furnish the permissible external forces and moments that can be withstood by suction and discharge nozzles of pump constructed of steel, alloy steel and cast iron material. While computing the permissible external forces and moments, vendor shall take into account the following as a minimum:

a) Effect of operating temperature.
b) Size of the pump i.e. discharge nozzle size.
c) Design of base plate.
d) Shaft displacement at the coupling on the installed pump to a maximum of 127 microns (0.005 inch) in any direction when subjected to the forces and moments as allowed / recommended by vendor, simultaneously to the pump through each nozzle.
e) The maximum allowable forces and moments on the pump nozzles shall be as per Table B.3 of ISO: 5199-2002. Any one Component of force or moment on any nozzle shall be 1.4 times of value as per Table B.3 of ISO:5199-2002. While being simultaneously subjected to maximum allowable forces and moments (as above) through each nozzle, the lateral displacement of the shaft end of the pump shall not exceed the limits as per Table B.4 of ISO-5199:2002.

2.3 IMPELLER, SHAFT & SHAFT SLEEVES

2.3.1 Impellers shall be single piece castings. Fabricated impellers are not acceptable.

2.3.2 Shaft shall be provided with sleeves under the packing/seal and shall be locked to the shaft. The material of sleeve shall be 12 percent chrome steel (hardened). Where the size of pump makes the use of shaft sleeve impracticable, the shaft shall be constructed of 12 percent chrome steel (hardened). For vertical pumps, shaft material shall be 12 percent chrome steel.

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2.3.3 Impellers shall be secured to the pump shaft and shall be retained against circumferential moment by keying. Overhung impellers shall be secured to the shaft by a cap screw or cap nut that does not expose shaft threads. Impellers shall be positively locked by mechanical locking method.

2.3.4 Impellers shall have solid hubs.

2.3.5 Shaft shall be of ample size to transmit the maximum torque required under any specified operating condition including 105% speed for variable speed drive.

2.4 WEAR RINGS

2.4.1 Unless otherwise specified, renewable wear ring shall be furnished at least on the casings. Mating wear surfaces of hardenable materials shall have a difference in Brinell hardness number of at least 50. Integral impeller wear surfaces shall have higher hardness than that of the casing wear rings, when only casing wear rings are provided.

2.4.2 Renewable wear rings shall be held in place by a press fit with locking pins or threaded dowels or by flanged and screwed methods. Tack welding is not acceptable.

2.4.3 Vendor shall also furnish in the proposal the maximum permissible running clearance, which in no case shall be less than twice the minimum diametrical running clearances as specified below:

Table 2: Minimum Running Clearances

Diameter of Rotating Member at Clearance (mm)	Minimum Diametrical Clearance (mm)
< 50	0.25
50 – 64.99	0.28
65 – 79.99	0.30
80 – 89.99	0.33
90 – 99.99	0.35
100 – 114.99	0.38
115 – 124.99	0.40
125 – 149.99	0.43

For diameters greater than 149.99 mm, the minimum diametrical clearance shall be 0.43 mm plus 0.025 mm for each additional 25 mm.

Note: While selecting the running clearances, galling tendency of the offered wear rings shall be taken into consideration.

2.5 MECHANICAL SEAL

2.5.1 The mechanical seal shall be of a make, duly approved by the purchaser.

2.5.2 Only balanced type mechanical seal shall be furnished.

2.5.3 Seal manufacturers specific recommendation shall be obtained and submitted along with the proposal.

2.5.4 In case vendor has any reservation to the flushing plans and/or seal material selection, the vendor shall submit alternate proposal supported by seal manufacturer's recommendation.

2.5.5 All auxiliaries for flushing of mechanical seal shall be in vendor's scope of supply. For details of seal flushing plans, refer Annexure-A.

2.5.6 Jackets shall be provided on pump seal chamber, in case the pumping temperature is above

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120°C or with dead ended seal arrangement.

2.5.7 Requirement of the throat bushing shall be decided by the vendor to suit the operating conditions.

2.5.8 In case, the pump is to be supplied with packings, the stuffing box shall have minimum five packing rings plus lantern ring. Packing ring size shall be 3/8" or larger.

2.6 BEARINGS & BEARING HOUSINGS

2.6.1 Antifriction bearings 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.

2.6.2 The rise in bearing grease/oil temperature with continuous running of the pump 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. Bearings shall be equipped with constant level oilers, vent breather & drain point for oil lubricated arrangements.

2.6.3 Jacketed bearing housing shall be provided for pumping temperatures of 160°C and above. Cooling coils are not acceptable.

2.6.4 Sleeve bearing pumps shall be arranged so as to permit measurement of shaft vibration adjacent to at-least one bearing.

2.6.5 For self lubricated vertical pumps, the guide bushing shall be suitable for dry running start-up. For vertical pumps handling liquid containing solids, external lubrication arrangement for line-shaft bearings may be provided.

2.6.6 **Vibrations**

2.6.6.11 The un-filtered vibration for all anti-friction bearing pumps, measured on the bearing housing during the shop test at rated speed and capacity ±10% shall not exceed a velocity of 7.6 mm/sec (0.3 inch/sec) peak nor exceed a displacement of 63.5 micrometer (2.5 mils) peak-to-peak (including shaft run-out). The filtered vibration at running speed frequency, blade-passing frequency or frequencies etc. shall not exceed a velocity of 5.1 mm/sec (0.2 inch/sec) peak.

2.6.6.22 The un-filtered vibration for all sleeve bearing pumps, measured on the bearing housing during the shop test at rated speed and capacity ±10% shall not exceed a velocity of 10.2 mm/sec (0.4 inch/sec) peak nor exceed a displacement of 63.5 micrometer (2.5 mils) peak-to-peak (including shaft run-out). The filtered vibration at running speed frequency, blade-passing frequency or frequencies etc. shall not exceed a velocity of 7.6 mm/sec (0.3 inch/sec) peak.

2.6.6.33 The vibration limits specified vide clause. 2.6.6.1 and 2.6.6.2 above shall be applied for pumps only. The vibration limits for the drivers shall be as per their respective applicable standards. Where respective applicable standards do not specify such limits for the associated drivers, the driver manufacturer's recommendation shall be applied for acceptance of the driver. Such acceptable limits shall be indicated by the vendor in their proposal.

2.7 MATERIALS

2.7.1 The material of construction of pump parts shall be in accordance with pump data sheet.

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Vendor shall furnish the equivalent material as per ASTM.

2.7.2 Unless otherwise specified in the data sheet, material test certificates (chemical and mechanical properties) shall be supplied for impeller, shaft, shaft sleeve, wearing rings and casings.

2.7.3 The repair of pressure castings by peening, plugging, impregnating or by the use of plastic or cement compound is prohibited. The Inspector's prior approval shall be obtained for the repair of castings. When authorised, repair shall be carried out in accordance with applicable ASTM Specification. Weld repair of pressure containing parts of Cast Iron construction is not permitted.

2.7.4 As a minimum, the components of the pumps shall be subjected to following tests and the test certificates furnished to the Purchaser accordingly:

a) Shaft, Impeller, Pressure Casing: Chemical Analysis and Tensile Test
b) Wearing rings, bushing and sleeve: Chemical Analysis and hardness.

Material Compliance Certificate can also be considered for wearing rings, bushing and sleeve

2.7.5 For Carbon Steel construction pumps, in caustic services, the pressure containing components as well as any welding performed on these, shall be stress relieved.

2.8 DYNAMICS

2.8.1 Actual critical speed shall not encroach upon the specified operating speed range. The separation margin of encroachment from all lateral modes shall be at least 20% over the maximum continuous speed for rigid rotors. This condition shall be satisfied for the entire range from the design running clearances upto the maximum permissible clearance.

2.8.2 The limits of vibration as specified in 2.6.6 shall also be applicable for the maximum clearances as specified in 2.4.3.

2.8.3 Torsional analysis shall be performed when the driver is IC engine or the drive is through a gear box. Torsional modes of the complete unit shall be at least 10% below any operating speed or at least 10% above trip speed.

