



## **Technical Requirements for Supply of Flanges Specification**

**03.01.217-Technical\_Requirements\_for\_Supply\_of\_Flanges-Specification**



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## Document History

| Version No. | Date       | Author            | Approver         | Description of Amendment |
|-------------|------------|-------------------|------------------|--------------------------|
| 1.0         | 01/12/2021 | Rashed Al Kamyani | Mahmood Al Aamri | First revision           |
|             |            |                   |                  |                          |
|             |            |                   |                  |                          |
|             |            |                   |                  |                          |



## 1. Purpose

The purpose of this document is to define minimum requirements for supply of metallic flanges, figure-8 Blanks, Spades and Spacers for piping item 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 flanges, figure-8 Blanks, Spades and Spacers for piping items.

Where it is not for:

- Flanges, figure-8 Blanks, Spades and Spacers of Plastic piping.
- Flanges, figure-8 Blanks, Spades and Spacers of pipelines.

## 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

Flanges 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.

|           |                                                                                                                              |
|-----------|------------------------------------------------------------------------------------------------------------------------------|
| 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, and Valves, and Parts for High Temperature Service |
| ASTM A240 | Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels, and for general applications       |
| ASTM A262 | Standard Practices for Detecting Susceptibility to Inter-Granular Attack in Austenitic Stainless Steel                       |
| ASTM A350 | Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components                                 |
| ASTM A370 | Standard Test Methods and Definitions for Mechanical Testing of Steel Products                                               |
| ASTM A387 | Pressure Vessel Plates, Alloy Steel, Chromium Molybdenum.                                                                    |
| ASTM A480 | General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip                              |



|                        |                                                                                                                                                                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM A516              | Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Temperature Service                                                                                                                                                                             |
| ASTM A578              | Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications                                                                                                                                                                         |
| ASTM A923              | Standard Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels                                                                                                                                           |
| ASTM A961              | Common Requirements for Steel Flanges, Forged Fittings, Valves and Parts of Piping application                                                                                                                                                               |
| ASTM B127              | Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip                                                                                                                                                                                                     |
| ASTM B462              | Forged or Rolled UNS N08020, UNS N08024, UNS N08026, and UNS N08367 Alloy Pipe Fittings, and Valves and Parts for Corrosive High-Temperature Service                                                                                                         |
| ASTM B463              | Forged or Rolled UNS N08020, UNS N08024, UNS N08026 Alloy Plate, Sheet, and Strip                                                                                                                                                                            |
| ASTM B564              | Nickel Alloy Forgings                                                                                                                                                                                                                                        |
| ASTM B575              | Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, Low-Carbon Nickel-Chromium-Molybdenum-Tantalum, Low-Carbon Nickel-Chromium-Molybdenum-Tungsten, and Low-Carbon Nickel-Molybdenum-Chromium Alloy Plate, Sheet, and Strip |
| ASTM E562              | Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count                                                                                                                                                                        |
| ASME B1.20.1           | Pipe Threads, General Purpose (Inch)                                                                                                                                                                                                                         |
| ASME B16.5             | Pipe Flanges and Flanged Fittings                                                                                                                                                                                                                            |
| ASME B16.20            | Metallic Gaskets for Pipe Flanges                                                                                                                                                                                                                            |
| ASME B16.47            | Large Diameter Steel Flanges                                                                                                                                                                                                                                 |
| ASME B16.48            | Line Blanks                                                                                                                                                                                                                                                  |
| ASME B31.3             | Process Piping                                                                                                                                                                                                                                               |
| ASME / BPVC Sec VIII-1 | ASME Boiler and Pressure Vessel Code - Section VIII Division 1 Rules for Construction of Pressure Vessels                                                                                                                                                    |
| AWWA C207              | Steel Pipe Flanges for Water Works Service                                                                                                                                                                                                                   |
| ISO 10474              | Steel and steel products - Inspection documents                                                                                                                                                                                                              |
| MSS SP-25              | Standard Marking System for Valves, Fittings, Flanges and Unions                                                                                                                                                                                             |
| MSS SP-53              | Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and other Piping Components – Magnetic Particle Examination Method                                                                                                         |
| NACE MR0103            | Materials Resistant to Sulphide Stress Cracking in Corrosive Petroleum Refining Environments                                                                                                                                                                 |
| NACE MR0175            | Materials for Use in H <sub>2</sub> S Containing Environments in Oil & Gas Production                                                                                                                                                                        |
| NACE TM0177            | Laboratory Testing of Metals for Resistance to Sulphide Stress Cracking in Hydrogen Sulphide (H <sub>2</sub> S) Environments                                                                                                                                 |
| NACE TM0284            | Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking.                                                                                                                                                               |



