

1.0 GENERAL

1.1 All pipes and their dimensions, tolerances, chemical composition, physical properties, heat treatment, hydro-test and other testing and marking requirements shall conform to the latest codes and standards specified in the Request for Quotation (RFQ). IGC Test for 321H material shall be as per ASTM A262 Practice "C" with acceptance criteria of 15 mils/year (max.).

1.2 Testing:

1.2.1 Test reports shall be supplied for all mandatory tests as per the applicable material specifications. Test reports shall also be furnished for any supplementary tests as specified in the RFQ & Clauses 1.10 & 1.11.

1.2.2 Minimum inspection requirements for pipes shall be as per TCE.M4-186-05, "Shop Inspection Requirements - Pipes and Pipe Fittings - Metallic".

1.2.3 Certificates for pipes shall have the following applicable minimum information:

- (a) Mill or manufacturer's name
- (b) Heat or charge number
- (c) Material standard
- (d) Size, rating/schedule, dimensional standard of the item to be certified
- (e) Steel making process
- (f) Chemical analysis
- (g) Temperature of manufacture, type of heat treatment and the cooling method
- (h) The methods, the extent and the results of mechanical testing
- (i) The methods, the extent and the results of non-destructive testing
- (j) The results of hydrostatic tests, where applicable
- (k) The results of visual examination and dimensional check
- (l) Inspector's name and signature

1.2.4 Tolerances on wall thickness, ovality and straightness shall be as per the applicable component standard.

1.3 Manufacturing Processes:

- 1.3.1 Steel made by acid Bessemer process shall not be acceptable.
- 1.3.2 All longitudinally welded pipes other than IS 3589 should employ only automatic welding.
- 1.4 Pipe shall be supplied in single or double random length of 4 to 7 and 7 to 14 meters respectively.
- 1.5 A. Seamless and E.R.W. pipes shall not have any circumferential seam joint in a random length. However, in case of E.FS.W pipe, in one random length one welded circumferential seam of same quality as longitudinal weld is permitted. This weld shall be at least 2.5 m from either end. The longitudinal seams of the two portions shall be staggered by 90°. Single random length in such cases shall be 5 to 7 m.
- B. Unless otherwise mentioned in the respective material code, E.FS.W pipes < 36" shall not have more than one longitudinal seam joint and E.FS.W pipes ≥ 36" shall not have more than two longitudinal seam joints.
- 1.6 Pipe with screwed ends shall have NPT external taper pipe threads conforming to ASME/ANSIB 1.20.1 up to 1.5" NB & IS 554 for 2" to 6" NB.
- 1.7 Pipe with beveled ends shall be in accordance with ASME B16.25. Weld contours shall be as follows:

| Material | Wall Thickness | Weld Contour |
|---|--------------------|-----------------|
| Carbon Steel (Except Low Temp. Carbon Steel) | Up to 22 mm | Figure 2 Type A |
| | >22mm | Figure 3 Type A |
| Alloy Steel, Stainless Steel & Low Temp. Carbon Steel | Up to 10 mm | Figure 4 |
| | > 10 mm & Up to 25 | Figure 5 Type A |
| | > 25 mm | Figure 6 Type A |

- 1.8 Galvanized pipes shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A 153
- 1.9 All austenitic stainless steel pipes shall be supplied in solution annealed condition. All types of 321 or 347 stainless steel pipes shall be in a stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to the normal solution annealing. Soaking time & holding temp, for stabilizing heat treatment shall be 900°C & 4 hrs respectively.

1.10 I.G.C. Test for Stainless Steels:

1.10.1 For all austenitic stainless steel pipes inter-granular corrosion test shall have to be conducted as per following:

ASTM A262 Practice "B" with acceptance criteria of "60 mils/year (max.)"

OR

ASTM A262 Practice "E" with acceptance criteria of "No cracks as observed from 20X magnification" & "Microscopic structure to be observed from 250X magnification".

1.10.2 When specifically asked for in RFQ for high temperature application of some grades of austenitic stainless steel (eg.SS 309, 310, 316, 316H etc.) ASTM A262 Practice "C" with acceptance criteria of "15 mils/year (max.)" shall have to be conducted.

1.10.3 For the IGC test as described in 1.10.1 & 1.10.2, two sets of samples shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and the other set corresponding to the highest pipe thickness. When testing is conducted as per Practice "E", photograph of microscopic structure shall be submitted for record.

1.11 All welded pipes indicated as 'CRYO' & 'LT' in RFQ shall be impact tested per requirement & acceptance criteria of ASME B31.3. The impact test temperature shall be -196°C & -45°C for stainless steel and carbon steel respectively unless specifically mentioned otherwise in RFQ.

1.12 Pipes under "NACE" category shall meet the requirements given in MR-01-75 unless mentioned otherwise.

1.13 Specified heat treatment for carbon steel and alloy steel and solution annealing for stainless steel pipes shall be carried out after weld repairs. Number of weld repairs at the same spot shall be restricted to maximum two by approved repair procedure.

1.14 For black or galvanized pipes to IS 1239, the minimum percentage of elongation shall be 20%.

1.15 All 1Cr-1/2Mo and 1^{1/4}Cr-1/2Mo seamless pipes shall be normalised and tempered.

1.16 For all welded alloy steel pipes with mandatory requirement of heat treatment and radiography, radiography shall be performed after heat treatment.

1.17 For Hydrogen service pipes following special requirements shall also be met:

1.17.1 All carbon steel pipes having wall thickness 9.53 mm (0.375") and above shall be normalised. Cold drawn pipes shall be normalised after the final cold draw pass for all thicknesses.

1.17.2 All alloy steel (Cr-Mo) pipes shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a

part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psig.

- 1.17.3 For carbon steel Pipes, hardness of weld and HAZ shall be 200 BHN (max.). For alloy steel Pipes, hardness of weld and HAZ shall be 225 BHN (max.).
- 1.17.4 For all austenitic stainless steels, the weld deposit shall be checked for ferrite content. A Ferrite No.(FN) not less than 3% and not more than 10% is required to avoid sigma phase embrittlement during heat treatment. FN shall be determined by Ferritescope prior to post weld heat treatment.
- 1.17.5 For all Carbon steel and Alloy steel pipes with wall thickness over 19mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°Celsius shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 19J (15 ft-lb)

2.0 IBR PIPES

2.1 IBR Documentation:

- 2.1.1 Pipes under purview of IBR shall be accompanied with IBR certificate original in Form IIIA, duly approved and countersigned by IBR authority/local authority empowered by the Central Boiler Board of India. Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.
- 2.1.2 For materials 1^{1/4}Cr - 1/2Mo (ASTM A335 Gr.P11 / A691 Gr. 1^{1/4}Cr) & 2^{1/4}Cr - 1Mo (ASTM A335 Gr.P22 / A691 Gr.2^{1/4}Cr), Form III-A approved by IBR shall include the tabulation of E_t, S_c & S_r values for the entire temperature range given below. E_t, S_c & S_r values shall be such that throughout the temperature range.

$$\begin{array}{l}
 E_t/1.5 \geq \\
 S_r/1.5 \geq \\
 S_c \geq
 \end{array}
 \left|
 \begin{array}{l}
 \\
 S_A
 \end{array}
 \right.$$

Where

- S_A : Allowable stress at the working metal temperature.
- E_t : Yield point (0.2% proof stress at the working metal temperature)
- S_c : The average stress to produce elongation of 1%(creep) in 100000 hrs at the working metal temperature
- S_r : The average stress to produce rupture in 100000 hrs at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature

| S _A (psi) | | | | | | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|------|
| Temp(°F) Material | 500 | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1050 | 1100 |
| A335 Gr.P11 | 17200 | 16700 | 16200 | 15600 | 15200 | 15000 | 14500 | 12800 | 9300 | 6300 | 4200 | 2800 |
| A691 Gr.1 ^{1/4} Cr | 18900 | 18300 | 18000 | 17600 | 17300 | 16800 | 16300 | 15000 | 9900 | 6300 | 4200 | 2800 |
| A335 Gr.P22 / A691 Gr.2 ^{1/4} Cr | 17900 | 17900 | 17900 | 17900 | 17900 | 17800 | 14500 | 12800 | 10800 | 7800 | 5100 | 3200 |

Note : S_A values shall be as per the latest edition prevailing.

