



Offshore Design Section
Engineering Services
ISO – 9001:2008

**FUNCTIONAL
SPECIFICATION FOR
PIPING DESIGN**

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**FUNCTIONAL SPECIFICATION
FOR
PIPING DESIGN**

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1. INTRODUCTION

1.1 GENERAL

This refers to the minimum and mandatory requirements of designs & materials for piping & piping components. All piping assemblies, equipment & materials supplied or installed under these specifications shall be in accordance with sound engineering principles. Any omission from this specification shall not relieve the contractor from his responsibility of furnishing equipment or materials to meet the specific process parameters, environmental parameters, safety parameters and any other applicable statutory laws or relevant codes & standards. Substitution or changes from this specification must be accompanied with sufficient information/justification and written approval shall be obtained from the Company.

All piping, piping components, piping specialties and vessels shall be painted in accordance with Spec. No. 2005.

All piping, piping components, piping specialties and vessels shall be insulated in accordance with Spec. No. 2006.

All welding and NDT shall be performed as per Spec. 2009 F.

1.2 PURPOSE OF THIS DOCUMENT


This document shall form the basis upon which the Engineering Procurement and Construction Contractor can develop a detailed specification. This document should be considered as a general specification. The Contractor should update this document with the detailed design information that is developed during the detailed design phase.

1.3 CONTRACTOR'S RESPONSIBILITIES

The Contractor shall be responsible for the selection and design of piping, including full compliance with all applicable project specifications and design Codes / Standards, including those listed in Piping Design Criteria.

The Contractor shall provide and follow detailed pipe work specifications, covering materials, classes, fittings, valves, branches and special items. These specifications shall generally comply with this Specification.

This Specification covers all pipe work on the offshore production facilities at New platforms and for modification jobs as per the bid package and approved P&ID except the following: -

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- a. All instrument piping downstream of the last piping block valve, as defined on the P & ID's.

The Contractor shall provide the Company with all drawings, specifications and detailed pipe stress calculations for approval.

2. ENVIRONMENTAL DESIGN CRITERIA AND UTILITIES

2.1 BASIC CLIMATIC CONDITIONS

Refer structural design criteria, Vol-II, Section-3.4 attached in bid package.

2.2 SEISMIC AND TRANSPORTATION LOADS

All equipment supports and braces, pipe supports and other support steel work, including temporary braces, shall be designed to withstand seismic loads applicable to the present location. Refer to the Structural Basis of Design for seismic design considerations.

All equipment supports and braces, pipe supports and other support steel work, including temporary braces, shall be designed to withstand the operating, lifting, transport (by road and by sea) and hydro-test loads specified in Project Specification.

2.3 DESIGN LIFE

The process facilities design life requirement is 25 years.

2.4 DIMENSIONS

S1 units shall be used. Dimensions shall be in mm and be related to the Platform datum's or reference lines.

3. DESIGN REQUIREMENTS

3.1 GENERAL

Design requirement shall be as per Cl. 4 of piping design criteria, Vol-II section 3.3.

3.2 DESIGN LOAD CASES

Pipe work, its supports and anchors, shall be designed to withstand the results of the following applicable combinations of loads and forces within the limits of stress set by ASME B31.3:

- a) Hydro-test Condition (The empty weight plus weight of water to fill the piping).

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- b) Operating and Design Conditions (The empty weight plus the weight of operating fluid).
- c) Wind loading condition
- d) Dynamic Loading Condition
- e) Periodic Site Test Condition
- f) Any other condition that would affect the safety of the pipe work, e.g. cyclic loading and slug forces, when identified on the Data Sheet.

The pipe work shall be analyzed in its corroded state for each load combination.

3.3 DESIGN STRESS

Allowable stress shall be the maximum stresses permitted by ASME B31.3.

3.4 DRAWINGS AND CALCULATIONS

The Isometric drawings submitted by contractor shall contain information not limited to the following:

- a) Material of construction.
- b) Design pressure and design temperature.
- c) Pressure rating of piping/piping components.
- d) Hydro-test pressure.
- e) Stress relieving requirements.
- f) Stress analysis requirements.
- g) Insulation requirements.
- h) Supports details.
- i) Line number.
- j) NDT requirements.

Note:

In addition to above isometric drawing shall contain all pertinent information relating to the Standards, Codes and Specifications used in the design, fabrication, and inspection and testing of the pipe work, including the materials used.

The Contractor shall submit detailed calculations establishing the compliance of their design with applicable codes and standards specified in Piping Design Criteria.

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All calculations shall be complete, giving all references and showing all working methods. The Contractor shall be able to provide proof of software verification for any software used. Computer printouts will not be accepted without input data and complete printout.

Wherever relevant, additional calculations shall be undertaken regarding the effects of slug forces.

Contractor to prepare the piping material specification for each class & shall provide the complete information such as pipe size, thickness, fittings, flanges branch connection tables, valve selection & tag numbers, designed pressure- temperature ratings and applicable codes/standards etc. Contractor shall submit the piping class data sheets for company's approval.

Contractor to prepare the data sheets & specifications for piping specialties based on good engineering practice & applicable codes/standards and obtain company's approval.

Approval of drawings, calculations and other documents by the Company does not relieve the Contractor of their responsibility for the correctness of the design to suit the stated conditions.

4. MECHANICAL REQUIREMENTS

4.1 MINIMUM THICKNESS

The minimum thickness of material other than carbon steel shall be based on requirements of pressure & other mechanical loading. However, the minimum thickness of high alloy steel vessels (austenitic) & their components shall not be less than 3 mm.

Contractor to provide thickness calculations for each size & piping class. Minimum wall thickness of carbon steel & low alloy pipes, including corrosion allowance, shall be as following:

- DN 40 (1½") or less – schedule 80
- DN 50 (2") through DN 150 (6")- schedule 80
- DN 200 (8") through DN 600 (24")- standard wall.

4.2 CORROSION ALLOWANCES

Unless otherwise specified on the Pipe Specification Index & other project specifications, carbon steel pipes shall have 3 mm corrosion allowance & carbon steel (NACE) shall have 6



mm corrosion allowance applied to all pressure retaining parts and all surfaces of non-removable internals exposed to the process fluid.

When corrosion protection is provided by a corrosion resistant metallic lining, a minimum thickness of 3 mm of lining material shall be used.

Pipe work that is subjected to erosion e.g. due to impingement by the process stream, shall be protected with extra wall thickness.

5. MATERIALS

5.1 GENERAL SPECIFICATION

Materials shall be as per ASTM, BS or API specifications referenced in Piping Design Criteria.

Materials shall be new and unused, clean and free from rust, pits and obvious defects. Material older than one year from date of manufacturing shall not be permitted.

Cast, ductile or malleable iron, aluminum, copper, or copper-bearing alloys shall not be used in hydrocarbon service.

For carbon/carbon manganese steel vessels operating below 0°C and requiring impact testing, all pressure parts and direct attachment materials shall be manufactured with fully killed, fine grain materials.

All pipe fittings specified as galvanized shall be hot dip galvanized with a minimum of 763 grams of galvanizing material per square meter of surface area, in accordance with ASTM A123M/ASTM A153.

5.2 SOUR SERVICE REQUIREMENTS

5.2.1 CARBON STEEL (NACE)

This shall be in accordance with NACE Standard MR-01-75/ISO 15156-1/2/3 and shall meet the following special requirements: -

SPECIAL REQUIREMENTS FOR MANUFACTURE, INSPECTION, TESTING AND SUPPLY OF CARBON STEEL (NACE) MATERIAL:

5.2.1.1 MANUFACTURE

The following treatments during steel making are mandatory:

- All steel shall be fully killed and fine grained.



- b) All steel shall be produced using Basic oxygen or Electro Furnace Process.
- c) Steel shall be made by low sulphur and low phosphorous refining process and shall be vacuum degassed while molten by means of an approved procedure.
- d) Effective sulfide shape control by calcium treatment shall be carried out if sulphur level is in excess of 0.002% for CS-NACE plate material and piping finished product fabricated from plate material.
- e) Specific treatment to control non-metallic inclusions likes Aluminum oxide clusters, silicates and magnesium sulphide etc.

The manufacturer shall take particular care to control the rolling and heat treatment conditions so as to eliminate low temperature transformation microstructures associated with segregation such as bainite band or islets of martensite in order to reduce the propagation of HIC.

5.2.1.2 INSPECTION AND TESTING

The following tests shall be conducted in addition to relevant codes and standards. Test certificates shall be duly witnessed & certified by a Company approved third party inspection agency.


A. HYDROGEN INDUCED CRACKING (HIC) TESTING

This test shall be conducted only for pre-qualification of vendors who are not listed in suggested vendor list. This test shall be carried out on one finished product of each heat (material wise and type of construction wise, i.e. seamless and welded separately) irrespective of size/thickness. The test shall be carried out as per NACE-TM-02-84 standards.

HIC testing for casting is not required.

The test shall be performed on a set of three test specimens. The test shall be performed, as per NACE-TM-02-84 and the acceptance criteria shall be as Crack sensitivity ratio (CSR) < 1% & Crack Length Ratio (CLR) < 10.00%

In case any one of the above samples fails to meet the acceptance criteria, three more additional specimen from the product from which the first set of specimen were taken, shall be retested and results reported.

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In case of failure of any of the samples in above, two additional products shall be selected from the same heat and size specimens shall be tested (three from each product).

In case of failure of any one of the six-samples, the particular heat will be rejected.

B. SULPHIDE STRESS CORROSION CRACKING (SSCC) TEST

This test shall be conducted only for pre-qualification of vendors who are not listed in suggested vendor list. This test shall be carried out on one finished product of each heat (material wise and type of construction wise i.e. seamless and welded separately) irrespective of size/thickness. The test shall be carried out as per NACE-TM-01-77.

Reporting of test result: Curve shall be reported as per NACE-TM-01-77 for various stress level between 72% and 90% of SMYS.

Acceptance Criteria: At 72% SMYS, time of failure shall not be less than 720 hrs.

Sampling for test shall be same as indicated clause no. 5.2.1.2 A

C. HARDNESS TEST

This shall be carried out on finished product of each heat irrespective of size/thickness.

This test shall be carried out as per ASTM E-18/ ASTM E-92/ASTM E 10.

The product/heat for which hardness values are found in excess of specified value shall be rejected. Maximum hardness value shall be limited to HRC-22.

D. MICROSCOPIC TEST

This shall be carried out on finished product of each heat (material wise and type of construction wise i.e. seamless and welded separately) irrespective of size/thickness.

This test shall be carried out as per ASTM E-45 Method D. Steel shall be calcium treated for inclusion morphology control & there shall not be elongated manganese sulphide inclusions.

E. CHEMICAL ANALYSIS

This shall be carried out on finished product & raw material for each heat (material wise and type of construction wise i.e. seamless and welded separately) irrespective of size/thickness. Test results shall meet the relevant codes & standards.

The acceptable level of Sulphur is as follows:

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- i) 0.003 % Max for Flat rolled Products
- ii) 0.01 % Max for Seamless products.
- iii) 0.025 % Max for Forging.

If the Sulphur level is higher than these limits, HIC test as per clause no. 5.2.1.2 A shall be carried out.

Carbon equivalent (CE) shall be less than 0.40 & PCM shall be less than 0.21 and shall be computed as per one of the following formulae depending upon.

- a) If $C \geq 0.12\%$, $CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15$
- b) If $C < 0.12\%$, $PCM = C + Si/30 + (Mn+Cu+Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B$

F. MECHANICAL TEST

The mechanical properties shall be as per the specified material specification.

F. THROUGH THICKNESS TENSION TEST (FOR PLATES)

Plates 25mm and above in thickness shall be tested perpendicular to the rolled, surface with frequency and test procedure as per ASTM A 770 and determination of reduction of area as per ASTM A370. Minimum reduction area shall not be less than 35%.

G. ULTRASONIC TESTING (FOR PLATES)

Test shall be performed for thickness 12.7mm and above according to ASTM A578 level – B. No repaired welding shall be permitted on plates.

5.2.2 STAINLESS STEEL (NACE)

This shall be in accordance with NACE Standard MR-01-75/ ISO 15156-1/2/3 and test requirement as per applicable material standard.

A. INTER GRANULAR CORROSION CRACKING (IGC)

For all austenitic stainless steel Piping, Piping components and Valves, Inter-granular Corrosion Test (IGC) shall be conducted as per following ASTM A 262 practice “B” with acceptance criteria of 60 mills per year (max) for all materials- forged, rolled, wrought and casting.

5.2.3 DUPLEX STAINLESS STEEL

This shall be in accordance with NACE Standard MR-01-75/ ISO 15156-1/2/3 and test requirement as per applicable material standard.

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The following tests shall be conducted in addition to relevant codes and standards. Test certificates shall be duly witnessed & certified by a Company approved third party inspection agency.

A. CHLORIDE STRESS CORROSION CRACKING TEST

This test shall be conducted only for pre-qualification of vendors who are not listed in suggested vendor list.

Either of the two tests given below can be carried out to assess the chloride Stress Cracking Resistance of the Material.

Test: 1

This test shall be conducted on the material at 155 Deg C with aeration in 45% MgCl₂ solution as per ASTM G36. Stress to cause rupture in 500 hours shall exceed 0.35 times the ultimate tensile strength. This test shall be carried out on one finished product of each heat irrespective of size & thickness.

Test: 2

This test shall be conducted on specimen as per ASTM G 36 at 100 degree Celsius with aeration in boiling 40% CaCl₂ solution & pH shall be at 6.5. Stress to cause rupture in 500 hours shall exceed 0.85 times the ultimate tensile strength. This test shall be carried out on one finished product of each heat irrespective of size & thickness.

B. PITTING CORROSION TEST

This test shall be conducted on specimen as per **ASTM G48** using ferric chloride solution (10% FeCl₃.6 H₂O) as per method A at 22±2⁰ C for 72 hours and at 50⁰ C for 24 hours. The acceptance criteria shall be no pitting shall occur on surface of tested material for the test at 22±2⁰ C and for the test at 50⁰ C weight loss shall be reported to company for review. In addition to that, another test shall also be carried out to establish the critical pitting temperature as per method E of ASTM G 48 and report the critical pitting temperature to company for review. Preferably minimum critical pitting temperature shall be 30⁰ C.

C. INTERGRANULAR CORROSION TEST (HUEY TEST)

The test shall be carried out, as per **ASTM A 262 Practice C**. weight loss shall not exceed 4 mils/month. This test shall be carried out on one finished product of each heat irrespective of size & thickness. The entire test reports shall be from the product specimen drawn from the heat bearing same number.

D. CHEMICAL TEST

This test shall be carried out on finished product of each heat irrespective of size & thickness as per relevant codes & standards with following limitation.