## 4.2 Referenced OQ Specifications

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

| Document Reference                                                           |
|------------------------------------------------------------------------------|
| 03.01.19-Positive_Material_Identification_PMI_program-Specification          |
| 03.01.16-Surface_Preparation_Painting coating_ and_ Lettering -Specification |
| 03.01.158 -Metallic_Materials-Specification                                  |
| 03.01.14-Material_certification_requirements-Specification                   |
| 03.01.124-Mechanical_Basis_of_Design-Specification                           |

## 5. Dimensions and Facing

Dimensions of flanges in sizes 1/2" NPS to 24" NPS shall be in accordance with ASME B16.5, unless noted otherwise.

Dimensions of flanges in 26" NPS and larger shall be in accordance with ASME B16.47 Series B for class rating  $\leq 900\#$ .

Dimensions of figure-8 blanks, spades and spacers shall be in accordance with ASME B16.48 up to and including 24" NPS. Dimensions of spades and spacers for ASME B16.47 Series B flanges above 24" NPS for class rating  $\leq 900\#$  shall be in accordance with Project Standard Drawing to be developed by Contractor

Dimensions of spades and spacers for AWWA C207 CL-D / CL-E Flanges above 24" NPS shall be in accordance with Project Standard Drawing which shall be developed by Contractor

Gasket contact surface finish for raised or full face Flanges, Fig 8, Spades and Spacers shall be in accordance with ASME B16.5 and ASME B16.47 as applicable.

Unless otherwise stated in the requisition, flanges above 60" NPS or not covered by ASME B16.47 shall be in accordance with ASME VIII DIV1. Vendor shall provide GA drawings and calculations for review after placement of order.

Gasket contact surface finish for Ring type joint grooved Flanges, Fig 8, Spades and Spacers shall be finished in accordance with ASME B16.5 and ASME B16.47 as applicable.

Ring type joint grooved figure-8 blanks, spades and spacers shall be female grooved type.

All flanges  $\leq$  Class 600 and all flanges in cryogenic service shall be supplied as raised face. Class 900 and above shall be ring joint face unless otherwise stated, except flanges in cryogenic service, which shall be supplied as raised face.

Unless specified otherwise on Process and Instrument Diagrams, the sizes for figure-8 blanks, spades and spacers shall be as follows:

| Rating     | Figure – 8 Size (NPS) | Spades and spacers (NPS) |
|------------|-----------------------|--------------------------|
| Class 150  | $\leq 8$ NPS          | $> 8$ NPS                |
| Class 300  | $\leq 8$ NPS          | $> 8$ NPS                |
| Class 600  | $\leq 8$ NPS          | $> 8$ NPS                |
| Class 900  | $\leq 4$ NPS          | $> 4$ NPS                |
| Class 1500 | $\leq 4$ NPS          | $> 4$ NPS                |

Wherever jack screw flanges are required, jack screw flanges shall be supplied with jack screw bolts.

All weld neck flanges must be supplied with the thickness at bevelled end as stated in the material requisition. Taper boring of flanges is not permissible. Flange bore shall be straight through, with diameter to suit pipe ID of the thickness stated in the material requisition.



## 6. General Material Requirements

For flanges only, forged material as defined in Section 3.2.5 and Section 3.2.5.1 of ASTM A961 are acceptable.

Any flange manufactured from free machining material is not acceptable.

Flanges shall not be manufactured from bar stock.

Figure-8 blanks, spades and spacers may be forged or plate material. Components shall be constructed from single plate; welded joints are not acceptable (except for the handle or web, if required).

Galvanized flanges shall be supplied with threads free of galvanizing. Galvanizing shall be by hot dip method with coating weights equal to ASTM A153 requirements.

All threaded flanges shall have taper threads in accordance with ASME B1.20.1 (NPT).

