



Exploration & Production

GENERAL SPECIFICATION

PIPELINES - RISERS

GS PLR 232

Carbon steel flanges and branch outlet fittings for pipelines (Intermediate and Severe Sour Service)

03	11/03	Change of Group name and logo
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Note: Appendix 1 shows a table which is to be filled-in by the Engineer and incorporated in the Project Particular Specification (PPS)

1. Scope

- This specification defines the COMPANY's general technical requirements for the design, materials, manufacture, testing and inspection of hot forged carbon steel flanges and the like (e.g. anchor flange/deadweight support, swivel flange/swivel ring, etc.), of the welding neck type, to be used in onshore and offshore pipeline systems.

It also applies to branch outlet fittings.

- 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.
- Within this specification the term "flanges" is indifferently used to designate all items stated in para 1.1 here-above.
- This specification applies to flanges with minimum yield strength ranging from 241 N/mm² (35,000 psi) up to 448 N/mm² (65,000 psi).
- This specification also covers ring joint gaskets, as well as stud bolts and nuts for the flanges.

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

- Flanges specified in this specification are to be used in Intermediate Sour Service or Severe Sour Service as defined in specification **GS COR 170**.
- Flanges shall comply with the requirements of **MSS SP 44** for flanges and **MSS SP 97** for branch outlet fittings, except where otherwise noted in this specification. Pressure-temperature ratings shall be defined in table of Appendix 1.
- Flanges shall be forgings meeting the material requirements of this specification and the requirements of **ASTM A 694** and **NACE MR-01-75**, unless otherwise indicated in this specification.
- Special requirements are also stated in this specification for flanges to be used in platform topsides, risers, expansion loops, etc., where the properties of Base Steel are to be ascertained after a Post Weld Heat Treatment.
- Flanges may be supplied welded onto a piece of pipe at least 500 mm in length, when so required in the PPS. This welded pipe piece is designated as "pup piece" in this specification.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

The order of precedence of the applicable documents shall be:

- The Purchase Order (PO)/Requisition
- The Project Particular Specification

- 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.

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.

Note: The specification **GS COR 170** is mentioned herein only as a background to the definition of the types of sour services (i.e. Intermediate Sour Service or Severe Sour Service) and corresponding “areas” on graph of the said specification (i.e. area 2 or 3).

Standards

Reference	Title
ASTM E 23	Method for Notched Bar Impact Testing of Metallic Materials
ASTM E 384 (or BS 427, Part 1)	Test Method for Micro-Hardness of Materials
ASTM E 709 (or BS 4124, Part 2)	Magnetic Particle Examination
ASTM A 193/A 193 M	Alloy-Steel and Stainless Steel Bolting Materials for high temperature service
ASTM A 194/A 194 M	Carbon and Alloy Steel Nuts for High Pressure and High Temperature Service
ASTM A 370	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 388/A 388 M (or BS 4124, Part 1)	Ultrasonic Examination of Heavy Steel Forgings
ASTM A 694/A 694 M	Specification for Forgings, Carbon and Alloy Steel for Pipe Flanges, Fittings, Valves and Parts for High Pressure Transmission Services
ISO 148	Charpy impact test (V-notch)
ISO 6507	Hardness test - Vickers test - Part 1: HV54 to HV10
ISO 9002	Quality systems: Model for quality assurance in production, installation and servicing

Reference	Title
EN 10 204	Types of inspection documents
EN 473	Qualification and certification of non-destructive testing personnel
ASME B 16.5	Pipe Flanges and Flanged Fittings
ASME B 16.20	Ring-Joint Gaskets and Grooves for Steel Pipe Flanges
ASME B 18 and B 1.1	Bolting Dimensions

Professional Documents

Reference	Title
MSS SP 44	Steel Pipeline Flanges
MSS SP 97	Integrally reinforced forged branch outlet fittings
NACE MR 01-75	Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
ASME V	Boiler and Pressure Vessel Code. Section V. Non-Destructive Examination

Other documents

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
GS COR 170	Materials for sour service. Specification for design
GS COR 350	External protection of offshore and related structures and equipment by painting
GS PLR 211	Fabrication of seamless pipes for pipelines (Intermediate or Severe Sour Service)
GS PLR 421	Site welding of carbon steel pipelines to API 1104 (Intermediate or Severe Sour Service)

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 authorisation 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 Approve, Approved and Approval 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
- Design calculation of ring joint and bolting
- Aimed chemical composition of flange material
- Manufacturing Procedure Specification, describing all proposed forging operations, heat treatment, inspection and non-destructive testing in their correct sequence. This document

will also mention the characteristics of equipment used to carry out above mentioned operations

- Sketch showing the rough forging piece before machining and, when applicable, the prolongation or the test blank with exact location and orientation of test specimens (refer to para. 5.4.1)
- Material heat treatment(s) and recording procedures, including number and location of thermocouples
- Welding end preparations
- Dimensional inspection procedures
- Non-destructive inspection procedures
- H₂S corrosion test procedures
- Quality Control Plan
- Welding Procedures Specifications (where applicable)
- Welder qualifications (when applicable)
- Handling, storage and packing procedures
- Proposed measures for temporary corrosion prevention (non-coated flanges).