2.2 For carbon steel pipes under IBR the chemical composition shall conform to the following

Carbon (max) : 0.25%

Others (S, P, Mn) : As prescribed in IBR

The chemical composition as indicated in this clause is not applicable for pipes other than IBR services.

3.0 HYDROSTATIC TEST

3.1 All pipes shall be hydrostatically tested.

3.2 The mill test pressure shall be as follows:

3.2.1 Seamless, E.R.W. & Spiral Welded

(a) Carbon Steel

| Material Std. | Test Pressure Std. |
|------------------------------|--------------------|
| ASTMA106Gr.B | ASTM A530 |
| API 5L Gr. B, Seamless | API 5L |
| API 5L, E.R.W. | API 5L |
| API 5L, Spiral | API 5L |
| ASTM A333 Gr.3 & 6, Seamless | ASTM A530 |
| ASTM A333 Gr.3 & 6, E.R.W. | ASTM A530 |

(b) Seamless Alloy Steel

| Material Std. | Test Pressure Std. |
|--|--------------------|
| ASTM A335 Gr.P1, P12, P11, P22, P5, P9 | ASTM A530 |
| ASTM A268 TP 405, TP410 | ASTMA530 |

(c) Seamless Stainless Steel

| Material Std. | Test Pressure Std. |
|---|--------------------|
| ASTM A312 Gr.TP 304, 304L, 304H, 316, 316L, 316H, 321,347 | ASTM A999 |

(d) Seamless Nickel Alloy

| Material Std. | Test Pressure Std. |
|------------------------|--------------------|
| ASTM B161 UNS No. 2200 | ASTMB161 |
| ASTM B165UNS No. 4400 | ASTMB165 |
| ASTM B167 UNS No. 6600 | ASTMB167 |
| ASTM B407 UNS No. 8800 | ASTM B407 |

(e) Welded Nickel Alloy

| Material Std. | Test Pressure Std. |
|-----------------------------|--------------------|
| ASTM B725 UNS No. 2200,4400 | ASTM B725 |
| ASTM B517 UNS No. 6600 | ASTM B517 |
| ASTM B514 UNS No. 8800 | ASTM B514 |

3.2.2 Electric Fusion Welded

(a) Carbon Steel & Alloy Steel E.FS.W (16" & above).

| Material Std. | Test Pressure Std. |
|--|---|
| API 5L Gr.B | P = 2ST/D |
| ASTM A671 Gr.CC65, 70 (C1.32) | S = 90% of SMYS |
| ASTM A672 Gr.C60, 65, 70 (Cl. 12,22) | Except for API 5L Gr.B |
| ASTM A671 Gr.CF60, 65, 66, 70 | S = 85% of SMYS |
| ASTMA691 Gr.1/2Cr, 1Cr, 1 ^{1/4} Cr, 2 ^{1/4} Cr | For API 5L Gr.B |
| 5Cr, 9Cr (C1.42) | T = Nominal Wall Thickness D = O.D of Pipe |

(b) Stainless Steel E.FS.W (2" to 6")

The hydrostatic test pressure in kg/cm² for the following materials shall be as given below:

Material Gr.1: ASTM A312 TP 304 / 304H / 316 / 316H / 321 / 347 welded.

Material Gr.2: ASTM A312 TP 304L / 316L welded

| Size | Pipe Schedule : 10S | | Pipe Schedule : 40S | | Pipe Schedule : 80S | |
|------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| | Material Gr. 1 | Material Gr.2 | Material Gr.1 | Material Gr.2 | Material Gr.1 | Material Gr.2 |
| 2" | 100 | 80 | 155 | 130 | 230 | 190 |
| 3" | 80 | 60 | 155 | 130 | 230 | 190 |
| 4" | 80 | 50 | 155 | 130 | 230 | 190 |
| 6" | 65 | 35 | 90 | 75 | 155 | 130 |

(c) Stainless Steel E.FS.W (8" and above).

| Material Std. | Test Pressure Std. |
|---|---|
| ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 1, 3 & 4) | P = 2ST/D S = 85% of SMYS T = Nominal Wall Thickness D = O.D of Pipe |
| ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 2 & 5) | P = 2ST/D S = 72% of SMYS T = Nominal Wall Thickness D = O.D of Pipe |

(d) Carbon Steel Pipes to BIS Standards.

| Material Std. | Test Pressure Std. |
|---------------|--------------------|
| IS 1239 | IS 1239 |
| IS 3589 | IS 3589 |

4.0 MARKING AND DESPATCH

- 4.1 All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition the purchase order number, the item code & special conditions like "IBR", "CRYO", "NACE", "H2" etc. shall also be marked Vendor shall submit the following with the offer:
- 4.2 Pipes under "IBR","CRYO", "NACE", "H2" & "SHTP" shall be painted in red stripes, light purple brown stripes, canary yellow, sea green stripes & deep orange stripes respectively longitudinally throughout the length for easy identification. Pipes for sizes 1" and below shall be marked circumferentially at one meter interval along the length of pipe.
- 4.3 Paint or ink for marking shall not contain any harmful metal or metallic salts such as zinc, lead or copper which cause corrosive attack on heating.
- 4.4 Pipes shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.
- 4.5 Pipes shall be protected from rust & corrosion.
- 4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.
- 4.7 Both ends of the pipe shall be protected with the following material.
- | | | |
|--------------|---|-------------------------------|
| Plain end | : | Plastic cap |
| Bevel end | : | Wood, Metal or plastic cover |
| Threaded end | : | Metal or plastic threaded cap |
- 4.8 Pipes may be provided with plastic push-fit type end caps/ steel caps without belt wire.
- 4.9 Steel end protectors to be used on galvanized pipes shall be galvanized. Plastic caps can also be used as end protectors for galvanized pipe ends.

5.0 REFERENCES

- 5.1 TCE.6079A-: Specification for Positive Material Identification (PMI) at Supplier's Works
- 5.2 ANNEXURE – A : Special requirement for hydrogen service (pipes, Flanges & Fittings).
- 5.3 ANNEXURE – II : Material requirements for Carbon Steel Components used in Sour Service in Petroleum Refinery Environment.
- 5.4 ANNEXURE – III : Procedure for Pickling.

