



Exploration & Production

GENERAL SPECIFICATION

PIPELINES - RISERS

GS PLR 233

Carbon steel tees for pipelines (Intermediate and Severe Sour Service)
--

03	10/03	Change of Group name and logo
02	10/02	Up-dating for H ₂ S corrosion tests
01	11/01	Up-dating
00	02/01	First issue
Rev.	Date	Notes



Contents

1. Scope	4
2. Reference documents.....	4
3. General.....	6
3.1 Definitions	6
3.2 Approval of SUPPLIER's procedures	7
3.3 Quality assurance/quality control	7
3.4 Project Particular Specification (PPS)	7
4. Design	8
4.1 Design data.....	8
4.2 Tee design	8
5. Materials.....	8
5.1 Manufacturing process.....	8
5.2 Chemical composition	9
5.3 Mechanical properties	10
5.4 Material rings for welding tests.....	12
5.5 H ₂ S corrosion tests	12
6. Welding and welds	12
7. Welding neck ends.....	13
8. Inspection and non-destructive testing	13
8.1 General.....	13
8.2 Visual and Non-Destructive Testing (NDT).....	14
9. Repair of defects	15
10. Dimensional requirements and inspection	15
10.1 General	15
10.2 Wall thickness.....	15
10.3 Diameter at tee ends.....	16
10.4 Out-of-roundness	16
10.5 Tee end preparation.....	16



10.6	Pig gauge trial	16
10.7	Bulges, Dents ad flat Areas.....	16
10.8	Dimensional tolerances.....	16
11.	Mill hydrostatic testing	16
12.	Protection	17
13.	Marking of tees.....	17
14.	Handling, storage and packing	18
15.	Documentation	18
15.1	Mill certificates and production report.....	18
15.2	Schedule.....	19
15.3	Documentation to submit by the SUPPLIER at bid stage	19
16.	Technical Queries/Non-Conformance Reports.....	20
Appendix 1	Tees characteristics.....	21
Appendix 2	Welding of pup pieces (if any).....	22

1. Scope

1. This specification defines the COMPANY's general technical requirements for the design, materials, manufacture, testing and inspection of hot extruded carbon steel tees (including barred tees and sphere tees) of the welding neck type, for use in onshore and offshore pipeline systems.
2. Tees specified in this specification are to be used in Intermediate or Severe Sour Service as defined in specification **GS COR 170**.
3. This specification applies to tees with minimum specified yield strengths ranging from 290 N/mm² (42,000 psi) to 448 N/mm² (65,000 psi).
4. Tees shall comply with the requirements of **MSS SP 75**, except where otherwise noted in this specification. Pressure-temperature ratings shall be defined in Appendix 1.
5. Requirements are also specially stated in this specification for tees where the properties of base material are to be ascertained after a Post Weld Heat Treatment.
6. Tees may be supplied welded onto piece(s) of pipe at least 500 mm long, when so required in the PPS. These welded pipe pieces are designated as "pup pieces" in this specification.
7. This specification shall be used in conjunction with a Project Particular Specification (PPS) detailing the additional tests requirements or the possible modifications to the present specification, based on the particular design conditions of the pipeline Project.

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

Applicable Codes and Standards, which are to be used in conjunction with this specification shall be as 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 at time of contract award of the referenced Codes and Standards, 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 the written approval of the COMPANY.

The SUPPLIER shall equip himself with copies of all the 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 A 283	Low and Intermediate Tensile Strength Carbon Steel Plate
ASTM A 370	Mechanical Testing of Steel Products
ASTM A 578	Straight-beam ultrasonic examination of plain and clad steel plates of special application
ASTM E 23	Notched Bar Impact Testing of Metallic Materials
ASTM E 384	Test Method for Micro-hardness of Materials
ASTM E 709	Magnetic Particle Examination
ISO 148	Charpy impact test (V-notch)
ISO 1027	Radiographic Image Quality Indicators for non-destructive testing. Principles and identification
ISO 6507	Hardness test - Vickers test - Part 1: HV5 to HV10
ISO 9002	Quality systems: Model for quality assurance in production, installation and servicing
ISO 12096	Radiographic testing of longitudinal and spiral welds for the detection of imperfections
EN 10204	Types of inspection documents
EN 473	Qualification and certification of non-destructive testing personnel

Professional Documents

Reference	Title
MSS SP 75	Specification for high test wrought butt welding fittings
API 5 L	Specification for line pipe

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
ASME, Section V	Boiler and Pressure Vessel code: Non-destructive Examination
ASME, Section VIII Division 1	Boiler and Pressure Vessel Code
ANSI B 16.9	Factory-Made Wrought Steel Butt welding Fittings

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS COR 170	Materials for sour service (Upstream Applications). Specification for design
GS PLR 212	Fabrication of longitudinally submerged arc welded 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 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.
- 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.

- a) Design calculations and fabrication drawings of tees
- b) Manufacturing Procedure Specification, describing all proposed forming and forging operations, heat treatment, inspection and non-destructive testing in their correct sequence. This document will also include the characteristics of equipment used to carry out above mentioned operations
- c) Sketch showing location and orientation of test specimens in test tee
- d) Heat treatment and recording procedures, including number and location of thermocouples
- e) Dimensional inspection procedures
- f) Non-destructive inspection procedures
- g) Quality Control Plan
- h) Welding Procedures Specifications (where applicable)
- i) Welder qualifications (when applicable)
- j) Handling, storage and packing procedures
- k) Proposed measures for temporary corrosion prevention (non-coated tees).