Once approved, these procedures shall not be altered without the approval of the COMPANY.

3.3 Quality Assurance/Quality Control

The SUPPLIER shall operate a Quality Assurance system in accordance with [ISO 9002](#) Std, or equivalent, approved by a COMPANY recognised authority. The Quality Assurance Manual shall be submitted prior to the start of work.

Four weeks prior to the commencement of the flange manufacture, the SUPPLIER shall prepare and submit a Quality Control Plan, which describes the inspections to be performed during the supply of flanges. The Quality Control Plan shall set forth “witness”, “hold”, “review”, and “monitor” points.

3.4 Project Particular Specification (PPS)

The PPS shall clarify, where needed, the following:

- The necessity or not to have pup piece(s) (refer to Section 1).
- The minimum flange thickness above which the simulated PWHT is required, if this thickness is below or equal to 25 mm (refer to para. 5.4.5).
- The sour service severity and type of pipeline effluent to clarify the H₂S test conditions and hardness requirements in welds (if any) (refer to para. 5.6 and 14.4.3)
- The supply or not of 1”1/2 valve and plug for blind flanges (refer to Section 9).
- The number of originals and copies required for the documentation (refer to para. 19.2).
- The flanges characteristics, including impact test temperature (refer to para. 5.4.3 and Appendix 1).

4. Design

4.1 Design data

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

4.2 Flange design

- The SUPPLIER shall provide design calculations and fabrication drawings in accordance with [MSS SP 44](#) (flanges) or [MSS SP 97](#) (branch outlet fittings) and ASME, section VIII, Division 1, Appendix 2, for approval. Specially, the flanges 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 flange service temperature.

However, the design factor for hoop stress, longitudinal stress and combined stress shall comply with [ASME B 31.4](#) or [B 31.8](#), as applicable, and shall be, as a minimum, that of the matching pipeline (specially at flange hub).

The dimensions of flanges shall be, as a minimum, those specified in ASME B 16.5 for NPS ½" through 24", and ASME B 16.47 for NPS 26" through 60".

Design calculations shall also be provided for flange bolts (pretensioning included) and ring joint for the intended service conditions.

- The required type of flange facing (i.e. raised face, ring type joint) shall be clarified in the PPS or requisition. Flange facings (including ring joint grooves) shall be in accordance with [MSS SP 44](#) and [ASME 16.5](#), as applicable.
- All flanges shall be designed with material tensile properties at least equal to those of the matching pipes (refer to par. 5.4 of this specification).
- The nominal internal diameter (bore) shall be that of the matching pipeline/riser as defined in Appendix 1, with a tolerance of ± 1.0 mm.
- The minimum wall thickness at weld neck (or hub) shall not be less than that of the matching pipeline. The flange hub shall be designed so that it can be easily fitted to the matching pipeline.

5. Flange material

5.1 Applicable specification

Flange material shall comply with [ASTM A 694](#) and the requirements stated in the following.

5.2 Manufacturing process

Steel shall be made by the Electric Furnace or Basic Oxygen Converter, and shall be fully killed and made to fine grain practice.

Inclusion control with respect to content, distribution and shape shall be carried out by desulphurising, degassing and calcium injection, in order to provide resistance of steel to sour environments.

The material shall be hot forged to bring it as close as possible to the final shape and size of flange. All parts shall undergo a minimum total reduction ratio of a least 3.5 to 1 during the forging process.

All flanges shall be quenched and tempered after hot forging.

5.3 Chemical composition

Unless alternative compositions are proposed by the SUPPLIER and approved at the bid stage, the chemical analysis shall comply with the following for ladle and product.

Element	Weight % max.	
	Ladle	Product
Carbon	0.16	0.18
Manganese	1.30	1.40
Silicon	0.35	0.40
Aluminium (total)	0.050	0.050
Phosphorus	0.020	0.020
Sulphur	0.010	0.010
Niobium	0.06	0.06
Vanadium	0.06	0.06
Titanium	0.015	0.015
Nickel	0.60	0.60
Nb+V+Ti	0.12	0.12
Chromium	0.25	0.25
Molybdenum	0.20	0.20
Copper	0.30	0.30
Cr + Mo +Cu	0.50	0.50
Nitrogen	0.012	0.012
Calcium	0.006	0.006
Hydrogen	2 ppm	2 ppm
Oxygen	0.003	0.003
CE (IIW)	0.42	0.44
Pcm	0.23	0.24

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

$$Pcm = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$$

No alloying additions of elements other than those listed above shall be made without prior approval of the COMPANY.

The SUPPLIER shall perform analysis for all the elements listed above and any other intentionally added elements.