SECTION 3 - ACCESSORIES

3.1 DRIVER

3.1.1 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.

Pump Rated BKW *		**Motor MCR**
Less than 22 kW	:	To suit maximum BKW indicated on pump data sheet or 125% of rated pump BKW, whichever is higher.
22 kW - 55 kW	:	115% of rated pump BKW.
Higher than 55 kW	:	110% of rated pump BKW.

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

Note :

1. The motor nameplate rating for pumps under parallel operation or for pumps with auto-start operation, shall not be less than the max. BKW indicated on pump data sheet (Power at End of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable

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for start-up under open discharge valve condition.

2. The motor nameplate rating for applications where the specific gravity of pumped fluid is less than 1.0 shall either be 100% of the BKW of pump at minimum continuous stable flow with clean cold water of sp. gravity 1.0 or shall have the specified margin as per this clause, whichever is greater.

3.1.2 Steam Turbine rating shall be at-least 110% of rated pump BKW (unless higher rating is dictated by Note 1 and/or Note 2 above) at the rated speed with coincident minimum inlet & maximum exhaust steam conditions.

3.2 COUPLING & GUARDS

3.2.1 Coupling shall be of forged steel and of non lubricated, laminated disc type, with stainless steel/monel laminations. A spacer coupling (127mm minimum normal length) shall be used unless otherwise specified. The spacer length shall permit the removal of coupling, bearings, seal and/or rotor as applicable without disturbing the driver or the suction and discharge piping. It shall be the responsibility of the pump Vendor to obtain Purchaser's approval for the selected coupling, its make and rating.

3.2.2 Coupling shall be dynamically balanced in accordance with grade 2.5 as per ISO 1940 and a certificate to this effect shall be furnished.

3.2.3 Whether or not pump vendor is required to mount the driver the vendor shall still deliver the fully machined coupling assembly alongwith the pump. The driver shaft dimensions and tolerances shall be furnished by the Purchaser to the pump vendor.

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 pump vendor that the allowable shaft stresses of the pump train are not exceeded under any circumstances including any offset condition or conditions of maximum torque. For pump trains having gear-box, the coupling service factor shall not exceed the gear-box service factor.

3.3 BASEPLATE

3.3.1 Baseplate shall extend under the pump, gear box and motor/turbine driver and shall be fully machined for mounting the above equipment. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate. Baseplate shall be steel fabricated and shall have sufficient rigidity to avoid vibration and distortion. Baseplate shall be so designed as to facilitate proper grouting (Vent holes where required shall be provided). Baseplate shall be cleaned (sand blasted) inside and outside and coated with suitable anticorrosion paint.

Drain Pan Type Baseplate surrounding the entire baseplate to be provided. Baseplate to be provided with minimum 2" flanged drain connection.

3.3.2 The length shall be atleast equal to the overall length of the pump and drive-train assembly.

3.3.3 Unless otherwise specified, base plate for all sizes of pump shall be grouted. Type of grout material and technical details shall be furnished by vendor in his proposal.

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3.3.4 For driver trains over 18.5 kW, alignment positioning screws shall be provided for each drive element to facilitate longitudinal and transverse horizontal adjustments. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the drive element.

Vertical leveling screws, spaced for stability shall be provided on the outside perimeter of the baseplate. These shall be numerous enough to carry the weight of the baseplate, pump, gear-box (if any) and driver without excessive deflection.

3.3.5 Pumps in corrosive service shall have provision to collect and drain the leakage from mechanical seal or packing, through drip pan of metallurgy equivalent or superior to pump casing. Leakages from drip pan shall be piped to baseplate with a flanged connection for onwards disposal by purchaser. Where the design prohibits the provision of drip pan, the material of bearing bracket shall be suitable for the corrosive service.

3.3.6 The baseplate shall be provided with lifting lugs for at-least a four point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the baseplate or machinery mounted on it.

3.3.7 **Mounting Plates for Vertical Pumps**
Unless otherwise specified, mounting plate for vertical pumps shall be having a minimum thickness of 48 mm and is to be made from IS:2062/IS:2002 plate material or can be of the same material as that of vessel / tank. Mounting plate shall be supplied with gaskets (as applicable) & fasteners.

Alignment positioning screws shall be provided for all motors.

3.4 **PIPING & APPURTENANCES**

3.4.1 Cooling water, lube oil and auxiliary process piping including all accessories such as gauges, valves, shall be furnished by the manufacturer fully assembled and installed on horizontal pumps and where practical on vertical pumps. All piping & appurtenances shall be located within the confines of baseplate.

3.4.2 Vendor shall provide gate valve at C.W. inlet line and Globe valve at the return line. Gate valve shall conform to API 602 with ASTM A105 body as CS + 13% Cr steel trim. Globe valve shall conform to BS5532 800# SW ASTM A105 Body and CS+13% Cr steel.

3.4.3 Unless otherwise specified, Carbon Steel piping conforming to A106 Gr.B Sch 80 shall be provided for cooling water. Socket welded/flanged connections shall be employed. Connections to pump pedestal, stuffing box jacket or bearing housing jacket shall be screwed.

3.4.4 Sight flow indicator shall be provided in each cooling water outlet line. Sight flow indicator shall have ball or flag for easy verification of water flowing through pipes. Thermal relief valve (in each isolatable cooling water circuit) shall be provided upstream of globe valve on the cooling water outlet line.

3.4.5 Temperature indicator at the outlet of each mechanical seal flushing fluid cooler shall be provided. As specified in the inquiry/order, instruments associated with seal flushing plans e.g. pressure gauges, pressure transmitters, level gauges, level transmitters, flow indicator etc. shall be provided. The switches shall be suitable for the specified area classification, supply voltage and contact rating.

3.4.6 Restriction orifice of diameter not less than 3.2 mm in diameter shall be furnished when required.

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3.4.7 Unless otherwise specified, material for mechanical seal flushing fluid cooler shall be as per the following:

Tube or Coil : Type 316 stainless steel or Monel.
Shell : Carbon Steel

Cooling medium shall be re-circulating cooling water which shall be on the shell side.

3.4.8 In case where operating condition warrants use of orifice and flushing fluid cooler in flushing plan for mechanical seal, flushing fluid cooler shall be installed upstream of orifice.

SECTION 4 - INSPECTION AND TESTS

4.1 GENERAL

4.1.1 Unless otherwise specified, all pumps shall be inspected and all tests shall be witnessed by the Purchaser or by the Purchaser's authorised representative.

4.1.2 Purchaser's or their authorised representative shall have access to the plant including sub vendors plants where work on or testing of equipment is being performed.

4.1.3 No surfaces of parts of pumps are to be painted until the inspection is completed.

4.1.4 Vendor shall give to the purchaser at-least 15 days notice prior to commencement of testing. Vendor shall carry out all running tests and mechanical checks and satisfy himself prior to purchaser's arrival for inspection and shall maintain desired log of tests.

4.1.5 Acceptance of shop test shall not constitute a waiver of requirement to supply equipment as per specification and/or to meet field test under operating condition, nor does inspection relieve the manufacturer of his responsibility in any way whatsoever.

4.1.6 Pump shall be unitised, along with job driver at pump manufacturer's works.

4.1.7 **Inspection & Testing requirements:**

A. Pump-Centrifugal Horizontal (GPP)

Sno.	Inspection & Tests	Scope of Inspection (Note-1)	
1	Shop Test / Inspection	R	
2	Material Certificates	R	
3	Hydrostatic test	R	
4	Performance Test / Sound level Test	Upto 55 kW	R
		55 kW to 160 kW	W (1 per tag)
		More than 160 kW	W (all tags)
5	NPSH Test as required (as per specification)	Upto 55 kW	NR (Note-2)
		55 kW to 160 kW	W (1 per tag)
		More than 160 kW	W (all tags)
6	Dismantle Inspection & Re-assembly after test	W (Note-3)	
7	Unitization / Check of direction of rotation of pump	R (but not required for PMC jobs; to be governed by contractor's quality plan)	
8	Visual, dimension and skid completeness check	W (Conventional jobs) R (PMC jobs)	

B. Pump-Centrifugal Vertical (GPP)

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Sno.	Inspection & Tests	Scope of Inspection (Note-1)
1	Shop Test / Inspection	R
2	Material Certificates	R
3	Hydrostatic test	R
4	Performance Test / Sound level Test	W
5	Minimum Submergence Test (for Vertical pumps)	W
6	Dismantle Inspection & Re-assembly after test	W (Note-3)
7	Unitization / Check of direction of rotation of pump	O (but not required for PMC jobs; to be governed by contractor's quality plan)
8	Visual, dimension and skid completeness check	W (Conventional jobs) R (PMC jobs)

Legends:

R: Required: Reviewing of manufacturer's shop test reports shall be considered as adequate.

