

GENERAL SPECIFICATION

PIPELINES - RISERS

GS EP PLR 227

Carbon Steel Flanges, Branch Outlet Fittings and Forged Components for Pipelines

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1. Scope

- This specification defines the Company's general requirements for the design, materials, manufacture, testing and inspection of hot forged carbon steel pipeline components such as:
 - Flange and the like (e.g. standard flange, compact flange, tap-able flange, anchor flange/ deadweight support, swivel flange / swivel ring, hang-off collar, buckle arrestors, etc.), and
 - Forged fittings (e.g. wye, reducer, tension and taper stress joints, bulkheads, end fittings, branch outlet fittings, etc.).

Of the welding neck type, to be used in onshore and offshore pipeline systems.

- Flanges and forged fittings specified in this specification are to be used in Sweet (*Region 0*) and Sour Service (*Region 1, 2, or 3*) as defined in **GS EP COR 170**.
- This specification also covers ring joint gaskets, as well as stud bolts and nuts for flanges, as applicable.

Note: for sour service application, split ring of swivel flanges (to hold the swivel flange in position) needs not to meet any special requirements as regards to H₂S service.

- This specification applies to flanges with minimum specified yield strength ranging from 290 N/mm² (42,000 Psi) up to 482 N/mm² (70,000 Psi) for sweet and mild sour service application and 450 N/mm² (65,000 Psi) for intermediate and severe sour service application.
- This specification shall be used in conjunction with a Project Particular Specification (PPS) detailing the additional tests and requirements or the possible modifications to the present specification, based on the particular design conditions of the pipeline project.
- Flanges and forged fitting may be supplied welded onto a piece of pipe at least 1.5 pipe OD or 750 mm in length whichever greater, when so required in the PPS. This welded pipe piece is designated as "pup piece" in this specification.
- Flanges and forged fitting covered within specification shall not be used for operating temperature higher than 200°C.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. The order of precedence of the applicable documents shall be:

- The Purchase Order (PO) / Requisition
- The Project Particular Specification (PPS)
- The present General Specification
- The Codes and Standards in reference.

Applicable Codes and Standards which are to be used in conjunction with this specification are stated hereafter.

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Unless otherwise specifically indicated in writing, the Supplier shall work in accordance with the requirements specified herein and the applicable requirements of the latest editions of the referenced Codes and Standards at time of Contract award, whenever requested in the present specification.

Where this specification states no overriding requirements, the referenced Codes and Standards shall apply in full.

Standards equivalent to those referred to herein shall not be substituted without written approval of the Company.

The Supplier shall equip himself with copies of all the reference specifications referred to in this specification and shall make them readily available to all fabrication, testing and inspection personnel involved on the work.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
API RP 6HT	Heat Treatment and Testing of Carbon and Low Alloy Steel Large Cross Section and Critical Section Components
API SPEC 20B	Open Die Shaped Forgings for Use in the Petroleum and Natural Gas Industry
API SPEC 5L	Specification for Line pipe
API SPEC 6A	Specification for Wellhead and Christmas Tree Equipment
ASME B1.1	Unified Inch Screw Threads
ASME B16.20	Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
ASME B18.18	Quality Assurance for Fasteners
ASME B31.4	Pipeline Transportation Systems for Liquid and Slurries
ASME B31.8	Gas Transmission and Distribution Piping Systems
ASME BPVC Section IX	Welding, Brazing, and Fusing Qualifications
ASME BPVC Section V	Nondestructive Examination
ASME BPVC Section VIII Div 1	Rules for Construction of Pressure Vessels
ASME BPVC Section VIII Div 2	Alternative Rules

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Reference	Title
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A262	Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A388	Standard Practice for Ultrasonic Examination of Steel Forgings
ASTM A694	Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
ASTM A707	Standard Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
ASTM A961	Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
ASTM A991	Standard Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products
ASTM E112	Standard Test Methods for Determining Average Grain Size
ASTM E21	Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials
ASTM E23	Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
ASTM E384	Standard Test Method for Knoop and Vickers Hardness of Materials
ASTM E45	Standard Test Methods for Determining the Inclusion Content of Steel
ASTM E709	Standard Guide for Magnetic Particle Testing
DNV-OS-F101	Submarine Pipeline Systems
EN 10204	Metallic products - Types of inspection documents
ISO 10423	Petroleum and natural gas industries - Drilling and production equipment - Wellhead and christmas tree equipment
ISO 13623	Petroleum and natural gas industries - Pipeline transportation systems