5.5 ANNEXURE – IV : Requirements for wet H₂S services (NAC4, NAC6 & NAC7) applicable to carbon steels and alloy steels.

6.0 ABBREVIATIONS:

| | | |
|--------|---|--|
| ANSI | : | American National Standards Institute |
| API | : | American Petroleum Institute |
| ASME | : | American Society of Mechanical Engineers |
| ASTM | : | American Society for Testing & Materials |
| BHN | : | Brinell Hardness Number |
| BIS | : | Bureau of Indian Standards |
| E.FS.W | : | Electric Fusion Weld |
| E.R.W | : | Electric Resistance Weld |
| HAZ | : | Heat Affected Zone |
| IBR | : | Indian Boiler Regulations |
| IGC | : | Inter Granular Corrosion |
| IS | : | Indian Standard |
| LT | : | Low Temperature |
| RFQ | : | Requisition for Quotation |
| NB | : | Nominal Bore |
| NPT | : | Nominal Pipe Thread |
| PMI | : | Positive Material Identification |
| PR | : | Purchase Requisition |
| SMYS | : | Specified Minimum Yield Strength |
| SS | : | Stainless Steel |

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| | <u>ANNEXURE-II</u> MATERIAL REQUIREMENTS FOR CARBON STEEL COMPONENTS USED IN SOUR SERVICE IN PETROLEUM REFINERY ENVIRONMENT | SHEET 1 OF 4 |

1.0 SCOPE

- 1.1 In general, for refinery services, NACE Standard MR 0103 shall be applicable. For services where HIC (Hydrogen Induced Cracking) resistant carbon steel is specifically mentioned in the Process Documents, this specification shall be followed.
- 1.2 This specification lays down the requirements related to the chemical composition, manufacture, fabrication and testing requirements for carbon steel components intended to be used in sour service in petroleum refinery environments. These requirements are specified in order to make the carbon steel component resistant to the various forms of material damage in a sour environment, such as Sulfide Stress Cracking (SSC), Hydrogen Induced Cracking (HIC), Stress Oriented Hydrogen Induced Cracking (SOHIC), Blistering etc. These requirements shall be used for resisting Alkaline Stress Corrosion Cracking (ASCC) also. This specification is applicable for corrosive petroleum refining facilities.
- 1.3 The service medium is defined as "Sour" when the service environment conforms to one of the following conditions, as defined in NACE Standard MR0103.

Service environments containing free water (in liquid phase) and

- (a) >50 ppmw dissolved H₂S in the free water.
- (b) Free water pH < 4 and some dissolved H₂S present.
- (c) Free water pH >7.6 and 20 ppmw dissolved hydrogen cyanide (HCN) in the water and some dissolved H₂S present.
- (d) >0.003 MPa absolute (0.05 psia) partial pressure H₂S in the gas in processes with a gas phase.

2.0 REFERENCED CODES/STANDARDS

| | | |
|--------------------------------|------------|---------------------|
| NACE MR 0103 | ASTM A 694 | ASTM A 770 |
| NACE RP 0472 | ASTM A 216 | ASTM A 370 |
| NACE Publication 8X194 & 8X294 | ASTM A 106 | ASTM A 578 |
| NACE TM 0284 | API 5 L | ASME SEC II PART C |
| ASTM A 20 | API 6 A | ASME SEC VTII-DIV.I |
| ASTM A 516 | ASTM E 18 | ASME SEC IX |
| ASTM A 105 | ASTM E 45 | ANSI B 16.34 |
| ASTM A 234 | ASTM E 92 | ANSI B 31.3 |

All ASTM Standard designations shall be applicable for corresponding ASME designations which would be read as ASME SA XXX instead of ASTM A XXX.

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3.0 GENERAL REQUIREMENTS

- 3.1 The Steel for sour service shall be manufactured by either basic oxygen or electric arc furnace route and shall be fully killed and fine grained.
- 3.2 Carbon steel shall not contain intentional additions of elements such as lead, selenium or sulphur to improve machinability.
- 3.3 Carbon steel shall be used in one of the following heat treatment conditions.
- (a) Hot-rolled;
 - (b) Annealed;
 - (c) Normalised;
 - (d) Normalised and tempered;
 - (e) Normalised, austenitised, quenched and tempered;
 - (f) Austenitised, quenched and tempered;
- 3.4 All material after cold forming shall be thermally stress relieved to meet a hardness requirement of 200 BHN maximum.
- 3.5 All products shall be free of low temperature transformation microstructures such as bainite bands or islets of martensite.

4.0 MATERIAL SPECIFICATION

All items are required to conform to the chemical composition of the respective specification as listed below.

Plate: SA-516 Gr.60

Pipe: SA-106 Gr. B or SA-333 Gr.1 or 6

Forgings: SA-105 or SA-350 Gr. LF1 or LF2 or SA-266 Class 1

Fittings: SA-234 Gr. WCB or SA-420 Gr.WPL6

Casings: SA-216 Gr. WCA, WCB or WCC or SA-352 Gr. LCA, LCB or LCC

Tubing: SA-I79 or SA-214

Fasteners: SA-193 Gr.B7M or B8MA-Class 1A, SA-194 Gr.2HM, 7M or 8MA

5.0 PRODUCT SPECIFIC REQUIREMENTS

5.1 Plates and rolled products:

All rolled products such as plates and sheets and fittings/pipes made of rolled products shall meet the following specific requirements:-

- 5.1.1 The steel shall be made through a clean steel making route and shall have minimum of inclusions.
- 5.1.2 The sulphur level shall be restricted to 0.003 wt%.

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5.1.3 The steel shall be calcium treated for inclusion morphology control and the Ca/S ratio shall be in the range of 2 to 3. When sulphur content is less than 0.0015%, then Ca/S ratio is not applicable and calcium can be present up to 50 ppm.

5.1.4 For all thickness of plates either vacuum degassing treatment shall be applied during steel making or through-thickness tensile testing shall be carried out in accordance with ASTM A770, with minimum reduction in area being 35% as determined in accordance with ASTM A370, on one plate per heat treatment batch.

5.1.5 No repair welding shall be permitted on plates.

5.1.6 When the fabrication of the components from the previously HIC tested plates involves no heavy wall thickness reduction or material flow, such as bending, spinning or welding, no fresh HIC test would be required on the final product. However, for fabrication of products where heavy reduction of thickness and heavy flow of material is encountered while forming such as like forging, extrusion or drawing, metallographic examination of the final product shall be required to be carried out to ensure absence of elongated inclusions.

5.1.7 The plates shall be procured only from pre-qualified manufacturers

5.2 Pre-qualification criteria for vendors with prior experience track record:

Vendors/manufacturers who have proven track record of supplying materials for sour service applications in petroleum refineries to any of the reputed operating companies/Engineering Consultants or Process Licensors such as UOP/IFP/EXXON/BP/CHEVRON/IOCL/HPCL/BPCL/EIL shall be considered as 'pre-qualified vendors/manufacturers', on production of the relevant Purchase Orders and test certificates, certified by a witnessing third party inspection agency such as DNA/Lloyds/BV/ABSTECH/TUV/SGS/CEIL for the conformance of the materials to the respective materials specification of the mentioned operators/engineering consultants. For pre-qualified vendors, Clause No.5.4 is not applicable.

5.3 Pre-qualification criteria for New Vendors without track record:

A vendor who has no track record of supplying sour service materials to any of the reputed engineering consultants/operators, as mentioned in Clause 5.2 above, shall be considered as a new vendor and shall be required to carry out HIC test as detailed out in Clause 5.4 for pre-qualification by anyone of the reputed third party inspection agencies like Lloyds, BV, CEIL, DNV or TUV etc.

5.4 Hydrogen Induced Cracking (HIC) Test:

The requirements for HIC test shall be as follows.

1. This test is required for vendor pre-qualification only
2. This test shall be performed on a set of three specimens representing each production batch/heat of rolled products in accordance with NACE TM 0284 with the following acceptance criteria:
 - (a) Crack Length Ratio(CLR) \leq 10.0%
 - (b) Crack Sensitivity Ratio (CSR) \leq 1 %

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3. In case of failure of anyone of the specimens, three more specimens from the same product shall be retested and all the specimens shall meet the acceptance criteria. In case of failure of any retest sample, the material shall be considered unacceptable.