O: Observed: Purchaser shall be notified but work may proceed after scheduled date.

W: Witnessed: A HOLD shall be applied and work shall not proceed without approval.

NR: Not Required.

Notes:

1. The inspection & test requirements specified are applicable for each pump unless otherwise specified.
2. For pumps up to 55 kW, during evaluation of bids, no pumps with margin between NPSHA & NPSHR less than or equal to 1m shall be accepted.
3. 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.

4.2 **TESTS**

Following tests shall be performed, as a minimum. The basic reference standard shall be the latest edition of HI or IS:5120.

4.2.1 **Hydrostatic Test**

4.2.1.1 Pressure casings including column pipe and discharge head (if any) shall be hydrostatically tested with water at ambient temperature at 1½ times the maximum allowable working pressure specified in the data sheet.

4.2.1.2 Jackets for bearing, stuffing box, coolers, etc, shall be tested at 1½ times the maximum allowable jacket working pressure.

4.2.1.3 Hydrostatic test shall be maintained for a minimum period of 30 minutes.

4.2.2 **Performance Test**

4.2.2.1 Unless specifically agreed upon, each pump shall be tested within ±3% of the rated speed specified in the data sheet with calibrated motors, atleast for four hours. During the four hour run test, complete data including pressure, capacity, power, vibration levels, bearing temperatures and noise levels (for records only) shall be recorded and guaranteed parameters verified.

4.2.2.2 The pump shall be tested with water at ambient temperature.

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4.2.2.3 The tolerance of the guaranteed parameters shall be as follows:

Rated head	:	Zero negative tolerance.
Shut-off head	:	Zero negative tolerance. Positive tolerance permitted as long as the downstream design pressure is not exceeded. Negative tolerance permitted so long as the curve is continuously rising to shutoff without any drooping and minimum 110% head rise to shutoff shall be available for pumps in parallel operation. Note: As a guideline, shut-off head is generally 120% of rated head for horizontal pumps and 140% for vertical pumps.
Min. Submergence required (for vertical pump) / NPSH(R)	:	Zero Positive Tolerance.
Rated BKW	:	Zero positive tolerance (However pumps may be accepted upto 104 percent of Guaranteed BKW subject to Penalties as defined elsewhere)

As a minimum, data at Shut-off (no vibration data required), minimum continuous stable flow, midway between minimum and rated flow, rated flow and maximum allowable flow (as a minimum, 120% of best efficiency flow), shall be measured and recorded during tests. All the instruments used for conducting the tests shall be calibrated before tests and calibration certificates furnished from a recognised testing institution to the Inspector.

4.2.2.4 Engine driven horizontal and vertical pumps shall be subjected to a 4 hour complete unit string test at the pump vendor's works during which mechanical performance of the train shall be verified, in terms of vibration, bearing/oil temperature, engine parameters and controls. If there are multiple units of Engine driven pumps, then only one unit shall be subjected to complete unit string test at pump vendor's works. Any modification due fault noticed in the tested unit shall also be carried out in the other units.

4.2.2.5 During the performance test, rise in temperature of bearing oil shall be measured and results recorded on the test log. Values shall not exceed those given in 2.6.2.

4.2.2.6 During the performance test, the equipment shall be checked for its sound level, values shall not exceed those given in 2.1.8.

4.2.3 **NPSH Test / Min. Submergence Test**

Unless otherwise specified, NPSH test (for pumps beyond 55 kW) shall be carried out where difference between NPSH available and NPSH required is 1 meter or less at the Rated point.

In case of vertical pumps, all pumps shall be subjected to minimum submergence test. Testing for NPSH is not required for Vertical pumps.

Test points shall be similar to those of Performance test.

4.2.4 **Vibration Measurement**

During performance test vibration shall be measured on the bearing housing for the capacity range from pump MCF to 110% of rated capacity.
For checking the vibration, flat surface shall be provided on bearing housing by pump manufacturer, as per manufacturer's standards. The vibrations shall be within the limits as specified in clause no. 2.6.6.

4.2.5 **Dismantling Inspection**

Dismantle inspection of pump after performance test shall be applicable only in case of

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abnormality in mechanical behaviour (such as excessive noise and vibration, bearing temperature rise etc.) during performance test.

If it is necessary to dismantle a pump after the performance test for the sole purpose of machining impellers to meet the tolerances for differential head, no re-test will be required unless the reduction in diameter exceeds 5 percent of the original diameter. The diameter of the impeller at the time of shop test, as well as the final diameter of the impeller, shall be recorded on a certified shop test curve that shows the operating characteristics after the diameter of the impeller has been reduced.

If it is necessary to dismantle a pump for some other correction, such as improvement of power, NPSH, or mechanical operation, the initial test will not be acceptable, and the final performance test shall be run after the correction is made.

4.2.6 **Final Inspection**

After the performance/dismantle test the pump and the job driver shall be unitised on the job base plate, aligned and coupled to make a complete unit. The pump will then be checked for visual inspection to confirm compliance to the GA drawings, nozzle dimension and facing, elevations, anchor bolts position, direction of rotation etc.

4.2.7 Prior to start of tests, vendor shall furnish the following:

1. Certificate of calibration of driver, which should be recalibrated after a period of every three years.
2. Certificate of calibration of measuring instruments, which should be recalibrated after a period of every one year. Magnetic flowmeters shall be recalibrated once in two years. Pressure gauges shall be calibrated prior to start of test and after completion of test.
3. Record of all running test and mechanical checks (including test curves and data) completed prior to purchaser's inspection.

4.2.8 Unless otherwise specified in the data sheet, the following tests shall also be performed on each pumps:

1. Dynamic balancing of impellers for Overhung pumps (Observed).
2. Other tests (if any) as specified elsewhere.

4.3 PREPARATION FOR SHIPMENT

4.3.1 The equipment shall be suitably prepared for shipment after all tests & inspections have been completed and equipment has been released by the purchaser. All exposed mechanical surfaces and all internal parts shall be thoroughly coated with a rust preventive. All exterior parts of the unit except machined surfaces shall receive one prime coat and one coat of vendor's standard enamel.

4.3.2 All flanges, nozzles shall be blanked off. All untapped openings shall be provided with substantial wood or metal closure. The ends of small piping may be sealed with tape.

4.3.3 The pump shall be supplied with a nameplate containing the following information:

- Purchaser's Item No.
- Manufacturer's Name
- Type and Serial No
- Rated capacity in m3/hr.
- Differential head at rated capacity in m.
- Casing hydrostatic test pressure in kg/cm².
- Speed in rpm.

The nameplate shall be of stainless steel and relevant information shall be punched into the same.

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4.3.4 All auxiliary, dismantled and packed separately shall be properly marked with the Item No. for which it is intended by means of metal tag.

4.3.5 The pump shall be suitably packed, fastened to avoid damage during transit and crated for shipment and storage for a period of 12 months. 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 of lifting points, gross weights and dimensions be clearly marked on each package. Each package shall clearly identify the equipment contained therein. 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 listed under "PRINTS WITH QUOTE" in the enclosed Vendor Data Requirement Form.
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 specs.
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 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 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 forms. 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

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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 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 forms 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 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.

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**

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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 (8½" x 11") size.

5.2.3.3 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) 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 center 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.
xiv) Line diagram of sealing piping indicating direction of flow of fluid by arrow and inlet and outlet.

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/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.

