



Technical Requirements for Supply of Pipe Fittings Specification

03.01.218-Technical_Requirements_for_Supply_of_Piping_Fittings-
Specification



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Document History

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1. Purpose

The purpose of this document is to define minimum technical requirements for design, manufacturing, testing and supply of Fitting for piping for all OQ group of Company's projects.

2. Scope

The scope of this specification is to define the minimum requirement for supply of metallic fittings for piping items. Pipe fittings includes, tees, elbows, reducers...etc. The supply of metallic pipe fittings for Pipelines and the supply of non-metallic pipe fittings are not covered by this Specification. Non-metallic pipe and fittings shall be provided in accordance with selected manufacturers' standards and project requirements in the Piping Material specification to be developed by the Contractor during the Detail Design phase.

3. Confidentiality and Distribution

- This document is the property of OQ Group of Companies. Unless otherwise authorized by the Company, the distribution and use of this specification is limited to Company authorities and the Contractors' nominated by the Company. Unauthorized sharing is strictly prohibited and Company shall not bear any responsibility further.
- This document should be part of the ITT/Contract and thus becomes a contract requirement for the Contractor / Vendor to comply with as applicable.
- This document shall be revised only by the document custodian that is OQ Projects, CoE team.

4. Normative references

All codes and standards shall be the edition current at Purchase requisition issue date unless otherwise specified.

4.1 International Codes and Standards

Piping fitting shall be designed, manufactured, inspection, tested and delivered in accordance with the relevant sections of the latest revisions of International Codes, Standards, Rules and Regulations referred in this specification and referred in any of below International Codes and Standards.

ASME B1.20.1	Pipe Threads General Purpose (Inch)
ASME B16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B31.3	Process Piping
ASME / BPVC SEC IX	Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators
ASTM A20	General Requirements for Steel Plates for Pressure Vessels
ASTM A105	Carbon Steel Forgings for Piping Applications
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A182	Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings,
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A262	Standard Practices for Detecting Susceptibility to Inter-Granular Attack in Austenitic Stainless Steels
ASTM A350	Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel
ASTM A387	Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum
ASTM A403	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A420	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Low-
ASTM A578	Straight Beam Ultrasonic Examination of Rolled Steel Plates for Special
ASTM A815	Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping



ASTM A923	Standard Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels
ASTM B462	Forged or Rolled Nickel Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service
ASTM B564	Nickel Alloy Forgings
ASTM E112	Standard Test Methods for Determining Average Grain Size
ASTM E213	Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing
ASTM E562	Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count
ASTM E570	Standard Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products
AWWA C-208	Dimensions for Fabricated Pipe Fittings
BS 3799	Steel Pipe Fittings, Screwed and Socket Welding for the Petroleum
ISO 10474	Steel and steel products - Inspection documents
MSS SP-25	Standard Marking System for Valves, Fittings Flanges and Unions
MSS SP-43	Wrought and Fabricated Butt-Welding Fittings for Low Pressure Corrosion
MSS SP-53	Quality Standard for Steel Castings and Forgings for Valves, Flanges, Fittings, and Other Piping Components - Magnetic Particle Examination Method
MSS SP-75	Specification for High-Test Wrought Butt Welding Fittings
MSS SP-95	Swage(d) Nipples and Bull Plugs
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings: Socket Welding, Threaded, and Buttwelding Ends
NACE MR0103	Materials Resistant to Sulphide Stress Cracking in Corrosive Petroleum
NACE MR0175	Materials for use in H ₂ S-containing environments in oil and gas production

4.2 Referenced OQ Specifications

Additional requirements for piping fittings requirement are contained in the following specifications and documents:

Document Reference
03.01.19-Positive_Material_Identification_PMI_program-Specification
03.01.14-Material_certification_requirements-Specification
03.01.16-Surface_Preparation_Painting_Coating_and_Lettering-Specification
03.01.158-Metallic_Materials-Specification
03.01.124-Mechanical_Basis_of_Design-Specification

5. Dimensions and Ends

Dimensions of butt weld fittings shall be in accordance with ASME B16.9 except for tolerances of butt weld elbows wall thickness, and tolerances of all stainless steel and nickel alloy fittings with 10S wall thicknesses.

The tolerances for butt weld elbows shall be as follows: -

- The wall thickness shall not exceed the specified nominal thickness by more than 20%, for sizes up to & including 24" NPS or 15%, for sizes 26" NPS and larger. Permissible under tolerance on nominal wall thickness shall be in accordance with ASME B16.9 Table 13.
- Manufacture by taper boring of the weld ends of fittings having an initial NOMINAL thickness greater than that specified is not acceptable.
- In the case of pipe fittings minimum 10% of each size, pressure rating / thickness and type shall be dimensionally checked at vendor's works by Contractor or Inspection Agency assigned by Contractor. For elbows and bends 100% inspection of crown thickness shall also be conducted by Contractor or



Inspection Agency assigned by Contractor to ensure that the thickness due to thinning is not less than that specified in the requisition. For this purpose, thickness checks shall be carried out by ultrasonic or calliper measurement on extrados of the elbows & bends at the mid-span and end tangents as a minimum.

- All other tolerances shall be in accordance with ASME B16.9 Table 13.

Tolerances ONLY for all butt welded stainless steel and nickel alloy fittings with 10S wall thickness shall be in accordance with MSS SP-43.