The SUPPLIER shall carry out a chemical analysis on each cast of steel used and also on two products per heat.

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 analysed and all products failing to meet the requirements shall be rejected.

For flange diameter above 12" NPS, chemical analysis shall be carried out on every products.

5.4 Mechanical properties

5.4.1 Sampling and frequency of testing

The SUPPLIER shall test specimens cut from a complete production forging from locations and with orientations shown in Appendix 2 and Appendix 3. However, when thickness of flange hub or ring exceeds 100 mm, then the specimens may be located at 50 mm minimum from hub or ring surface.

For flange 24" and larger in size, testing on prolongations is permitted, subject to COMPANY approval on prolongation sizes and location of test specimens. Testing on separately forged test blanks may exceptionally be agreed, at COMPANY's option, provided that shape and size of test blanks (to be proposed by the SUPPLIER) are quite realistic against size of the products to test and approval has been obtained from the COMPANY at the bid stage.

The sampling requirement shall be one full set of tensile and Charpy impact test per each steel cast, flange size and heat treatment batch. Grouping of flange sizes and materials may be agreed with the COMPANY at the bid stage.

Hardness tests shall be carried out on every flanges after heat treatment and final machining.

5.4.2 Tensile properties

Round bar tensile tests shall be carried out in accordance with [ASTM A 370](#). Each test shall consist of one specimen. The largest practical test specimen size shall be used. The required tests results are stated in the following table.

Mechanical properties	Flange material grade (ASTM A 694)						
	F 36	F 42	F 46	F 52	F 56	F 60	F 65
Minimum Yield Strength (0.2% proof stress) (MPa)	241	290	317	358	386	413	448
Minimum TS (MPa)	414	414	434	455	468	517	530
Minimum Elongation in 2 inches (%)	25	25	25	25	22	20	20
Max YS/TS	≤ 0.85	≤ 0.85	≤ 0.85	≤ 0.85	≤ 0.85	≤ 0.88	≤ 0.90
Vickers Hardness (5 or 10 kg)	200	250	250	250	250	250	250

5.4.3 Impact properties

Charpy V-notch tests shall be carried out in accordance with [ASTM A 370](#) and [ASTM E 23](#) at locations shown in sketches of Appendix 2 and Appendix 3. Each impact test shall consist of three specimens with notch oriented as per the Figures of above Appendices. Full size specimens (10 mm x 10 mm) shall be used.

The minimum required impact energies shall be as stated in the table below. The impact test temperature shall be stated in the PPS and/or Data Sheet.

Grade (A 694)	Minimum Average Value (J)	Minimum Individual Value (J)
F 36	28	22
F 42	30	24
F 46	32	26
F 52	36	30
F 56	39	32
F 60	42	35
F 65	45	38

5.4.4 Hardness survey

A VICKERS hardness survey shall be carried out on each produced flange after final heat treatment and final machining, in accordance with [ASTM E 384](#), or equivalent, using a 5 or 10 kg load. A minimum of eight equi-spaced readings shall be carried out on the inside edge (or outside edge when impracticable) close to the welding neck (i.e. on flange "hub"). A further minimum of eight readings shall also be made at random locations on the thicker part of each flange (i.e. on flange "ring") and on the transition part of hub.

Hardness shall not exceed the minimum individual hardness shown in table of para. 5.4.2 above, at any point. The Inspector reserves the right to ask for hardness checks at any other location on the flange, e.g. when any doubt occurs about consistency of results.

Hardness testing shall be performed using a portable equipment approved by the COMPANY.

5.4.5 Simulated PWHT

When so required in the PPS (and in all cases when wall thickness at flange welding end exceeds 25 mm), tensile tests and impact tests as per para. 5.4.2 and 5.4.3 above shall be repeated after a simulated Post Weld Heat Treatment (PWHT) has been made on the flange material at a soaking temperature of $620^{\circ}\text{C} \pm 10^{\circ}\text{C}$ for one hour per 25 mm thickness of flange hub. The test procedures and test results shall meet the requirements of this specification.

PWHT tests shall also be required on flanges when a PWHT is made by the MANUFACTURER on weld between flange and pup piece, if any.

All heat treatment records shall be approved, signed, dated and stamped by the Inspector.

5.4.6 Failed tests

The Inspector will only permit a retest if there is reason to believe that failure was due to some fault in preparation or testing and that result was not representative of the test sample.

Otherwise, the failed test shall be carried out on every flanges in the cast or lot, or alternatively, the entire cast or lot shall be re-heat treated and the full set of tests carried out on one flange, minimum.

5.5 Material rings for welding tests

When it is agreed that flanges can be supplied without welded pup pieces, then the SUPPLIER shall supply three (3) test rings to the COMPANY for qualification of weld procedures to be made by others. The rings shall be of the same steel cast and size as the flange hub and also shall have been forged and heat treated in the same way as the related supplied flanges.