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ix) Total mass of rotating parts.
x) Total mass of reciprocating parts (in case of engine driven units).
xi) Suggested dynamic factor and ratio of weight of foundation to weight of machine.
xii) Short circuit loads caused in motor drivers.
xiii) Operating speed of the machine and the driver.
xiv) Scope of Supply of the Foundation Bolts (unless otherwise specified, by vendor).
xv) 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).
xvi) 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.]

c) **Heat Exchanger Drawings**

Heat exchanger drawing and data shall include heat and mass balance data, details of provisions for separating and withdrawing the condensate, construction details, cross sections & general arrangement drawings of heat exchangers, vendors recommendations regarding provision for support and piping expansion.

5.2.3.4 **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.

5.2.4 **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 head, power recalculated to the proper specific gravity and efficiency plotted against capacity. If applicable, viscosity corrections shall be indicated. If NPSHR test is specified, the water NPSHR curve (drawn upto minimum continuous flow) shall also be included. The curve sheet shall include the maximum and minimum diameters of the impeller design supplied, the eye area of the first stage impeller, the identification number of the impeller or impellers and the pump serial number.

5.2.5 **Data Sheet**

5.2.5.1 The Vendor shall provide completely filled in data sheets, first for "as purchased" and then

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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 Catalogues**

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) 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. It shall also contain the following information:

(a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centerline 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.

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, 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,

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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 data with permissible unbalance.

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 (ASTM) etc.to facilitate identification of parts and for procurement of spares.

v) Following information shall also be included in the Technical Data Manual/Mechanical Catalogue:

a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.

b) 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.

5.2.6.3 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.

5.2.6.4 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 manuals / 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.

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ANNEXURE – A

Seal Flushing Plans for Primary Seals

Plan 01	:	Integral (Internal) re-circulation from pump discharge to seal.
Plan 02	:	Dead ended seal box with no circulation of flush fluid. Water cooled box jacket and throat bushing required unless otherwise specified. Plugged connections for possible future use of circulation of flush fluid to be provided.
Plan 11	:	Recirculation from pump discharge case through orifice to seal.
Plan 12	:	Recirculation from pump discharge case through strainer and orifice to seal.
Plan 13	:	Recirculation from seal chamber through orifice to pump suction.
Plan 21	:	Recirculation from pump discharge case through orifice and cooler to seal. Temperature Indicator is to be provided.
Plan 22	:	Recirculation from pump discharge case through strainer, orifice and cooler to seal. Temperature Indicator is to be provided.
Plan 23	:	Recirculation from seal with pumping ring through cooler and back to seal. Temperature Indicator is to be provided.
Plan 31	:	Recirculation from pump discharge case through cyclone separator delivering clean fluid to seal and fluid with solids back to pump suction.
Plan 32	:	Injection to seal from external source of clean fluid. The fluid characteristics shall be indicated in the inquiry/order. The desired pressure (in kg/cm^2g) & consumption (in m^3/hr) to be indicated by vendor.
Plan 41	:	Recirculation from pump case through cyclone separator delivering clean fluid through cooler to seal and fluid with solids back to pump suction.

Seal Flushing Plans for Throttle Bushing, Auxiliary Seal Device

Plan 61	:	Tapped connections for owner's use.
Plan 62	:	External fluid quench (steam, water etc.).

Cooling Water Piping Plans

Plan A	:	Cooling to bearing housing.
Plan B	:	Cooling to bearing housing with parallel flow to seal plate.
Plan C	:	Cooling to stuffing box jacket.
Plan D	:	Cooling to stuffing box jacket with parallel flow to seal plate.
Plan E	:	Cooling to stuffing box jacket & bearing housing in series.
Plan F	:	Cooling to stuffing box jacket & bearing housing in series with parallel flow to seal plate.
Plan G	:	Cooling to pedestals, stuffing box jacket & bearing housing in series.
Plan H	:	Cooling to pedestals, stuffing box jacket & bearing housing in series with parallel flow to seal plate.
Plan J	:	Cooling to stuffing box jacket with parallel flow to cooler.
Plan K	:	Cooling to stuffing box jacket & bearing housing in series with parallel flow to cooler.
Plan L	:	Cooling to pedestals, stuffing box jacket & bearing housing in series with parallel flow to cooler.

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उपकेन्द्रीय पम्प के लिए मानक विनिर्देश (जल सेवा)

STANDARD SPECIFICATION FOR CENTRIFUGAL PUMPS (WATER SERVICE)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	02/12/24	REVISED & ISSUED AS STANDARD SPECIFICATION	MK	JSD/TK	NK	MN
5	09/01/20	REVISED & ISSUED AS STANDARD SPECIFICATION	BBS	JSD	SM	RKT
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3	20/03/08	REVISED & ISSUED AS STANDARD SPECIFICATION	NK	AKN	VKM	VC
2	04/09/02	REVISED & ISSUED AS STANDARD SPECIFICATION	NK	KDS	VJN	GRR

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Abbreviations:

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
CG	:	Centre of Gravity
DCI	:	Document Control Index
EC	:	Experience Criteria
engDMS	:	Engineering Electronic Document Management System
GA	:	General Arrangement
IC	:	Internal Combustion
ISA	:	Instruments Society of America
MAWP	:	Maximum Allowable Working Pressure
MCF	:	Minimum Continuous Flow
MCR	:	Maximum Continuous Rating
MCS	:	Maximum Continuous Speed
NFPA	:	National Fire Protection Association
NPSH	:	Net Positive Suction Head
NPSHA	:	Net Positive Suction Head Available
NPSHR	:	Net Positive Suction Head Required
OD	:	Outside Diameter
P&ID	:	Piping and Instrumentation Diagram
PTR	:	Proven Track Record
VDM	:	Vendor Document Management
VDR	:	Vendor Data Requirements

Rotating Equipment Standards Committee

Convenor: Mr. Nalin Kumar

Members:
Mr. Tarun Kumar
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Mr. Pintu Lal
Mr. Aasheesh K Handa (Projects)

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SECTION 1 - GENERAL

1.1 SCOPE

i. This specification together with the attendant Data Sheets and other specifications/attachments to inquiry/order defines the minimum requirements for vertical and horizontal centrifugal pumps and their accessories/auxiliaries for use in clean, cold water service. Water injection pump, boiler feed water pumps and pumps for sea water services are not covered by this specification.

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 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.

1.3 DEFINITION OF TERMS

1.3.1 The **Normal operating point** is the point at which usual operation is expected.

1.3.2 The **Rated operating point** is the point at which the vendor certifies that performance is within the tolerances stated in this specification.

1.3.3 **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 the equipment is operating at the maximum allowable temperature.

1.3.4 **Maximum allowable temperature** 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 specified liquid at the specified pressure.

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1.3.5 **Minimum continuous stable flow** is the lowest flow at which the pump can operate continuously without exceeding the noise and vibration limits imposed by this specification.

1.3.6 The **Pressure casing** is the composite of all stationary pressure containing parts of the unit, including all nozzles, glands and other attached parts.

1.3.7 Unless otherwise specified, **Supplier / Vendor** shall be a manufacturer of centrifugal pumps (water service) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete centrifugal pumps (water service) package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed centrifugal pumps (water service).

1.3.8 **Net positive suction head** (NPSH) is the total absolute suction head, in meters of liquid, determined at the suction nozzle and referred to the datum elevation minus the vapour pressure of the liquid in meters absolute. The datum elevation is the shaft centreline for horizontal pumps, the suction nozzle centreline for vertical in-line pumps and the top of foundation for other vertical pumps.

1.3.9 **Net positive suction head available** (NPSHA) is the NPSH in meters of liquid, determined by purchaser for pumping system with the liquid at the rated flow and normal pumping temperature.

1.3.10 **Net positive suction head required** (NPSHR) is the NPSH in meters, determined by vendor testing with water. NPSHR is measured at the suction flange and corrected to the datum elevation. NPSHR at rated and other capacities is equal to the NPSH that produces a 3 percent head drop (first stage head in multistage pumps) due to cavitation within the pump.