6.0 POST WELD HEAT TREATMENT (PWHT) AND HARDNESS REQUIREMENT

All the weld joints, irrespective of thickness, shall be given a post weld heat treatment. The temperature range for PWHT shall be 595-650°C. Other aspects such as rate of heating, holding time, etc., for the PWHT shall be as per ASME Sec. VIII, Div. I/ ANSI B31.3 requirements. The hardness of the weldment after PWHT shall be 200 BHN maximum.

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| | ANNEXURE-IV REQUIREMENTS FOR WET H2S SERVICES (NAC4, NAC6 & NAC7) APPLICABLE TO CARBON/ALLOY STEELS | SHEET 1 OF 4 |

1.0 GENERAL

This document defines job specific requirements for NACE items under NAC4, NAC6 & NAC7 for Carbon Steels & Alloy Steels.

2.0 REQUIREMENTS OF 'NAC4', 'NAC6' AND 'NAC7' ITEMS APPLICABLE TO CARBON STEELS.

2.1 All 'NAC4' Carbon steel items shall meet the following requirements:

- (a) Requirements as per NACE MR0103.
- (b) Requirements for Carbon Steels 'Wet H2S Resistant' as elaborated in the document.
- (c) Special requirements for Hydrogen service as defined in Technical Notes for the item or ANNEXURE – A, as applicable.

2.2 All 'NAC6' Carbon steel items shall meet the following requirements:

- (a) Requirements as per NACE MR0103
- (b) Requirements of Carbon Steels 'HIC Resistant' as elaborated in the document.

2.3 All 'NAC7' Carbon steel items shall meet the following requirements:

- (a) Requirements as per NACE MR0103
- (b) Requirements of Carbon Steels 'HIC Resistant' as elaborated in the document
- (c) Special requirements for Hydrogen service as defined in Technical Notes for the item or ANNEXURE – A, as applicable.

3.0 REQUIREMENTS OF 'NAC4' ITEMS APPLICABLE TO ALLOY STEELS

3.1 All 'NAC4' Alloy Steel items shall meet the following requirements:

- (a) Requirements as per NACE MR0103
- (b) Requirements for Alloy Steel 'Wet H2S Resistant' as elaborated in the document
- (c) Special requirements for Hydrogen service as defined in Technical Notes for the item or ANNEXURE – A, as applicable.

4.0 REQUIREMENTS OF CARBON STEELS 'WET H2S RESISTANT'

Following are the design requirements for Carbon Steels "Wet H2S resistant":

4.1

- (a) Carbon steel must be Fully Killed Carbon Steel type
- (b) Hardness of the base metal shall be below 22HRC
- (c) Ni content less than 1%,
- (d) Carbon content shall be 0.20% maximum

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- (e) Plate material shall be supplied in Normalized condition, regardless of thickness
- (f) Typical limitation of Carbon Equivalent are the following:
 - i. C_{eq} lower than 0.42% for thicknesses for below 2"
 - ii. C_{eq} lower than 0.45% for thicknesses below 2"
 - iii. With $C_{eq} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$
- (g) Thermal Stress Relieving required for all welds (PWHT), even if it is not required by code.
- (h) Thermal stress Relieving required for cold bend zones producing outer fiber deformation greater than 5%, even if it is not required by codes
- (i) Hardness of the production welds shall be lower than 200HB

4.2 Application to Plates (and Welded pipes)

All the specifications given at clause 4.1 are applicable and shall be supplemented by following limitations

- (a) Maximum allowable Phosphorus content 0.020%
- (b) Maximum allowable Sulfur content 0.015%
- (c) Welded pipes shall fulfill the same requirements as for plate material

4.3 Application to Process Piping (SMLS) and accessories

All the specifications given clause 4.1 are applicable and shall be supplemented by following limitations on impurities level :

- (a) Maximum allowable Phosphorus content 0.030%
- (b) Maximum allowable Sulfur content 0,020%

4.4 Application to Flanges and accessories

All the specifications given clause 4.1 are applicable and shall be supplemented by following limitations on impurities level

- (a) Maximum allowable Phosphorus content 0.030%
- (b) Maximum allowable Sulfur content 0.025%

5.0 REQUIREMENTS OF CARBON STEELS 'HIC RESISTANT'

When "HIC" is specified, in addition to the recommendations relative to "Wet H2S resistant steels", the following requirements shall also be met

5.1

- (a) Carbon steel made by vacuum degassing process,
- (b) Oxygen content less than 0.0025% (target being 0.002.%)
- (c) Calcium treatment, if any, shall be Ca/S ratio greater than 1.2
- (d) It is required to pass the NACE standard TM0284 (Evaluation of Pipeline and Pressures Vessels Steels for Resistance to Hydrogen-Induced Cracking) by using the acidified test solution A specified in

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| | ANNEXURE-IV REQUIREMENTS FOR WET H2S SERVICES (NAC4, NAC6 & NAC7) APPLICABLE TO CARBON/ALLOY STEELS | SHEET 3 OF 4 |

NACE standard TM0177 (Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H2S environments) with :

Crack Length Ratio (CLR) lower than or equal 5 %

- (e) Mill test reports shall include the values for the crack length ratio (CLR), crack sensitivity ratio (CSR) and crack thickness ratio (CTR) as defined in NACE standard TM-02-84 and also carbon equivalent (CE)

5.2 Application to Plates and Welded pipes

All the specifications given at clause 5.1 are applicable and shall be supplemented by following limitations on impurities level:

- (a) Maximum allowable Phosphorus content 0.010% (target 0.008%)
- (b) Maximum allowable Sulfur content 0.002% (0.007% if inclusion shape controlled by calcium treatment)
- (c) Welded pipes, if any, shall fulfill the same requirement as for plate material

5.3 Application to Flanges and accessories

All the specifications given at clause 5.1 are applicable and shall be supplemented by following limitations on impurities level :

- (a) Maximum allowable Phosphorus content 0.025%
- (b) Maximum allowable Sulfur content 0.020%

5.4 Application to Process Piping and accessories

- (a) Basically, specification dedicated to the HIC resistant steels is not to be applied on process pipes provided that these latter are seamless type. For seamless piping only "wet H2S resistant" steel specification shall then be applied.
- (b) However, welded pipe, if any, shall fulfill the same requirements as for plate material.

6.0 REQUIREMENTS OF ALLOY STEELS 'WET H2S RESISTANT'

Following are the design requirements for Alloy Steels "Wet H2S resistant"

6.1

- (a) Hardness of the base metal shall be below 26HRC,
- (b) Typical limitation of Carbon Equivalent are the following:
 - i. C_{eq} lower than 0.42% for thicknesses below 2"
 - ii. C_{eq} lower than 0.45% for thicknesses above or equal to 2"
 - iii. With $C_{eq} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$
- (c) Thermal Stress Relieving required for all welds (PWHT), even if it is not required by code.

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| | ANNEXURE-IV REQUIREMENTS FOR WET H2S SERVICES (NAC4, NAC6 & NAC7) APPLICABLE TO CARBON/ALLOY STEELS | SHEET 4 OF 4 |

- (d) Thermal Stress Relieving required for cold bend zones producing outer fiber deformation greater than 5%, even if it is not required by code.

6.2 Application to Plates (and Welded pipes)

All the specifications given at clause 6.1 are applicable and shall be supplemented by following limitations:

- (a) Maximum allowable Phosphorus content 0.020%
- (b) Maximum allowable Sulfur content 0.015%
- (c) Welded pipes shall fulfill the same requirements as for plate material

6.3 Application to Process Piping (SMLS) and accessories

All the specifications given clause 6.1 are applicable and shall be supplemented by following limitations on impurities level:

- (a) Maximum allowable Phosphorus content 0.030%
- (b) Maximum allowable Sulfur content 0.020%

6.4 Application to Flanges and accessories

All the specifications given clause 6.1 are applicable and shall be supplemented by following limitations on impurities level:

- (c) Maximum allowable Phosphorus content 0.030%
- (d) Maximum allowable Sulfur content 0.025%

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| SPEC. NO. TCE.6079A –B- 590-006 | TATA CONSULTING ENGINEERS LIMITED | SECTION: D |
| | ANNEXURE – A SPECIAL REQUIREMENT FOR HYDROGEN SERVICE (PIPES, FLANGES AND FITTINGS) | SHEET 1 OF 2 |

1.0 GENERAL

These requirements are applicable in addition to the requirements specified in the Piping Material Specifications.