TEEs manufactured in accordance with ASME B16.9 shall comply with ASME B31.3 Appendix D. Crotch thickness shall be inspected by Contractor or Inspection Agency assigned by Contractor. The extent of inspection for crotch thickness shall be in accordance with the Criticality Rating as specified in the material requisition. The crotch thickness shall not be less than the fitting thickness specified in the requisition.

For reducing butt-welding fittings having a different wall thickness specified at each end, the wall thickness of the fitting shall be based on the thicker end and the ends shall be matched to suit respective thickness values.

Dimensions of socket-weld and screwed fittings shall be in accordance with ASME B16.11.

Dimensions of Swage Nipples shall be in accordance with MSS SP-95 and BS 3799.

Galvanised fittings shall be supplied with threads free of galvanising. Galvanising shall be by hot dip method with coating weights equal to ASTM A153 requirements.

All screwed fittings shall have threads in accordance with ASME B1.20.1 (NPT).

Pipe fittings not directly referenced in relevant international standards (for example lateral branches not covered by ASME B16.9 and elbows not covered by MSS SP-97) shall meet the basic design criteria stated in the associated standards. In addition, the Supplier shall provide certified dimensional drawings and data for any Special Fittings, for which dimensional information is not provided in the associated standard.

For integrally reinforced forged branch outlet fittings (weldolets, sockolets, laterolets, threadolets, nipoflanges), the Vendor shall provide installation and welding details that include detailed drawings showing weld line and weld size.

Vendor shall submit product catalogue data, including technical literature of the manufacturing processes involved, for all pipe fittings ≤ 48 " NPS offered in the quotation.

Butt weld elbows shall be long radius type (radius = 1.5 nominal pipe size). Short radius elbows are not permitted.

5.1.1 Pipe Fittings > 48" NPS in Process Piping:

Design and dimensions of fittings larger than 48" NPS in process piping shall be in accordance with MSS SP-75 and generally in accordance with ASME B16.9 except for tolerances of butt weld elbows wall thickness which shall be as specified above. Overall dimensions of fittings shall be in accordance with Dimensions for Large Bore Fittings specified by Contractor. TEEs manufactured by pipe to pipe connection (with or without reinforcement pads) are not acceptable. Vendor shall specify the manufacturing methods of welded fittings in the bid.

5.1.2 Pipe Fittings > 48" NPS in Water (non-process) Service: -

- Design and dimensions of fittings larger than 48" NPS for water services shall be in accordance with AWWA C-208.
- 90° elbows shall be supplied as 5 piece mitre bend with four welds in accordance with AWWA C-208.
- 45° elbows shall be supplied as 3 piece mitre bend with two welds in accordance with AWWA C-208.
- Miter bends may only be used in ASME rating class 150 and with the approval of the Company. Miter bends shall be calculated in accordance with ASME B31.3.

5.1.3 GA / Fabrication Drawings for Pipe Fittings > 48" NPS: -

- Vendor shall submit GA drawings including overall dimensions, wall thicknesses, tolerances and design calculations for all pipe fittings > 48" NPS within 4 weeks after placement of order for Contractor Engineering Department review and approval. Location of longitudinal welds shall be indicated on the drawing.



- Manufacturing of the fittings shall not commence prior to Contractor Engineering Department approval.
- Vendor shall also submit description of manufacturing process involved, including heat treatment for information to Contractor Engineering Department.

6. General Material Requirements

Carbon Steel, Impact Tested Carbon Steel and Alloy Steel (Cr-Mo) wrought fittings ≤ 14 " NPS, and Stainless Steel, Duplex Stainless Steel and Ni Alloy wrought fittings ≤ 8 " NPS shall be of seamless construction except where specified otherwise in the requisition.

Fabricated fittings shall be radiographed individually throughout the entire length of each weld after forming and heat treatment, in accordance with ASTM A234. This shall also apply to pipe fittings > 48 " NPS referenced in Section 5 of this Specification.

Any fitting manufactured from free machining material is not acceptable. Fittings shall not be manufactured from bar stock.

Wrought steel butt weld fittings, including branch fittings, made from block forgings are not acceptable.

Reinforced branch fittings shall be near shape forged. Welded, cast fittings and fittings made from bar stock are not acceptable.

Vendor to confirm in the offer that the design of all offered fittings is qualified by proof tests and the same shall be available for inspection by Contractor or Inspection Agency assigned by Contractor.

All Welded fittings shall be supplied in single seam construction. However, for sizes ≥ 36 " NPS a double seam construction manufactured from two plates is acceptable if not available from any source as a single seam. Vendor shall clearly state in the quotation the sizes where fittings with double seam construction manufactured from two plates have been offered.

Fabricated piping items in carbon steel material, which is not covered by any relevant manufacturing standard for hardness limitation, shall have a hardness check made on each welded item. The maximum hardness measured in the plate, HAZ, and weld shall not exceed 200 BHN. Fittings manufactured to ASTM A234 are already covered for this aspect.

Weld procedures and welder qualification records shall be submitted for all welded fitting materials as specified in Section 7 for approval by Contractor Engineering Department in accordance with the project Specification "03.01.11-Welding_NDE_of_Piping_Amend API RP 582-Specification"

All welding shall be carried out to a qualified procedure for the base materials concerned and the work shall be done only by ASME IX qualified welders.