1.3.11 **Minimum Submergence required** is the liquid level with respect to pump suction flange face, in millimeters, determined by the vendor when testing with water for vertical pumps. This is the level required to prevent vortex formation/ingress of air/vapour into the pump suction resulting in loss of flow/head.

1.4 EXPERIENCE CRITERIA

1.4.1 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 NPSHR) for the complete range of operation of the offered model shall have been established in the shop test. (Details to be furnished, if required).

The offered pump model with identical hydraulics and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions, bearing span/column length, 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, bearing span/column length would mean approx. 80% or higher)

Multiple references can be furnished to justify the above.

1.4.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump meets the above criteria by furnishing references of flow, head, pressure & temperature, driver rating & speed, number of stages, bearing span / column length (as applicable), efficiencies, material of construction, bearing

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design & lubrication. In addition, manufacturer's catalogue and general reference list for centrifugal pump (water service) to be furnished along with the proposal.

SECTION 2 - BASIC DESIGN

2.1 GENERAL

2.1.1 The vendor shall have UNIT RESPONSIBILITY of complete centrifugal 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.

2.1.2 Pumps with constant speed drivers shall be capable of at-least 5 percent head increase at rated condition and pump rated speed by replacing with a new impeller or impellers. Offered impeller shall in no case be less than the minimum diameter impeller.

2.1.3 Horizontal pumps of the close-coupled, the two stage overhung, or the single stage double suction overhung, type shall not be furnished.

2.1.4 Unless otherwise specified, Pumps where difference between NPSHA and NPSHR is 0.6 meter or less are not acceptable. The said NPSHR value shall correspond to the maximum value of NPSHR from rated flow down to the recommended minimum continuous stable flow specified by the vendor. However, for pumps having pump rated BKW up to 55 kW, pumps with margin between NPSHA & NPSHR less than or equal to 1 m are not acceptable.
For Pumps with open discharge valve/auto-start condition, the NPSHR at the 120% of Best Efficiency Point (BEP) flow shall not exceed the NPSHA.
Note: Actual datum for NPSHA (i.e. grade level, top of foundation level or any other level as defined in enquiry) shall be referred from the data sheets forming part of enquiry document.

Pumps fitted with inducers for reducing NPSHR are not acceptable.

2.1.5 Pumps shall have stable head/capacity curves (continuous head rise to shut-off). When parallel operation is specified, head rise shall be at least 10 percent of the head at the rated capacity. The shut off head shall not be more than 120 percent of the rated head in horizontal pumps and 140 percent in the case of vertical turbine pumps. In no case shutoff pressure shall exceed downstream design pressure. Unless otherwise specified, discharge orifice shall not be used to achieve required head rise to shut off, even in the case of parallel operation.

2.1.6 The best efficiency point for the furnished impeller is preferred between the rated point and the normal point. However the rated point shall be between 70 to 110 percent of the best efficiency point of the rated impeller except for intermittent duty applications and for pumps having rated BKW upto 22 kW.

2.1.7 Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (pump + driver) train shall not exceed 85 dBA measured at 1 meter from pump surface in any direction for the recommended range of operation at site.

2.1.8 For vertical pumps, not provided with non-reverse ratchet, vendor shall describe the precaution taken, to prevent damage due to reverse rotation.
Vertical pumps shall be provided with their own thrust bearing designed to carry rotor

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weight and pump generated axial forces and shall not transmit any thrust to the bearings of driver.

2.1.9 Pump-Driver train shall be designed to be suitable for outdoor installation without a roof.

2.1.10 Lifting lugs/eye hooks shall be provided for ease of lifting of complete pump as well as the heavy maintenance components of the pump (e.g. Top half casing cover of axially split pump).

2.1.11 The guaranteed parameters shall be demonstrated during shop test without any coating on impellers or casings.

LCWP (Horizontal/vertical) shall be internally coated after pump performance test to improve the pump efficiency to the extent possible. One pump per tag will be performance tested (testing procedure similar to pump tested without coating) after coating to witness the actual improvement in efficiency.

2.1.12 Pumps with variable speed drivers shall be capable of operating continuously upto 105 percent of rated speed as well as operating briefly upto driver trip speed.

2.1.13 Casing vents alongwith vent valves, as per manufacturer standards, for all pumps shall be provided. For all horizontal pumps, casing drain with isolation valve and flanged piping terminated at the skid edge shall be provided. Baseplate shall also be provided with flanged drain connection.

2.1.14 Horizontal between bearing pumps, pumps with rated flow above 500 m3/hr (horizontal) and pumps with rated flow above 100 m3/hr (vertical) shall be considered as Large Capacity Water Service (LCWS).

2.2 PRESSURE CASING DESIGN

2.2.1 Maximum allowable working pressure (MAWP) for all pressure containing parts e.g. casing, bowl, discharge head, discharge pipe, column pipe (in case of vertical turbine type pump), stuffing box etc. shall in no case be less than the maximum discharge pressure produced by the pump at shut-off (including tolerances), at the maximum suction pressure, for the rated impeller diameter and the maximum continuous speed.
Note: Shut-off pressure for vertical pumps shall be calculated at the delivery flange at the top of mounting plate in the same way bowl head is calculated, since the shut-off head corresponds to the rated impeller, at the Pump casing discharge flange.

MAWP shall also not be less than the specified downstream design pressure.

These pressure containing parts shall be suitable for hydrostatic test pressure of 1.5 times the MAWP.

Note: MAWP shall not be less than 10 kg/cm²g for pumps with 125# flanges (i.e. with Cast Iron casing) & 16 kg/cm²g for pumps with 150# flanges (i.e. with Carbon Steel or Alloy Steel casing).

2.2.2 Pumps shall have suction and discharge flanges designed for same rating. Unless otherwise stated, flanges shall be machined and drilled conforming to ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24).

2.2.3 Pumps shall be provided with Flanged nozzles.

2.2.4 Unless otherwise specified, all pumps shall be supplied with companion flanges with rating conforming to applicable specification of ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24), drilled and faced in accordance with pump suction

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and discharge flanges alongwith gaskets and fasteners.

For pumps with casing material as cast iron (CI), the companion flanges shall be of slip-on (SO) type [for flange sizes 50 mm (2 inches) & above] or socket welded (SW) type [for flanges of size 15 mm (0.5 inches) to 40 mm (1.5 inches)] with flat face (FF) & of carbon steel material. The gasket shall be of full face type.

For pumps with casing material other than cast iron, the companion flanges for pump suction and discharge connections shall be of weld neck (WN) type with raised face (RF) & of the material compatible with piping material.

2.3 IMPELLER, SHAFTS AND SHAFT SLEEVES

2.3.1 Impellers shall be cast as one piece.

2.3.2 Shaft shall be provided with sleeves under the packing/seal and shall be locked to the shaft. The material of sleeve shall be 12 percent chrome steel (hardened). Where the size of pump makes the use of shaft sleeve impracticable, the shaft shall be constructed of 12 percent chrome steel (hardened). For vertical pumps, shaft material shall be 12 percent chrome steel.

2.4 WEAR RINGS

Unless otherwise specified, renewable wear ring shall be furnished at least on the casings. Mating wear surfaces of hardenable materials shall have a difference in Brinell hardness number of at least 50. Integral impeller wear surfaces shall have higher hardness than that of the casing wear rings, when only casing wear rings are provided.

2.5 DYNAMICS

The following vibration limits shall be applied at rated speed and at flow of ±10 percent of rated flow.

2.5.1 **Horizontal Pumps**

Unfiltered vibration velocity (peak) for horizontal pumps upto 3000 rpm with antifriction bearing or sleeve bearings when measured at the bearing housing in horizontal or vertical direction shall not exceed 4.0 mm/sec (0.16 inch/sec).

Bearing housings shall be suitable to permit measurement of vibration.