2.0 PIPES, FLANGES AND FITTINGS

2.1 Method of Manufacture

2.1.1 All carbon steel pipes, fittings and flanges having wall thickness 9.53 mm and above shall be normalized. Cold drawn pipes and fittings shall be normalized after the final cold draw pass for all thicknesses. In addition, fittings made from forgings shall have Carbon - 0.35% max. and Silicon - 0.35% max. The normalizing heat treatment shall be a separate heating operation and not a part of the hot forming operation.

2.1.2 All alloy steel (Cr-Mo) pipes, forgings and fittings shall be normalized and tempered. The normalizing and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psi.

2.2 Post Weld Heat Treatment

2.2.1 All carbon steel pipes and fittings having wall thickness 19 mm and above shall be post weld heat treated.

2.2.2 All alloy steel (Cr-Mo) pipes and fittings shall be post weld heat treated irrespective of type or thickness of weld.

2.2.3 All austenitic stainless steel grades shall be solution annealed after welding.

2.2.4 All stabilized grades of stainless steel shall be given a stabilizing heat treatment in addition to solution heat treatment at 900 deg C.

2.3 Ferrite No. Test

2.3.1 For all austenitic stainless steels, the weld deposit shall be checked for ferrite content. A Ferrite No. (FN) not less than 3% and not more than 10% is required to avoid sigma phase embrittlement during heat treatment. FN shall be determined by Ferritescope prior to post weld heat treatment.

2.4 Impact Test

2.4.1 For all carbon steels and alloy steels pipes, flanges and fittings with thickness over 19 mm, Charpy- V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-I for weld metal and base metal from the thickest item per heat of material and per heat treating batch Impact test specimen shall be in complete heat treated condition and in accordance with ASTM A370. Impact energies at 0 C shall average greater than 27J (20 ft-lb) per set of 3 specimens, with a minimum of 19J (15 ft-lb).

2.4.2 If welding is used in manufacture, impact test of Heat Affected Zone (HAZ) and weld metal shall also be carried out.

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| | ANNEXURE – A SPECIAL REQUIREMENT FOR HYDROGEN SERVICE (PIPES, FLANGES AND FITTINGS) | SHEET 2 OF 2 |

2.5 Hardness

- 2.5.1 For carbon steel pipes and fittings, hardness of weld and HAZ shall be limited to 200 BHN (max.)
- 2.5.2 For alloy steel pipes and fittings, hardness of weld and HAZ shall be limited to 225 BHN (max.)

2.6 Radiography

- 2.6.1 All girth welded joints (longitudinal and circumferential) shall be 100% radiographed in accordance with UW-51 of ASME Section VIII, Div-I and ASME Section V. Radiography shall be performed after post weld heat treatment.

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| SPEC. NO. TCE.6079A | TATA CONSULTING ENGINEERS LIMITED | SECTION: D |
| | ANNEXURE – A SPECIAL REQUIREMENT FOR HYDROGEN SERVICE (PIPES, FLANGES AND FITTINGS) | SHEET 1 OF 2 |

1.0 GENERAL

These requirements are applicable in addition to the requirements specified in the Piping Material Specifications.

2.0 PIPES, FLANGES AND FITTINGS

2.1 Method of Manufacture

2.1.1 All carbon steel pipes, fittings and flanges having wall thickness 9.53 mm and above shall be normalized. Cold drawn pipes and fittings shall be normalized after the final cold draw pass for all thicknesses. In addition, fittings made from forgings shall have Carbon - 0.35% max. and Silicon - 0.35% max. The normalizing heat treatment shall be a separate heating operation and not a part of the hot forming operation.

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2.2 Post Weld Heat Treatment

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- 2.2.3 All austenitic stainless steel grades shall be solution annealed after welding.
- 2.2.4 All stabilized grades of stainless steel shall be given a stabilizing heat treatment in addition to solution heat treatment at 900 deg C.

2.3 Ferrite No. Test

2.3.1 For all austenitic stainless steels, the weld deposit shall be checked for ferrite content. A Ferrite No. (FN) not less than 3% and not more than 10% is required to avoid sigma phase embrittlement during heat treatment. FN shall be determined by Ferritescope prior to post weld heat treatment.

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| | ANNEXURE – A SPECIAL REQUIREMENT FOR HYDROGEN SERVICE (PIPES, FLANGES AND FITTINGS) | SHEET 2 OF 2 |

2.5 Hardness

- 2.5.1 For carbon steel pipes and fittings, hardness of weld and HAZ shall be limited to 200 BHN (max.)
- 2.5.2 For alloy steel pipes and fittings, hardness of weld and HAZ shall be limited to 225 BHN (max.)

2.6 Radiography

- 2.6.1 All girth welded joints (longitudinal and circumferential) shall be 100% radiographed in accordance with UW-51 of ASME Section VIII, Div-I and ASME Section V. Radiography shall be performed after post weld heat treatment.

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| SPEC NO. TCE-M4-185-01 | TATA CONSULTING ENGINEERS LIMITED | SECTION : D |
| | INFORMATION TO VENDORS ON QUALITY PLANS AND GENERAL INSPECTION REQUIREMENTS | SHEET 1 OF 3 |

THIS SPECIFICATION SHALL BE FOLLOWED BY THE VENDOR IN ADDITION TO THE REQUIREMENTS SPECIFIED IN SPECIFICATION NO. TCE.M4-904 TITLED “SHOP INSPECTION AND TEST PROCEDURE”.

1.0 QUALITY ASSURANCE/QUALITY CONTROL PROGRAMME

- 1.1 Only critical inspection stages have been indicated in the enclosed “Minimum Inspection Requirements” documents. This is however, not intended to form a comprehensive programme as it is the VENDOR’s responsibility to draw up and implement such programme duly approved by the PURCHASER. The detailed Quality Plans for manufacturing and field activities should be drawn up by the BIDDERS, separately in the format attached and shall be submitted to PURCHASER at the time of submitting his offer.
- 2.0 All the sub-vendors proposed by the VENDOR for procurement of major bought out item including castings, forgings, semi-finished and finished components/equipment, shall be subject to PURCHASER’s review/clearance for systems and packages.
- 3.0 A consolidated list of all major equipment including boughtouts like pumps, valves, fans etc. shall be submitted by the VENDOR along with the offer for PURCHASER’s review/comments.
- 4.0 The PURCHASER reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the VENDOR’s or their SUB-VENDOR’s quality management and control activities. The VENDOR shall provide all necessary assistance to enable the PURCHASER to carry out such audit & surveillance.
- 5.0 The VENDOR shall undertake an inspection and testing programme during manufacture in his works and that of his sub-contractor to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identification and acceptability of all materials, parts and equipment. He shall carry out all tests/inspections required to establish that the items/equipment conform to requirements of contract specification and the relevant codes/standards specified therein, in addition to carrying out tests as per the approved Quality Plan.
- 6.0 VENDOR shall use calibrated instruments for testing, with traceability to NATIONAL /INTERNATIONAL levels. If not the PURCHASER/CONSULTANT will not witness the tests till the same is organised.
- 7.0 Only latest edition of the codes/standards and specifications shall be used for materials and testing. The latest edition is reckoned with the date of contract awarded.