Test rings shall have a minimum length of 300 mm. Three rings shall be required for each flange size and material grade. Both ends of the rings shall be bevelled as for the related bends of the order.

Identification marking of test rings shall be agreed with the COMPANY.

5.6 H₂S corrosion tests

Hydrogen Induced Cracking (HIC) tests and Sulfide Stress Cracking (SSC) tests shall be carried out in accordance with Appendices 5 and 4 respectively of spec. [GS PLR 211](#), using specimens cut in an extension ring at flange hub. The number of specimens shall be one set of three specimens for HIC tests and two sets (one set sub-surface at flange internal and one set at flange mid-thickness) of three specimens for SSC tests. All specimens shall be cut longitudinally to flange axis and the three specimens of each set shall be at three equispaced locations around the flange hub circumference. All SSC tests shall be made at 80% actual yield strength of tested material. Test duration shall be 96 hours for HIC tests and 30 days for SSC tests. Acceptance criteria shall be as stated in the said appendices.

H₂S corrosion tests shall be made once per steel source/steel grade/steel cast and heat treatment batch, on a product selected in agreement with the Inspector.

When there are pup pieces welded to flanges, the circular welds shall be subject to SSC tests as per [GS PLR 421](#).

6. Welding neck ends

The flange welding neck bevel shall be as per [MSS SP 44](#), except that root face shall be 1.6 mm ± 0.6 mm.

7. Gaskets and bolting materials

7.1 Gaskets

Ring joint gaskets shall be made to [ASME B 16.20](#) and [MSS SP 44](#) and shall be manufactured from soft iron having a maximum hardness of 250 HV 5 or 10.

7.2 Bolting (bolts and nuts)

Unless otherwise specified in the PPS, bolts and nuts shall be as follows (H₂S exposed bolting):

- Bolts as per [ASTM A 193](#) Grade B7M, with cut threads and 22 HRC max
- Nuts as per [ASTM A 194](#) Grade 2HM, with 22 HRC max.

Surface treatment is not recommended. After assembly, stud bolts and nuts shall be cleaned (washed and degreased), abrasive blasted and painted as per General Specification [GS COR 350](#).

The bolts provided shall allow for use hydraulic tightening system.

7.3 Electrical continuity

The SUPPLIER shall ensure that the flanges shall achieve the electrical continuity of the pipeline after installation. The bolting shall be in electrical contact with the flanges.

8. Pup pieces

The welded pup pieces, if any, (refer to Section Appendix 1 of this specification) shall be selected among the pipes procured for the pipeline Project, and complying with the requirements of relevant Project specifications.

9. Blind flanges

When required in the PPS, blind flanges with a 1½ valve and plug, suitable for hydrotest, will be supplied with the flanges. Blind flanges will be forged items.

These items are temporary items and bolts and gaskets used for the connections to the flange are also considered as temporary items (i.e. they will not be re-used for the final connection).

These temporary items have to be designed (flange rating) by the SUPPLIER for one-year design life on the construction site.

Blind flanges and gaskets shall comply with [MSS SP 44](#) and [ANSI B 16.20](#).

10. Particular requirements for carbon steel flanges to be connected to stainless steel flanges

Carbon steel flanges to be connected to stainless steel flanges (e.g. valve flanges) shall have a welding overlay made of the said stainless steel on the complete surface of the flange to be in contact with the stainless steel flange, plus on a band 30 mm wide minimum at the inner surface of the flange (in continuation with the overlay of flange surface).

The welding overlay shall be made with two layers minimum of stainless steel, so that there shall be no dilution with carbon steel within the last 3 mm in thickness below flange surface finish.

Chemical analysis of weld overlay shall be made by energy dispersive X-Rays spectography on the finished surface of each flange to check the conformance of chemical composition.

The procedure for welding overlay shall be qualified by a test made in a same way as for "Electrical Connecting Welds" (refer to para. 8.6 of specification [GS PLR 421](#)). In addition, the chemical analysis of weld overlay shall be made as stated above at a point located 2 mm mini. below the anticipated machine finish surface to check the conformance of chemical composition.

Gaskets to be used shall be those specified for the stainless steel flange.

Bolting shall be that specified for the carbon steel flange (however, protection of bolting shall be ensured to avoid corrosion by contact with stainless steel).

11. Inspection and non-destructive testing

11.1 General

The Inspector shall have access to the Mill at all times when work is in progress and shall be at liberty to inspect the manufactured items at any stage and to reject any part not complying with this specification.

Sufficient inspections shall be made at all stages of the work by the SUPPLIER and MANUFACTURER to ensure that the materials, manufactured items and testing comply in all respects with the requirements of this specification.

The COMPANY inspection shall not relieve the SUPPLIER from his responsibility, being understood that the SUPPLIER shall remain responsible for quality and inspections.

11.2 Non-Destructive Testing (NDT)

11.2.1 General

The SUPPLIER shall submit detailed inspection and NDT procedures for review and approval. This shall also detail the full extent of the inspection.