Pitting index (P.I) shall be computed as per following formulae.

$$P.I. = \%Cr + 3.3(\% Mo) + 16(\% N_2)$$

The Pitting index of the material shall be greater than 35.

Carbon content shall be 0.03% (max.)

Sulphur content shall be 0.02%(max.)

E. MICRO STRUCTURAL EXAMINATION AND FERRITE MEASUREMENT

Ferrite content measurement of the material shall be carried out as per ASTM E 562 for each heat by metallographic examination. Ferrite content shall be in the range of 45% to 55%.

F. HARDNESS TEST

This test shall be carried out on finished product per heat, manufacturing method wise as per ASTM E 18 irrespective of size & thickness. Maximum hardness of the product shall be limited to HRC 25 (max.).

G. SULPHIDE STRESS CORROSION CRACKING (SSCC) TEST

This test shall be conducted only for pre-qualification of vendors who are not listed in suggested vendor list.

Resistance of the materials to sulphide stress corrosion cracking shall be tested using:

- NACE –TM- 01-77 test solution (test temp. 24° C) minimum stress for cracking in 720 hrs. is 350 N/mm².
- NACE-TM-01-77 test solution (test temp. 90° C and total pressure of H₂S =16 bars) minimum stress for cracking in 720 hrs. is 325 N/mm².


H. MECHANICAL TEST

The following mechanical test shall be carried out: -

(I) Tensile Test

The material in solution-annealed condition shall conform to the mechanical properties requirements specified below-

- Ultimate Tensile Strength : 680-900 N/mm²
- Yield Strength (0.2% offset) : 450 N/mm² (min)

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c) Yield Strength (1.0% offset) : 500 N/mm² (min)

d) Elongation : 25% minimum

e) Hardness : HRC-25 (max.)

(II) Impact Test

Fracture Toughness (Charpy V-Notch Energy)

- For Wrought Materials

At +20 °C (68 °F)	120 Joule (Avg)
	90 Joule (Min)
At -30 °C (-22 °F)	100 Joule (Avg)
	75 Joule (Min)
- For Cast Materials

At +20 °C (68 °F)	75 Joule (Avg)
	55 Joule (Min)
At -30 °C (-22 °F)	60 Joule (Avg)
	40 Joule (Min)

I. CREVICE CORROSION

This test shall be conducted on specimen as per **ASTM G48** using ferritic chloride solution (10% FeCl 3.6 H₂O) at 25 degree Celsius for 24 hours. The acceptance criteria shall be no crevice corrosion shall occur on surface of tested material at specific temperature. This test shall be carried out on finished product of each heat irrespective of size & thickness.

5.2.4 Incoloy 825/Inconel 625 AND Incoloy 825/ Inconel 625 CLAD CARBON STEEL PIPE MATERIALS

This shall be in accordance with NACE Standard MR-01-75 and test requirement as per applicable material standard.

A TECHNICAL REQUIREMENTS FOR CLAD PLATES

- Clad plates shall be made by using standard practice suitable to obtain metallurgical bonding between carbon steel and corrosion resistant alloy. A detailed procedure for production of clad plates shall be submitted for company's approval and shall include the following as a minimum:
 - Material traceability system

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- b) Steel and plate making process
 - c) Heating technique, rolling reductions, and working temperatures.
 - d) Cladding process
 - e) Procedure for heat treatment
 - f) Ultrasonic testing of plates and bond integrity check.
2. Each finished plate shall be subjected to automatic ultrasonic examination for checking bonding integrity and soundness of carbon steel backing plate. This test shall be carried out on 100% plate surface area on both sides, in accordance with ASTM A 578 and its supplementary requirement S3. The acceptance criteria for the finished clad plates shall be as per ASTM A 578 level B besides specific technical requirements mentioned below.
3. Discontinuity, causing complete loss of back reflection, which cannot encompass within 75-mm diameter circles, shall be unacceptable.
4. Clad plates having a total area of discontinuity greater than 6,000 sq. mm. shall be rejected. Also where the lamination exceeds 6.35 mm. in length measured along the two longitudinal edges of the plate, shall be rejected. A Laminar defect in the backing plate is also unacceptable. Unbounded area, which cannot be encompassed within 25-mm. diameters circles, shall be unacceptable.
5. Acceptance criteria for integrity of bond of the cladding material shall be as per ASTM A578, level S7.
6. No defect in corrosion resistant alloy is permitted. Minor defects, if any as mentioned in (a) and (b) below may be repaired with company's prior approval by welding and shall be subsequently tested by dye-penetrant examination. This manufacturer shall submit welding procedure for company's approval prior to undertaking such repair works.
- a) Finished clad plates having defects lower than 500-cm² area and total defect area lower than 1.5% of the total plate surface area is only allowed to be repaired.
 - b) The plates having defects lower than 500 cm² area and total defects greater than 1.5% but lower than 3% of the total surface are may be repaired with company's prior approval.
 - c) Plates having defective area greater than 3% or single defect greater than 500 cm² shall be rejected.



B. TECHNICAL REQUIREMENTS FOR CLAD PIPES

1. A detailed procedure for manufacture of pipes from clad plates shall be submitted for company's approval and shall include the following as a minimum.

- a. Pipe making procedure
- b. Welding procedure specification including chemical composition of filler wire and flux
- c. Flux handling, Heat treatment
- d. Visual and dimensional checks
- e. Inspection and testing, chemical, mechanical, corrosion, microstructure etc.
- f. Non destructive testing etc.
- g. Hydrostatic testing
- h. Finishing treatment
- i. Marking

2. The tolerances on dimensions and weights of the finished clad pipes shall be as per API Spec. 5L with the following modifications:

Permissible tolerances on nominal wall thickness shall be as follows:

- a) On Carbon Steel backing material + 10%, -5%
- b) On Cladding (Incoloy-825/Inconel-625) material + 10%, negative tolerance NIL
- c) Cumulative tolerance: The cumulative tolerance resulting from all the individual variation shall be such that the maximum radial mismatches between the inside diameter of any two-pipe cross-sections is limited to 0.5mm.

3. Pipe ends shall be beveled to suit API-5L.

C. HEAT TREATMENT

After finish rolling for bonding, all clad plate produced shall be normalized at a temperature of 950 + 50 deg.C followed by air cooling and water quenching. This will be followed by tempering treatment at 620/650 deg.C followed by air cooling.

The detailed heat treatment procedure (including any alternatives proposed) shall be submitted for Company's approval.



D. PHYSICAL PROPERTIES AND TESTS

Test tabs of adequate length shall be attached to an adequate number of pipes so as to facilitate carrying out the specified mechanical and corrosion tests.

The clad pipe shall be subjected to the following tests to determine the physical properties of the finished product. The test shall be carried out on the full thickness of carbon steel, after removal of corrosion resistant alloy Incoloy-825 Inconel 625, on the finished pipe. While removing corrosion resistant alloy, care must be taken not to reduce the wall thickness of carbon steel backing metal as far as possible.

1. MECHANICAL PROPERTIES

The carbon steel backing metal shall meet the requirements of mechanical properties set forth in API spec. for Line pipe and shall in addition have fracture toughness of minimum 47 Joules (average)/38 Joules (individual), when subjected to Charpy V-notch test at 0 deg.C, in accordance with ASTM A370. Testing frequency shall be as required for guided bend test mentioned below. Orientation, location, and number of specimens per pipe shall be as per supplementary requirements SR 5 of API Spec.5L.

2. WELD TENSILE TEST

The specimen shall represent full wall thickness of carbon steel with corrosion resistant alloy removed from specimen. The ultimate tensile strength shall be higher than the minimum specified for the base material. Testing frequency shall be as required for guided bend test mentioned below.

3. GUIDED BEND TESTS

The guided bend test shall be carried out on specimens taken from the each of the two representative pipes of each lot. The lot shall be defined as a maximum of 50 pipes belonging to the same heat of carbon steel and manufactured with the same process.

4. MICROSCOPIC EXAMINATION AND HARDNESS TEST

Test specimen for microscopic examination shall be taken transverse to the longitudinal weld, from the finished pipe. The width of the specimen shall be minimum of three times the width of the weld. The specimen shall then be ground suitably and etched to reveal the microstructure. The specimen shall be visually examined using a magnification profile with smooth transition to base material. The microstructure shall also be examined at a suitable, higher magnification to ensure favorable distribution of micro-constituents. Chemical composition shall be ascertained by appropriate methods to verify that in the top 2mm of the cladding it is within the specified limits. Hardness test HV 10 according to ASTM A370 and at suitable locations as per MR 01 75/ISO 15156-2, Fig.2 (Along with hardness at Parent



material, weld metal and HAZ of Cladded layer) shall be carried out on the test pieces already submitted to micro structural examination. In the heat affected zone indentations shall start as close to the fusion line as possible. The maximum Vickers hardness value for each single point shall not exceed 248 HV 10 on carbon steel portion and 285 HV 10 corrosion resistant alloys.

E. BOND EFFICIENCY TEST

1. SHEAR TEST

Shear test shall be performed according to ASTM A265 and minimum shear strength in the longitudinal direction shall be 140 Mpa.

2. DUCTILITY TESTS

Ductility test in longitudinal direction shall be performed according to ASTM A 265. No crack and no unbounding shall be allowed.

3. CHARPY IMPACT TEST

This test shall be performed in accordance with ASTM A 370. From each finished pipe per lot representing same heat of carbon steel and manufactured with the same process, five samples shall be taken transverse to the principal rolling direction. From each sample three specimens shall be machined. The specimens shall be notched as follows: -

- Weld Metal
- Fusion line + 2MM
- Base metal

At the test temperature of 0⁰.C, the fracture toughness values obtained shall be consistent with those indicated in clause C-1 above.

F. CORROSION TESTS

The specimen shall be machined only to remove the carbon steel portion and shall contain the full weld on the corrosion resistant alloy in as welded condition. Corrosion resistant alloy shall not be ground or picked and surface of specimen shall approximate the same roughness as the finished pipe. Specimen shall be machined transverse to the weld with following dimensions:-

Width (transverse to the weld)	:	50 mm
Length (parallel to the weld)	:	25 mm
Thickness	:	1.5 mm (Min.)



The following corrosion tests shall be carried out on the specimens prepared as above.

1. INTERGRANULAR CORROSION TEST

- (a) For Incoloy 825, this test shall be carried out in accordance with ASTM A-262 practice C. Maximum permitted weight loss shall not exceed 0.0040 inch/month.
- (b) For Inconel 625, this test shall be carried out in accordance with ASTM G28 Method A. Maximum permitted weight loss shall not exceed 0.0040 inch/month

2. PITTING CORROSION TEST

This test shall be conducted on specimen as per ASTM G48 using ferric chloride solution (10% FeCl₃.6 H₂O) as per method A at 22±2⁰ C for 72 hours and at 50⁰ C for 24 hours. The acceptance criteria shall be no pitting shall occur on internal pipe surface of tested material for the test at 22±2⁰ C and for the test at 50⁰ C weight loss shall be reported to company for review. In addition to that, another test shall also be carried out to establish the critical pitting temperature as per method C of ASTM G 48 and report the critical pitting temperature to company for review. Preferably minimum critical pitting temperature shall be 30⁰ C for Incoloy 825 and 85⁰ C for Inconel 625.

3. SULPHIDE STRESS CORROSION CRACKING (SSCC) TEST

This test shall be conducted only for pre-qualification of new vendors who are not listed in suggested vendor list.

Sulphide Stress Corrosion cracking test shall be carried out on the cladding alloy as follows:

- a) Test as per NACE-TM-01-77 at test temperature.
 - i) Room/24⁰C
- b) Test as per NACE-TM-01-77 except that the test solution shall have H₂S partial pressure of 5bars and CO₂ partial pressure of 20bars and test temperature shall be:
 - i. At 90⁰C
 - ii) At 120⁰C

Note:- Test solution – 5% NaCl + 0.5% Acetic Acid



Each test result shall be evaluated based on acceptance criteria of Minimum Stress for no cracking to occur after 720 hrs equals to 95% of SMYS of cladding material used

G. HYDROSTATIC TEST

All the finished pipes shall be subject to mill hydrostatic test pressures corresponding to 90% of the specified minimum yield strength for Carbon Steel and the test pressure shall be held for at least 30 seconds. Permanent test records (Pressure time chart) shall be maintained by the manufacturer and submitted for review of Company.

H. NON-DESTRUCTIVE INSPECTION

The following non-destructive inspection shall be performed on each pipe after hydrostatic testing. A detailed non-destructive testing specification shall be developed and submitted to Company for qualification and approval.

1. RADIOGRAPHIC EXAMINATION

After hydrostatic test, the weld seams shall be checked for detection of longitudinal and transverse defects to the weld by radiographic method on the full length of the pipe. Acceptance criteria for the radiographs shall be as per ASME BPV-VIII, Division I, clause UW 51.

The film used for radiographic inspection of pipe welds shall be class 1 and 2 referring to Table –II of ASTM E-94, with film density of 1.8-3.8 that allow the sensitivity of at least 1.5% of the nominal total thickness of pipe weld bead.

2. SOUNDNESS OF BONDING

After hydrostatic test, each pipe shall be inspected by ultrasonic method for the detection of lamination and for bonding check on a circumferential band of 50mm along each side of the longitudinal weld.

No lamination and unbonding are allowed on pipes. Pipe ends of each pipe shall also be inspected by Ultrasonic examination with angle probe to detect hair line crack defects on pipe body, perpendicular to the surface, for a length at least 50 MM. No defect shall be allowed.

3. MAGNETIC PARTICLE EXAMINATION

After hydrostatic testing, all pipes shall be subject to Magnetic particle examination. This shall include full length of external surface of the weld bead of backing material to be examined by Magnetic particle method. The test procedure shall be in accordance with



ASTM E 709 and acceptance criteria shall be according to ASME Sec. VIII, Div.2 Part 7 Clause no. 7.5.6.2.

5.3 CORROSION ALLOWANCE

The corrosion allowance for various service of piping systems are shown below. MOC shall be as indicated in the P & ID.

(Wherever more than one material is indicated against the same service, the MOC shall be as per the class and grade indicated in the P&ID.)