Unless otherwise specified elsewhere in this Specification or material requisition, hardness test result shall be reported in the Material Test Certificate (MTC) for each batch of material from the same heat in the same final heat treated condition. Hardness test shall be carried out in accordance with ASTM A370. Test result shall be reported on Material Test Certificate of the finished product based on Brinell hardness unit of measurement.

Seamless or forged fittings requiring weld repair are not acceptable. Weld repair on the weld of welded fittings is acceptable and shall be indicated on the weld map. Repaired welds shall be heat treated and radiographed. Weld repair on base material is not acceptable. Vendor shall notify Contractor Engineering Department prior to repair in writing for approval.

7. Materials Supplementary Requirements

All materials shall be new and unused and in accordance with the purchase item description and project specifications.

In addition to the requirements given in 03.01.158_Specification_for_Metallic_Materials, each project shall produce material supplementary requirement latest by project *Define phase* (FEED) sooting the project nature. Attachment 3 give an example of material supplement.



8. Positive Material Identification

Alloy materials including all grades of Cr-Mo steels, Nickel based alloys, stainless steels and non-ferrous materials shall be subject to PMI inspection in accordance with 03.01.19-Positive_Material_Identification_PMI_program-Specification. Test results shall be reported in Material Test Certificates (MTC).

Carbon steels are not subject to PMI.

All material rejected by PMI check, or with inadequate documentation or marking shall be strictly quarantined pending investigation. Proven non-compliant material shall be rejected and returned at vendor's cost.

9. Marking

Marking and colour coding shall be in accordance with Certification, Marking and Colour Coding of Bulk Piping Materials Standard to be developed by Contractor.

Marking shall be carried out in accordance with the manufacturing standard (i.e. B16.9, B16.11 and MSS-SP-25) and the requirements of 03.01.16-Surface_Preparation_Painting_Coating_and_Lettering-Specification.

Proprietary reinforced branch connectors shall be marked with the following: -

- i. Material and heat number
- ii. Pressure classifications/wall schedule
- iii. Size
- iv. Manufacturer's identification
- v. Mark of inspecting authority

The permitted methods of marking are: -

- By raised lettering.
- Stamping with round-nosed, low-stress stamps (conventional 'V' stamps shall not be used). Marks shall not be deep enough to form cracks or reduce wall thickness below the minimum required.
- Electro-etching or vibro-tool marking.

Marking shall not be applied to internal surfaces, highly stressed parts, weld preparations or gasket faces.

Marking by stamping shall be applied prior to heat treatment. In this context, heat treatment includes post weld heat treatment and stress relief. All items in austenitic Stainless Steels and Nickel Alloys should be marked by stress-free marking technique (e.g. Electro-etching or Vibro-tool marking) or shall be solution annealed after stamping.

Each component shall be marked with identification numbers or symbols which enable the cast or melt number and heat treatment to be traced.

10. Packaging and Protection

All fittings shall be adequately protected to prevent damage during handling or in transit. The package shall be labelled with the order number, ASTM specification no. and size of fittings.

All materials shall be prepared for shipment in accordance with applicable Project Specifications.

All ferritic steels both carbon and alloy steels shall be protected from oxidation inside and outside. Outside protection shall be either varnish or rust inhibitor and last for a period of twelve months in outside storage conditions at the construction/fabrication site. The protection shall be easily removed by light sand blasting. Outside protection shall be as per manufacturer's recommendations.

Vendor shall provide full details of proposed protection & packing in the technical bid including the details of protection particularly for large bore fittings.



Contact between stainless steels and carbon steels shall not occur. Also, contact between stainless and nickel alloy shall not occur. Direct contact between stainless steel and wood shall be prohibited.

Large bore fittings shall be internally supported at both ends as a minimum to prevent any deformation during transit and storage. Details of packing and internal supports shall be submitted along with bid for Contractor Engineering Department review.

11. Inspection and Certification

All vendor's facilities, materials and fabrication work may be subjected to Inspection by Contractor or Inspection Agency assigned by Contractor.

When specified by the Material Requisition, tests on materials or components shall be witnessed by Contractor Inspection Engineer or Representative of Inspection Agency assigned by Contractor. Company shall have the right to attend any inspection/testing. 03.01.42-Project_Inspection_Coordination-Procedure shall be followed.

Company and / or Contractor shall be given access to those parts of the manufacturer's works engaged on the production of fittings, to inspect the materials being processed at any stage of manufacture. The Inspection Engineer may reject any materials or components which in his opinion do not conform to the requisition.

The manufacturer shall submit certificates of chemical composition, and physical properties including details of any tests and heat treatments applied for inspection purposes and to accompany supply of goods to site.

The certificates shall be available at the time the fittings are ready for inspection.

The requirements for Certification of pipe fittings shall be in accordance with 03.01.14-Material_certification_requirements-Specification. All bulk material defined as CR-1 in accordance with the project specification for Criticality Ratings shall be supplied with ISO 10474 type 3.2 certification. Attachment-1 lists the minimum required certification for pipe fittings. Attachment-1 lists the minimum required certification for pipe fittings.

The certificates shall be written in English Language and be clearly legible.