The SUPPLIER shall establish, before commencing production, an identification system such that each flange can be fully identified against the Mill test certificates.

The NDT personnel used shall be fully certified and subject to approval of the Inspector. The Inspector reserves the right to retest and reject any of the NDT personnel at any time.

11.2.2 Extent of inspection

Flanges shall be subject to the following inspections:

- 100% visual inspection of internal and external surfaces
- 100% Magnetic Particle Inspection of internal and external surfaces
- 100% ultrasonic inspection.

Final NDT shall be carried out after final heat treatment, with the forging in the finish-machined condition.

11.2.3 Visual inspection

Forgings shall comply with the workmanship, finish and appearance requirements of [ASTM A 694 Std.](#)

11.2.4 Magnetic Particle Inspection (MPI)

MPI shall be carried out over the entire surface area of the forgings in accordance with SE 709, Article 25 of [ASME V](#) or [ASTM E 709](#), using wet particles and the yoke method.

No linear indication shall be permitted.

11.2.5 Ultrasonic inspection

Ultrasonic testing shall be carried out in accordance with [ASTM A 388/A 388 M](#). The entire volume of the forging shall be subject to UT (straight-beam and angle-beam examinations).

a) Straight Beam Examination

The reference block calibration method shall be used. The reference block of thickness representative of that of the tested forging shall comprise flat-bottom holes of 5 mm dia. distributed through the thickness at different depths to develop a calibration reference curve and adjust the sensitivity.

All indications that exceed the DAC reference curve when examined with the gain setting used to produce the DAC reference curve shall be cause for rejection.

b) Angle Beam Examination

Indications which are equal to or exceed those obtained from a 60 deg. V-notch 25 mm long and having a depth no greater than 5% of the actual thickness under examination in the forging are unacceptable.

12. Repair of defects

Minor surface defects on flanges shall be ground out leaving a smooth gradual profile provided that the wall thickness is not reduced below the nominal value given in [MSS SP 44](#) or by proper calculations for non-standard flanges. Any ground areas (except for cosmetic grinding) shall be examined by Magnetic Particle Inspection. Forgings containing larger defects shall be rejected. Repair welding of forging shall not be permitted.

13. Dimensional requirements and inspection

Flanges shall be machined according to the dimensions and tolerances of [MSS SP 44](#) for sizes above NPS 10", and of [ANSI B 16.5](#) for NPS 10" and smaller, or otherwise according to calculation results for non-standard flanges.

In all cases, the nominal internal diameter of the flange shall be the same as the nominal internal diameter of the matching pipeline (as shown in Appendix 1), with a tolerance of ± 1.0 mm (refer. to para. 4.2.4 of this specification).

This shall be checked in the presence of the Inspector using internal callipers, gauges or equivalent approved devices.

The finish of contact faces of flanges shall be checked on each flange in full compliance with [MSS SP 44](#).

Profile and dimensions of weld neck ends are defined in Section 6 of this specification. This requirement also applies to welded pup pieces, if any.

The dimensional inspection shall be carried out after welding the pup piece (if any) to the flange.

14. Welding of pup piece (if any)

14.1 General

Welding of pup pieces to flanges shall be in accordance with the requirements of specification [GS PLR 421](#) and the additional requirements stated in the following.

14.2 Welding process

The use of welding processes other than SMAW and SAW shall not be permitted without prior approval of the Inspector, except that GTAW is acceptable for root runs. Only low hydrogen coated electrodes shall be used when the SMAW arc process is employed.

14.3 Welding Procedure Specification (WPS)

Before performance of qualification test welds (see para. 14.4 hereafter), the SUPPLIER shall submit to COMPANY detailed Welding Procedure Specifications (WPS) for the main weld and repair welds.

Each WPS shall include:

- A detailed description of the welding procedure
- Bevel profile and dimensions
- The MANUFACTURER, brand name and designation of all welding consumables
- The extent and method of interpass cleaning
- For each run, the current type, polarity, arc current and voltage, direction of welding, welding speed and/or run out length (when applicable)
- Preheating and interpass temperature
- Details of welding consumable baking and handling procedures.

14.4 Welding Procedure Qualification tests

14.4.1 Welding test performance

After approval of the proposed WPS, the SUPPLIER shall demonstrate by qualification tests that the proposed WPS and the equipment he intends to use enable him to produce welds which meet the quality and property requirements of this specification. Final approval by the Inspector shall only be given on satisfactory completion of all testing to this specification.

The welding procedure qualification tests shall be carried out on a butt weld between a flange from the same lot as the rest of the flanges being supplied and a pup piece of matching nominal pipe size and wall thickness.

The welding consumables used for weld procedure qualification tests shall be from the same lots as those planned for use in production welding.

Tests conducted by the SUPPLIER in qualifying the welding procedures shall be witnessed by the Inspector.

14.4.2 Examination of qualification weld

The completed test weld shall be examined visually in accordance with specification **GS PLR 421**.