SERVICE	Min CA (mm)	PIPES	FITTINGS	FLANGES
Hydrocarbon (Sour service) for a) Gas Lift b) Well Fluid	6.0	CS (NACE)	CS (NACE)	CS (NACE)
	1.5	SS316L (NACE)	SS316L (NACE)	SS316L (NACE)
	0.0	DSS	DSS	DSS
	0.0	CS with INCOLOY	CS with INCOLOY	CS with INCOLOY
INJECTION WATER	3.0	CS	CS	CS
PRODUCE WATER	0.0	GRE (Glass reinforce d Epoxy)	GRE	GRE
INSTRUMENT GAS	1.5	SS316L (NACE)	SS316L (NACE)	SS316L (NACE)
	6.0	CS (NACE)	CS (NACE)	CS (NACE)
CLOSED DRAIN	6.0	CS (NACE)	CS (NACE)	CS (NACE)
OPEN DRAIN	3.0	CS	CS	CS
	0.0	GRE	GRE	CS
SEA WATER	0.0	90- 10Cu-Ni	90-10 Cu-Ni	90-10Cu-Ni
a)Raw Sea Water • Utility Water				



<ul style="list-style-type: none"> Cooling Water Fire water 	0.0	GRE	GRE	Al-Bronze
b)TreatedSeaWater	0.0	GRE	GRE	CS
<ul style="list-style-type: none"> Fire water 	3.0	CS	CS	CS
INSTRUMENT AIR	1.5	CS(G)	CS(G)	CS(G)
CHEMICAL	0.0	SS316L	SS316L	SS316L
FERRITIC CHLORIDE CHEMICALS	0.5	TITANI UM	TITANIUM	TITANIUM
Potable Water	0.0	Cu	Cu	BRONZE
(Drinking)	0.0	GRE	GRE	BRONZE
Sodium Hypo chlorite	0.0	CPVC	CPVC	CPVC
SEWAGE	0.0	GRE	GRE	GRE
ACIDISATION	3.0	CS	CS	CS

ABBREVIATIONS:

AL-NI -	ALUMINIUM NICKEL
CA -	CORROSION ALLOWANCE
CPVC -	CHLORINATED POLYVINYL CHLORIDE
CS -	CARBON STEEL
CS(G) -	CARBON STEEL (GALVANISED)
DSS -	DUPLEX STAINLESS STEEL
GRE -	GLASS REINFORCED EPOXY
MM -	MILIMETER
NACE -	NATIONAL ASSOCIATION OF CORROSION ENGINEERS
PVC -	POLYVINYL CHLORIDE
SS -	STAINLESS STEEL



5.4 CARBON STEEL

5.4.1 CARBON STEEL (NON-NACE)

Carbon Steel materials used and specified as per American specifications. Bolting shall be ASTM A193 Grade B7/194 Grade 2H and it shall be Hot dip galvanized as per ASTM 153.

PIPES:

ASTM A 106 Gr. B (seamless), API 5L Gr. B (seamless / SAW),
API 5 L Gr. X 52 (Seamless/SAW), API 5L Gr. X 60 (Seamless / SAW), ASTM 333
Gr.6 (Seamless)

FITTINGS:

ASTM A 234 Gr. WPB,	ASTM-A105,
MSS SP Gr. WPHY 52	MSS SP Gr. WPHY 60
ASTM A 350 Gr. LF2	ASTM A 420 Gr. WPL6

FLANGES:

ASTM A105,	ASTM A694 Gr. F52,
API 6A Type 2,	API6A Type 4
ASTM A 350 Gr. LF2	

VALVES:

BODY- ASTM 216 GR WCB, ASTM A 105, ASTM A 350 Gr. LF2, ASTM A 352 Gr. LCC
TRIM- 11-13% CROME (MIN.)/ ASTM 182 GRADE F316

PLATE : ASTM A-516 Grade 70

5.4.2 CARBON STEEL (NACE)

Material shall be same as clause no. 5.4.1. Sour service requirement shall be in compliance with clause no. 5.2.1 of this document.

STUD BOLTS:	ASTM A-193 Grade B7M, For Low temperature use ASTM A 320 Gr. L7,(22 HRC max. hardness)
NUTS:	ASTM A-194 Grade 2HM, For low temperature use ASTM 194 Gr.4 (22 HRC max. hardness)

Stress relieving of rolled plates, formed heads and pipe fittings shall be in accordance with NACE Standard MR0175.



5.5 STAINLESS STEEL

5.5.1 STAINLESS STEEL (Non-NACE)

Stainless steel materials are suitable for inner/wet parts of valves, instrumentation & vessels. Only following American specifications as specified against each product are permitted. MOC of stud bolt and nut shall be same as that of CS NON-NACE (cl. 5.4.1). Necessary considerations shall be followed to avoid galvanic corrosion.

PIPES : ASTM A 312 Gr. TP 316
ASTM A 358 TP 316

FITTING : ASTM A 403 Gr. WP 316
ASTM A 182 Gr. F316

FLANGES : A 182 Gr. F 316

VALVES :
BODY : ASTM A 182 GRADE F 316 / ASTM A 351 GR CF8M SS 316
TRIM : ASTM A 182 GRADE F 316 / SS 316

Note:

For all austenitic stainless steel Piping, Piping components and Valves, Inter-granular Corrosion Test (IGC) shall be conducted as per following ASTM A 262 practice “B” with acceptance criteria of 60 mills per year (max) for all materials- forged, rolled, wrought and casting.

Or

ASTM A 262 practice “E” with acceptance criteria of “No cracks as observed from 20X Magnifications” for all materials other than castings “Microscopic structure to be observed from 250-X magnification” in addition.

5.5.2 STAINLESS STEEL (NACE)

Sour service requirement shall be in compliance with clause no. 5.2.2 of this document. MOC of stud bolt and nut shall be same as that of CS NACE (cl. 5.4.2).

PIPES : ASTM A 312 Gr. TP 316 L
ASTM A 358 TP 316 L

FITTING: ASTM A 403 Gr. WP 316 L
ASTM A 182 Gr. F316L

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FLANGES: A 182 Gr. F 316 L

VALVES: BODY : ASTM A 182 GRADE F 316L / ASTM-A-351 GR CF8M SS316L
TRIM : ASTM A 182 GRADE F 316L / SS 316L

5.6 DUPLEX STAINLESS STEEL MATERIAL

Two grades are indicated in this MOC. However, MOC shall be as per the class and grade indicated in the P&ID.

PIPES : a) ASTM A790 UNS S 32205
b) ASTM A790 UNS S 31803

Note:

On case to case basis for higher thickness if manufacturing of seam less pipe is not possible, ASTM A 928 Class1 & 3 may be used.

FITTINGS: a) ASTM A790 UNS S 32205,
ASTM A182 Gr. F60 UNS S 32205,
ASTM A815 Gr. WP-S/WX UNS S 32205
b) ASTM A790 UNS S 31803,
ASTM A182 Gr. F51 UNS S 31803,
ASTM A815 Gr. WP-S/WX UNS S 31803

FLANGES: a) ASTM A182 Gr. F60 UNS S 32205
b) ASTM A182 F51 UNS S 31803

BOLTING: ASTM A 453 GR 660 Class A

GASKETS: Duplex stainless steel spiral wound with CNAF, Octagonal ring duplex stainless steel UNS S 32205/ UNS S 31803; Maximum hardness 22HRC.

VALVES: BODY-DSS, TRIM –DSS

NOTES:

- Maximum hardness shall be limited to 25 HRC. Material shall meet the requirement of NACE MR 01-75 along with additional requirements

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indicated in clause no. 5.2.3 of this document. This specification is in addition to relevant codes & standards.

2. Maximum temp. Limit shall be limited to 121⁰C. For max temp greater than 121⁰C, company's approval shall be obtained.
3. Stub end connections are not permitted for branch connection.
4. For butt weld fittings thickness shall be same as pipe
5. DSS shall have approximately equal proportion of Austenitic & ferritic matrix phase (ferritic content: 45-55%) for DSS.

5.7 (A) INCOLOY CLAD PIPING (Incoloy 825)

PIPES: ≤ 6" Seamless Pipe as per ASTM B423 (UNS N 08825) cold finished annealed.

>6" but ≤ 12" Seamless Pipe as per ASTM B423 (UNS N 08825) hot finished annealed. SMYS of hot finished annealed pipe shall as be established considering it as unlisted component of ASME B 31.3 for the temperature range based on actual evaluation after testing.

≥ 14" – API 5L Gr. B / API 5L Gr X52, Cladding Material – Incoloy 825.

FITTING: ≤ 1 ½ " Forged ASTM B564 (UNS N 08825)

2" – 12" Butt welded fitting ASTM B366 (WP NIC MC S)

≥ 14" – from clad steel with single weld seam (joint factor 1), Cladding Material Incoloy 825.

FLANGE: ≤ 12" -- ASTM B564 (UNS N 08825)

≥ 14" -- ASTM A105 with Cladding Material Incoloy 825.

BOLTING: ASTM A453 Gr. 660 Class A.

GASKET: Spiral wound duplex stainless steel with CANF, Octagonal ring duplex stainless steel, Hardness 22HRC

VALVE: ≤ 11/2" Body Forged ASTM B 425/ASTM B 564 (UNS N08825)

Trim Incoloy -825

≥ 2" but ≤ 6" Body Incoloy 825/DSS and Trim Incoloy 825/DSS



$\geq 8''$ Body = (ASTM A 105 + 3mm Weld overlay Incoloy 825)/Solid Incoloy 825/DSS and Trim Incoloy 825/DSS. (See note-4)

5.7 (B) INCONEL CLAD PIPING (Inconel 625)

- PIPES: $\leq 12''$ Seamless Pipe as per ASTM B444 UNS N 06625Gr.1 annealed.
 $\geq 14''$ – API 5L Gr. B / API 5L Gr X52, Cladding Material – Inconel 625.
- FITTING: $\leq 1 \frac{1}{2}''$ Forged ASTM B564 (UNS N 06625)
 $2'' - 12''$ Butt welded fitting ASTM B366 (WP NC MC S) UNS N 06625
 $\geq 14''$ – from clad steel with single weld seam (joint factor 1), Cladding Material Inconel 625.
- FLANGE: $\leq 12''$ -- ASTM B564 (UNS N 06625)
 $\geq 14''$ -- ASTM A105 with Cladding Material Inconel 625.
- BOLTING: ASTM A453 Gr. 660 Class A.
- GASKET: Spiral wound duplex stainless steel with CANF, Octagonal ring duplex stainless steel, Hardness 22HRC
- VALVE: $\leq 11/2''$ Body Forged ASTM B 446 UNS N 06625
Trim Inconel -625
 $\geq 2''$ but $\leq 6''$ Body Inconel 625/DSS and Trim Inconel 625/DSS
 $\geq 8''$ Body = (ASTM A 105 + 3mm Weld overlay Inconel 625) /Solid Inconel 625/DSS and Trim Inconel 625/DSS. (See note-4)

NOTES:

1. The corrosion resistant alloy shall meet the requirements of ASTM B424, UNS No N 08825 or ASTM B 443, UNS N 06625 as applicable with the following additional stipulated requirements:
 - (i) **For Incoloy 825**
 - a) Max carbon content shall be 0.025%
 - b) Minimum pitting index shall be 32.
Pitting index = (% Cr + 3.3%Mo)
 - c) The minimum cladding thickness shall be 3mm.
 - d) Hardness shall be as per NACE MR-01-75/ISO-15156-3.
 - (ii) **For Inconel 625**
 - a) Max carbon content shall be 0.05%

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- b) Minimum pitting index shall be 52.
Pitting index = (% Cr + 3.3%Mo)
- c) The minimum cladding thickness shall be 3mm.
- d) Hardness shall be as per NACE MR-01-75/ISO-15156-3.

2. This shall be in accordance with NACE Standard MR-01-75 and test requirement as per applicable material standard along with requirements indicated below for solid Incoloy/Inconell:

- (a) Mechanical Properties Test.
- (b) Hardness Test.
- (c) Chemical Properties.
- (d) Corrosion Test as per clause No. 5.2.4, (F), (1) & (2) shall be carried out on each heat and test indicated in clause no. 5.2.4(F), (3) shall be carried out only for qualification of vendor not listed in suggested vendor list of ONGC.

3. For thickness of clad pipe and piping items only base material shall be considered.

4. MOC of valve shall be decided based on service.

5.8 CUPRO-NICKEL (90-10)

Cupro-nickel materials are suitable for firewater, seawater & salt-water services. Only following American/British specifications as specified against each product are permitted. Bolting shall be ASTM A193 Grade B7/194 Grade 2H and it shall be Hot dip galvanized as per ASTM 153.

PIPES: ASTM B 466 Copper alloy no. C-70600 or BS 2871 CN 102

FLANGE: EEMUA 145


FITTINGS: 90-10 Cu-Ni

VALVES Body - 5% Ni-AL BRONZE (BS 1400 AB2C), ASTM B 148 C 95800
Trim - MONEL K 500 for sizes up to and including 6" and K400/K500 above 6"

NOTES:

- a) 90-10 Cu-Ni piping material thickness EEMUA PUB 144 to be decided based on 16-bar system
- b) Blind flanges shall be A 105 with 3 mm 90-10 Cu-Ni overlays.
- c) For composite flanges the outer flange shall be ASTM A105 (galvanized) to #150 of ASME B-16.5 up to 24" and ASME B 16.47 A for 22" and 28" &

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inner flange shall be 90/10 CU-NI forged for < 2” S.O, 3” to 24” W.N.(For 3” to 24” S.O. Bossed flanges (suitable for welding)
F F material Cu Ni forged (When used with flanged valve use full faced gasket and S.O. Bossed flange).

- d) Stud bolts shall be supplied with insulating sleeves and washers.

5.9 COPPER

Copper materials are suitable for potable water (drinking water) services. Only following American/British specifications as specified against each product are permitted. Bolting shall be ASTM A193 Grade B7/194 Grade 2H and it shall be Hot dip galvanized as per ASTM 153/ ASTM 123.

PIPES: Seam less hard drawn H-80/H55 regular Copper to ASTM B 42(UNS NO. C12200)

FLANGES: ISO 7005-3: ASTM B 61(Leaded tin Bronze)

FITTINGS: For less than or equal to 2” ASTM B 124 (UNS C 11000),
For 3 to 4” ASTM B42 (UNS NO C 12200)

VALVES: BODY, BONNET, TRIM – ASTM B 61(Leaded tin Bronze)
Stem, Wedge disc, Body seat ring - Forged Brass as per ASTM B 124 UNS NO. C37700 (No casting)

NOTES:

- Stud bolts to be supplied with insulating sleeves & washers.
- Blind flanges for Cu. piping shall be ASTM A105 with 3 mm copper overlays
- Composite flange: Outer Flange : ASTM A 105 (Galvanized)
Inner Flange : ASTM B 124 (UNS NO. C 11000)
 $\leq 2''$ S.O.
 ≥ 3 to 4” W.N
For S.O. and W.N. Flange FF valves shall be used for size 2 to 4” only. FF solid slip on class 150 flange to ISO-7005-3: ASTM B 61 shall be used.
- Threading on pipes is not allowed. Screwed are only for vents and drains.