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| SPEC NO. TCE-M4-185-01 | TATA CONSULTING ENGINEERS LIMITED | SECTION : D |
| | INFORMATION TO VENDORS ON QUALITY PLANS AND GENERAL INSPECTION REQUIREMENTS | SHEET 2 OF 3 |

8.0 Copies of all the test certificates/calibration reports/internal inspection reports shall be furnished by the VENDOR during the relevant inspection stages to the PURCHASER/ CONSULTANT.

9.0 The BIDDER shall furnish his fully documented, operational manual on the quality assurance programme (QAP) indicating the following minimum details:

- a) Organisation chart for the following quality inspection activities:
 - i) Purchasing of raw materials and bought out items
 - ii) Engineering and design
 - iii) Manufacturing
- b) Applicable quality standards and procedures for material, design and manufacture including non-destructive testing.
- c) QAP for design engineering and documentation control system
- d) The inspection and tests programme indicating details of inspections/tests to be carried out during various manufacturing stages indicating acceptance norms, extent of inspection by the VENDOR as given in the enclosed format. PURCHASER will review and approve the programme indicating his 'HOLD' points. These stages will be witnessed by the PURCHASER's ENGINEER/AUTHORISED REPRESENTATIVE.
- e) Procurement of control system for equipment or services purchased outside including approval of sub-suppliers/sub-contractors and surveillance on sub-suppliers/sub-contractors.
- f) Material control to ensure that only the approved materials are used in the manufacture.
- g) Details of final stages of inspection and tests at shops.
- h) Corrective actions on items or systems containing significant conditions adverse to quality.
- i) Control and inspection of material handling, storage, packing and shipping.
- j) Quality records/test certificates/calibration reports of testing & measuring instruments with traceability to National Standards, to provide objective evidence that all quality assurance requirements have been met.
- k) Quality assurance based on feed back received from the previous operating installations.

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SPEC NO.

TCE-M4-185-01

TATA CONSULTING ENGINEERS LIMITED

SECTION : D

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QUALITY PLAN

| CLIENT | QUALITY PLAN | MAIN VENDOR | | MAIN ITEM | | Q.P. NO. | |
|---------|-------------------------------------|------------------------|---------|---------------------------------|------------------|-----------|---------------------------|
| | | SUB - VENDOR | PROJECT | SUB - ITEM | P.O.NO. & DT. | Q.P. DATE | TCE REF. |
| SR. NO. | COMPONENT / CHARACTERISTICS CHECKED | TYPE / METHOD OF CHECK | EXTENT | REF. DOCUMENT / ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | REMARKS / HOLD POINTS (H) |
| 1 | 2 | 3 | 4 | 5 | 6 | S M T C | 8 H 9 |
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- A. STATUTORY REQUIREMENTS SHALL BE COMPLIED WITH BY THE VENDOR.
- B. MATERIAL TESTS OF SAMPLES DRAWN BY TCE SHALL BE WITNESSED BY TCE.
- N C. FOR STAGES WITNESSED / DOCUMENTS REVIEWED BY TCE, COPIES OF RELEVANT DOCUMENTS SHALL BE FURNISHED TO TCE.
- O D. TCE'S IDENTIFICATION STAMP ON MATERIALS SHALL BE PRESERVED / GOT TRANSFERRED BY TCE AT APPROPRIATE STAGES.
- T E. THE EXTENT INDICATED IN COLUMN 5 IS IN VENDOR'S SCOPE. TCE / CLIENT MAY INSPECT AS PER THIS COLUMN OR RANDOM SAMPLES.
- E F. COLUMN 6 SHALL BE AS PER TCE / CLIENT APPROVED DRAWINGS / DATA SHEETS / SPECIFICATIONS WHEREVER APPLICABLE.
- G. INSTRUMENTS FOR LEAK TESTS & PERFORMANCE TESTS SHALL HAVE VALID CALIBRATION CERT. WITH TRACEABILITY TO NATIONAL LEVEL.
- H. LEGENDS : S - SUB - VENDOR, M - MAIN VENDOR, T - TCE, C - TCE'S CLIENT, 1 - WITNESS, 2 - DOCUMENTS REVIEW, H - HOLD POINT.

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| S | SIGN. | NAME |
| M | SIGN. | NAME |
| T | SIGN. | NAME |
| C | SIGN. | NAME |

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| SPECIFICATION NO. TCE.M4-186-05 | TATA CONSULTING ENGINEERS LIMITED | | | | | | | | | | SECTION D | | | | | | | | | |
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| | SHOP INSPECTION REQUIREMENTS PIPES AND PIPE FITTINGS-METALLIC | | | | | | | | | | | SHEET 1 OF 1 | | | | | | | | |
| SERIAL NO. | DESCRIPTION | VISUAL EXAMINATION | DIMENSIONS | MATERIAL TEST CERT. | IDENTIFICATION AND CORRELATION | ULTRASONIC TEST | WELDING QUALIFICATION | FTT UP | BACKHIP-PT | PT / MT | RADIOGRAPHY | | OVALITY, THINNING | HEAT TREATMENT | SURFACE FINISH | HYDROSTATIC LEAK TEST | HARDNESS TEST | SPARK, ADHESION TEST | THICKNESS CHECK | MATERIAL CHECK TEST |
| A | ORDERED ON MANUFACTURER | | | | | | | | | | | | | | | | | | | |
| 1 | PLATES / PIPES FOR FABRICATED ITEMS | D | D | C | D | D | | | | | | | | | | | | | | |
| 2 | ROLLING, FORMING FOR FAB. ITEMS | D | D | | | | | | | | | D | | | | | | | | |
| 3 | BUTT, GROOVE WELDS FOR FABRICATED ITEMS | D | D | | | B | C/A | D | D | B | B | | | | | | | | | |
| 4 | FINISHED ITEMS | A | A | C | A | B | | | | | | | C | B | B | | | | D | |
| 5 | LININGS, IF ANY | A | | | | | | | | | | | | | | A | A | A | | |
| 6 | COATINGS, IF ANY | A | | | | | | | | | | | | | | | | A | | |
| B | ORDERED ON DEALERS / STOCKISTS ETC. | A | A | C | A | | | | | | | | | A | C | A ^x | A ^x | A ^x | D | |
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| LEGEND | | NOTES | | | | | | | | | | | | | | | | | | |
| A - WITNESSED BY TCE. | | 1 - ALL STAGES SHALL BE CHECKED 100% BY VENDOR AND RECORDS THEREOF SHOWN TO TCE. | | | | | | | | | | | | | | | | | | |
| B - WITNESSED BY TCE IF REQUIREMENT IS SPECIFIED. | | 2 - WITNESSING BY TCE MAY BE 100 % OR ON RANDOM SAMPLES. | | | | | | | | | | | | | | | | | | |
| C - RECORDS VERIFIED BY TCE WHEREVER APPLICABLE. | | 3 - THIS DOCUMENT SHALL BE READ IN CONJUNCTION WITH INSPECTION REQUIREMENTS MENTIONED IN TCE. M4 - 904 AND RELEVANT TECHNICAL SPECIFICATIONS. | | | | | | | | | | | | | | | | | | |
| D - A OR C, AT TCE'S DISCRETION WHEREVER APPLICABLE. | | 4 - THE PRESSURE GAUGES AND INSTRUMENTS FOR MEASURING CRITICAL PARAMETERS SHALL HAVE VALID CALIBRATION CERTIFICATE TRACEABLE TO NATIONAL LABORATORY. | | | | | | | | | | | | | | | | | | |
| X - FOR LINED ITEMS. | | | | | | | | | | | | | | | | | | | | |

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| SPEC. NO. TCE.M4-904 | TATA CONSULTING ENGINEERS LIMITED | SECTION: E |
| | SHOP INSPECTION AND TESTS | SHEET 1 OF 7 |

1.0 **SCOPE**

This specification covers the requirements for Shop Inspection and Tests to be carried out by the PURCHASER/CONSULTANT/INSPECTION AGENCY.