2.5.2 **Vertical Pumps**

Unfiltered vibration velocity (peak) for vertical pumps with antifriction and or sleeve bearings when measured at the top bearing housing of pump or top bearing housing of motor or mounting flange for measuring points upto 3 meters above the mounting base shall not exceed the following limit:

Pumps greater than 1500 rpm	=	7.0 mm/sec (0.28 inch/sec)
Pumps upto & including 1500 rpm	=	5.1 mm/sec (0.2 inch/sec)

2.5.3 The vibration limits (peak) specified vide clause. 2.5.1 and 2.5.2 above shall be applied for pumps only. The vibration limits for the drivers shall be as per their respective applicable standards. Where respective applicable standards do not specify such limits for the associated drivers, the driver manufacturer's recommendation shall be applied for acceptance of the driver. Such acceptable limits shall be indicated by the vendor in their proposal.

2.6 MECHANICAL SEAL/PACKING

2.6.1 Unless otherwise specified, the pump shall be supplied with packings. Stuffing box shall

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have minimum five packing rings plus lantern ring. Packing ring size shall be 3/8" or larger.

2.6.2 The mechanical seal shall be of a make, duly approved by the purchaser.

2.6.3 Seal manufacturers specific recommendation shall be obtained and submitted alongwith the proposal.

2.6.4 All auxiliaries for flushing of mechanical seal shall be in vendor's scope of supply.

2.6.5 Large Capacity Water Service (LCWS) Pumps shall be provided with Non-API, balanced & horizontal split mechanical seals.

2.7 BEARINGS

2.7.1 Antifriction bearings 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.

2.7.2 The rise in bearing grease/oil temperature with continuous running of the pump shall be within the allowable limits which shall not exceed 30°C for grease and 39°C for oil lubricated bearings above ambient. Cooling arrangements shall be provided if required. Bearings shall be equipped with constant level oilers, vent breather & drain point for oil lubricated arrangements.

2.7.3 Unless otherwise specified, for vertical pumps with open shaft, the intermediate bearings / bushings shall be suitable for operation without any lubrication during start / shut-down or during normal operation (i.e. bearing bush material shall be of self lubricating type). Details of line shaft bearings shall be furnished with the proposal.

2.7.4 Unless otherwise specified, for vertical pumps, thrust from the pump shall not be transferred to the electric motor.

2.8 MATERIALS

2.8.1 The material of construction of parts shall be as specified. Vendor shall furnish the equivalent material as per ASTM.

For impellers in cast iron or bronze construction, the tip speed shall be limited to 40 meters/sec. Unless otherwise specified, for tip speeds exceeding 40 meters/sec, the material of impellers shall be stainless steel.

2.8.2 Unless otherwise specified in the data sheet, material test certificates (chemical and mechanical properties) shall be supplied for impeller, shaft, shaft sleeve, wearing rings and casings.

2.8.3 The repair of pressure castings by peening, plugging, impregnating or by the use of plastic or cement compound is prohibited. The Inspector's prior approval shall be obtained for the repair of castings. When authorised, repair shall be carried out in accordance with applicable ASTM Specification. Weld repair of pressure containing parts of Cast Iron construction is not permitted.

2.9 PUMPS FOR FIRE WATER APPLICATION

Pumps for Fire Water Application shall also meet the following additional requirements:

2.9.1 Unless otherwise specified, Pumps shall meet the requirements of NFPA (National Fire

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Protection Association). Technical requirements specified in the data sheet are also to be met. The vendor shall also be responsible for obtaining the necessary approvals as specified in inquiry.

2.9.2 Pumps shall be direct-coupled except in the case of engine-driven vertical turbine pumps wherein gear drives through universal joint and cardan shaft shall be used. Belt driven pumps are not acceptable.

2.9.3 Parts of pumps like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal preferably brass or bronze unless the quality of water dictates the use of special metals/alloys which shall be insisted upon.

2.9.4 Pumps shall be capable of discharging not less than 150 percent of rated capacity at a head not less than 65 percent of the rated head.

2.9.5 Difference between NPSHA and NPSHR at 150 percent of the duty point shall not be less than 0.6 meters.

2.9.6 The electrical motor shall be of continuous rating type and the rating shall be 110 percent of the power at rated point or equal to maximum BKW rated impeller whichever is higher.

2.9.7 For Diesel engine drivers, the net continuous site power available after considering the deration 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) 20 percent in excess of the BKW required to drive the pump at rated condition.
(b) Maximum BKW rated impeller as indicated by the manufacturer in the pump data sheets.

SECTION 3 - ACCESSORIES

3.1 DRIVERS

3.1.1 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.

Pump Rated BKW *		**Motor MCR (% of Pump Rated BKW)**
Less than 22 kW	:	To suit maximum BKW indicated on pump data sheet or 125% of rated pump BKW, whichever is higher.
22 kW - 55 kW	:	115% of rated pump BKW.
Higher than 55 kW	:	110% of rated pump BKW.

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

Note :

1. The motor nameplate rating for pumps under parallel operation shall not be less than the max. BKW indicated on pump data sheet (the power at End of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for start-up under open discharge valve condition.

3.2 GEARS

The type of gears shall be as specified in the inquiry document.

Unless otherwise specified, gear box shall be selected with a minimum of AGMA service factor of 1.75 over the driver rating.

Wherever right angle gear box are required the same shall be supplied non-reversible

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ratchet and shall allow for vertical adjustment of the impeller. Further the gearbox shall be suitable for absorbing the maximum thrust under any case of operation.

3.3 COUPLING & GUARDS

3.3.1 Unless otherwise specified, connection between pump and driver shall be made by a flexible metallic coupling.

A spacer (127 mm minimum normal length), shall be used to permit the removal of coupling, bearings, seal and/or rotor as applicable without disturbing the driver, the suction and discharge piping, or the casing top cover, for all horizontal pumps.

It shall be the responsibility of the pump vendor to obtain purchaser's approval for the selected coupling, its make and rating.

3.3.2 Whether or not pump vendor is required to supply the driver, he shall still deliver the fully machined coupling assembly alongwith the pump. The driver shaft dimensions and tolerances shall be furnished by the Purchaser to the pump vendor.

3.3.3 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.

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

3.4 BASEPLATE

3.4.1 Baseplates for Horizontal Pumps

3.4.1.1 Baseplate shall extend under the pump, gear box and motor/turbine driver and shall be fully machined for mounting the above equipment. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate. Baseplate shall be steel fabricated and shall have sufficient rigidity to avoid vibration and distortion. Baseplate shall be so designed as to facilitate proper grouting (Vent holes where required shall be provided).Type of grout material and technical details shall be furnished by vendor in his proposal. Baseplate shall be cleaned (sand blasted) inside and outside and coated with suitable anticorrosion paint.

Drain Pan Type Baseplate surrounding the entire baseplate to be provided. Baseplate to be provided with minimum 2" flanged drain connection.

3.4.1.2 The baseplate shall be provided with lifting lugs for at-least a four point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the baseplate or machinery mounted on it.

3.4.1.3 For driver trains over 75 kW, alignment positioning screws shall be provided for each drive element to facilitate longitudinal and transverse horizontal adjustments. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the drive element.

3.4.1.4 Vertical leveling screws, spaced for stability shall be provided on the outside perimeter of

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the baseplate. These shall be numerous enough to carry the weight of the baseplate, pump, gear-box (if any) and driver without excessive deflection.

3.4.2 **Baseplate / Mounting Plate for Vertical Pumps**

3.4.2.1 Vertical pumps shall have the manufacturer's standard mounting arrangement.

3.4.2.2 Alignment positioning screws shall be provided for 18.5 kW and above and as per manufacturer's standard practice for lower ratings.

3.4.2.3 Unless otherwise specified, mounting plate for vertical pumps shall be having a minimum thickness of 48 mm and is to be made from IS:2062/IS:2002 plate material or can be of the same material as that of vessel / tank. Mounting plate shall be supplied with gaskets (as applicable) & fasteners.

3.4.2.4 Alignment positioning screws shall be provided for all motors.

3.5 STRAINERS

Unless otherwise specified, all vertical pumps shall be provided with suction strainers of SS-316 material.

SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.1 GENERAL

4.1.1 Unless otherwise specified, all pumps shall be inspected and all tests shall be witnessed by the Purchaser or by the Purchaser's authorised representative.