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5.10 GLASS REINFORCED EPOXY

Refer Annexure- 1

Note: Valve material for GRE piping shall be suitable to services for which GRE piping is used.

5.11 POLY VINYL CHLORIDE

PVC materials are suitable for sewage water & chemical services. Only following American specifications as specified against each product are permitted:

PIPES	:	ASTM D 1785
FLANGES	:	ASTM D 2466/ASTM D 2467
FITTINGS	:	ASTM D 2466/ASTM D 2467
VALVES	:	BODY – PVC-ASTM D 1784 TRIM – As per manufacturer Standards.

NOTES:

- Complete piping system shall be enclosed in Galvanized carbon steel pipe for protection against mechanical damage. The size of cover shall be one size higher than the line size.
- The hydro test pressure shall be 1.5 times the design pressure.


5.12 CHLORINATED POLY VINYL CHLORIDE

CPVC materials are suitable for sodium hypo chloride services. Only following American specifications as specified against each product are permitted

PIPES	:	ASTM F 441
FLANGES	:	ASTM F 439 up to 3”/ ASTM F 437 for Threaded fittings.
FITTINGS:		ASTM F 439 S.W up to 3”, ASTM F437 Union up to 3”/ / ASTM F 437 for Threaded fittings.
VALVES	:	Body ASTM- D-1784 Trim –As per manufacturer standards.

NOTES:

- Complete piping system shall be enclosed in Galvanized carbon steel pipe for protection against mechanical damage. The size of cover shall be one size higher than the line size.
- All CPVC material shall be type IV Gr. 1 complying to ASTM-D-1784 (Class-23447-B)

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- c) Union shall be provided on one side of SCRD valves to facilitate its removal.
- d) Maximum test pressure for valve and fabrication assembly shall be 225 psi.

5.13 TITANIUM

Following American specifications as specified against each product are permitted.

- PIPES : ASTM B 861 Grade 2/ B862 Grade2
- FLANGES : ½” to 6” # 150 ANSI , Lap Joint Flange -Inner Flange ASTM B 363 Gr WPT2, Outer Flange ASTM A 105
or
½” to 6” #150 WN, RF to ASTM B 381Gr F2
½” TO 6” Blind Flange ASTM B 381Gr F2
- FITTINGS : ASTM B 363 Gr WPT2 Seam less/ BW
(Lap joint stub end with Neo prene insulating ring)
- VALVES : Body/Trim: ASTM B 381Gr F2/ASTM B 367Gr C2

5.14 MATERIAL IDENTIFICATION

All piping materials (pipe, fittings, flanges, valves, piping specialties etc., shall be supplied with mill certified test reports and certificates to identify the type of steel, composition, heat number and any special testing.

The Contractor shall furnish to the Company with one (1) copy of all mill certificates for all the materials purchased by the Contractor duly certified by company approved third party inspection agency.

The contractor shall mark with double blue stripes for NACE materials.

5.15 SUPPORTS AND MISCELLANEOUS

Any material shall not be welded directly on process piping. If situation arises then prior approval of Company shall be sought during detail Engineering & shall note that the material welded directly to pressure retaining pipe work shall be of similar quality as the pipe work, including impact requirements, if any, for a length measured from the vessel wall of at least 150 mm. The material of such items beyond this point may be structural

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quality A283 Gr. C. or equal/superior (contractor to substantiate with sufficient information & documentary evidence).

5.16 BOLTING

For carbon steel and stainless steel flanged piping systems, stud bolts shall comply with ASTM A193-B7 and ASME B1.1. Nuts shall be heavy hexagon semi-finished per ASTM A194-2H and ASME B18.2.2. Carbon steel studs and nuts shall be hot dip spun galvanized in accordance with ASTM A153.

For carbon steel (NACE) flanged piping systems, stud bolts shall comply with ASTM A193-B7M and ASME B1.1. Nuts shall be heavy hexagon semi-finished per ASTM A194-2HM and ASME B18.2.2. Carbon steel (NACE) studs and nuts shall be hot dip spun galvanized in accordance with ASTM A153.

Duplex stain less steel flange, studs and nut shall be ASTM A 453 Gr 660 Cl A.

5.17 GASKETS

Gasket materials must be such that the internal fluids shall have no harmful or corrosive effects on them.

Gaskets for raised face flanges shall be spiral wound, non-asbestos filled, with 316 stainless steel in accordance with ASME B16.20, with the exception that compressed fibre gaskets complying with ASME B16.21 are acceptable for cooling water service.

Full-face gaskets for flat face flanges shall be made from 3-mm (1/8") thick compressed, oil-resisting non-asbestos sheets, or neoprene. Materials shall be specified in the pipe class Data Sheets.

Ring gasket for ring type joint shall be octagonal and shall be as per ASME B 16.20. Rings for API 5000# flanges shall conform to API 6A. Type RX rings shall be used.

5.18 CERTIFICATION DOCUMENTS

All pressure parts material certification shall be traceable to heat numbers. Certificates, including all material certificates, Mechanical test certificates, welding qualification certificates, heat treatment certificates and hydrostatic test certificates duly certified by



company recognized third party inspection agency shall be available at final inspection and for counter signature by the certification authority and stored by the Contractor for a minimum of 5 years after acceptance of the piping by the Company. Pressure retaining parts shall be clearly marked to allow verification of tractability.

6. TECHNICAL NOTES OF PIPING COMPONENTS

6.1 PIPE

Pipe dimensions shall be in accordance with ASME B36.10 for carbon steel pipe and ASME B36.19 for stainless steel pipe and BS2871 Part 2 for 90/10 Cu-Ni pipe work up to DN 500 (20").

Nominal pipe sizes DN 30 (1¼"), DN65 (2½"), DN85 (3½") and DN 125 (5") shall not be used except where they are required for connections to equipment of standard design or where specific velocities must be maintained. When these sizes are used on equipments, the connecting piping shall be increased or decreased to standard sizes as close to equipment as practical.

Company approval shall be sought prior to using such components.

The minimum nominal pipe size shall be DN20 (¾") except for air, instrument air, water and manufacturer's standard equipment piping.

All nipples shall be made from pipe of same quality as that of parent piping

Carbon steel pipe DN40 (1½") and smaller used for process lines and other lines carrying flammable or toxic fluids shall have wall thickness at least Schedule 80.

Galvanized pipe shall not be bent or welded. Piping requiring bending, welding or threading shall be galvanized after fabrication.

All CS Pipes shall be seamless up to 16". Above 16" pipes shall be SAW with 100% radiography. Weld joint factor to be considered shall be as per ASME B 31.3/ASME B 31.4/ASME B 31.8 (As applicable).

All 90/10 Cu-Ni pipes shall be seamless up to 16". Above 16" pipes shall be SAW with 100% radiography. Weld joint factor to be considered shall be as per ASME B 31.3.



All stainless steel including DSS piping up to 8" shall be seamless. Above 8" shall be EFW with 100% radiography. Weld joint factor to be considered shall be as per ASME B 31.3.

All pipes shall have bevel end for size equal to and above 2" and plain end below 2".

6.2 TUBING

All tubing, unless otherwise noted, shall be 316 SS/316L SS seamless with wall thickness appropriate for the service & piping class.

Refer to the Specification FS 3507 for Instrumentation Bulk item requirements.

6.3 FITTINGS

All unions DN25 (1") and larger shall comply with BS 3799.

No street elbows or threaded bushings shall be used in piping. Hexagonal bushings (but no flush bushings) may only be used with tubing fittings for connection to instruments, or as otherwise specifically approved by the Company.

The thickness of reducing fittings shall match the wall thickness of the higher schedule pipe wall. The fitting wall thickness shall be tapered on a 1:4 gradient to ensure that the pipefitting wall thickness matches the lower schedule pipe wall.

All 90°-weld elbows shall be long radius, unless restricted by available space. Short radius (SR) welding elbows shall not be used unless absolutely required for clearance purpose with prior approval from the company. If short radius weld elbows are used, they shall be de-rated to 80% of the calculated allowable working pressure if subject to pulsations.

Thickness for fitting shall be same as that of corresponding pipe. Short radius elbows, which have been de-rated as specified above, may require a wall thickness greater than that of the connecting pipe.

Welded fittings materials shall be compatible with the piping material.

Fittings DN40 (1-1/2") and smaller shall be socket weld except as dictated.

Fittings DN50 (2") and larger shall be butt welded except as dictated.



Mitred joints shall not be used.

6.4 BRANCH CONNECTIONS

Branch connections shall be in accordance with API RP 14E. Branch connections for non-ferrous materials shall be as per manufactures standard with prior approval from Company. Contractor to prepare and list the branch tables in piping class data sheets. The lists shall show requirements for branches at 90° angles to the header & branching component with sufficient details.

6.5 FLANGES

Flanges shall be in accordance with ASME B16.5 for DN50 to DN600 and with ASME B16.47 Series A for flanges DN650 and larger. They shall be raised face unless otherwise shown on the individual vessel data sheets and/or drawings. Non-standard size flanges shall be calculated in accordance with ASME Code Rules & prior approval shall be sought from company.

Flanges shall be raised face up to #600 rating and shall be RTJ above #600 rating.

API ring joint 5000-psi flanges shall comply with API 6A.

ASME ring joint (RTJ) flanges shall have octagonal grooves conforming to ASME B 16.5.

API ring joint flanges shall conform to API specification 6A.

The bolt-hole pitch circle diameter for orifice flanges DN50, DN80 and DN100 shall be 1.6 mm smaller than specified in ASME B16.5.

Flange bolt-holes shall straddle the piping vertical and horizontal centerlines.

Flanges in the piping shall be kept to a minimum. Flanges shall be installed only to facilitate construction, maintenance and inspection and in cases where process conditions dictate.



Spectacle blinds rather than spade blinds shall be provided where required. Thickness of blinds shall be calculated in accordance with ASME B31.3. Pairs of spacers and blinds shall be used instead of spectacle blinds of size DN 350 and larger.

Class 400 flanges shall not be used unless required to match nozzles of compressors, pump, turbines, etc. of standard design supplied by equipment manufacturers.

Smooth finish on flanges shall be 32-63 AARH.

Wherever face finish is not mentioned, it shall be serrated spiral/concentric

6.6 BOLTING

Flange bolting of nominal size M40 (1-½”) and above shall be subject to bolt tensioning. Flange bolting shall be a full threaded alloy steel stud bolt, each with two heavy hexagonal nuts. Stud bolts shall have full continuous threads and have lengths in accordance with B16.5 with the provision that a minimum of one (1) thread and a maximum of three (3) threads outside each nut and complete with 2 nuts to facilitate bolt tensioning.

Stud bolts shall be used for all piping closures except where tapped wafer valves dictate the use of machine bolts.

6.7 VALVES

Valve bodies, seals, etc., shall be in accordance with the design pressure and design temperature of the applicable project Specification. Valves may be supplied with higher design pressure or design temperature trims in order to meet the service requirements.

Each valve shall be supplied with a stainless steel tag, attached to the gland bolting, or hand wheel, with stainless steel wire, bearing the applicable valve identification, Tag Number and Purchase Order number.

Ball valves shall comply with API 6D or BS EN ISO 17292/BS 5351 (below 2”). All ball valve body patterns shall be long pattern to ASME B16.10 and shall be quarter-turn design. Soft seals and seats for ball valves shall be suitable for the maximum applied differential pressure, the service fluid and the specified pressure and temperature ratings.



As a general philosophy, ingress of sand particle is envisaged in well fluid and injection water services unless indicated otherwise elsewhere in the bid hence all valves are required to be metal seated in well fluid and injection water service. Trim of the metal seated Ball Valves as a minimum shall be Tungsten Carbide coated. Minimum surface hardness shall be 1050 Vickers and minimum coating thickness of finished and machined surface of Tungsten Carbide shall be 150 μ to 250 μ . Uses of soft seated valves are allowed only when no erosive effect is envisaged due to abrasive particle. Contractor is required to establish the same during detail engineering.

Check valves shall comply with BS 1868 or BS 5352/BS EN ISO 15761 or API 602. Swing type check valves shall have bolted bonnets. Where check valves are placed in vertical runs, valves shall be equipped with flapper stops. The stops shall not be connected to bonnet taps in any way.

In pulsating, turbulent or high velocity flow, to avoid possibility of slamming in check valve tilting disc slam check valve shall be preferred.

For heavy check valves, provisions shall be available for lifting by way of lugs, eyebolts and such standard devices

Gate valves shall comply with API 600, 602 or 603 as applicable. Gate and butterfly valves shall be used in “clean” non-hydrocarbon services like firewater services only.

In hydro carbon services for #900 & above, gate valves may be used in hydrocarbon service in place of ball valves for sizes up to 1.5”.


Globe valves shall comply with API 602/ BS 1873/ BS 5352/BS EN ISO 15761.

Plug valves shall comply with BS 1873/ BS 5353.

Butterfly valves shall comply with BS 5155/BS EN 593/ API 609

Steel and alloy valves shall be designed and tested in accordance with the applicable codes as per type & class of valves are as under: -

1. ASME 150# - Designed and examined in accordance with ASME B16.34 and tested in accordance with API 598.

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<p>2. ASME 300# through ASME 2500# - Designed and tested in accordance with API 6D for ball valves & other applicable codes as per type of valves.</p> <p>3. API 2000# through API 5000# - Designed and tested in accordance with API 6A.</p> <p>4. All hydrocarbon valves with non-metallic seats and seals including ball valve and butterfly valve shall be fire-safe, tested in accordance with API 607, API 6FA, ISO 10497 or BS 6755 PART II. The ball valves shall be fire safe in accordance with the requirements of either API 6FA (for trunnion ball valves) or API 607/ISO 10497 (for floating ball valves). All valves shall be witnessed & certified by a company approved third-party agency.</p> <p>5. Metal Seated Ball valve shall be tested as per API 6D or API 6A as applicable. Leakage rate shall not be more than Rate – “B” as per API 6D/ISO 5208.</p> <p>Valves i.e. Ball, Gate, Globe, Choke and Needle used in service with more than 230ppm of H₂S shall be designed for Fugitive Emission from external leakage paths of Valve stem seals and body joints/Seals. Each type of valve design shall be certified by type testing as per BS EN ISO 15848-1. Each valve as a minimum shall comply with:</p> <p>(a) Tightness Class as per Table -1 (Based on type of stem seal) and Leakage from body seals as per Table-2 of BS EN ISO 15848-1.</p> <p>(b) Endurance Class - CO1 of BS EN ISO 15848-1</p> <p>(c) Temperature Class – (t-RT) & (t200⁰C) of BS EN ISO 15848-1</p> <p>The type test for each design of Valve shall be witnessed and certified by ONGC approved Third Party Inspection Agency.</p> <p>During production of Valves, each valves which has been type tested as per BS EN ISO 15848-1 shall be revalidated by testing for tightness class as per BS EN ISO 15848-2. Tightness class test for each Valve shall be witnessed and certified by ONGC approved Third Party Inspection Agency.</p> <p>Gate, globe, angle, ball and check valves shall be supplied with replaceable seats. Where replaceable seats are not available, the valve seat shall be stellite and welded into the valve body.</p>				

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Valves designated “LO” (Locked Open) or “LC” (Locked Closed) on drawings, shall be provided with locking devices. Valves shall be furnished with the locking tab hardware installed.