ATTACHMENT# 1 – List of Required Typical Material Certification

Pipe material (3)	Mat'l test cert's (1) (2)	Impact test cert's	Certificate of conformity (overall)	PMI cert's	Reports of supplier inspection / audits
Carbon steel	Yes	As applicabl e	Yes	No	Yes
Impact tested carbon steel	Yes	Yes	Yes	No	Yes
Lined carbon steel	Yes (includes liner test results)	No	Yes	No	Yes
SS304/304/ 316/316/ 321 duplex SS UNS S2205 / s31803	Yes	As applicabl e	Yes	Yes	Yes
Cr-Mo steel	Yes (includes welding consumable)	As applicabl e	Yes	Yes	Yes
Nickel alloy	Yes	No	Yes	Yes	Yes

1. MTC shall contain NACE / HIC compliance (If applicable), including test results.
2. Details of all heat treatment shall be included in the material certification.
3. Contractor shall update this as required to add additional materials during detail design phase.



ATTACHMENT #2 Materials Supplementary Example

This attachment needs to be updated for each specific project during the *Define phase (FEED)* and amended as applicable.

1. Carbon Steel and Impact Tested Carbon Steel Wrought Fittings

1.1 Seamless and Welded Carbon Steel ASTM A234 Grades WPB-S, WPB-W, and Seamless and Welded Impact Tested Carbon Steel ASTM A420 Grades WPL6-S, WPL6-W Wrought Fittings.

Chemical composition, by ladle and product analysis, shall be restricted as follows: - Carbon: 0.23% max.

Carbon Equivalent (C.E.): 0.45% max., where

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

Carbon Equivalent shall be calculated and reported on Material Test Certificate (MTC). All fittings shall be normalised.

All fittings shall be heat treated after all forming operations.

Hardness of base metal, weld and HAZ for grade WPL-6 shall be limited to 200BHN (max.). Verification of hardness is required in accordance with Section 6 of this Specification. The hardness requirement for grade WPB shall be in accordance with ASTM A234.

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

1.2 Seamless Carbon Steel ASTM A234 Grade WPB-S and Seamless Impact Tested Carbon Steel ASTM A420 Grade WPL6-S Wrought Fittings – NACE (For Low and High Severity Sour Service)

Seamless fittings shall meet the following requirements in addition to the requirement of NACE MR0103.or NACE MR0175 as applicable.

Must be Fully Killed Carbon Steel type. Ni content <1%.

All Fittings shall comply with the following chemical analysis: -

ELEMENTS	% Max.
Carbon	0.20
Manganese	1.10
Silicon	0.30
Sulphur	0.020
Phosphorus	0.030
Carbon Equivalent	0.41

Carbon Equivalent shall be calculated and reported on Material Test Certificate (MTC) using the formula given in Section para 1.1 of above.

All fittings shall be normalised.

All fittings shall be heat treated after all forming operations.

Verification of hardness is required in accordance with Section 6 of this Specification.

For grade WPL6 Hardness shall be limited to 200BHN. The hardness requirement for grade WPB shall be in accordance with ASTM A234.

Non Destructive Testing for Seamless Fittings: -

- Seamless fittings of thickness greater than 19 mm shall be examined on their full length by ultrasonic, by pulse angle beam method in accordance with ASTM E213.
- All fittings shall be magnetic particle inspected 100% on forged or extruded surface in accordance with MSS-SP-53.



1.3 Welded Carbon Steel ASTM A234 Grade WPB-W and Welded Impact Tested Carbon Steel ASTM A420 Grade WPL6-W Wrought Fittings – NACE (For Low Severity Sour Service)

Welded fittings in low severity wet sour service shall meet the following requirements in addition to the requirements of NACE MR0103/NACE MR0175 and NACE SP0472.

Must be Fully Killed Carbon Steel type. Ni content <1%.

All Fittings shall comply with the following chemical analysis: -

ELEMENTS	% Max.
Carbon	0.20
Sulphur	0.015
Phosphorus	0.020
Carbon Equivalent (CE) for plate < 2 in. thick	0.42
Carbon Equivalent (CE) for plate 2 – 4 in. thick	0.45
Carbon Equivalent (CE) for plate > 4 in. thick	0.48

Carbon Equivalent shall be calculated and reported on Material Test Certificate (MTC) using the formula given in para 1.1 of above.

All fittings shall be normalised.

All fittings shall be heat treated after all forming operations.

Verification of hardness is required in accordance with Section 6 of this Specification.

Hardness for grade WPL6 shall be limited to 200BHN. The hardness requirement for grade WPB shall be in accordance with ASTM A234.

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

All fittings shall be magnetic particle inspected 100% on forged or extruded surface in accordance with MSS-SP-53.

1.4 Welded Carbon Steel ASTM A234 Grade WPB-W and Welded Impact Tested Carbon Steel ASTM A420 Grade WPL6-W Wrought Fittings – NACE + HIC (For High Severity Sour Service)

Welded CS pipe fittings in high severity sour / wet H₂S service shall meet the following requirements in addition to the requirements of NACE MR0103/NACE MR0175 and NACE SP0472.

Must be Fully Killed Carbon Steel type.

Ni content <1%.

All Fittings shall comply with the following chemical analysis: -

ELEMENTS	% Max.
Carbon	0.20
Manganese	1.20
Silicon	0.45
Sulphur	0.002
Phosphorus	0.010
Copper	0.25
Nickel*	0.3



Chromium	0.25
Molybdenum	0.20
Nb + V	0.20
Nb + V + Ti	0.12
Carbon Equivalent (CE) for plate < 2 in. thick	0.42
Carbon Equivalent (CE) for plate 2 – 4 in. thick	0.45
Carbon Equivalent (CE) for plate > 4 in. thick	0.48

*Ni containing weld consumable has been found to have no adverse effect on weld metal SSC resistance up to 2.2% Ni content provided the hardness is controlled in accordance with NACE standard.