2.0 **GENERAL**

2.1 The plant and equipment covered by the PURCHASE ORDER/CONTRACT shall be subjected to inspection and testing. The VENDOR/CONTRACTOR shall provide all services to establish and maintain quality of workmanship in his works and that of his SUB-VENDOR's/SUB-CONTRACTOR's works to ensure the mechanical accuracy of components, compliance with approved drawings, identification and acceptability of all materials, parts and equipment.

2.2 For supply of systems, the VENDOR/CONTRACTOR shall, at the start of the PURCHASE ORDER/CONTRACT, furnish a total list of items in his scope of work. This list, giving a brief description of the item, quantity, names of probable SUB-VENDORS/SUB-CONTRACTORS, and a blank column for agency for final approval of drawings and documents, shall be submitted for approval by PURCHASER/CONSULTANT. The blank column shall be filled by PURCHASER/CONSULTANT. The list shall be submitted within two weeks from the date of Letter of Intent.

2.3 For systems and major items such as pressure and load bearing items, machineries etc., the VENDOR/CONTRACTOR shall furnish quality plan giving details of checks and tests to be conducted by them on material, process, sub-assembly and assembly. These shall include requirements as prescribed in the applicable specifications, codes and statutory requirements. The quality plan shall be reviewed by the PURCHASER/CONSULTANT and the stages to be witnessed and verified shall be indicated by the PURCHASER/CONSULTANT in the approved quality plan.

2.4 The VENDOR/CONTRACTOR shall give the PURCHASER/CONSULTANT written notice of any material being ready for testing as per format enclosed. The clear notice period shall be seven (7) days for local inspection and fifteen (15) days for outstation inspection. Such tests shall be to the VENDOR's/CONTRACTOR's account except for the expenses of the PURCHASER/CONSULTANT. The PURCHASER/CONSULTANT, unless the inspection of the tests is virtually waived, shall fix a date for inspection with the VENDOR/CONTRACTOR and attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test and inspection failing which, the VENDOR/CONTRACTOR may proceed with the tests and shall forthwith forward to the PURCHASER/CONSULTANT duly certified copies of tests in triplicate. If the VENDOR/CONTRACTOR fails to offer the equipment for inspection as per the agreed date, he is liable to pay for the time and expenses for the infructuous visit of the PURCHASER/CONSULTANT.

2.5 In all cases where inspection and tests are required whether at the premises or works of the VENDOR/CONTRACTOR or of any SUB-VENDOR/SUB-CONTRACTOR or at laboratory, the VENDOR/CONTRACTOR, except where otherwise specified, shall provide free of charge all facilities such as labour,

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| | SHOP INSPECTION AND TESTS | SHEET 2 OF 7 |

materials, electricity, fuel, water, stores, test bed, apparatus and instruments, laboratory tests etc. as may be required by the PURCHASER/CONSULTANT to carry out effectively such tests of the equipment in accordance with the PURCHASE ORDER/CONTRACT and shall give facilities to the PURCHASER/CONSULTANT to accomplish testing.

- 2.6 The PURCHASER/CONSULTANT shall at all working hours have access to all parts of the VENDOR's/CONTRACTOR's and his SUB-VENDOR's/SUB-CONTRACTOR's factory where the items of the plant are being prepared, for carrying out inspection activities as deemed necessary. A set of the relevant latest approved drawings with approval marking of the PURCHASER/CONSULTANT and drawings for proprietary items shall be made available by the VENDOR/CONTRACTOR to the PURCHASER/CONSULTANT, for reference during inspection.
- 2.7 In the case of stage inspection hold points, the VENDOR/CONTRACTOR shall proceed from one stage to another only after the component is inspected by the PURCHASER/CONSULTANT and written permission given to proceed further. The same procedure shall be adopted for any rectifications and repairs suggested by the PURCHASER/CONSULTANT.
- 2.8 The PURCHASER/CONSULTANT shall have the right to inspect any machinery, material, structures, equipment or workmanship furnished or used by the VENDOR/CONTRACTOR and may reject any which is defective or unsuitable for the use and purpose intended, or which is not in accordance with the intent of the PURCHASE ORDER/CONTRACT. The VENDOR/CONTRACTOR, upon demand by the PURCHASER/CONSULTANT, shall remedy or replace at the VENDOR's/CONTRACTOR's expense such defective or unsuitable items of the plant, or the PURCHASER/CONSULTANT may, at the expense of the VENDOR/CONTRACTOR, remedy or replace such defective or unsuitable items of the Plant.
- 2.9 All principal mill test reports, the VENDOR/CONTRACTOR inspection and tests reports, test certificates and test curves shall be supplied for all inspection and tests carried out including other records such as stress relieving charts, radiographic charts and other non-destructive testing records in accordance with the provisions of the PURCHASE ORDER/CONTRACT, duly certified by the main VENDOR/CONTRACTOR. The PURCHASER/CONSULTANT shall reserve the right to call for certificates of origin and test certificates for all raw material and equipment at any stage of manufacture.
- 2.10 The PURCHASER/CONSULTANT shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the VENDOR/CONTRACTOR of any non-conformance pertaining to all or any equipment and workmanship which in his opinion is not in accordance with the PURCHASE ORDER/CONTRACT. The VENDOR/CONTRACTOR shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the PURCHASER/CONSULTANT giving reasons therein that no modifications are necessary to comply with the PURCHASE ORDER/CONTRACT.

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2.11 When the factory tests and documentation have been satisfactorily completed at the VENDOR's/CONTRACTOR's or SUB-VENDOR's/CONTRACTOR's works, the PURCHASER/CONSULTANT shall issue acceptance note or shipping release note or a certificate to this effect within fifteen (15) days after completion, but if the tests are not witnessed by the PURCHASER/CONSULTANT, the certificate or comments thereof shall be issued within fifteen (15) days of the receipt of the VENDOR's/CONTRACTOR's test certificate by the PURCHASER/CONSULTANT. Failure of the PURCHASER/CONSULTANT to take such an action shall not prevent the VENDOR/CONTRACTOR from proceeding with the work. The completion of these tests or the issue of the certificates shall not bind the PURCHASER/CONSULTANT to accept the equipment, should it, on further tests after erection, be found not to comply with the PURCHASE ORDER/CONTRACT.

2.12 None of the plant and the equipment to be furnished or used in connection with the PURCHASE ORDER/CONTRACT shall be despatched until shop inspection, satisfactory to the PURCHASER/CONSULTANT has been made. However, such shop inspection and/or certification shall not relieve the VENDOR/CONTRACTOR of his responsibility for furnishing the plant and the equipment conforming to the requirements of the PURCHASE ORDER/CONTRACT nor prejudice any claim, right or privilege which the PURCHASER/CONSULTANT may have because of the use of defective or unsatisfactory items. Should the PURCHASER/CONSULTANT waive the right to inspect any item, such waiver shall not relieve the VENDOR/CONTRACTOR in any way from his obligation under the PURCHASE ORDER/CONTRACT. In the event of the PURCHASER's/CONSULTANT's inspection revealing poor quality of goods, the PURCHASER/CONSULTANT shall be at liberty to specify additional inspection procedures, if required, to ascertain the VENDOR/CONTRACTOR's compliance with the equipment specifications.