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Reference	Title
ISO 148-1	Metallic Materials - Charpy pendulum impact test - Part 1 Test method
ISO 15156 (Parts 1; 2) / NACE MR0175	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - Parts 1; 2
ISO 6507 (All parts)	Metallic materials - Vickers hardness test - All parts
ISO 9001	Quality management systems - Requirements
ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
ISO/TS 29001	Petroleum, petrochemical and natural gas industries - Sector-specific quality management systems - Requirements for product and service supply organizations
MSS SP-44	Steel Pipeline flanges
MSS SP-55	Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
MSS SP-75	High-Strength, Wrought, Butt-Welding Fittings
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded, and Buttwelding Ends
NORSOK L-005	Compact flanged connections
NORSOK M-650	Qualification of manufacturers of special materials

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP COR 170	Materials for upstream sour service application - Specification for selection and design
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP PLR 100	Submarine pipeline systems
GS EP PLR 104	Onshore pipeline systems
GS EP PLR 205	Carbon steel, clad and lined pipe manufacturing for linepipe applications according to API SPEC 5L and DNV-OS-F101 (sweet and sour service, onshore and offshore)

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Reference	Title
GS EP PLR 425	Site welding of carbon steel pipelines (sweet and sour service, onshore and offshore) according to API STD 1104
GS EP PLR 426	Site welding of carbon steel and CRA pipelines (sweet and sour service, onshore and offshore) according to DNV-OS-F101
GS EP PVV 175	Cleaning of piping and vessels
GS EP PVV 611	Welding of pressure containing piping and equipment

3. General

3.1 Definitions

Throughout this specification, the following definitions shall apply:

Purchaser	Means the Company or the Supplier (as applicable), which have placed the purchase order to the Manufacturer.
Inspector	Means the Company's Inspector(s) or the Inspector(s) from an independent Inspection Agency duly appointed by the Company or the Supplier (as applicable) to act on its behalf for the purpose of the Contract.
Mill	The plants, Mills, workshops, laboratories or other locations where the fabrication, inspection and testing of materials and products are to be performed complete or in part, shall be referred to herein as the "Mill".
Approval	Means the authorization in writing given by the Company to the Supplier on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the Supplier from any of his obligations or liabilities under the Contract or at law. The words <u>Approve</u> , <u>Approved</u> and <u>Approval</u> shall be construed accordingly.
PPS	Designates the Project Particular Specification.

3.2 Approval of Supplier's Procedures

The Supplier shall submit the following documentation for review and approval one month prior to commencement of fabrication.

- Design calculations and fabrication drawings of flanges and/or forged fittings
- Design calculation of ring joint and bolting
- Aimed chemical composition of flange and/or forged fittings material
- Manufacturing Procedure Specification (as per Appendix 2)
- Quality Control Plan.

Once approved, these procedures shall not be altered without Company's approval.

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3.3 Quality assurance / Quality Control

Company Approval

Supplier(s) shall be qualified by Company (HQ Pipeline & Riser Department). Non-approved Supplier(s) shall not be considered on Company projects.

All sub-Contractors (e.g. raw material supply (ingot, forged bar, billet), forge-master, machining, non destructive examination, etc.) shall be clearly identified at the bid stage and shall also be approved by Company.

Quality Control

The Supplier and sub-Contractors shall operate a Quality Management System (QMS) in accordance with [ISO/TS 29001](#) or [ISO 9001](#), approved by a recognized authority; to ensure the requirements within this specification can be reliably and consistently satisfied.

Supplier shall take full responsibility to ensure the quality of sub-contracted works to their sub-Contractors.

The Quality Manual (QM) shall be submitted prior to the start of work. The Supplier's quality system shall include provision for the QM of raw materials, intermediate products, manufacturing process, and final inspections.