Open-ended valves shall be equipped with threaded plugs or blind flanges.

- a) Ball shall be solid type unless otherwise specified.
- b) All valves shall be forged type for 1 ½” & below.
- c) All valves shall be supplied with position indicator.
- d) All trunnion mounted ball valves shall be supplied with double block & bleed arrangement

Every block valve shall be provided with a lever, handle, or hand wheel as necessary to operate the valve.

Gear operators shall be heavy-duty lubricated type and shall be completely housed in a weatherproof enclosure.

Socket-weld valves shall be bolted body or top entry design, allowing removal of seats/seals for heat protection, prior to welding, without loss of assembly orientation. Single piece valve bodies, or valves bodies assembled by screwed-together components, shall not be used with socket-weld ends.

If an overlay weld-deposit is used for the body seat ring, seating surface, the seat ring base material shall be at least equal to the corrosion resistance of the material of the shell.

All valves shall be reduced bore unless & otherwise specified. Full bore valves shall be provided for all piggable lines.

Valve body thickness shall be as per relevant valve standard, shall be in accordance with ASME B16.34.

Valve body of Cast material of Construction shall be 100% radiographed irrespective of rating in accordance with ASME B16.34 Annexure B.



Valves body other than Cast material of Construction shall be radio graphed to the following extents: -

ASME 150#, DN600 or smaller	25%
ASME 150#, DN650 or larger	100%
ASME 300#, DN400 or smaller	25%
ASME 300#, DN450 or larger	100%
ASME 600# and higher	100%
Carbon steel to NACE requirements	100%
Stainless and high alloy steel (Cast or Forged)	100%
Other alloys (Cast or Forged)	100%


UT in place of radio graphy is acceptable for forged valve in accordance with ASME B16.34.

Socket-weld-end valves with non-metallic seats or seals shall be provided with 80mm long nipples having materials and thickness equivalent to those specified in the relevant piping specifications. These nipples shall be welded to the valves on both ends before the packing, seats and seals are fitted.

Stem protection is required for all carbon steel gate and globe valves where 13% Chromium trims are specified. The stems shall be totally enclosed in sleeves, which shall be packed with grease.

By-pass requirement for gate valves shall be provided as per following. Basic design of bypass shall be MSS-SP-45 & ASME B-16.34

ASME 150 class	on sizes 26" and above.
ASME 300 class	on sizes 16" and above.
ASME 600 class	on sizes 6" and above.

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ASME 900 class on sizes 4” and above.

ASME 1500 class on sizes 4” and above.

ASME 2500 class on sizes 3” and above.

By-pass valve shall be a globe valve. The sizes shall be as under:

On main valve	≤ 4”	½” or more
On main valve	> 4” but <10”	¾” or more
On main valve	≥10”	1” or more.

Valves with by-pass shall have the direction of flow marked on the main valve. By-pass attachment to the main valve body shall not be screwed. All fillet welds for by-pass installation shall be 100% examined by DP/MP test.

The by-pass piping arrangement shall be such that clearance between main valve body & bypass assembly shall be the minimum possible for layout reasons.

Material of construction of yoke shall be minimum equivalent to body/bonnet material.

Stelliting / hard facing by deposition shall be minimum 1.6 mm.

Soft-seated Ball, plug & butterfly valves shall be supplied with antistatic devices.

Soft seated Ball valves shall be floating ball type/trunnion mounted type as per following:

150#	8” & below	floating ball
	10” & above	trunion mounted
300#	4” & below	floating ball
	6” & above	trunion mounted
600#	1.5” & below	floating ball
	2” & above	trunion mounted

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For metal seated ball valve, trunion mounted ball valve in place of floating ball valve is acceptable. However, vise-versa is not acceptable.

Generally the valves are hand wheel or lever operated. Gear operation shall be provided as under:

VALVE TYPE	CLASS	SIZE REQUIRING GEAR OPER.
Gate valve & diaphragm	150 class	14" and larger
	300 class	14" and larger
	600 class	12" and larger
	900 class	6" and larger
	1500 class	3" and larger
	2500 class	3" and larger
Globe valve	150 class	10" and larger
	300 class	8" and larger
	600 class	6" and larger
	900 class	6" and larger
	1500 class	3" and larger
	2500 class	3" and larger
Ball/plug Valve (other than pressure balance plug valve)	150 class	6" and larger
	300 class	6" and larger
	600 class	4" and larger
	900 class	3" and larger
	1500 class	3" and larger

Where gear operator is not called for as per above but vendor recommends a gear operator, he shall highlight such cases & obtain company's approval. For basis of finalization of gear operator vendor shall follow the guide line as mentioned below:

Torque and Gear Ratio required shall be based on guide line as indicated below:

Valve hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on either side. Effort shall not exceed 35 Kg at hand wheel periphery. Failing to meet above criteria vendor shall offer gear operated Valves even if valve does not fall into the category indicated in the above table

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The following guide line shall be followed for gear box/hand wheel/lever:

Hand wheel -operated:

Max. Single hand forces: 200 N.

Max. Diameter of hand wheel: 750 mm.

(Max. torques 150 Nm).

Lever-operated:

Max. Force: 350 N.

Max. Length of lever: 600 mm.

(Max. torques 270 Nm).

Manual and gear operated valve shall be operated without use of any extension device. The torque/force value shall be recorded during the test. Torque value recorded shall not be more than indicated above.

Valve hand wheel/Lever shall be solid malleable Iron to ASTM A 47 (or any other applicable standard)/ Solid SS-316 material as per suitable MOC of the valve for required torque. In case of Malleable Iron, hand wheel shall be galvanized with thickness suitable to marine environment and subsequently painted as per FS 2005.

Vendor shall declare the operating torque value of each valve based on above guide line and carryout the required test as indicated in clause no. 6.7.1.1 through 6.7.1.7

6.7.1 TEST REQUIREMENTS OF VALVES

This clause elaborates minimum mandatory tests required to be carried out by the vendor at his premises, at fabrication yard of LSTK Contractor and offshore location. The tests indicated against this clause are related to the valve only, other material tests as required by relevant clause of this specification shall be complied by the vendor in addition to the tests indicated under this clause.

6.7.1.1 SHUT DOWN VALVE

- Material tests as per clauses no. 5 and sub clauses of FS 2004 A.
- Radiography of shell/body of the valve.
- DPT or MPT (as applicable) of the items/parts of the valve.
- Fire type test with respect to design of the valve.
- Hydrostatic Shell Test.
- Hydrostatic Seat Test.
- Pneumatic Seat Test.
- Check Torque of the Valve against zero differential pressure (as indicated in relevant para. of clause 6.7 of FS 2004A).
- Check Torque of the Valve against rated full differential pressure (as indicated relevant para. of clause 6.7 of FS 2004A).
- Check Torque of the Actuator as per FS 2004D.
- Type test of Fugitive Emission as per BS EN ISO 15848-1(If applicable).
- Fugitive Emission test as per BS EN ISO 15848-2 (If applicable).
- Check surface preparation and all the stages of protective coating as per FS 2005.
- Functional Test of the Valve – Shut Down Valve be pressurized to full differential rated pressure with liquid same as used for hydro test and thereafter shut down valve be operated by giving full rated pressure to actuator and rated voltage to Solenoid Valve. Full opening

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and closing shall be checked. The operation of the valve shall be smooth and jerk free. This activity shall be repeated 5 times at manufacturer's location.

Sequence of operation in the entire test shall be alternate with one cycle with zero differential pressure across the valve and one cycle with full differential pressure across the valve.

Same activity shall be repeated 5 times with zero differential pressure across the valve on installation at fabrication yard and 5 times at offshore.

- (o) Valve shall be API Monogrammed which are designed under API Codes and Standards, as applicable.

6.7.1.2 MOTORIZED BALL VALVE

- a) Material tests as per clauses no. 5 and sub clauses of FS 2004 A.
- b) Radiography of shell/body of the valve.
- c) DPT or MPT (As applicable) of the items/parts of the valve.
- d) Fire type test with respect to design of the valve.
- e) Hydrostatic Shell Test.
- f) Hydrostatic Seat Test.
- g) Pneumatic Seat Test.
- h) Check Torque of the Valve against no differential pressure zero differential pressure (as indicated in relevant para. of clause 6.7 of FS 2004A).
- i) Check Torque the Valve against rated full differential pressure (as indicated relevant para. of clause 6.7 of FS 2004A).
- j) Check Torque of the Actuator as per FS 2004D.
- k) Type test of Fugitive Emission as per BS EN ISO 15848-1 (If applicable).
- l) Fugitive Emission test as per BS EN ISO 15848-2 (If applicable).
- m) Check surface preparation and all the stages of protective coating as per FS 2004D.
- n) Functional Test of the Valve – Motor Operated Valve (MOV) shall be pressurized to full rated differential pressure with liquid same as used for hydro test and thereafter MOV shall be operated by giving full rated power to actuator. Full opening and closing shall be checked. The operation of the valve shall be smooth and jerk free. There shall be not abrupt fluctuation of current except during brake to open and Brake to close. The operation of the valve shall be smooth and jerk free. This activity shall be repeated 5 times at manufacturer's location

Sequence of operation in the entire test shall be alternate with one cycle with zero differential pressure across the valve and one cycle with full differential pressure across the valve.



Same activity shall be repeated 5 times with zero differential pressure across the valve on installation at fabrication yard and 5 times at offshore.

- (o) Valve shall be API Monogrammed which are designed under API Codes and Standards, as applicable.

6.7.1.3 BALL VALVE.

- (a) Material tests as per clauses no. 5 and sub clauses of FS 2004 A.
- (b) Radiography of shell/body of the valve.
- (c) DPT or MPT (As applicable) of the items/parts of the valve.
- (d) Fire type test with respect to design of the valve.
- (e) Hydrostatic Shell Test.
- (f) Hydrostatic Seat Test.
- (g) Pneumatic Seat Test.
- (h) Check Torque of the Valve against no differential pressure zero differential pressure (as indicated in relevant para. of clause 6.7 of FS 2004A).
- (i) Check Torque of the Valve against rated full differential pressure (as indicated relevant para. of clause 6.7 of FS 2004A).
- (j) Not Applicable.
- (k) Type test of Fugitive Emission as per BS EN ISO 15848-1 (If applicable).
- (l) Fugitive Emission test as per BS EN ISO 15848-2 (If applicable).
- (m) Check surface preparation and all the stages of protective coating as per FS 2005.
- (n) Functional Test of the Valve – Ball Valve shall be pressurized to full rated differential pressure with liquid same as used for hydro test and thereafter shall be operated by single hand. Full opening and closing shall be checked. The operation of the valve shall be smooth. The operation of the valve shall be smooth and jerk free. This activity shall be repeated 5 times at manufacturer's location

Sequence of operation in the entire test shall be alternate with one cycle with no differential pressure across the valve and one cycle with full differential pressure across the valve.

Same activity shall be repeated 5 times with zero differential pressure across the valve on installation at fabrication yard and 5 times at offshore.

- (o) Valve shall be API Monogrammed which are designed under API Codes and Standards, as applicable.

6.7.1.4 GATE VALVE.

- (a) Material tests as per clauses no. 5 and sub clauses of FS 2004 A.
- (b) Radiography of Shell/Body of the valve.
- (c) DPT or MPT (As applicable) of the items/parts of the valve.
- (d) Hydrostatic Shell Test.
- (e) Hydrostatic Seat Test.
- (f) Pneumatic Seat Test.



- (g) Check Torque of the Valve against no differential pressure zero differential pressure (as indicated in relevant para. of clause 6.7 of FS 2004A).
- (h) Check Torque of the Valve against rated full differential pressure (as indicated relevant para. of clause 6.7 of FS 2004A).
- (i) Type test of Fugitive Emission as per BS EN ISO 15848-1 (If applicable).
- (j) Fugitive Emission test as per BS EN ISO 15848-2 (If applicable).
- (k) Check surface preparation and all the stages of protective coating as per FS 2005.
- (l) Functional Test of the Valve – Gate Valve shall be pressurized to full rated differential pressure with liquid same as used for hydro test and thereafter shall be operated by single hand. Full opening and closing shall be checked. The operation of the valve shall be smooth. The operation of the valve shall be smooth and jerk free. This activity shall be repeated 5 times at manufacturer's location

Sequence of operation in the entire test shall be alternate with one cycle with no differential pressure across the valve and one cycle with full differential pressure across the valve.

Same activity shall be repeated 5 times with zero differential pressure across the valve on installation at fabrication yard and 5 times at offshore.

6.7.1.5 GLOBE VALVE

- (a) Material tests as per clauses no. 5 and sub clauses of FS 2004 A.
- (b) Radiography of Shell/Body of the valve.
- (c) DPY or MPT (As applicable) NDT of the items/parts of the valve.
- (d) Hydrostatic Shell Test.
- (e) Hydrostatic Seat Test.
- (f) Pneumatic Seat Test.
- (g) Check Torque of the Valve against no differential pressure zero differential pressure (as indicated in relevant para. of clause 6.7 of FS 2004A).
- (h) Check Torque of the Valve against rated full differential pressure (as indicated relevant para. of clause 6.7 of FS 2004A).
- (i) Type test of Fugitive Emission as per BS EN ISO 15848-1 (If applicable).
- (j) Fugitive Emission test as per BS EN ISO 15848-2 (If applicable).
- (k) Check surface preparation and all the stages of protective coating as per FS 2005.
- (l) Functional Test of the Valve – Globe Valve shall be pressurized to full rated differential pressure with liquid same as used for hydro test and thereafter shall be operated by single hand. Full opening and closing shall be checked. The operation of the valve shall be smooth. The operation of the valve shall be smooth and jerk free. This activity shall be repeated 5 times at manufacturer's location

Sequence of operation in the entire test shall be alternate with one cycle with no differential pressure across the valve and one cycle with full differential pressure across the valve.

Same activity shall be repeated 5 times with zero differential pressure across the valve on installation at fabrication yard and 5 times at offshore.