4.1.2 Purchaser's or their authorised representative shall have access to the plant including sub vendors plants where work on or testing of equipment is being performed.

4.1.3 No surfaces of parts of pumps are to be painted until the inspection is completed.

4.1.4 Vendor shall give to the purchaser at-least 15 days notice prior to commencement of testing. Vendor shall carry out all running tests and mechanical checks and satisfy himself prior to purchaser's arrival for inspection and shall maintain desired log of tests.

4.1.5 Acceptance of shop test shall not constitute a waiver of requirement to supply equipment as per specification and/or to meet field test under operating condition, nor does inspection relieve the manufacturer of his responsibility in any way whatsoever.

4.2 TESTS

As a minimum following tests shall be performed. The basic reference standard shall be the latest edition of Hydraulic Institute Standard or IS:5120.

4.2.1 **Hydrostatic Test**

4.2.1.1 Pressure casings including column pipe and discharge head shall be hydrostatically tested with water at ambient temperature at 1½ times the maximum allowable working pressure specified in the data sheet.

4.2.1.2 Jackets for bearing, stuffing box, coolers, etc, shall be tested at 1½ times the maximum allowable jacket working pressure.

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4.2.1.3 Hydrostatic test shall be maintained for a minimum period of 30 minutes. Shop test certificate is required.

4.2.2 **Performance Test**

4.2.2.1 Unless otherwise specified, performance test for Horizontal Pumps for General Water Service (GWS) shall be carried out as per the following:

Pumps with drivers upto 55 kW	Non witnessed. Only review of manufacturer's shop test reports are required.
Pumps with drivers from 55 kW to 160 kW	One pump per tag/Item no. to be witnessed
Pumps with drivers above 160 kW	All pump units in an item to be witnessed

However in case of vertical pumps and for pumps for Large Capacity Water Service (LCWS), all pumps in a tag needs to undergo witnessed performance test.

4.2.2.2 Unless specifically agreed upon, pump shall be tested at the rated speed specified in the data sheet with calibrated motors, at least for four hours. During the four hour run test, complete data including pressure, capacity, power, vibration levels, bearing temperatures and noise levels shall be recorded and guaranteed parameters verified.

Prior to start of test, manufacturer shall furnish the certificate of latest calibration / re-calibration of driver and measuring instruments. Unless electrical or mechanical failure occurs, driver used for shop testing need not be recalibrated and original calibration certificate shall remain valid. Duration of recalibration for all measuring instruments shall be as per the recommendations of HI Standards and/or relevant standards of the country of origin of the pump manufacturer.

4.2.2.3 The pump shall be tested with water at ambient temperature. Suitable rust inhibitor shall be added in the water used during any internal testing / performance testing of the pumps, to prevent rusting of pump internals.

4.2.2.4 The performance test for the pumps shall be in accordance with Indian Standard IS:5120 latest edition and the tolerance of the guaranteed parameters shall be as follows:

Rated head	:	Zero negative tolerance.
Shut-off head	:	Positive tolerance permitted as long as it does not exceed downstream design pressure. Negative tolerance permitted so long as the curve is continuously rising to shutoff without any drooping and minimum 110% head rise to shutoff shall be available for pumps in parallel operation.
Min. Submergence required (for vertical pumps)/ NPSH(R)	:	Zero Positive Tolerance.
Rated BKW	:	Zero positive tolerance (However pumps may be accepted upto 104 percent of Guaranteed BKW subject to Penalties as defined elsewhere)

As a minimum, data at Shut-off (no vibration data required), minimum continuous stable flow, midway between minimum and rated flow, rated flow and maximum allowable flow (as a minimum, 120% of best efficiency flow), shall be measured and recorded during tests. All the instruments used for conducting the tests shall be calibrated before tests and calibration certificates furnished from a recognised testing institution to the Inspector.

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4.2.2.5 For fire water application all engine driven horizontal and vertical pumps shall be subjected to a 4 hour complete unit string test at the pump vendor's works during which mechanical performance of the train shall be verified, in terms of vibration, bearing/oil temperature, engine parameters and controls.

In case multiple units are ordered, only one number of diesel engine and gear box unit (if used) may be brought to the pump vendor shop for complete unit (string) test for the fire water pump unit. For the remaining pumps, complete unit (string) need not be done. However, any modification required to be done on the first unit shall be uniformly done on the remaining units also for proper unitization of the same at site.

4.2.3 **NPSH Test / Min. Submergence Test**

Unless otherwise specified, NPSH test for Horizontal Pumps for General Water Services (GWS) shall be carried out as per following:

For pumps with driver rating upto 55 kW	Not Applicable
For Pumps with driver rating between 55 kW to 160 KW	One pump tag/item to be witnessed
For Pump with driver rating above 160 KW	All pump units to undergo witness test

Additionally, in case of vertical pumps, all pumps in tag needs to undergo minimum submergence test Testing for NPSH is not required for Vertical pumps.

Also for all pumps in LCWS, all pumps in a tag needs to undergo NPSH test if required as per specification.

Unless otherwise specified NPSH test shall be carried out where difference between NPSH available and NPSH required is 1 meter or less at the rated point, for pumps beyond 55 kW.

Test points shall be similar to those of Performance test.

4.2.4 **Vibration Measurement**

During performance test vibration shall be measured on the bearing housing for the capacity range from pump MCF to 110% of rated capacity. For checking the vibration, flat surface shall be provided on bearing housing by pump manufacturer. The vibrations shall be within the limits as specified in clause no. 2.5.

4.2.5 **Dismantling Inspection**

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

If it is necessary to dismantle a pump after the performance test for the sole purpose of machining impellers to meet the tolerances for differential head, no re-test will be required unless the reduction in diameter exceeds 5 percent of the original diameter. The diameter of the impeller at the time of shop test, as well as the final diameter of the impeller, shall be recorded on a certified shop test curve that shows the operating characteristics after the diameter of the impeller has been reduced.

If it is necessary to dismantle a pump for some other correction, such as improvement of power, NPSH or mechanical operation, the initial test will not be acceptable and final performance test shall be run, after the correction is made.

4.2.6 **Final Inspection**

After the performance/dismantle test the pump and the job driver shall be unitised on the

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job base plate, aligned and coupled to make a complete unit except for engine driven vertical pumps. The pump will then be checked for visual inspection to confirm compliance to the GA drawings, nozzle dimension, elevations, anchor bold position, direction of rotation etc.

4.2.7 Prior to start of tests, vendor shall furnish the following:

1. Certificate of calibration of driver, which should be recalibrated after a period of every three years.
2. Certificate of calibration of measuring instruments, which should be recalibrated after a period of every one year. Magnetic flowmeters shall be recalibrated once in two years. Pressure gauges shall be calibrated prior to start of test and after completion of test.
3. Record of all running test and mechanical checks (including test curves and data) completed prior to purchaser's inspection.

4.3 PREPARATION FOR SHIPMENT

4.3.1 After all tests are completed and after inspection is made, all exposed mechanical surfaces and all internal parts shall be thoroughly coated with a rust preventive. All exterior parts of the unit except machined surfaces shall receive one prime coat and one coat of vendor's standard enamel.

4.3.2 All flanges, nozzles shall be blanked off. All untapped openings shall be provided with substantial wood or metal closure. The ends of small piping may be sealed with tape.

4.3.3 The pump shall be supplied with a nameplate containing the following information:

- Purchaser's Item No.
- Manufacturer's Name
- Type and Serial No
- Rated capacity in m3/hr.
- Differential head at rated capacity in m.
- Casing hydrostatic test pressure in kg/cm^2.
- Speed in rpm.

The nameplate shall be of stainless steel and relevant information shall be punched into the same.

4.3.4 All auxiliary, dismantled and packed separately shall be properly marked with the Item No. for which it is intended by means of metal tag.