After visual examination and at least 24 hours after completion of welding, the test joint shall be 100% examined by X-radiography in accordance with above mentioned General Specification.

The Inspector may request to have an ultrasonic examination where there is any doubt on weld quality after X-radiography inspection.

Mechanical testing of the joint can only proceed after the weld is judged satisfactory.

14.4.3 Destructive testing

The number, type and position of test specimens shall be as stated in specification **GS PLR 421**. Test procedures and results shall comply with the requirements of specification **GS PLR 421**.

a) Macrosection/Hardness tests

The maximum HV5 hardness values shall not exceed the values stated in Table below:

Sour Service	Weld Root	Weld Cap
Intermediate	280	300
Severe	250	275

b) Impact tests

The specimen size shall be the largest practicable. The minimum values of impact energy absorption for weld and base material are stated in specification **GS PLR 421** or related PPS and/or pipeline Data Sheets, together with the impact test temperature.

No fabrication shall commence until the procedure qualification test results have been approved by the Inspector.

14.4.4 SSC tests

They shall be made according to the requirements of **GS PLR 421** for the specified sour service (i.e. Intermediate or Severe Sour Service) and type of effluent.

14.5 Qualification of welders

Welders shall be qualified as per **GS PLR 421**. Welders who are already qualified according to a standard other than the required one may be accepted at the discretion of the Inspector.

14.6 Inspection and testing

14.6.1 Non-destructive examination

Inspection of production welds shall not commence until at least 24 hours have elapsed since weld completion.

All welds shall be 100% visually inspected for surface appearance and defects, and shall satisfy the acceptance criteria of **GS PLR 421**.

All welds shall then be 100% examined by Magnetic Particle Inspection and radiography in accordance with **GS PLR 421**.

All NDT procedures shall have been previously submitted to and approved by the Inspector.

14.6.2 Weld acceptance criteria

The weld acceptance criteria for welding procedure qualification tests, welder qualification tests and production welds shall be as defined in **GS PLR 421**.

15. Mill hydrostatic testing

The SUPPLIER shall certify that the flanges (including pup pieces, if any) can withstand the hydrostatic test pressure which develops a hoop stress of 90% of SMYS of matching pipe (using the Barlow's formula and the specified nominal wall thickness of matching pipe for calculation).

16. Protection

The bevelled ends and contact faces of flanges shall be protected by a peel-off varnish. Unless otherwise agreed, flanges (or their pup pieces) shall be fitted with bevel protectors of a type approved by the COMPANY.

17. Marking of flanges

Marking shall be such that complete traceability is demonstrated in all stages of manufacture.

Each flange shall be clearly identified and paint marked on the outside rim with the following data:

- COMPANY's name
- Project name
- Purchase Order no.
- MANUFACTURER name/Mill Name/Mark/Logo
- Steel grade ([ASTM A 694](#))
- Item No./Requisition No.
- Heat number
- Pressure-temperature rating ([MSS SP 44](#))
- Nominal flange diameter and WT
- Theoretical weight (in kg).

Marking shall be approved by the Inspector prior to flange production. The original marking of the pipes shall be transferred to each corresponding pup piece, if any.

The flange size (O.D. x W.T.), steel grade, class rating and applicable Std (e.g. [MSS SP 44](#)), as a minimum, shall be die stamped on the periphery of each flange ring. The mark of the Inspector shall also be added.

18. Handling, storage and packing

The SUPPLIER shall ensure that all finished flanges are handled and stored in such a manner as to preserve the machined faces and general surface condition of the product.

The SUPPLIER shall ensure that all flanges are adequately protected against corrosion on a temporary basis (until installation), on those areas where atmospheric corrosion may occur.

The flanges shall be stored clear of the ground and adequately protected from water and mud.

The SUPPLIER shall take suitable corrective action if damage is observed by the Inspector due to inadequate handling or storage conditions.

19. Documentation

19.1 Mill Certificates

Mill certificates shall be 3.2 according to [EN 10204 Std](#) for the flanges. Mill certificates shall be issued by the flange MANUFACTURER, and signed, dated and stamped by the Inspector.

Mill certificates shall make reference to [MSS SP 44](#) or [MSS SP 97](#), where applicable, together with the present General Specification and related PPS.

Mill certificates shall show the following:

- MANUFACTURER's name
- Product serial number/Requisition no.
- Flange diameter and rating
- Purchase Order number
- Heat number
- Test number
- Chemical analysis (ladle and product) including Carbon Equivalent and Pcm
- Mechanical test results
- Non-Destructive tests performed with results
- Heat treatment batch with number and temperature
- Any additional tests and inspections carried out
- Definition of overlay (if any).