6.7.1.6 CHECK VALVE

- (a) Material tests as per clauses no. 5 and sub clauses of FS 2004 A.
- (b) Radiography of Shell/Body of the valve.
- (c) DPT or MPT (As applicable) of the items/parts of the valve.
- (d) Hydrostatic Shell Test.
- (e) Hydrostatic Seat Test.
- (f) Pneumatic Seat Test.
- (g) Type test of Fugitive Emission as per BS EN ISO 15848-1 (If applicable).
- (h) Fugitive Emission test as per BS EN ISO 15848-2 (If applicable).
- (i) Check surface preparation and all the stages of protective coating as per FS 2005.
- (j) Functional Test of the Valve – Check Valve shall be pressurized gradually with liquid same as used for hydro test in the direction of flow and the minimum pressure at which the valve allows flow to take place shall be recorded.

6.7.1.7 NEEDLE VALVE.

- (a) Material tests as per clauses no. 5 and sub clauses of FS 2004 A.
- (b) Radiography of Shell/Body of the valve.
- (c) DPT or MPT (As applicable) of the items/parts of the valve.
- (d) Hydrostatic Shell Test.
- (e) Hydrostatic Seat Test.
- (f) Pneumatic Seat Test.
- (h) Check Torque of the Valve against no differential pressure zero differential pressure (as indicated in relevant para. of clause 6.7 of FS 2004A).
- (i) Check Torque of the Valve against rated full differential pressure (as indicated relevant para. of clause 6.7 of FS 2004A).
- (k) Type test of Fugitive Emission as per BS EN ISO 15848-1 (If applicable).
- (l) Fugitive Emission test as per BS EN ISO 15848-2 (If applicable).
- (m) Check surface preparation and all the stages of protective coating as per FS 2005.
- (n) Functional Test of the Valve – Needle Valve shall be pressurized to full rated differential pressure with liquid same as used for hydro test and thereafter shall be operated by single hand. Full opening and closing shall be checked. The operation of the valve shall be smooth. The operation of the valve shall be smooth and jerk free. This activity shall be repeated 5 times at manufacturer's location

Sequence of operation in the entire test shall be alternate with one cycle with no differential pressure across the valve and one cycle with full differential pressure across the valve.

Same activity shall be repeated 5 times with zero differential pressure across the valve on installation at fabrication yard and 5 times at offshore.

6.8 SPECIALTY ITEMS

Specialty Items shall be supplied, designed, tested & installed as specified in the Project Specification for specialty items spec.2004D.



7. PIPING SYSTEM DESIGN

7.1 GENERAL

Design calculations for pressure/temperature wall thickness requirements, vibrations, thermal expansion and contraction, pipe weights and flexibility shall be carried out in accordance with ASME B31.3 and ASME SEC VIII and submitted to the Company for acceptance.

Piping components shall be located where they can safely be operated (where necessary) and maintained. Access shall be provided to such components, which are located out of reach from the platform deck. The use of extended hand wheel stems or chain wheels shall be avoided.

Dead ends on distribution and collection headers shall be blind flanged.

Long radius elbows shall generally be used, but for pigged lines long radius 5D bends are required. Short radius elbows shall be avoided unless essential for clearances. Cold-formed bends are not permitted. Fabricated mitre bends can only be used on gas turbine exhausts.

7.2 PIPE ROUTING

Piping shall be routed so as to have the short runs and minimize pipe supports whilst providing sufficient flexibility for thermal expansion and contraction and mechanical movement.

Expansion and swivel joints shall be avoided.

Large bore piping shall be designed to minimize pressure drops. Smaller bore piping shall be routed in groups where practical along main pipe racks.

Piping shall be kept within the deck boundaries.

The number of flanges and unions shall be minimized. The piping carrying hydrocarbon/hazardous chemicals in the safe area shall be of continuous length with welded joints such that no valves, regulators, flanges etc. are located in the safe area. One breakable joint in the safe area at the consumer points is permitted, with adequate safeguards.

Piping shall be routed to avoid trip and overhead hazards.

Consecutive elbows in different planes shall be avoided.

Pipe routing shall allow sufficient space for bolting up flanges or for line-up clamps to be used for field welds. Refer “Piping Clearances” described in piping fabrication (spec 2004-B).

Piping passing through firewalls shall be sealed with fire-retarding sleeves.

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Primary utility (air, steam and water) connections on piping shall be DN20 ($\frac{3}{4}$ ") or larger through the first block valve.

All instrument air and fuel gas connections shall be from the top of the associated headers.

The angle between any branch and its header shall not be less than 45°.

Scraper tees shall be provided for lines, which are to be pigged as per approved P&IDs.

Dimensional rules for piping design are as follows:

Min pipe dia. for thermo-well connection on straight run pipe	DN 100.
Minimum pipe diameter for thermo-well connection on 90° elbow	DN 80
Pipe racks to be sized to allow for the future equipment	+20%.
Minimum run size of piping in racks	DN 50
Spacing of instrument air take-offs along pipe rack headers in process areas.	≥3000 mm
Minimum slope of HP and LP flare headers	1:100
Minimum slope of open drain header	1:100
Minimum slope of closed drain header	1:100
Minimum slope of pump suction lines where vapour may be present	1:50

7.3 PIPE SUPPORTS

Refer piping design criteria (Vol II, sec 3.3). Piping shall be suitably supported to prevent sagging, mechanical stresses vibrations and consequent fatigue, while allowing for thermal and structural movement. Piping shall be adequately supported for the weight of piping filled with water, with attached components unsupported, subject to wind, seismic, insulation and any other applicable loads. The supports shall prevent excessive stresses in the piping and in the nozzles of the equipment to which it is connected.

Small bore instrument tubing and piping shall be adequately supported and protected from impact damage.

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Bracing shall be provided for small-bore branches in piping adjacent to vibrating machinery.

Supports used for Cu-Ni piping shall be lined with soft packing strip or pad free from ammoniac components (EG: NEOPRENE ASTM D 2000) to prevent chafing and undue stressing and also to permit free expansion/contraction of Cu-Ni pipes between anchors (Selection of Grade & Type of Neoprene Rubber will be based on Design Temperature & as per ASTM D-2000)

7.4 PIPE WAYS

Generally the piping should be routed in either platform north/south or east/west in established pipe ways. All lines running platform north/south shall be a different elevation from lines running platform east/west, as far as practical. Where possible, a minimum of 400 mm or more between changes in elevation of pipe runs in pipe ways shall be maintained.

7.5 PIPING CLEARANCES

The minimum clearance for maintenance access shall be 750 mm. The following design constraints shall also apply.

Minimum height from underside of pipe or insulation to high point of deck level or platform	200 mm
<u>Control valve arrangement:</u> Preferred bottom of pipe (BOP) of control valve above deck level or platform.	400 mm
For meter runs, the minimum clearance between BOP and deck is	760 mm
<u>Pipe spacing:</u> Minimum space between pipes without flanges (after allowing for insulation and lateral movement)	100 mm
Minimum space between pipes with flanges (largest flange to pipe) (after allowing for insulation and Lateral movement)	100 mm
- Minimum distance from pipe to face of steel work (after allowing for insulation)	50 mm
- Minimum distance from flange to face of steel work, etc.	50 mm
<u>Valve installations and access:</u> Preferred height of hand wheel from deck or platform:	
* horizontally mounted valves	1000/1350 mm
* vertically mounted valves	1100/1300 mm



Maximum height from local deck or platform level to center line of horizontal hand wheel without platform on chain wheel	
Vertically-mounted valves (DN100 and larger) (DN 80 and smaller)	2000 mm 2250 mm
* maintenance or isolation (except where temporary platforms can be used and at pipe racks)	3000 mm
Use of chain wheels and extension stems shall be kept to a minimum. Chain shall clear operating level by:	1000 mm

7.6 FLANGED CONNECTIONS

Flanged connections shall be minimized, being used only where frequent dismantling will be required, where specific flanged spools are needed, where needed to provide clearances for equipment removal, or for piping class or material changes.

7.7 THREADED PIPE-WORK

Threaded piping shall not be used to carry hydrocarbons.

Piping DN40 (1½”) and smaller, when used for services up to 1900 kPa (g) (275 psig), may be threaded with prior approval of Company.

Screwed fittings shall be rated at least 20.7 Mpa (3000 psi).

Bushings, close nipples and street elbows shall not be used.

Pipe threads shall conform to ASME B1.20.1.

Cu-Ni pipe work shall not be threaded. Adapters can be used at valves or equipment.

7.8 CHANGES IN MATERIALS

Where dissimilar piping materials are connected insulation gaskets shall be provided to prevent galvanic corrosion.

7.9 VENTS, DRAINS AND BLEEDS

High points on all lines shall be provided with DN20 (¾”) minimum plugged or flanged connections for venting during hydrostatic tests. For lines carrying hydrocarbons or other toxic fluids, the vents shall be piped to the nearest vent header.



All ODD cups shall be provided with temporary (welded/bolted) plates as cover so as to prevent the clogging/chocking of drain lines during drilling operation in addition to grid plates.

Low points in lines shall be provided with drain connections of nominal sizes as follows: -

Line Size

Drain Size

DN15 (½")

DN15 (½")

DN20 (¾") TO DN 100 (4")

DN20 (¾")

DN150 (6") to DN250 (10")

DN25 (1")

DN300 (12") and larger

DN25 (1") to DN 40 (1½")

Drains on lines other than firewater shall be provided with valves and plugged. Firewater drains do not need valves.

All hydro-test vents and drains in hydrocarbon service shall be DN 20 with valves and steel plugs unless noted otherwise.

A hydrostatic vent and drain philosophy shall be developed during detail design and shown on the isometrics.

7.10 CORROSION INHIBITION AND MONITORING PIPE WORK

Corrosion monitoring fittings shall be located as close as practical to the pipe work being monitored, where servicing access is easy and away from sources of vibration. Clearance shall be provided for the removal of the injection quills and monitoring probes, suiting each nozzle orientation and the length of the associated probe. Corrosion probe nozzles shall be mounted on the underside of the pipes.

7.11 RELIEF VALVES

Relief valve assemblies shall be installed in the vertical position, as close to the pressure source as possible, and shall be provided with permanent platform access. Relief valves shall be bolted directly to vessel and equipment nozzles.



Relief valve piping shall be designed to withstand reaction forces and moments caused by the valve discharging.

Piping from relief valves to closed systems shall slope toward the headers and enter them from above, or, where that is not practical, shall have DN20 (¾”) drains in safe areas. Headers shall have at least 1:100 slopes toward downstream.

Refer to the Project Specification for General Instrumentation.

7.12 CONTROL VALVES

Control valves shall preferably be installed in horizontal lines, with the actuator in the vertical position. Each valve shall be located as close as possible to the item of plant under control and shall be easily accessible from the deck or permanent platform.

Where control valves are less than line size, reducing spools shall be made long enough to permit bolt removal.

Consideration shall be made for removal or withdrawal of valves or part of valves for maintenance.

Refer to the Project Specification for Instrumentation for additional requirements.

7.13 ISOLATIONS

Piping shall be designed, so the connections to equipment and vessels can be isolated for safe maintenance. This may be accomplished by providing for the insertion of blind flanges at strategic points or removable spools if blinding is not practical due to line size. All vessels containing hydrocarbons or other hazardous fluids and which would involve personnel entry during maintenance require such blinds.

Blinds shall be located so that insertion can be made from the deck or permanent platforms or access ways. Permanent hook eyes shall be provided above blinds, which weigh more than 25 kg. Where blinds are not required for isolation, valves must be provided for safe isolation.

Double block and bleed isolation shall be provided wherever shown in P&ID.



7.14 FIRE SUPPRESSION SYSTEM

Refer design criteria of the Mechanical and safety & life saving equipment (Vol II sec 3.7) and functional safety specification (spec 5102) for fire suppression attached elsewhere in bid package.

7.15 CUPRO-NICKEL PIPE WORK

Cupro-Nickel or Copper-Nickel (Cu-Ni) piping shall be used for firewater deluge systems.

All Cu-Ni piping shall be designed such that velocity in piping does not exceed the values given in project specifications. However, in special circumstances such as downstream of control valves, orifice plate, etc, where fluid velocity may exceed those given in the design criteria special material such as DSS/SDSS/Monel subject to company's approval may be used to withstand higher velocities. When one side is ASME Class 150 Cu Ni and other side is of higher rating carbon steel, a spool of carbon steel having one end of higher rating CS flange and other of lower rating CS flange shall be inserted which also acts as a sacrificial piece

Supports for Cu-Ni piping shall be lined with soft packing pads, neoprene or similar, which shall be free of ammonia compounds.

7.16 COPPER PIPING

Copper (Cu) piping shall be used for potable and other clean water systems.

7.17 GRE PIPING SYSTEMS

Glass-Reinforced Epoxy (GRE) piping shall be used for water services where there is little risk of physical impact, typically for overboard lines.

When a GRE pipe penetrates a fire rated wall or floor, the GRE shall be substituted by a flanged metallic spool piece, fabricated from a material suitable for the proposed service.

GRE piping shall be enclosed in one size higher metallic material when there is risk of moderate physical impact.

7.18 PIPING ON AREAS SUBJECT TO DIFFERENTIAL MOVEMENT

The design of the piping on such areas (if any) shall take into account the differential movement between the two structures under extreme (100 years) storm conditions and thermal expansion



and contraction. Flexibility analysis of the piping systems shall be carried out. The Contractor shall provide any necessary pipe loops and supports.

7.19 PIPING AT EQUIPMENT

Piping at equipment shall be arranged so that the equipment can be removed easily by dismantling / adjusting the piping adjacent to the equipment without the need to dismantle any component of the equipment.

Equipment will not be used to anchor piping. Forces transmitted to equipment at tie-in points will be within the Equipment Supplier's recommended limits.

Piping connected to rotating equipment shall be designed and supported to minimize the transmission of vibrations from the machines. The Contractor shall carry out flexibility analysis of this pipe work to prevent exceeding, allowable nozzle loads as defined by the equipment manufacturer.

7.19.1 PIPING AT HEAT EXCHANGERS

Cooling water piping to shell & tube exchangers shall be arranged so that water will not drain from the outlet when water supply fails.

Exchanger piping shall be arranged so that the exchanger can be removed as one unit and so that the tube bundle can be pulled after disconnecting channel piping.

Piping connections to exchangers shall be designed and properly aligned to allow for hot & cold service and to limit the stress on exchanger nozzles to within allowable levels.

Filters shall be provided in lines to cooling fluid inlets.

7.19.2 PIPING AT PUMPS

Piping at pumps shall be designed and supported so that equipment can be dismantled or removed with a minimum number of temporary supports and without dismantling valves and piping other than the spool that connects to the pump. Clearances shall permit installation of blind flanges against block valves when the service is hazardous and the removal of pump rotating elements.