3.0 **SUB-ORDERS AND SUB-CONTRACTS**

3.1 In order to facilitate the inspection of bought-out materials and plant, the VENDOR/CONTRACTOR shall submit for approval, three (3) copies of all sub-orders and sub-contracts placed by him as soon as these are issued. Copies of any drawings referred to in the sub-order or sub-contracts shall also be submitted, unless agreed otherwise by the PURCHASER/CONSULTANT.

3.2 The sub-orders, sub-contracts and drawings referred to above shall include all components which are subjected to electrical and mechanical pressure or stress when the plant is in operation, and also auxiliaries and spares which are to be directly despatched to site from the SUB-VENDOR's/SUB-CONTRACTOR's works.

3.3 All sub-orders and sub-contracts of the main VENDOR/CONTRACTOR shall clearly be marked with the main VENDOR's/CONTRACTOR's name and the PURCHASER's/CONSULTANT's name and the PURCHASE ORDER/CONTRACT reference. These shall include the following statement:

The plant or the equipment which is the subject of this PURCHASE ORDER/CONTRACT shall comply in every respect with the requirements of the

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PURCHASER's/CONSULTANT's technical specifications and shall be subject to inspection and tests to the satisfaction of the PURCHASER/CONSULTANT.

- 3.4 For the purpose of this para, it is obligatory on the VENDOR/CONTRACTOR that he advises his SUB-VENDOR/SUB-CONTRACTOR of the pertinent clauses in this specification when ordering bought-out plant, equipment or materials. In particular, the VENDOR/CONTRACTOR shall advise every SUB-VENDOR/SUB-CONTRACTOR that he is required to supply design calculations, drawings, inspection reports and test certificates strictly in accordance with this specification and technical information for inclusion in the Instruction Manual as specified in Section E of the Enquiry Document. The SUB-VENDORS/SUB-CONTRACTORS should also be reminded that they shall include with their offer all tools and appliances necessary for proper maintenance and all spare parts in accordance with Section E of the Enquiry Document. Itemised prices of the recommended spare parts shall be submitted together with the appropriate part numbers and drawings.
- 3.5 Sub-ordering and sub-contracting for major items such as pressure and load bearing items, machinery etc. can be done only with the approval of the PURCHASER/CONSULTANT.

4.0 **MATERIAL TESTS**

- 4.1 In the event of the PURCHASER/CONSULTANT being supplied with the certified particulars of tests which have been carried out for the VENDOR/CONTRACTOR by the supplier of material, the PURCHASER/CONSULTANT may, at his own discretion, accept the same as proper evidence of compliance with the requirements of appropriate specifications for the materials.
- 4.2 The VENDOR/CONTRACTOR is to provide test pieces as required by the PURCHASER/CONSULTANT to enable him to determine the quality of material supplied under the PURCHASE ORDER/CONTRACT. If any test piece fails to comply with the requirements, the PURCHASER/CONSULTANT may reject the entire lot of material represented by the test piece.
- 4.3 Critical materials used in manufacture of the equipment and construction of the plant covered by the PURCHASE ORDER/CONTRACT may also be subjected to one or more of the Non-Destructive Tests (NDT) as called for in the enquiry document or as mutually agreed. Salvaging of material due to unacceptable defect is to be attempted by the VENDOR/CONTRACTOR only after getting specific concurrence from the PURCHASER/CONSULTANT and according to the approved procedures.

5.0 **WELDING**

- 5.1 All welding involved in construction and fabrication of the plant and items covered under the PURCHASE ORDER/CONTRACT shall be carried out in accordance with specifications and applicable codes.
- 5.2 Welding procedures and welders' qualifications shall be approved by the PURCHASER/CONSULTANT. Where applicable, welders shall be tested as

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detailed in codes specified for pipe welding, vessel welding and structural welding and appropriate to the corresponding weld position using test pieces of appropriate parent metal to be used on the job. The PURCHASER/CONSULTANT shall have the right to have any welder re-tested at any time during the PURCHASE ORDER/CONTRACT.

5.3 Recommendations of applicable codes shall be followed for non-destructive tests, wherever applicable.

5.4 Copies of all welding procedures, procedure qualification records, welders' performance qualification certificates, post-heating and stress relieving records, NDT records and other test results shall be made available upon request of the PURCHASER/CONSULTANT.

6.0 **FABRICATION AND INSPECTION**

Fabrication and inspection procedures for vessels, heat exchangers, pipes, tubes and valves etc. shall be in accordance with procurement specifications, quality plan, applicable codes or any other approved equal.

7.0 **TESTS AT MANUFACTURER'S WORKS**

7.1 **GENERAL**

The tests at works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards and approved drawings and specifications and in addition any test called for by the PURCHASER/CONSULTANT to ensure that the plant being supplied fulfils the requirements of the specifications. The VENDOR/CONTRACTOR shall carry out all the shop tests and inspections specified under individual items of the equipment in Section-D of the enquiry document, in addition to those normally required as per codes and standards. For items not covered by any code or specifically mentioned in the specifications, the tests are to be agreed with by the PURCHASER/CONSULTANT. If considered necessary by the PURCHASER/CONSULTANT, multi-part assemblies shall be fully erected and tested in the works prior to packing and despatch to the site.

7.2 **TEST CERTIFICATES**

Test certificates including test records, performance curves and balancing certificates shall be supplied according to the Distribution Schedule. All the tests shall be carried out in accordance with the provisions of the PURCHASE ORDER/CONTRACT.

All test certificates must be endorsed with sufficient information to identify the material or the equipment to which the certificates refer, and must carry at the top right hand corner the identification of the PURCHASER/CONSULTANT and the PURCHASE ORDER/CONTRACT.

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7.3 CALIBRATION

All instruments used for critical measurement such as pressure gauges for leak tests, instruments for measuring performance parameters; instruments for precision dimension measurements shall have valid calibration certificates traceable to national standards. This means that the calibrating agency engaged by the VENDOR/CONTRACTOR shall use instruments which are in turn calibrated by Government approved agencies and such information shall be recorded in the calibration certificate issued by the calibrating agency by giving the certificate number, date and date of validity of the certificate given by the Government approved agency.

**FORMAT FOR INSPECTION REQUEST FROM THE
VENDOR/CONTRACTOR**

To,

TATA CONSULTING ENGINEERS LIMITED, Attn: Mr/Ms

PROJECT MANAGER

Dear Sir/Madam,

Items detailed below are ready for inspection. Please arrange inspection and confirm the date.

1. PURCHASER
2. PROJECT
3. PURCHASE ORDER/CONTRACT REFERENCE NUMBER
4. CONSULTANT (TCE) REFERENCE NUMBER
5. SUB-VENDOR/SUB-CONTRACTOR
6. SUB-VENDOR's/SUB-CONTRACTOR's ADDRESS
7. PLACE OF INSPECTION AND ADDRESS
8. CONTACT PERSON, PHONE, FAX AND E-MAIL ID
9. DESCRIPTION OF ITEM AND QUANTITY
10. NATURE OF INSPECTION REQUIRED

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11. PROPOSED DATES

12. WEEKLY HOLIDAY

We confirm that the items have been fully inspected and tested by us. All stages of inspection as per approved quality plan have been carried out by us and all material test certificates, quality control records and test reports and valid calibration reports of measuring and testing instruments with traceability to national level are ready with us.

Thanking you and awaiting your confirmation,

Yours faithfully,

Note 1 Following clear notice periods (Date of Receipt at TCE to Date of Inspection) are required:

(a) Local Inspection - 7 days

(b) Outstation Inspection - 15 days

Note 2 Weekly Holidays for TCE - Saturday and Sunday

cc: Purchaser

cc: Sub-Vendor/Sub-Contractor

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