Carbon Equivalent shall be calculated and reported on Material Test Certificate (MTC) using the formula given in para 1.1 of above.

Material Test Certificate (MTC) shall also include Chemical Analysis of all elements specified above.

All fittings shall be normalised.

All fittings shall be heat treated after all forming operations.

Verification of hardness is required in accordance with Section 6 of this Specification.

Hardness for grade WPL6 shall be limited to 200BHN. The hardness requirement for grade WPB shall be in accordance with ASTM A234.

Fittings requiring weld repairs are not acceptable.

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

All fittings shall be magnetic particle inspected 100% on forged or extruded surface in accordance with MSS SP-53.

1.4.1 Manufacture of steel plate in High Severity Service: -

The steel plate in High Severity Service shall be produced considering the following requirements:

- The steel shall be made by electric arc furnace or in the basic oxygen furnace process.
- The steel shall be made by vacuum degassing process and produced to a fine grain practice, with low sulphur and phosphorus process. Grain size shall be 7 or finer as defined by ASTM E112.
- The oxygen content of the steel to be < 0.0025%.
- Sulphur content up to 0.007% may be allowed if the steel is inclusion shape control treated by Calcium addition. This option should be left at steel manufacturer's option. Alternative methods of inclusion shape control shall be subject to the acceptance by Contractor Engineering Department.
- Calcium treatment, if any shall be at a Ca/S ratio >1.2 and shall not exceed 3 times the sulphur content.

The Manufacturer shall submit the following information in their quotation:

- Steel making route, deoxidisation and desulphurisation practice, inclusion shape control method, and use of vacuum degassing.
- Casting route, ingot or continuous casting, segregation controls procedures, rolling reduction.
- Methods, standards for preventing Centre Line Segregation.
- HIC test results on previous similar material. The Mill test report shall include the value for the Crack Length Ratio (CLR), Crack Sensitivity Ratio (CSR) and Crack Thickness Ratio (CTR) as defined in NACE standard TM0284.
- Heat treatment

1.4.2 Ultrasonic testing: -



Materials supplied in accordance with this Specification, shall be ultrasonically tested in accordance with the requirement of ASTM A578 with supplementary requirements S1.

Acceptance criteria level C shall apply.

1.4.3 HIC testing: -

- HIC testing in accordance to 03.01.158_Specification_for_Metallic_Materials.

1.4.4 Material Certification:-

Material test certificate shall include the provisions for simulated Post Weld Heat Treatment to anticipate maximum heat treatment cycle foreseen during fabrication of the equipment in accordance with ASTM A20 Supplementary Requirements S3.

Certified Material Test Report (CMTR) shall include:

- Chemistry
- Mechanical properties (including tests after simulated PWHT)
- HIC testing results
- Ultrasonic examination results
- Impact tests results
- Heat treatment report
- Hardness test results and location shall be recorded in CMTR

1.5 HIC Test Procedure for Welded Carbon Steel ASTM A234 Grade WPB-W and Welded Impact Tested Carbon Steel ASTM A420 Grade WPL6-W Wrought Fittings (For High Severity Sour Service)

1.5.1 Reference Procedure: -

- HIC test shall be conducted in accordance with the procedure defined in NACE Standard TM 0284 using the test solution A in accordance with NACE Standard TM0177.

1.5.2 Acceptance criteria: -

- In accordance to 03.01.158_Specification_for_Metallic_Materials,
- Should any of initial test coupons failed to meet the acceptance criteria, the tested pipe shall be rejected. Two retest coupons shall be taken from another pipe with the same wall thickness and from the same heat. If both the coupons pass the test, then rest of the pipes with the same wall thickness and from the same heat will be accepted.
- If any of these two coupons fails, then one test coupon from another pipe with the same wall thickness and from the same heat shall be tested with the following acceptance conditions: -
 - a) If this coupon passes the test, the rest of the pipes (including the pipe which two test coupons were taken from) with the same wall thickness and from the same heat shall be accepted.
 - b) If this coupon fails in the test, then all pipes with the same wall thickness and from the same heat shall be rejected.
- For any test coupon failures, the Pipe Manufacturer shall investigate the cause of failure and submit a report (including the cause of failure) to Engineering Department for review and comment. This report shall include the proposed means by pipe manufacturer to prevent the similar failure for other heats.

1.5.3 HIC Test Reporting: -

HIC Report shall include the following information: -

- Full chemical analysis and mechanical property results of material tested.
- Results of cracking evaluation indicating individual and average CLR, CTR and CSR for each section.
- Photomicrographs of the specimens showing cracking, together with following photomicrographs of adjacent material structures:



- Unetched, showing the type of inclusions in the steel (magnification 200X).
- Etched, showing the parent material microstructure (magnification 200X).
- pH of H₂S saturated solution at the beginning and at the end of the test and type of solution.
- Photographs of specimens showing blister.
- Location and dimensions of specimens

2. Carbon Steel and Impact Tested Carbon Steel Forged Fittings

2.1 Carbon Steel ASTM A105N and Impact Tested Carbon Steel ASTM A350 Grade LF2 Class 1 Forgings

Carbon: 0.25% max

Carbon Equivalent (C.E.): 0.45% max.

Carbon Equivalent shall be calculated and reported on Material Test Certificate (MTC) using the formula given in para 1.1 of above.