19.2 Production report

Upon completion of flange manufacture, the SUPPLIER shall produce a production report which shall include the following minimum information and documents:

- Manufacturing Procedure Specification (MPS) of flanges.
- Report of flange manufacturing procedure qualification tests.
- Production test report (mechanical tests, NDT reports, dimensional reports, etc.).
- Mill certificates of flanges.
- Quality Control Plan.
- Heat treatment charts signed dated and stamped by the Inspector, showing date of treatment and clear definition of the scales used.
- Sketch showing test specimen removal (see para. 5.4).
- H₂S corrosion test reports.
- WPS, WPQR and Non-Destructive Testings made on production welds (if any).
- Hydrostatic testing certificate of compliance.
- Compilation of concessions/deviations, if any, granted by the COMPANY.



The PPS shall state the number of originals and copies of the production reports which are to be supplied to the COMPANY.

The Inspector shall stamp (rubber stamp), sign and date the original documents. The copies shall be stamped (as a minimum) by the Inspector.

19.3 Schedule

The flanges shall be dispatched only after a Release Certificate has been issued by the Inspector.

Mill Certificates shall be supplied at the time of dispatch of the flanges.

The full production report as above shall be transmitted to the COMPANY without delay after completion of flanges production. The latest date of submission of this report shall be three weeks max. after dispatch of flanges.

19.4 Documentation to submit by the SUPPLIER at bid stage

Full technical features of raw materials: sourcing, aimed chemical composition (including Carbon Equivalent and Pcm), shape and dimensions, etc.

A simplified Manufacturing Procedure Specification (MPS) giving the main features of manufacturing process, forging process, forging ratio, parameters that are monitored and/or recorded, sampling of test specimens, etc.

Final heat treatment.

Nominated COMPANY for conducting flange design/calculations.

Nominated laboratory for conducting the H₂S embrittlement tests.

Past experiences of SUPPLIER and laboratory on HIC and SSC tests as per this specification (including the laboratory preliminary or typical procedures).

Details of bevel protections.

Details of flange packing.

Quality Assurance Certification (ISO 9002, etc.).

SUPPLIER's past experience records in manufacturing flanges similar to those of the order.

Deviations to present specification, if any.

20. Technical Queries/Non-Conformance Reports

Any SUPPLIER's requests for clarifications or deviations to COMPANY specifications shall be submitted to COMPANY only through Technical Queries (TQ), the format of which shall have prior approval of the COMPANY.

A deviation to specification shall not be considered as accepted if it has not been submitted to and accepted by COMPANY through a Technical Query.

Approval given by the COMPANY to any SUPPLIER's work procedures, specifications, equipment, etc. shall not release in any way the SUPPLIER from his obligation to meet the COMPANY specifications.

Any work performance or test result which is found, at a later date, not in conformance with COMPANY specifications or agreed procedure shall be subject to a Non-Conformance Report



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(NCR) to be issued by the SUPPLIER for submission to COMPANY. NCR report shall indicate corrective action intended by the SUPPLIER.

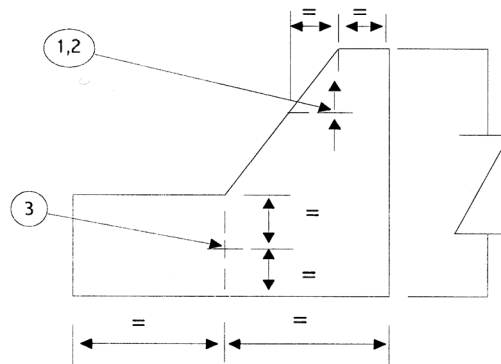
Appendix 1 Flanges characteristics

(Table to be filled-in and incorporated in PPS)

Flange nominal Dia.	.....	.....
• Pipeline service	.....	.....
• Flange steel grade (ASTM A 694)	.....	.....
• Pressure-temperature rating (MSS SP 44)	.....	.....
• Type of flange facing (e.g. raised face, ring type joint)	.....	.....
• Flange Nominal Internal Dia. (Bore) (mm)	.....	.....
• Matching pipe:	.....	.....
- Steel grade (API 5L)	.....	.....
- Nominal internal dia. (Bore) (mm)	.....	.....
- Nominal wall thickness (mm)	.....	.....
- Mill hydrostatic pressure (Barg)	.....	.....
• Design/Safety factor	.....	.....
• Max. Design Temperature (°C)	.....	.....
• Min. Operating Temperature (°C)	.....	.....
• Min. Design Temperature (°C)	.....	.....
• Min. Steel Design Temperature (°C)	.....	.....
• Design Pressure (Barg)	.....	.....
• Corrosion Allowance (mm)	.....	.....
• Charpy V impact Test Temperature	.....	.....

Appendix 2 Sampling of test specimens

(all flanges including inner rings of swivel flanges)



Positions for samples 1 et 2 may be floated down an equidistant line to enable sample removal where geometry is restrictive

Figure 1 - Sampling position of test specimens.