4.3.5 Pump with auxiliary shall be suitably packed, fastened to avoid damage during transit and crated for shipment and storage for a period of 12 months. 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 of lifting points, gross weights and dimensions be clearly marked on each package. Each package shall clearly identify the equipment contained therein. 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 listed under "PRINTS WITH QUOTE" in the enclosed Vendor Data Requirement Form.
b) Vendor's confirmation/comments on post-order Vendor Data Requirements (Type of

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Documents, no. of prints and date needed) indicated in Vendor Data Requirement forms data sheets and specs.

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 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 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 (DCI)" 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.

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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 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 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 (8½" x 11") size.

5.2.3.3 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) 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 center of gravity of the heaviest

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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.

b) **Foundation Drawings**

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

i) Foundation bolt sizes, pipe sleeve details, pocket sizes and locations and also distance between the first/ nearest anchor bolt and pump suction and discharge nozzle centrelines.

ii) Grouting thickness and other necessary technical details.

iii) Static weight of each skid/independently grouted item and location of center of gravity of each of such skid/items in all three planes.

iv) Weight distribution for each bolt/subsole plate location and total static weight.

v) Dynamic loading caused due to various items grouted independently.

vi) The direction and magnitude of unbalance forces and moments generated by each such item at the worst operating condition and short circuit moments of motor drivers at the C.G. of the pump-motor baseplate.

vii) GD^2 value of each item resolved to driver speed.

viii) Maximum permissible amplitude of vibration on the foundation at base level.

ix) Total mass of rotating parts.

x) Total mass of reciprocating parts.

xi) Suggested dynamic factor and ratio of foundation weight to weight of skid/equipment as per vendor experience.

c) **Layout Drawing** (For multi-skid packages)

This drawing shall include atleast the following:

i) Layout of all skid/equipment and their auxiliaries, vessels, control panels, exchangers etc. Vendor shall furnish an optimised layout (considering the space allocated, site wind conditions, area classification, the type of equipment located in the vicinity etc.) indicating elevation and dimension of skids/equipment.

ii) Minimum spacing required between the various skids/equipment and between the skids and the walls/columns/roof for an easy accessibility and maintenance.

iii) Layout for water piping, trenches for water piping, cable tray/trenches layout.

iv) Piping arrangement and piping support arrangement/location for piping in vendor's scope.

v) Layout for auxiliary equipment and operating platform details.

vi) Specification for crane/mono rail (including suggested mono rail layout) recommended for maintenance and height of the lifting hook from the centerline of equipment.

d) **Field Alignment Diagram**

The diagram shall indicate the relative displacement to be kept between the centrelines of various equipments at the time of installation, so that under normal running conditions the equipments get fully aligned. This relative displacement should be decided on the basis of centerline temperature rise data of driver, gear box/transmission system, driven equipment.

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e) **Heat Exchanger Drawings**
Heat exchanger drawing and data shall include heat and mass balance data, details of provisions for separating and withdrawing the condensate, construction details, cross sections & general arrangement drawings of heat exchangers, vendors recommendations regarding provision for support and piping expansion.

5.2.3.4 **P&I Diagrams** (with Bill of Materials)
Vendor shall supply 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.

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.

5.2.4 **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 head, power recalculated to the proper specific gravity and efficiency plotted against capacity. If applicable, viscosity corrections shall be indicated. If NPSHR test is specified, the water NPSHR curve (drawn upto minimum continuous flow) shall also be included. The curve sheet shall include the maximum and minimum diameters of the impeller design supplied, the eye area of the first stage impeller, the identification number of the impeller or impellers and the pump serial number.

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 Catalogues**

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

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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) 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. It shall also contain the following information:

(a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centerline 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.

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, 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 data with permissible 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

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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 (ASTM) etc.to facilitate identification of parts and for procurement of spares.

v) Following information shall also be included in the Technical Data Manual/Mechanical Catalogue:

a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.

b) 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.

c) 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 (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.

5.2.6.4 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 mechanical catalogues shall be submitted for each item.

5.2.6.6 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.

5.2.6.7 All post order documents shall be submitted / approved through EIL VDM portal.

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निश्चित विस्थापन पम्प - नियंत्रित आयतन के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR POSITIVE DISPLACEMENT PUMPS - CONTROLLED VOLUME

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convenor	Approved by: Standards Bureau Chairman
6	13/11/24	REVISED & ISSUED AS STANDARD SPECIFICATION	RT	JSD/TK	NK	MN
5	26/06/19	REVISED & ISSUED AS STANDARD SPECIFICATION	MKA	NK	SM	RKT
4	18/10/13	REVISED & ISSUED AS STANDARD SPECIFICATION	HM	TK	DB	SC
3	15/09/07	REAFFIREMED & ISSUED AS STANDARD SPECIFICATION	NK	VKM	RK	VJN
2	04/09/92	REVISED & ISSUED AS STANDARD SPECIFICATION	KNJ	KDS	VJN	GRR

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Abbreviations:

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
EC	:	Experience Criteria
GA	:	General Arrangement
ISA	:	Instruments Society of America
MAWP	:	Maximum Allowable Working Pressure
MCR	:	Maximum Continuous Rating
NPSH	:	Net Positive Suction Head
NPSHA	:	Net Positive Suction Head Available
NPSHR	:	Net Positive Suction Head Required
P&ID	:	Piping and Instrumentation Diagram
PTR	:	Proven Track Record
VDM	:	Vendor Drawing Management System
VDR	:	Vendor Data Requirements

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
Mr. Aasheesh K Handa (Projects)

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1 **SCOPE** (Substitution)

(i) This specification together with the attendant Data Sheets and other specifications/attachments to inquiry/order defines the minimum requirements for controlled volume-positive displacement type, direct plunger or hydraulically operated diaphragm 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 controlled volume pumps shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard 675 - Positive Displacement pumps - Controlled volume, Third edition, November 2012**.

(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 675, Third edition, November 2012**.

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 NPSHR & Precision Requirements) 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 and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions and pumping liquid and material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.

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

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, stroke speed, mechanical design (i.e. number of heads), material of construction etc., as applicable in the format. In addition, manufacturer's catalogue and general reference list for Positive Displacement Pumps (Controlled Volume) 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

2.1 (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.

3 TERMS & DEFINITION

3.61 **SUPPLIER / VENDOR** (Substitution)
The vendor shall be a manufacturer of positive displacement pumps - controlled volume (as per API 675) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete positive displacement pumps - controlled volume package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed positive displacement pumps - controlled volume.

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.

4.2 **GOVERNING REQUIREMENTS AND UNITS OF MEASUREMENT** (Modification)
Unless otherwise specified, MKS system of units shall be used.

5 STATUTORY

5.2 REQUIREMENTS

5.2.1 **Conflicting Requirements** (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)

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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

6.1.5 (Substitution)
The maximum permissible sound pressure level of the pump driver train shall not exceed 85 dBA measured at 1 meter from pump surface for the recommended range of operation.

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

6.1.15 (Modification)
Unless otherwise specified, the pump flow rate shall be adjustable over the range of "10% OR Process turndown flow (whichever is lower)" to 100% of rated capacity while the pump is running with all design requirements of 6.1.16 / 6.1.17 / 6.1.18 being met.

6.1.16 (Substitution)
Pump rated capacity shall be at least equal to the maximum capacity specified by the Purchaser.

6.1.17 (Addition)
The pump speed shall not exceed 100 strokes per minute. Due consideration shall be given for the viscosity of pumping liquid as well as NPSHR, while selecting the pump speed.

6.1.21 (Modification)
When requirement of jacketed housing is specified/required, jackets shall be suitable for design pressure of heating/cooling medium specified.

6.1.22 (New)
For multi-head pumps, suction and discharge nozzles of individual heads shall be manifolded together to result in one common inlet and one common outlet flanged connection for customer's connection. Material of the manifold shall be equivalent to cylinder head material.

6.1.23 (New)
Pumps where difference between NPSHA (considering acceleration head loss) and NPSHR is less than one (1) metre are not acceptable.

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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.

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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 m^3/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 m^3/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/cm^2 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.

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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 +/–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.

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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.

Signature Not Verified
Digitally signed by MD NAZHER ALI
Date: 2026.04.09 17:59:31 IST
Location: eProcure-EPROC

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