All forgings shall be normalised.

For ASTM A105 forgings, hardness shall be 187 BHN (max). For ASTM A350 LF2 forgings, hardness shall be 197BHN (max). Verification of hardness is required in accordance with ASTM A105 / ASTM A350 as applicable.

2.2 Carbon Steel ASTM A105N and Impact Tested Carbon Steel ASTM A350 Grade LF2 Class 1 Forgings – NACE (For Low and High Severity Sour Service)

Forgings shall meet the following requirements in addition to the requirement of NACE MR0103/NACE MR0175.

Carbon Equivalent shall be calculated and reported on Material Test Certificate (MTC) using the formula given in para 1.1 of above.

All forgings shall be normalised.

For ASTM A105 forgings, hardness shall be 187 BHN (max). For ASTM A350 LF2 forgings, hardness shall be 197BHN (max). Verification of hardness is required in accordance with ASTM A105 / ASTM A350 as applicable.

All forgings shall be magnetic particle inspected 100% on forged or extruded surface in accordance with MSS SP-53

3. Low Alloy / Alloy Steel Wrought Fittings

3.1 Low Alloy Steel Seamless and Welded 1 1/4Cr–1/2Mo Steel ASTM A234 Grade WP11 Class 1 Wrought Fittings

ASTM A234 Grade WP11 Class 1 fittings shall be Normalized and Tempered.

Accelerated cooling from the austenitising temperature is acceptable, where permitted by the applicable product form specification.

Hardness of base metal, weld and HAZ shall be limited to 197BHN (max.). Verification of hardness is required in accordance with Section 6 of this Specification.

For the manufacture of fitting from plate, ASTM A387 Class 1 plates shall be used. All fittings shall be heat treated after all forming operations.

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

3.2 Low Alloy Steel Seamless and Welded 2 1/4Cr–1Mo Steel ASTM A234 Grade WP22 Class 1 Wrought Fittings

ASTM A234 Grade WP22 Class 1 fittings shall be Normalized and Tempered. All fittings shall be heat treated after all forming operations.

Hardness of base metal, weld and HAZ shall be limited to 197BHN (max.). Verification of hardness is required in accordance with Section 6 of this Specification.



All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

3.3 Alloy Steel Seamless and Welded 5Cr–1/2Mo Steel ASTM A234 Grade WP5 Class 1 Wrought Fittings

ASTM A234 Grade WP5 Class 1 fittings shall be Normalized and Tempered.

For the manufacture of fitting from plate, ASTM A387 Class 1 plates shall be used. All fittings shall be heat treated after all forming operations.

Hardness of base metal, weld and HAZ shall be limited to 217BHN (max.). Verification of hardness is required in accordance with Section 6 of this Specification.

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

3.4 Low Alloy Steel Seamless and Welded 9Cr–1Mo Steel ASTM A234 Grade WP9 Class 1 Wrought Fittings

ASTM A234 Grade WP9 Class 1 fittings shall be Normalized and Tempered.

For the manufacture of fitting from plate, ASTM A387 Class 1 plates shall be used. All fittings shall be heat treated after all forming operations.

Hardness of base metal, weld and HAZ shall be limited to 217BHN (max.). Verification of hardness is required in accordance with Section 6 of this Specification.

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

3.5 Alloy Steel Seamless and Welded 9Cr–1Mo–V Steel ASTM A234 Grade WP91 Type 2

Finished product shall be normalised and tempered.

For the manufacture of fittings from plate, ASTM A387 Class 2 plates shall be used.

Finished product shall be Brinell hardness tested, with acceptance criteria 250 BHN maximum. Measured values shall be reported on the material test certificates.

All WP91 material shall be normalized in the range of 1040°C to 1080°C and tempered in the range of 760°C to 780°C. The heat treatment temperature and the soaking time shall be reported on the material test certificate. PWHT shall be carried out at 755°C +/- 10°C.

100% Flux leakage examination shall be carried out in accordance ASTM E570. Calibration against longitudinal and transverse notches- one of each-inside and outside sample. Notch depth shall be 5% of minimum wall thickness.

4. Low Alloy / Alloy Steel Forged Fittings

4.1 Low Alloy Steel Forgings ASTM A182 Grade F11 Class 2.

ASTM A182 Grade F11 Class 2 forgings shall be Normalised and Tempered. All forgings shall be heat treated after all forming operation.

Accelerated cooling from the austenitising temperature is acceptable, where permitted by the applicable product form specification.

Hardness shall be limited to 207BHN (max.). Verification of hardness is required in accordance with ASTM A182.

Forgings requiring weld repairs are not acceptable.

4.2 Low Alloy Steel Forgings ASTM A182 Grade F22 Class 3

ASTM A182 Grade F22 Class 3 forgings shall be Normalised and Tempered.

All forgings shall be heat treated after all forming operation.

Forgings requiring weld repairs are not acceptable.

4.3 Alloy Steel Forgings ASTM A182 Grades F5, F9, F91

ASTM A182 Grade F5, F9, F91 forgings shall be Normalized and Tempered.



All fittings shall be heat treated after all forming operations.

Forgings requiring weld repair are not acceptable.

5. Stainless Steel Wrought Fittings

5.1 Seamless and Welded Stainless Steel ASTM A403 Grades WP304-S, WP304-WX, WP304L-S, WP304L-WX, WP316-S, WP316-WX, WP316L-S, WP316L-WX, Wrought Fittings

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

All fittings shall after all forming be solution anneal heat treated strictly in accordance with Table 4 of ASTM A403.