## 7. Materials Supplementary Requirements

All materials shall be new and unused and in accordance with the purchase item description and project specific 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#2 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 Materials Identification". 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 relevant manufacturing standards (ASME B16.5, ASME B16.47, ASME B16.48 and AWWA C207) and the requirements of 03.01.16-Surface\_Preparation\_Painting\_Poating\_and\_Lettering -Specification and MSS-SP-25.

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 flanges, spade and spacers shall be adequately protected to prevent mechanical damage during handling or in transit. Bevel ends shall be protected by plastic caps or any alternative protective methods. The details of ends and flange surface protection shall be submitted along with the bid for EPC Contractor engineering department review.

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 in order 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 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 Flanges, Figure-8 Blanks, Spades and Spacers shall be in accordance "Certification, Marking and Colour Coding of flanges, Materials" Standard to be developed by Contractor and as per 03.01.14-Material\_certification\_requirements-Specification. Attachment 1 lists the minimum required certification. Attachment 1 lists the minimum required certification.

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





## ATTACHMENT 1 – List of Required Typical Material Certification

| Pipe material                                                      | Mat'l test cert's <sup>(1)(2)</sup>  | Impact test cert's                                       | Certificate of conformity (overall) | PMI cert's | Reports of supplier inspection / audits |
|--------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------|-------------------------------------|------------|-----------------------------------------|
| Carbon steel                                                       | Yes                                  | As Applicable                                            | Yes                                 | No         | Yes                                     |
| Impact tested carbon steel                                         | Yes                                  | Yes                                                      | Yes                                 | No         | Yes                                     |
| Lined carbon steel                                                 | Yes<br>(Includes liner test results) | No                                                       | Yes                                 | No         | Yes                                     |
| SS304/304L/<br>316/316L/ 321<br>duplex SS<br>UNS S2205 /<br>S31803 | Yes                                  | As Applicable                                            | Yes                                 | Yes        | Yes                                     |
| Cr-Mo steel                                                        | Yes<br>(Includes welding consumable) | As Applicable<br>(See Section 7.4 of this Specification) | Yes                                 | Yes        | Yes                                     |
| Nickel alloy                                                       | Yes                                  | No                                                       | Yes                                 | Yes        | Yes                                     |

Notes:

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 where required. In addition to the requirements specified in this attachment, minimum hardness values for flanges shall never be outside the value stated in the relevant ASTM standards. In particular, for RTJ flanges, flange hardness values shall be at least 20 HB units over the gasket hardness as defined in ASME B16.20 (reference shall be made to the 03.01.219-Technical\_requirements\_for\_Supply\_of\_Gaskets-Specification).

With respect to material grades not listed in this section, minimum hardness values for all RTJ flanges shall specified and confirmed by the manufacturer in the quotation.

### 1. Carbon Steel and Impact Tested Carbon Steel Forgings

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

All forgings shall be normalised.

Forgings requiring weld repairs are not acceptable.

For carbon steel and impact tested carbon steel forgings the chemical composition, by product analysis, shall be restricted as follows: -

- Carbon: 0.25% max (forgings)
- 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).

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

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

All material for wet sour service shall meet the requirements of NACE MR0103.

Must be Fully Killed Carbon Steel type.

All forgings shall be normalised.

Forgings requiring weld repairs are not acceptable.

Ni content <1%.

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

All forgings shall be normalised.

For ASTM A105 forgings, hardness shall be 187 BHN (max). For ASTM A350 LF2 forgings, hardness shall be 197 BHN (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.

No HIC testing is required on forgings.

### 2. Impact Tested Carbon Steel Plates

#### 2.1 Impact Tested Carbon Steel Plate ASTM A516 Grade 70, Supplementary Requirement S5

Material shall be supplied with Charpy V-Notch impact test in accordance with ASTM A516 supplementary requirement S5.

Hardness shall be limited to 200BHN (Max.).

#### 2.2 Impact Tested Carbon Steel Plate ASTM A516 Grade 70, Supplementary Requirement S5 – NACE (For Low Severity Sour Service)



Material shall be supplied in compliance with NACE MR0103.

Must be Fully Killed Carbon Steel type.

Ni content <1%.

Supplied in normalized condition.

Hardness of base metal shall be 200HBN (Max).

Material shall comply with the following chemical analysis: -

| ELEMENTS   | % Max. |
|------------|--------|
| Carbon     | 0.20   |
| Sulphur    | 0.015  |
| Phosphorus | 0.020  |

### 2.3 Impact Tested Carbon Steel Plate ASTM A516 Grade 70, Supplementary Requirement S5 – NACE + HIC (For High Severity Sour Service)

Material shall be supplied in compliance with NACE MR0103.