Four weeks prior to the commencement of the flange manufacture, the Supplier shall prepare and submit a QCP/ITP which list the sequence of activities contained in the MPS. The QCP/ITP shall set forth; "review", "approval", "monitor", "witness", and "hold" points; and as minimum shall include:

- All principal production, inspection and testing activities (incl. inspection of incoming materials)
- Location of each activity
- Associated procedure or specification including acceptance criteria governing the activity
- Verifying document to be used for recording inspection and test results
- Intervention point of all involved bodies (e.g. Contractor, Supplier, ITP, Company...).

3.4 Project Particular Specification (PPS)

The PPS shall clarify, where needed, the following:

- Type of flanges (e.g. standard flange, compact flange, anchor flange, swivel flange, etc.) and flange facing (i.e. raised face, ring type joint) or type of forged fittings
- The necessity or not to have pup piece(s) (refer to section 1)
- The minimum thickness on welded area (e.g. weld neck / hub) above which the simulated PWHT is required, if this thickness is below or equal to 25 mm (refer to § 5.5.6)
- The sour service severity and type of pipeline effluent to clarify the H₂S test conditions and hardness requirements in welds (if any) and the needs for corrosion testing (refer to § 5.7).
- The number of originals and copies required for the documentation (refer to § 19.2)

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- The flanges/forged fittings characteristics, including impact test temperature (refer to § 5.5.3 and Appendix 1) and additional tests other than test specified in section 5
- For blind flange, the supply or not of 1"1/2 valve and plug (refer to section 9).

Note: Appendix 1 shows a table which is to be filled-in by the engineer and incorporated in the Project Particular Specification (PPS).

4. Design

4.1 Design Data

Details of pipe diameter, wall thickness and material grades of the matching pipelines shall be stated in Data Sheet to be presented as per the form shown in Appendix 1 of the present specification, together with the relevant design conditions.

1. Based on this data, Supplier shall provide design calculations in accordance with [ASME BPVC Section VIII Div 2](#), however the design factor for hoop stress, longitudinal stress, combined stress shall also comply with applicable matching pipeline design code such as [ASME B31.4](#), [ASME B31.8](#), [ISO 13623](#), [DNV-OS-F101](#) or others (see [GS EP PLR 100](#) and [GS EP PLR 104](#)), and shall be, as a minimum, that of the matching pipeline (*only for the hub*).
2. Calculations shall also be provided for flange bolts (pre-tensioning included) and ring joint for the intended service conditions.
3. The flanges and forged fittings shall be checked / designed for the operating and extreme conditions. Equivalent pressure due to bending moment in the flange shall be considered, as well as decrease of allowable stresses due to service temperature.

In case of design temperature above 75°C, a dedicated tensile test at design temperature may be requested and the acceptance criteria shall be defined in pipeline design; but in any case the flanges and forged fitting covered within specification shall not be used for operating temperature higher than 200°C.

4.2 Flange Design

1. Dimension of weld neck flange shall be in compliance with [ASME B16.5](#) for NPS ½ through 10 and [MSS SP-44](#) for NPS 12 through 60.
2. All flanges shall be designed with material tensile properties in accordance with requirements of [MSS SP-44](#) and at least equal to those of the matching pipes for the welding neck.
3. If lower yield strength is proposed in the ring section (plateau), this proposal shall be assessed by calculation note for Company approval and in any case, the yield stress shall not be lower than 290 N/mm² (42,000 Psi).
4. For NPS 38 and larger sizes of class 300 and higher of welding neck flanges shall have 290 N/mm² (42,000 Psi) minimum yield strength in the ring section.
 - The nominal internal diameter (bore) shall be that of the matching pipeline, with a tolerance of ± 1.6 mm. The minimum wall thickness at weld neck (or hub) shall not be

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less than that of the matching pipeline. The flange hub shall be designed so that it can be easily fitted to the matching pipeline.

- Compact flange shall meet the requirement in Appendix 8.
- Tap-able and pig-able flange shall be designed with FEA and validated through drilling and pigging tests. Tapping and pigging equipment used for qualification test shall be industrial-type equipment and test report shall be submitted for Company approval. This requirement is also applied for flow-through plug used for hot tapping.