For ASTM A403 Gr.304 and Gr.304L fittings dual certified fittings ASTM A403 Gr. 304/304L is acceptable. Vendor shall clearly state the material grade offered in the technical bid.

Similarly, for ASTM A403 Gr.316 and Gr.316L fittings dual certified fitting material ASTM A403 Gr.316/316L is acceptable. Vendor shall clearly state the material grade offered in the technical bid.

ASTM A403 Gr. WP304-WX / WP304L-WX and WP316-WX / WP316L-WX fitting welds shall be qualified by impact test at minus 196°C with acceptance criteria of 0.38mm lateral expansion.

5.2 Seamless and Welded Stainless Steel ASTM A403 Grades WP304L-S, WP304L-WX, WP316L-S, WP316L-WX Wrought Fittings – NACE (For Wet Sour Service)

Fittings shall be supplied in compliance with NACE MR0103/NACE MR0175. Fittings shall be supplied with max. hardness of 22HRC.

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

All fittings shall after all forming be solution anneal heat treated strictly in accordance with Table 4 of ASTM A403.

Hardness verification is required in accordance with Section 6 of this Specification.

ASTM A403 Gr. WP304-WX / WP304L-WX and WP316-WX / WP316L-WX fitting welds shall be qualified by impact test at minus 196°C with acceptance criteria of 0.38mm lateral expansion.

5.3 Seamless and Welded Stainless Steel ASTM A403 Grade WP321-S, WP321-WX Wrought Fittings

All welds in welded fittings shall be made with the addition of filler metal and shall have 100% Radiography of the longitudinal weld after all forming and heat treatment.

All fittings shall, after all forming operations, be heat treated strictly in accordance with Table 4 of ASTM A403. Solution annealing shall be followed by thermal stabilisation at 815°C to 870°C for 4.7 min/mm of thickness, then furnace or air cooled. In addition, this grade shall comply with ASTM A262 practice E. The ASTM A262 practice test shall be performed on welded pieces to test material in the as welded condition.

6. Stainless Steel Forged Fittings

6.1 Stainless Steel Forgings ASTM A182 Grades F304, F304L, F316, F316L

Forgings requiring weld repair are not acceptable.

All fittings, shall after all forming operations, be solution anneal heat treated strictly in accordance with Table 1 of ASTM A182.

For ASTM A182 Gr.304 and Gr.304L fittings dual certified fittings ASTM A182 Gr.304/304L is acceptable. Vendor shall clearly state the material grade offered in the technical bid.

Similarly, for ASTM A182 Gr.316 and Gr.316L fittings dual certified fitting material ASTM A182 Gr.316/316L is acceptable. Vendor shall clearly state the material grade offered in the technical bid.

6.2 Stainless Steel Forgings ASTM A182 Grades F304L, F316L – NACE (For Wet Sour Service)

Material shall be supplied in compliance with NACE MR0103/ NACE MR0175. Fittings shall be supplied with max. hardness of 22HRC.

Forgings requiring weld repair are not acceptable.



All fittings shall after all forming be solution anneal heat treated strictly in accordance with Table 1 of ASTM A182. Verification of hardness is required in accordance with ASTM A182.

6.3 Stainless Steel Forgings ASTM A182 Grades F321

Forgings requiring weld repair are not acceptable.

All fittings shall, after all forming operations, be heat treated strictly in accordance with Table 1 of ASTM A182. Solution annealing shall be followed by thermal stabilisation at 815°C to 870°C for 4.7 min./ mm of thickness, then furnace or air cooled. In addition, this grade shall comply with ASTM A262 practice E. The ASTM A262 practice test shall be performed on welded pieces to test material in the as welded condition.

7. Duplex Stainless Steel Wrought Fittings

7.1 Seamless and Welded Duplex Stainless Steel ASTM A815 UNS S32205 / ASTM A815 UNS S31803 Class WP-S and WP-WX Wrought Fittings

Fittings shall be supplied in accordance with the ASTM specification in final solution annealed condition.

Micrographic examination is required (two samples per heat) and shall cover the mid- thickness region. The ferrite content shall be determined according to ASTM E562 or approved equivalent and shall be within 40 – 60%. The microstructure, as examined at 400X magnification on a suitably etched specimen, shall be free from inter-metallic phases and precipitates.

For welded fittings, welds shall be made using argon as shielding and backing gas with a minimum purity of 99.99%. The heat input shall be within the range of 0.5 – 1.5kJ/mm. The ferrite content of the weld metal and HAZ shall be within 30 – 60%.

Impact testing shall be carried out at minus 50°C in accordance with ASTM A370. Test results shall be at least 40 Joules (for standard specimen 10 x 10mm) as an average of three tests. One result may be lower than 40 Joules but shall have a minimum of 31 Joules. The required impact values for sub-size specimens shall be reduced as follows:

SPECIMEN SIZE (MM)	MULTIPLICATION FACTOR
10 x 7.5	0.8
10 x 5	0.7

Impact testing and Micrographic examination shall be carried out for each heat and heat treatment batch.

Where Impact test is not practical due to thickness restrictions, an alternative micrographic examination to ASTM A923 Method A shall be applied.

All product forms that fail to pass either the charpy impact testing as per ASTM A370 or micrographic examination to ASTM A923 Method A, are subject to rejection and shall be re-manufactured/supplied.