Pump suction lines shall end with at least four diameters of straight pipe with the same nominal size as the suction flanges. If reducers are required on suction lines, they shall be eccentric and installed flat side up.

Recycle lines shall be provided to allow minimum flows required for pumps.

Pressure relief lines shall be provided for positive displacement pumps.

Valves shall be located as close as possible to the pump nozzles as practical. Isolation valves on pump suction lines shall be full-bore ball type. Isolation valves on discharge lines shall be located downstream of check valves.

Pump suction lines in which, vapour may be present shall be inclined downward towards the pumps with slopes of at least 1:50.

Strainers shall be provided in all pump suction lines. Permanent Y-type or basket strainers shall be provided for reciprocating and rotary pumps. The open area of strainers shall be at least 300% of the cross-sectional area of the pipe. The piping shall be arranged so that the filter or strainer element can be removed from the flanged joints without altering the piping, supports or pump alignment.

7.19.3 PIPING AT TURBINES

Air Inlet and Exhaust duct termination shall be positioned away from hazardous areas, and areas frequented by personnel or any open ended or filtered inlet ducts.

Fuel gas piping within the turbine enclosure shall be subject to strict control with respect to the number and type of flanged joints, fully welded being preferred. Flanged joints shall be provided only for connection to the equipment and for isolation and shut down valves.

7.19.4 PIPING AT DIESEL ENGINES

All piping connected to diesel engines shall be arranged in such a manner that adequate flexibility is maintained so as to effectively isolate the piping from any engine vibration. Piping shall not be routed directly over diesel engines.

Fuel lines shall not be run over exhaust piping or any location where leaks would cause fuel to impinge on to hot surfaces. Fuel lines shall incorporate local isolation valves.



The fuel oil header shall not be dead-ended.

Silencers, where installed in suction and discharge piping, shall be located as close as possible to the engine.

Air intake openings shall be located away from any hazardous area, face toward the prevailing wind direction and be in such a position as to limit the ingress of dust (e.g. salt crystals) and moisture.

7.19.5 LAUNCHERS/RECEIVERS

The “barrel” of the launchers/receivers shall be designed as per ASME-B31.4/31.8 (as applicable) using a design factor of 0.5 and “end closure” shall be designed as per ASME Section VIII, Division-I. Corrosion allowance as per applicable piping class & Material of construction for intended service should be considered in design of barrels. Weld efficiency factor shall be as per ASME-B31.4/31.8 (as applicable)

Launchers and receivers if installed horizontally shall have 5° slopes in the direction of flow. The internal diameter of launcher/ receiver shall be at least 2” higher than the pipe diameter.

Barrel length shall be at least 1-½ times and 2 ½ times as long as the pig selected/specified for launchers and receivers, respectively.

Eccentric type reducers shall be used on all horizontal launchers and receivers with flat side down while concentric type shall be used for vertical launchers/receivers. A spool piece of sufficient length of line pipe size shall be provided with launchers/receivers to ensure an effective seal before the pig enters the first block valve.

Scraper barrel shall be equipped with quick opening hinged type closures. Closures shall be rated for intended service and shall be provided with suitable interlock safety devices to prevent opening under pressure.

Launching/receiving stations shall be provided with an indicating device to detect and indicate the passage of a scraper or sphere.

Launchers and receivers of 600 mm (24 inch) OD and larger shall be equipped with loading/unloading trays to facilitate handling of heavy scrapers and spheres.

All branches from the barrel shall be taken by means of weldolets / sockolets.



Suitable handling system for inserting/retracting the scraper/pig from the barrel shall be provided for each launcher/receiver. The system shall be self contained complete with handling and lifting devices.

7.19.6 PIPING FOR OFFSHORE HOOK-UP

Hook-up piping shall be minimized as far as possible. Piping systems shall be designed so that the contractor in his fabrication yard can perform the maximum level of testing, mechanical completion and commissioning work.


7.20 PIPING LAYOUT REQUIREMENTS

The layout of equipment and piping shall be based on following principles to provide neat and economical layout, allowing for easy supporting and adequate flexibility to meet equipment allowable nozzle load.

1. To locate all equipments identified on equipment list.
2. To comply with standards, regulations, codes, piping specifications and sound engineering practices.
3. To maximize safety of personnel, equipment and facilities.
4. To ensure operability & maintainability of equipment.
5. To provide means of escape & access for fire fighting.
6. To satisfy all requirements indicated in process documents (P&ID's)
7. To minimize shutdown duration.

All piping drawings shall be prepared to scale 1:331/3 with accuracy of +75mm and in metric system only. All piping for new platform shall be modeled using 3D modelling software as indicated elsewhere in bid package. Isometrics, Piping GADS, supports GAD's, material take off, interference checking, colour coding, structural module, instrument module, Design review model etc. shall be generated from the 3D model. The contractor shall make interim delivery of 3D model on the completion of each mile stone activity and final delivery on completion of the project. Contractor shall furnish the equipment lay out, safety route drawing, piping layout drawing (GAD), for company's review & approval. Contractor shall furnish one 3D modeling software terminal (dual type) along with dedicated modeling engineer at design center for online review of piping/equipment modeling to ONGC.

However, for modification jobs, piping plan shall be prepared in latest version of MICROSTATION/AUTOCAD.

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All the information regarding instrument, equipment and line identification, direction of flow for lines, elevations and dimensions shall be clearly marked on piping plans. Efforts shall be made to provide maximum possible information including operating platforms, ladders, monorails, other material handling equipment, electrical cable and instrument trays, etc. shall be shown on piping plans to avoid reference to other drawings.

For any portion of a line where complete details i.e. dimensions, elevations etc. cannot be furnished in piping plan, a detailed isometric for that portion shall be indicated at a suitable place in the same GAD only. As far as possible all such details shall be shown together at a particular space provided for the purpose.

Piping plans shall show all lines indicated in Piping and Instrument diagrams. Separate line list as per format shall be prepared & submitted to the Company.

Pipe support standard drawings shall be submitted to company for review and separate pipe support drawings shall be generated by marking pipe supports on piping plans.

Piping arrangement drawings for skid-mounted equipment/vessels shall be furnished separately for review and approval. Piping arrangement inside skids need not be shown on piping GAD's.

All distribution/collection headers shall have their dead ends blind flange. Piping Isometrics shall be prepared for all lines and furnished for information.

All the future lines shown in P&ID's shall be routed and shown as chain dotted on GAD's with full details indicating dimensions, line numbers, etc. All future/spare piping connections envisaged in the existing scope of work will be terminated with blind flange. Requirement of spectacle blind and valve at the termination shall be provided if indicated in P&ID. The following shall be the minimum to be shown on the piping drawings wherever applicable:

Line Number

Instrument/specialties/equipment Tag Number

Instrument Connections

Orientation of North arrow

Battery/Area limit as per area division/skid

Title block and drawing nos. as per area division/drawing schedule

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Key plan

Reference drawings

Legends and Notes

Table of Nozzle data orientation and location

Match line, continuation drawing number

Location of equipment as per equipment layout; P&ID's special notes.

Dimension & equipment elevations with reference to data sheets.

8. PROTECTIVE COATINGS & INSULATION

Painting and Protective Coatings:

Painting, protective coatings and the procedures used for the preparation of surfaces shall be specified in the Project Specification for Protective Coatings spec 2005.

Flanges shall be painted on the flange edges, inside bolt-holes, and up to the gasket surface.

Insulation:

Piping shall be insulated where indicated on drawings. The piping to be insulated shall be grit blasted and painted as per FS 2005 except for finish coat and only then, insulation to be applied as per the Project Specification for Insulation of Piping and Equipment spec 2006.

9. PIPING SPECIFICATION INDEX

DESIGN CODE: ASME B31.3

SN	CODE	RATING	MATERIAL	SERVICE
1	A1	150#	CS	NOTE-1
2	B1	300#	CS	NOTE-1
3	D1	600#	CS	NOTE-1
4	E1	900#	CS	NOTE-1
5	A2	150#	CS	Glycol
6	B2	300#	CS	Glycol
7	D2	600#	CS	Glycol
8	E2	900#	CS	Glycol
9	A1N	150#	CS-NACE	Hydrocarbon liquid & vapour



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10	B1N	300#	CS-NACE	Hydrocarbon liquid & vapour
11	D1N	600#	CS-NACE	Hydrocarbon liquid & vapour
12	E1N	900#	CS-NACE	Hydrocarbon liquid & vapour
13	F1N	1500#	CS-NACE	Hydrocarbon liquid & vapour
14	G1N	2500#	CS-NACE	Hydrocarbon liquid & vapour
15	XG1	API-5000	CS	Hydrocarbon liquid & vapour
16	XG1N	API-5000	CS-NACE	Hydrocarbon liquid & vapour
17	A3	150#	CS-Galv./SS	Instrument Air
18	B3	300#	CS-Galv./SS	Instrument Air
19	D3	600#	CS-Galv./SS	Instrument Air
20	A4	150#	CS-Galvanized	Potable Water-Non Drinking
21	A5	150#	90/10 Cu-Ni	Fire water/Raw sea water
22	A6	150#	SS	Exhaust
23	A8	150#	CS (GALVANISED)	Overboard line
24	A9	150#	SS-316	Lube oil & service oil
25	B9	300#	SS-316	Lube oil & service oil
26	D9	600#	SS-316	Lube oil & service oil
27	E9	900#	SS-316	Lube oil & service oil
28	A10	150#	SS-316L-NACE	Hydrocarbon liquid & vapour
29	B10	300#	SS-316L-NACE	Hydrocarbon liquid & vapour
30	D10	600#	SS-316L-NACE	Hydrocarbon liquid & vapour
31	E10	900#	SS-316L-NACE	Hydrocarbon liquid & vapour
32	F10	2500#	SS-316L-NACE	Hydrocarbon liquid & vapour
33	A12	150#	Titanium	Ferric Chloride/Chemical
34	A13	150#	COPPER	Potable water- Drinking
35	A1LN	150#	INCOLOY 825	Hydrocarbon liquid & vapour
36	A22	150#	SS-316L	Corrosion Inhibitor/Chemical
37	B22	300#	SS-316L	Corrosion Inhibitor/Chemical
38	D22	600#	SS-316L	Corrosion Inhibitor/Chemical
39	E22	900#	SS-316L	Corrosion Inhibitor/Chemical
40	A23	150#	DSS (UNS S 32205)	Hydrocarbon liquid & vapour
41	B23	300#	DSS (UNS S 32205)	Hydrocarbon liquid & vapour
42	D23	600#	DSS (UNS S 32205)	Hydrocarbon liquid & vapour
43	E23	900#	DSS (UNS S 32205)	Hydrocarbon liquid & vapour

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44	F23	1500#	DSS (UNS S 32205)	Hydrocarbon liquid & vapour
45	G23	2500#	DSS (UNS S 32205)	Hydrocarbon liquid & vapour
46	A15	150#	INCOLOY 825	Hydrocarbon liquid & vapour
47	B15	300#	INCOLOY 825	Hydrocarbon liquid & vapour
48	D15	600#	INCOLOY 825	Hydrocarbon liquid & vapour
49	E15	900#	INCOLOY 825	Hydrocarbon liquid & vapour
50	XG15	API 5000	INCOLOY 825	Hydrocarbon liquid & vapour
51	XH15	API 5000	INCOLOY 825	Hydrocarbon liquid & vapour
52	A15A	150#	INCONEL 625	Hydrocarbon liquid & vapour
53	B15A	300#	INCONEL 625	Hydrocarbon liquid & vapour
54	D15A	600#	INCONEL 625	Hydrocarbon liquid & vapour
55	E15A	900#	INCONEL 625	Hydrocarbon liquid & vapour
56	PE1	900#	CS	Hydrocarbon liquid & vapour
57	PB1N	300#	CS-NACE	Hydrocarbon liquid & vapour
58	PD1N	600#	CS-NACE	Hydrocarbon liquid & vapour
59	PE1N	900#	CS-NACE	Hydrocarbon liquid & vapour
60	A7	150#	CPVC	Sodium hypochlorite
61	A3S	150#	GRE	Fire Water (raw)
62	A3S-1	150#	GRE	Fire Water-Raw sea water (Dry)
63	A5S	150#	GRE	Produced water, sewage water/Gray Services, Cooling water, Open drain, Utility water,
64	A11	150#	DSS (UNS S 31803)	Hydrocarbon liquid & vapour
65	B11	300#	DSS (UNS S 31803)	Hydrocarbon liquid & vapour
66	D11	600#	DSS (UNS S 31803)	Hydrocarbon liquid & vapour
67	E11	900#	DSS (UNS S 31803)	Hydrocarbon liquid & vapour
68	F11	1500#	DSS (UNS S 31803)	Hydrocarbon liquid & vapour
69	A16	150#	SDSS	Hydrocarbon liquid & vapour
70	B16	300#	SDSS	Hydrocarbon liquid & vapour
71	D16	600#	SDSS	Hydrocarbon liquid & vapour
72	E16	900#	SDSS	Hydrocarbon liquid & vapour
73	A14	150#	PVC	Sewage Water

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74	F1	1500#	CS	Note-1
75	F10	1500#	SS-316L	Hydrocarbon liquid & vapour
76	F 15	1500#	Incoloy-825	Hydrocarbon liquid & vapour

NOTES:

1. This standard is used for injection water, vent gas, diesel fuel, process drain water, process drain hydrocarbon, blow down, nitrogen services. However, MOC shall be as per P & ID.
2. Corrosion allowance is indicated in Spec.2004A Clause no.5.3.
3. Material description & special requirements are listed in piping design criteria.
4. Contractor shall prepare the piping class data sheet and shall furnish to Company for review & approval.

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10 GENERAL REQUIREMENTS

10.1 PRE-QUALIFICATION CRITERIA AND TESTS FOR MANUFACTURERS (NEW VENDORS)

Suggested vendor list is listed elsewhere in bid package. The vendors who are not listed in suggested vendor list shall be required to furnish the following documents for Company's review for the purpose of pre-qualification.

1. The item/equipment should be in satisfactory service in offshore oil & gas operations for a minimum period of 2 years. This shall be supported with performance feedback from the end-users (The firm using the item/equipment for its offshore oil and gas operations) or repeat purchase orders from the same end user with a minimum time gap of two years of delivery.
2. Catalogue and Drawings for the product.
3. The name(s) & location of Manufacturer/Forging source/Raw material source (Mill) etc.
4. The manufacturer shall be qualified based on results of these tests & information furnished and Company's decision in this regard shall be final and binding on the bidder.
5. The list of manufacturing facilities and quality control equipment.
6. The tests certificates specified in clause 5 shall be conducted by the mill/supplier for the purpose of initial qualification. The test results shall be submitted to the company for approval prior to placement of order. In case the supplier has already carried out all these tests and the test results are certified by a recognized independent inspection agency (viz. Lloyds, BV, DNV etc.) all such test reports/certificates/document shall be forwarded to the company for review and approval. The Company shall assess the capability of the supplier upon scrutiny and verification of the documents submitted. Company's decisions in this regard shall be final and binding on contractor.
7. Qualification for NACE material shall be made product wise, material wise, type of product wise (Seamless or welded), type of valve wise irrespective of thickness/size/type of fittings/pressure rating. Following test certificates/documents to be required:
 1. Steel making procedure from raw material supplier including specific details and confirmation to requirements as per relevant codes & standards.