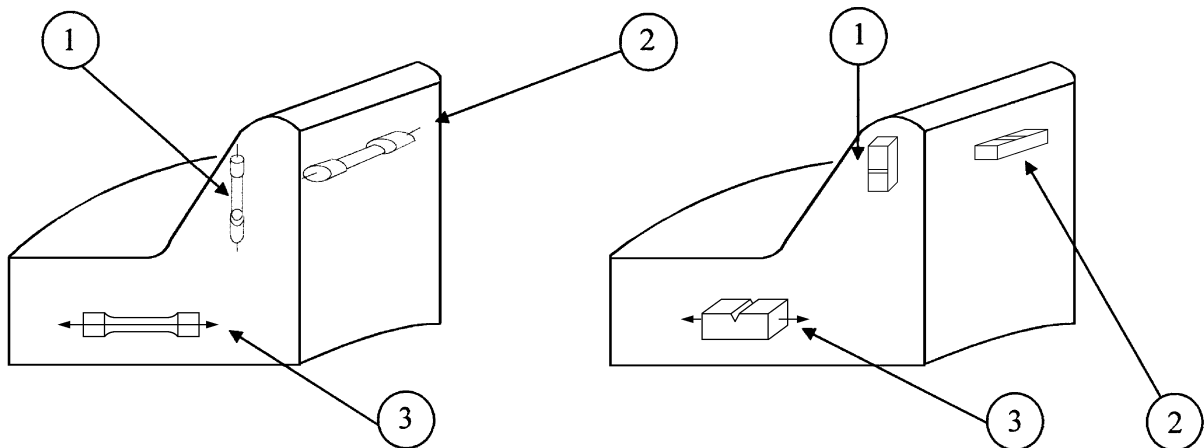


Figure 2 - Location and orientation of tensile specimens (1 specimen from each location)

Sample 1: Longitudinal test
Sample 2: Tangential test
Sample 3: Radial test

Figure 3 - Location and orientation of impact specimens (3 specimens from each location)

Samples 1 and 2 : Notch radial
Sample 3 : Notch tangential

Note: When thickness of flange hub or ring exceeds 100 mm, then the specimens may be located at 50 mm minimum from hub or ring surface.

Appendix 3 Sampling of test specimens (swivel rings)

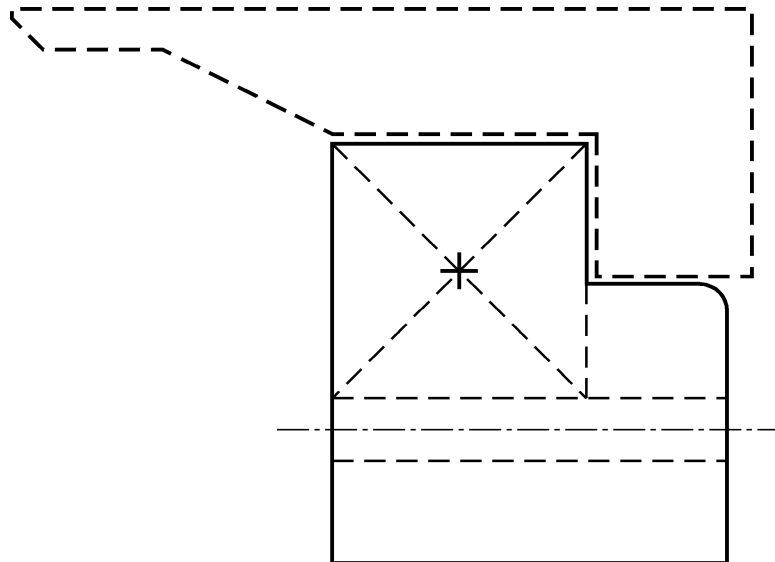


Figure 1 - Sampling position of mechanical test specimens

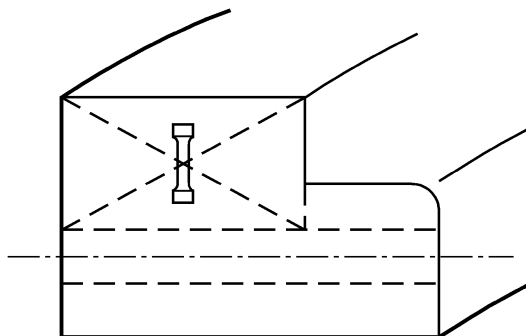


Figure 2 - Location and orientation of tensile specimens (1 specimen from the location)

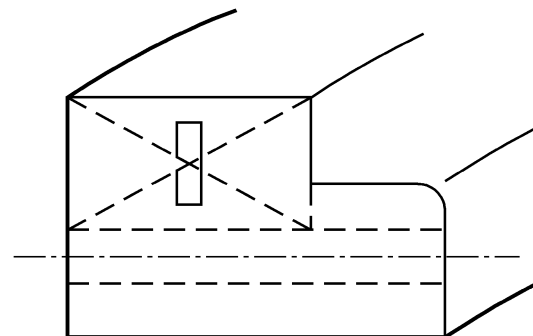


Figure 3 - Location and orientation of impact specimens (3 specimens from the location)