Charpy impact test procedure as per ASTM A370 and ASTM A923 method A procedure shall be submitted for Contractor Engineering Department review. In addition, the Material Test Certificate (MTC) shall indicate either the charpy impact testing or ASTM A923 Method A test results.

8. Duplex Stainless Steel Forged Fittings

8.1 Duplex Stainless Steel Forgings ASTM A182 Grade F60 (UNS S32205) / ASTM A182 Grade F51 (UNS S31803)

Fittings shall be supplied in accordance with the ASTM specification in final solution annealed condition.

Material shall have 0.15% minimum Nitrogen content.

Material composition shall provide a minimum Pitting Resistance Equivalent Number (PREN) of 35 as defined by the equation below.

$$\text{PREN} = \% \text{Cr} + (3.3 \times \% \text{Mo}) + (16 \times \% \text{N})$$



Periodic Intergranular corrosion test shall be carried out as per ASTM A262 Practice E. ASTM A182 Supplementary Requirement S4 Corrosion Test shall be applied if Periodic Intergranular corrosion test data is not available and shall be applied to each Heat.

Micrographic examination is required (two samples per heat) and shall cover the mid- thickness region. The ferrite content shall be determined according to ASTM E562 or approved equivalent and shall be within 40 – 60%. The microstructure, as examined at 400X magnification on a suitably etched specimen, shall be free from inter-metallic phases and precipitates.

Impact testing shall be carried out at minus 50°C in accordance with ASTM A370. Test results shall be at least 40 Joules (for standard specimen 10 x 10mm) as an average of three tests. One result may be lower than 40 Joules, but shall have a minimum of 31 Joules. The required impact values for sub-size specimens shall be reduced as follows:

SPECIMEN SIZE (MM)	MULTIPLICATION FACTOR
10 x 7.5	0.8
10 x 5	0.7

Impact testing and Micrographic examination shall be carried out for each heat and heat treatment batch.

Where Impact test is not practical due to thickness restrictions, an alternative micrographic examination to ASTM A923 Method A shall be applied.

All product forms that fail to pass either the Charpy impact testing as per ASTM A370 or micrographic examination to ASTM A923 Method A, are subject to rejection and shall be re-manufactured/supplied.

Charpy impact test procedure as per ASTM A370 and ASTM A923 method A procedure shall be submitted for Contractor Engineering Department review. In addition, the Material Test Certificate (MTC) shall indicate either the Charpy impact testing or ASTM A923 Method A test results.

Forgings requiring weld repairs are not acceptable.

9. Nickel Alloy Wrought Fittings

9.1 Nickel Alloy Forgings ASTM B462

ASTM B462 Grade UNS N08020 (Alloy 20) shall be supplied in stabilised annealed condition.

Forgings requiring weld repairs are not acceptable.

A manufacturer's certification shall be furnished stating that the material has been manufactured, tested, and inspected in accordance with this specification, and that the test results on representative samples meet the specification requirements. A report of the test results shall be furnished.

10. Nickel Alloy Forged Fittings

10.1 Nickel Alloy Forgings ASTM B462

ASTM B462 Grade UNS N08020 (ALLOY 20) shall be supplied in stabilised annealed condition.

Forgings requiring weld repair are not acceptable.

A manufacturer's certification shall be furnished stating that the material has been manufactured, tested, and inspected in accordance with this Specification, and that the test results on representative samples meet the specification requirements. A report of the test results shall be furnished.

7.10.2 Nickel Alloy Forgings ASTM B564 UNS N04400 (Monel)

Fittings shall be supplied in annealed condition.

Forgings requiring weld repair are not acceptable.

A manufacturer's certification shall be furnished stating that the material has been manufactured, tested, and inspected in accordance with this Specification, and that the test results on representative samples meet the specification requirements. A report of the test results shall be furnished.





Roles and Responsibilities

The Project CoE Leader have the responsibility to approve this document.

The Project CoE Mechanical Team Lead will be responsible to ensure this document is updated and rolled-out.

Any deviation to this specification shall be sign in accordance to OQ Technical Authority.



Appendix 1 - USER FEEDBACK PAGE

Document title					
Document number and the revision					
	User to use this Feedback Form to identify any inaccuracy, error or ambiguity to notify the Document Authority so that appropriate action can be taken. The user is requested to return this page fully completed, indicating precisely the proposed improvement and justification.				
Name:		Email:		Date:	
Page Ref:	Observation	Proposed Improvement & Justification			



DOCUMENT INFORMATION

Title	Technical Requirements for Supply of Piping Fittings Specification
Document Code	03.01.218-Technical_Requirements_for_Supply_of_Piping_Fittings-Specification
Purpose	In order to have common specification for Piping Fittings requirement for all OQ projects piping
Audience	Projects, Contractor and Vendors
Category	Governance
Subcategory	Projects/ CoE
Effective Date	17/03/2022
Review Date	16/03/2024
Document Advisor	Projects COE Mechanical Team Lead
Approving Authority	VP, Projects COE

RELATED AND SUPPORTING DOCUMENTS

Policy	N/A
Policy Manual	N/A
Process	N/A
Procedures	N/A
Related Documents and Forms	03.01.124-Mechanical_Basis_of_Design-Specification



DOCUMENT APPROVALS		
Authorized Approver	Date	Signature(s)
VP, Projects COE	20/03/2022	