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2. Following test certificates, duly witnessed and certified by any of the Company approved third party inspection agency (as listed in clause 10.2) as per relevant codes & standards and requirements listed below, shall be furnished for Company's approval.
 - 2.1 Chemical composition of heat & finished product. This shall meet the requirements of chemical composition indicated in relevant codes & standards.
 - 2.2 Mechanical Tests on heat & finished product as per relevant codes & standards.
 - 2.3 Hardness test on the heat & finished product as per relevant codes & standards.
 - 2.4 Corrosion tests (HIC, SSCC & inclusion count check) on the finished product of past supplies as per relevant codes & standards. The test shall be applicable to all materials for sour service application (viz: CS (NACE), DSS, INCOLOY CLAD MATERIAL).
 - 2.5 Other test for DSS & INCOLOY clad material: Other test as indicated in clause 5.7 & 5.8 (sour service requirements for DSS & INCOLOY CLADDING MATERIAL)
 - 2.6 The requirements stated in relevant codes & standards shall also be fully complied in order to meet the qualification of the product on each heat & finished product.
3. Each certificate shall indicate product name, heat number, raw material source/forging shop/cast shop/manufacturer (as applicable) and shall clearly indicate witnessed and certified with proper signature and seal of the inspecting agency. Any certificate not meeting these requirements shall be rejected.
4. Over and above these certificates, a certificate from the Company approved third party inspection agency shall be furnished containing the following:
 - 4.1 Scope to clarify the extent of involvement of the Inspection Agency for the job order.
 - 4.2 Certification that the sample for the test was taken from the finished product (e.g. pipe, fittings, flange, valve or plate etc.) manufactured from the heat indicated in the certificates and indicate the names of raw material source (Mill)/forging shop cast shop/manufacturer (as applicable) employed in manufacture of the finished product.
5. Quality Assurance Manual shall be furnished for Company's review, which should include the schemes for raw material quality assurance, on line process quality assurance,

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product quality assurance, storage and traceability of products, personal quality assurance and quality control procedures.

6. Bidder/manufacturer shall note that for manufacturing of the quoted items, the same sources (i.e. forging source, raw material source, manufacturer etc.) shall be utilized which was employed to manufacture the product on which prequalification tests are carried and approved. Subsequent to qualification, a change of manufacturer/forging source/raw material source (mill) shall not be permitted. In the event that the manufacturer desires to effect any change in any of the above, the manufacturer shall seek fresh qualification as indicated above.

10.2 SUGGESTED THIRD PARTY INSPECTION AGENCIES

M/s Lloyd registers of Shipping (LRS)

M/s Bureau Veritas (BV)

M/s Det Norske Veritas (DNV)

M/s Certification Engineers India Ltd (CEIL)

M/s Societe Generate De Surveillance (SGS)

M/s Moody's international

M/s TUV International

M/s ABS

If any of the party is nominated or specified for the job work, then supplier must follow the Company's Requirements.

10.3 QUALITY ASSURANCE

The manufacturer, supplier & his sub supplier shall operate a quality system satisfying the applicable provisions of ISO 9000 (SERIES) or Company agreed equivalent standard, commensurate with the goods & services provided.

10.4 SAFETY PROVISIONS

It is the intent of the company that operational hazards to be reduces to a minimum. Contractor shall use sound engineering judgments to complete an installation that will perform the required process functions without compromising this aim. The platform shall be designed in accordance with API RP 14C, Recommended practice for analysis, design, installation & testing of basic surface safety system on the offshore production platform (latest edition). The contractor shall also follow the safety provisions indicated elsewhere in bid package.



10.5 RECEIPT & STORAGE

The contractor shall develop the comprehensive plan for receipt, storage and release of all equipments released in contractor's care including item supplied by others or free issued by the company. This plan shall provide means to immediately establish the status & locations of any items, which has been issued to the contractor.

The contractor shall be fully responsible for equipment issued & shall provide secure facilities to provide a storage environment, which shall protect the equipment to the vendor's requirement. Any equipment damaged after issue to the contractor shall be repaired, reinstated or replaced by the contractor at company's decision.

10.6 SPARES

Manufacturer shall recommend and provide the spares required for start up and commissioning for all specialties/ vessels or any other item.

Manufacturer shall recommend and provide the spares needed for one-year operation and maintenance for all specialties.

10.7 WARRANTIES

- A. The contractor shall agree to warrant all the pipes, fittings, flanges, gaskets, bolting, valves, specialties & vessels furnished by him to be free from defects in design, material, & workmanship.
- B. The contractor shall agree to warrant all the pipes, fittings, flanges, gaskets, bolting, valves, specialties & vessels furnished by him will satisfy the requirements of intended use and to be suitable for application.
- C. The contractor shall agree to warrant all the pipes, fittings, flanges, gaskets, bolting, valves, specialties & vessels furnished by him for any repair or replace under present tender, which proves to be defective within a period of 12 months from date of completion and handing over to the operation group of company.
- D. The contractor shall be solely responsible for obtaining manufacture's performance warranty for all pipes, fittings, flanges, gaskets, bolting, valves, specialties & vessels purchased by him and shall produce the warranty certificate to the company.
- E. Where materials of construction or the application of items recommended by contractor do not confirm with the manufacture's recommendation, the contractor shall assume the



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equivalent of manufacturer's warranty and in the event of malfunction or damage resulting from this misapplication, the contractor will not be released from this warranty.

10.8 DOCUMENTATION

The contractor shall provide one set of soft copies on CD/Hard disc for approved drawings/documents & materials for all pipes, fittings, valves, flanges, piping specialties & vessels documents to the piping engineer designated for the project in additions to the company's project requirement. Further, hardcopy any of the above documents shall be submitted as and when required by company. The contractor shall submit the "ORIGINALS" on demand by company to verify the duplicate (Xerox) copies for test certificates review. On placement of order, the manufacturer/mill shall carry out all the production tests as indicated in relevant clauses of this document and submit reports to Company for review and approval. The test reports shall be submitted to Company before dispatch of material from the mill. The approved certificates from company shall be submitted to the piping engineer of company at fabrication site.

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GLASS REINFORCED EPOXY

Annexure – 1

1.1 Scope

This specification contains minimum requirements for design, manufacture, qualification, quality control, testing, site fabrication, installation and certification of (GRE) composite material piping for facilities on offshore platforms.

1.2 Design / Operating Data

The design / operating data such as pressure, temperature, flow rate, structural load, etc. shall be provided by the user section or the selection / design of GRE pipelines for the relevant services.

1.3 Design & Manufacture of GRE piping

- i. The piping and fittings shall be manufactured with epoxy resin as per ASTM D 2996 with thickness to suit the design pressure, taking into account the hydrostatic test pressure at the time of installation i.e. 1.5 times the design pressure. The manufacturer shall give full details of this methodology of arriving at the quoted thickness, including lower confidence limit static (LCLs). The hydrostatic design stress shall be calculated as : $0.5 \times \text{LCLs}$. However, all the components of piping system shall have minimum 3.0 mm reinforced wall thickness. Sea water piping shall be designed for a nominal velocity of 5 m/s. The fire water piping system shall also be designed for blast over pressures.
- ii. The piping and fittings shall be manufactured by using epoxy resin and the structural glass fiber shall be E-glass. The fittings shall be manufactured by the same piping manufacturer and compatible adhesives shall also be supplied by the manufacturer.
- iii. Inner surface of piping and fittings shall have at least 0.5 mm thick reinforced resin rich liner with C-glass or synthetic fibres and with resin content at least 65%.
- iv. For UV protection, UV stabilizer will be added in the resin used for manufacturing GRE piping.
- v. Filler shall not be used in the resin during manufacturing process of GRE piping.
- vi. The piping and fittings shall be joined by the bell & spigot joint using adhesives or butt and wrap joint.
- vii. Flanges shall be heavy-duty filament wound as per ASTM D 4024 and ASME B 16.5.
- viii. Stress analysis shall be carried out for estimation of stresses in circumferential and longitudinal direction. Stress analysis shall include, but not limited to, all anchors, guides and supports. The piping system shall be designed in such a way to minimize stresses resulting from surge or transient pressures on account of valve closures or other condition resulting in change in fluid velocity and those resulting from movements such as expansion and contraction from pressure and temperature differences.

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- ix. Epoxy resins and additives used in the manufacture of potable water piping and fittings shall satisfy the requirements of FDA / NSF / WHO or other Indian regulatory Authorities for potability of water.

1.4 Qualification & Quality Control of GRE Piping

- i. The piping and fittings shall be qualified for pressure rating as per ASTM D 2992. Manufacturer shall enclose the test report and calculations.
- ii. For quality control, the short term hydrostatic pressure (STHP) of at least one sample per production lot shall be determined in accordance with ASTM D 1599 at standard laboratory temperature and the value should not be less than mean of STHP for the representative product established in the qualification test. The test report for qualification and quality control shall be certified by reputed certifying agencies like LRS, DNV, BV, ABS, TUV, Vetco Tuboscope.
- iii. Test certificates shall be provided for use of GRE piping, fittings, O-rings, gaskets and adhesives in potable water applications as per FDA /NSF / SHO or other Indian regulatory Authorities.
- iv. The fire water piping shall qualify endurance testing requirements as per level 3 requirements of IMO Resolution A 753(18) or as latest version of ISO standard 14692-2 for glass reinforced plastics piping in Petroleum and Natural Gas Industries.
- v. The GRE piping including all its components for dry portion of fire water system shall be designed such that line is capable of withstanding initially fire up to maximum of 5 minutes by jet fire, followed by flowing water from deluge system by which time the line gets filled with water due to actuation of deluge system. The heat flux of impinging flame shall be decided based upon relevant codes and standard.
- vi. The GRE piping shall conform to the fire endurance tests for dry condition in accordance with appendix I of IMO resolution A. 753 (18), 1993.

1.5 Fabrication & Installation of GRE Piping

- i. The piping and fittings shall be fabricated and installed as per UKOOA's "Specifications and Recommended Practice for the use of GRP Piping Offshore", March 1994, ISO 14692-1/2/3/4(Petroleum and Natural Gas Industries-Glass Reinforced Plastic Piping).
- ii. All GRE/GRP piping shall be fabricated and installed under the supervision of manufacturer/Manufacturer's representative certified by the manufacturer.
- iii. All GRE piping shall be conductive and grounded through metallic parts in the system such as valves, pumps, etc. and as per manufacturer's recommendations.

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- iv. GRE piping & components which remain dry during normal operation of a platform; such as drain lines shall be applied intumescent coating for fire insulation / protection as per applicable standard/application. While deciding type of intumescent coating toxicity of the smoke shall also be considered. Fire insulation material should be such a type that does not require the use of reinforcing mesh.

1.6 Certification Requirements of GRE Piping.

Offered product shall have valid class and type certificate from reputed certifying agencies like LRS, DNV, BV, ABS

1.7 List of Codes & Standards for (GRE) Composite Material Piping

ASTM D 2992	Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings.
ASTM D 2996	Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
ASTM D 2105	Standard Test Method for Longitudinal Tensile Properties of “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Pipe and Tube
ASTM D 2143	Standard Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe.
ASTM D 2517	Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings.
ASTM D 2997	Standard Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe details the specifications for machine made glass fiber reinforced thermosetting resin pressure pipe.
ASTM C 581	Standard Practice for Determining Chemical Resistance to Thermosetting Resins.
ASTM D 570	Test Method for Water Absorption of Plastics.
ASTM D 2290	Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method.
ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of plastic pipe by parallel – plate Loading sets forth methods.
ASTM D 2924	Standard Test Method for External Pressure Resistance of “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Pipe.
ASTM D 5685-01	Standard Specification for “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Pressure Pipe Fittings.
ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
ASTM D 1598	Standard Test Method for Time to Failure of Plastic Pipe Under Constant Internal Pressure.
ASTM D 1599	Standard Test Method for Resistance to short time Hydraulic



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	Pressure of Plastic Pipe, Tubing and Fittings.
UKOOA	Specification and Recommended Practice for the Use of FRP Piping.
API Spec 15 LR	Low pressure fiberglass line pipe.
API Spec 15 HR	High pressure fiberglass line pipe.
API RP 15 TL 4	Recommended Practice for Care and Use of Fiberglass Tubulars.
ASME B 16.5	Pipes, Flanges and Flange Fittings.
ASME B 31.3	Process Piping.
ASME BPVC Section X	Boiler & Pressure Vessel Code.
ASTM D 695	Test Method for Compressive Properties of Rigid Plastic.
ASTM D 696	Test Method for Coefficient of Linear Thermal Expansion of Plastic.
AWWA C 950	Standard for Fiberglass Pressure Pipe.
BS 5480	Specification for Glass reinforced plastic (GRP) pipes, joints and fittings for use for water supply or sewerage.
BS 6464	Specification of reinforced plastic pipes, fittings and joints for process plants.
ASTM D 648	Test for deflection temperature of plastics under flexural loads.
ASTM D 2310	Classification for machine made reinforced thermosetting resin pipe.
ASTM D 1652	Test Method for epoxy content of epoxy resins.
ASTM D 2343	Test Method for Tensile Properties of Glass Fiber Strands, Yarn and Roving use in Reinforced plastics.
ASTM D 2344	Apparent Inter Laminar Shear Strength of Parallel Fiber Composites by Short Beam Method.
ASTM D 2393	Standard Test Method for Viscosity of Epoxy Resin and Related Components.
ASTM D 2471	Standard of Test Method for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resin.
ASTM D 2563	Standard Test Method for Classifying Visual Defects in Glass Reinforced Plastics Laminate Parts.
ASTM D 2583	Standard Test Method for Indentation Hardness of Rigid Plastics by mean of Barcol Impresser.
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins.
ASTM G 53	Weathering QUV Weatherometer.
UKOOA	Guidelines for Fiber Reinforced Use Offshore.
USCG PFM 1-98	US Coast Guard Guide on Fire test requirements for plastic pipe.
IMO A 753(18)	Guidelines for application of plastic pipes on ships.
ISO 14692 Part 1-4	Petroleum & Natural Gas Industries – Glass Reinforced Plastics Piping.

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