Material must be Fully Killed Carbon Steel type

Ni content <1%.

Supplied in normalized condition.

Hardness shall be 200 BHN Max.

Material shall be supplied with Charpy V-Notch impact test in accordance with ASTM A516 supplementary requirement S5.

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

The Manufacturer shall submit the following information in its 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

#### 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.

#### HIC testing: -

- HIC testing in accordance to 03.01.158\_Specification\_for\_Metallic\_Materials.

#### 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 the supplementary requirements S3 of ASTM A20.

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 reports

Hardness test results and location shall be recorded in CMTR

#### 2.4 HIC Test Procedure for Impact Tested Carbon Steel Plate ASTM A516 Grade 70, Supplementary Requirement S5 (For High Severity Sour Service)

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.

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 fitting shall be rejected. Two retest coupons shall be taken from another fitting with the same wall thickness and from the same heat. If both the coupons pass the test, then rest of the fittings 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 fitting 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 fittings (including the fitting 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 fittings with the same wall thickness and from the same heat shall be rejected.
- For any test coupon failures, the Manufacturer shall investigate the cause of failure and submit a report (including the cause of failure) to Contractor Engineering Department for review and comment. This report shall include the proposed means by fitting manufacturer to prevent the similar failure for other heats.

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:
  - a) Unetched, showing the type of inclusions in the steel (magnification 200X).
  - b) Etched, showing the parent material microstructure (magnification 200X).
- pH of H<sub>2</sub>S 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.

### 3. Low Alloy / Alloy Steel Forgings

#### 3.1 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.

### 3.2 Low Alloy Steel 1 1/4Cr–1/2Mo Steel Forgings ASTM A182 Grade F11 Class 2 – NACE (For Wet Sour Service)

ASTM A182 Grade F11 Class 2 forgings shall be Normalized and Tempered.

Forgings shall be in full compliance with NACE MR0103.

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

### 3.3 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.

### 3.4 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.

## 4. Low Alloy / Alloy Steel Plates

### 4.1 Low Alloy Steel 1 1/4Cr–1/2Mo Steel Plates ASTM A387 Grade 11 Class 2

ASTM A387 Grade 11 Class 2 plates shall be Normalized and Tempered.

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

All plate shall after all forming be in the Normalized and Tempered condition.

Hardness shall be limited to 225 BHN (max.).

### 4.2 Low Alloy Steel 1 1/4Cr–1/2Mo Steel Plates ASTM A387 Grade 11 Class 2 – NACE (For Wet Sour Service)

ASTM A387 Grade 11 Class 2 plates shall be Normalized and Tempered.

Material shall be in full compliance with NACE MR0103.

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

All plate shall after all forming be in the Normalized and Tempered condition.

Hardness shall be limited to 225 BHN (max.).

### 4.3 Low Alloy Steel 1 1/4Cr–1/2Mo Steel Plates ASTM A387 Grade 11 Class 2 – NACE + HIC (For Wet Sour Service)

ASTM A387 Grade 11 Class 2 plates shall be Normalized and Tempered.

Material shall be in full compliance with NACE MR0103.

Hardness shall be limited to 225 BHN (max.).



The Manufacturer shall submit the following information in its 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 using test solution A in accordance with NACE standard TM0177.
- Heat treatment

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.

HIC testing: -

Unless otherwise specified HIC testing shall be required for each steel manufacturing supplier, each steel grade and manufacturing steel process at following extent:

- At the beginning of production, the thickest and thinnest plate shall be tested from one of the first heat produced,
- During production, the thickest and thinnest plate shall be tested from one of the heat batch exhibiting the highest sulphur content.
- It is required that the material to pass HIC test in accordance with NACE standard TM0284 by using the test solution A specified in NACE TM0177. The testing procedure, acceptance and rejection criteria shall be agreed between the purchaser and supplier in the bid stage.

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 the supplementary requirements S3 of ASTM A20.

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 reports
- Hardness test results and location shall be recorded in CMTR

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

All plate shall after all forming be in the Normalized and Tempered condition.

#### 4.4 Low Alloy Steel 2 1/4Cr–1Mo Steel Plate ASTM A387 Grade 22 Class 2

ASTM A387 Grade 22 Class 2 plates shall be Normalised and Tempered.