4.3 Fitting Design

1. Dimension of forged branch outlet fittings shall be in accordance to [MSS SP-97](#).
2. Other forged fittings (e.g. wye, reducer, tension and taper stress joints, bulkheads, end fittings, etc.) shall be as per design with FEA and drawing approved by Company.
3. Minimum yield strength shall meet the yield strength used in design calculation / FEA and for cross section greater than 100 mm, shall not be less than 290 N/mm² (42,000 Psi), and this shall be included in the design calculation.
4. Design for butt-welded fitting shall have Design Proof Test(s) as per [MSS SP-75](#). If Design Proof Test is not available, hydrostatic pressure test shall be done at pressure equal to 90% of SMYS of matching pipe with minimum duration 5 minutes.
5. Design for pig-able fitting (e.g. wye) shall also be validated through pigging tests. Pigging equipment used for qualification test shall be industrial-type equipment and test report shall be submitted for Company approval.

5. Manufacturing Practices

5.1 Steel Making

Steel shall be made by the Electric Arc Furnace or Basic Oxygen Converter with double-deslagging process, coupled with vacuum degassing and secondary refining, and shall be fully killed and made to fine grain practice. Inclusion control with respect to content, distribution and shape shall be carried out appropriately in order to produce suitable steel properties.

Sufficient discard shall be made from each ingot to ensure freedom from piping and excessive segregation, and shall be described in the MPS. At manufacturer option the discard may also be made after forging operations, however this proposal shall be made at the bid stage and agreed by Company.

The raw material (i.e. ingot) is subject to visual inspection and shall conform to [MSS SP-55](#). Repair by welding is not permitted.

5.2 Chemical Composition

The chemical composition of the forgings shall meet the requirements within Appendix 3. Depending on the grade of flange/forged fitting to be produced, Supplier may select one of two options of chemical composition; however all the final products within the same order shall have the same nuance (i.e. either [ASTM A694](#) or [ASTM A707](#)), unless otherwise agreed by Company at the bid stage.

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Supplier may propose alternative compositions and it shall be approved by Company at the bid stage.

The Supplier shall carry out a chemical analysis on each cast of steel used and also on two products per heat. For diameter greater than NPS 12, chemical analysis shall be done on each product.

If any part of the product analyses fails to meet the requirements stated above, the whole cast shall be rejected or each individual product shall be fully analyzed and all products failing to meet the requirements shall be rejected.

5.3 Forging

Forgings shall be made by open die, closed die or ring rolling as applicable. The material shall be hot worked and shall be forged as close as possible to the finished shape and size.

The forging temperature shall be monitored by pyrometer or equivalent equipment and the applicable range of forging temperature shall be described in MPS.

Forging reduction ratio for a single hot work shall be calculated as per [API SPEC 20B](#) with minimum total forging reduction of 4:1 and reduction ratio on last forging stage shall be minimum 3:1; with following considerations:

- The initial free upsetting operations of the as cast ingot shall not be considered as part of the overall forging reduction ratio.
- Upsetting following cogging or drawing may be considered as part of the overall forging reduction ratio. If upsetting following cogging or drawing is to be considered, the overall forging reduction ratio shall be minimum 6:1.
- For ring rolling or mandrel forging, punching or piercing of holes shall not be considered as part of the overall forging reduction ratio.
- The overall reduction ratio shall be sufficient to produce a wrought structure throughout the entire part.

5.4 Heat Treatment

Prior to quality heat treatment, the forgings shall be machined with remaining extra material not exceeding 5 mm from the final geometry. At Supplier's option, normalizing heat treatment(s) may be done prior final heat treatment (QT).

Maximum transfer time of flanges/fittings from furnace to quenching pool shall not exceed 60 seconds. For large components it is recognized that a transfer time of 60 seconds may be difficult to achieve. In such cases a longer transfer time may be specifically qualified and agreed with Company. In any case the temperature of flanges/forgings before quenching shall not be lower than $Ac3 + 50^{\circ}C$.

Transfer time shall be measured from the time the furnace door is fully open and until the forgings is completely submerged into the quenching bath. The temperature prior quenching shall be measured and recorded by thermocouple or pyrometer gun.

Tempering shall be done within one hour after quenching. The furnace for quality heat treatment shall be qualified and fulfill all the requirements listed in Appendix 4.