All plate shall after all forming be in the Normalized and Tempered condition.

#### 4.5 Alloy Steel 5Cr–1/2Mo Steel Plates ASTM A387 Grade 5 Class 1



ASTM A387 Grade 5 Class 1 plates shall be Normalized and Tempered.

All plates shall after all forming be in the Normalized and Tempered condition.

#### 4.6 Alloy Steel 9Cr–1Mo Steel Plates ASTM A387 Grade 9 Class 1

ASTM A387 Grade 9 Class 1 plates shall be Normalized and Tempered.

All plates shall after all forming be in the Normalized and Tempered condition

#### 7.4.7 Alloy Steel 9Cr–1Mo Steel Plates ASTM A387 Grade 91 Class 2 Type 2

ASTM A387 Grade 91 Class 2 Type 2 plates shall be Normalized and Tempered.

All plates shall after all forming be in the Normalized and Tempered condition

### 5. Stainless Steel Forgings

In addition to the specifications detailed below, RTJ flanges in stainless steel grades F304, F316, F321 and F347 shall have a minimum hardness value 180 BHN to ensure flange hardness exceeds gasket hardness by at least 20 HB units.

#### 5.1 Stainless Steel Forgings ASTM A182 Grades F304, F304L, F316, F316L

Forgings requiring weld repair are not acceptable.

All flanges, 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.

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

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

Forgings requiring weld repair are not acceptable.

All flanges 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.

#### 5.3 Stainless Steel Forgings ASTM A182 Grades F321

Forgings requiring weld repair are not acceptable.

All flanges 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.

### 6. Stainless Steel Plates

#### 6.1 Stainless Steel Plates ASTM A240 Grades 304, 316

All plates shall after all forming be heat treated (solution annealed) strictly in accordance with Table A1.2 of ASTM A480.

#### 6.2 Stainless Steel Plates ASTM A240 Grades 304, 316 – NACE (For Wet Sour Service)

All plates shall after all forming be heat treated (solution annealed) strictly in accordance with Table A1.2 of ASTM A480.

Plate material shall meet the requirements of NACE MR0103.

Hardness 22 HRC (Max.).





### 6.3 Stainless Steel Plates ASTM A240 Grade F321

All plates shall after all forming be heat treated (solution annealed) strictly in accordance with Table A1.2 of ASTM A480.

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.

## 7. Duplex Stainless Steel Forgings

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

Forgings 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.

## 8. Duplex Stainless Steel Forged Plates

### 8.1 Duplex Stainless Steel Plates ASTM A240 UNS S31803 / UNS S32205

All plates 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.

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





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 EPC 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 Forgings

### 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.

### 9.2 Nickel Alloy Forgings ASTM B564 UNS N04400 (MONEL) & UNS N10276 (Hastelloy C-276)

Forgings shall be supplied in solution 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 Plates

### 10.1 Nickel Alloy Plate ASTM B463 Grade UNS N08020 (Alloy 20)

After all forming, plate shall be in the Stabilized annealed condition.

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.

### 10.2 Nickel Alloy Plates ASTM B127 Grade UNS N04400 (Monel)

Plates shall be Hot Rolled.

After all forming, plate shall be in solution annealed condition.

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.



#### 7.10.3 Nickel Alloy Plates ASTM B575 Grade UNS N10276 (Hastelloy C-276)

After all forming, plate shall be in the Solution annealed condition.

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. |                                                 |  |              |  |
| <b>Name:</b>                     |                                                                                                                                                                                                                                                                                     | <b>Email:</b>                                   |  | <b>Date:</b> |  |
| <b>Page Ref:</b>                 | <b>Observation</b>                                                                                                                                                                                                                                                                  | <b>Proposed Improvement &amp; Justification</b> |  |              |  |
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## DOCUMENT INFORMATION

|                     |                                                                                          |
|---------------------|------------------------------------------------------------------------------------------|
| Title               | Technical Requirements for Supply of Flanges Specification                               |
| Document Code       | 03.01.217-Technical_Requirements_for_Supply_of_Flanges-Specification                     |
| Purpose             | In order to have common specification for piping support requirement for all OQ projects |
| 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, Project 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 , Project CoE    | 20/03/2022 |  |
|                     |            |                                                                                    |
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