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

The SUPPLIER shall submit, at bid stage, to COMPANY's prior approval any deviations to requirements specified in applicable technical documents.

3.3 Quality assurance/quality control

1. 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 one month prior to commencement of work.
2. Four weeks prior to commencement of tee manufacture, the SUPPLIER shall prepare and submit a Quality Control Plan which describes the inspections to be performed during the supply of tees. 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:

- (1) The necessity or not to have pup piece(s) (refer to Section 1).
- (2) The requirement to have the ID of tee same as that of matching pipes (i.e. constant internal diameter pipeline) (refer to para. 4.2).
- (3) The minimum tee thickness above which the simulated PWHT is required, if this thickness is below or equal to 25 mm (refer to para. 5.3.5).
- (4) 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. 5.5 and 4.3 of Appendix 2).

- (5) The number of originals and copies required for the documentation (refer to para. 15.1).
- (6) The tees characteristics, including impact test temperatures (refer to para. 5.3.3, 6.1 and Appendices 1 and 2).

4. Design

4.1 Design data

Details of pipe diameter, wall thickness and material steel grades of the matching pipelines shall be given in Appendix 1 of this specification, together with the relevant design conditions.

4.2 Tee design

1. All tees shall be designed to **MSS SP 75**, unless otherwise stated in this specification. The SUPPLIER shall provide design calculations and fabrication drawings for approval by the COMPANY. The safety factor at welding ends shall be that of the matching pipeline.
2. All tees shall be designed in material with tensile properties at least equal to those of the matching pipes (refer to para. 5.3 of this specification).
3. The nominal internal diameter (bore) of the main header shall be that of the matching pipeline, unless otherwise stated in the PPS and in Appendix 2, with a tolerance of ± 1.6 mm.
4. The minimum wall thickness at welding ends shall not be less than those of the matching pipelines. Excess material shall be machined back as stated in para 10.2 of this specification. There should be no excess material on the internal diameter of tees when pipeline is designed as a constant internal diameter pipeline.
5. Internal bars (if any) shall be welded into the outlet neck of tees running longitudinally with the run and conform to the ID of the run, when nominal diameter of outlet neck is NPS 12" and above, unless otherwise stated in the PPS. Welds shall be full penetration welds, unless otherwise stated in PPS or on COMPANY approved drawings.
6. The SUPPLIER shall consider and meet the requirements stated about Design Proof Test in **MSS SP 75**.

When records of successful Design Proof Test corresponding to the tee of the order is not available, then Finite Element Analysis is required for the said tee together with hydrostatic testing as stated in Section 11 of this specification.

5. Materials

5.1 Manufacturing process

1. Steel shall be made by the Electric Furnace or Basic Oxygen Converter, and shall be fully killed and made to fine grain practice.
2. Inclusion control with respect to content, distribution and shape shall be carried out by desulphurising, degassing, calcium injection in order to provide resistance of steel to sour environments.
3. Tees shall be manufactured by the hot forging/hot extrusion process, i.e. extruded branch. The branch shall be formed diametrically opposite to any longitudinal weld.

4. All tees shall be normalised or preferably quenched and tempered after forging operations.
5. Bars or internal sleeves (if any) shall be manufactured from a low grade steel (e.g. steel with MSYS of 240 Mpa) or to a COMPANY approved higher grade, having a maximum hardness of 250 HV5.
6. The welded pup pieces, if any (refer to Section 1 of this specification), shall be selected among the pipes procured for the pipeline Project, and complying with the requirements of relevant Project specifications.

5.2 Chemical composition

The chemical analysis shall comply with the provisions of table hereafter for ladle and product. Alternate chemical composition may be proposed by the SUPPLIER, but it must be reviewed and approved by the COMPANY at bid stage.

Chemical element	Weight % max	
	Ladle	Product
Carbon	0.15	0.17
Manganese	1.20	1.30
Silicon	0.35	0.40
Aluminium (total)	0.060	0.060
Phosphorus	0.020	0.020
Sulphur	0.005	0.005
Niobium	0.06	0.06
Vanadium	0.06	0.06
Nickel	0.60	0.60
Chromium	0.25	0.25
Molybdenum	0.20	0.20
Copper	0.30	0.30
Cr + Mo + Cu	0.50	0.50
Nitrogen	0.015	0.015
Calcium	0.006	0.006
Oxygen	0.003	0.003
CE (IIW)	0.42	0.43
Pcm	0.22	0.23

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

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

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

The SUPPLIER shall analyse for all the elements listed above and for 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 cast.

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.

5.3 Mechanical properties

5.3.1 Sampling and frequency of testing

- a) One set of tests as defined below shall be cut from prolongations on both the main header and the outlet neck of the tee, after heat treatment.
- b) Each set of tests shall consist of the following:
 - Two tensile test specimens (one longitudinal and one transverse to pipe axis)
 - One set of three Charpy V-notch specimens transverse to pipe axis.
- c) The sampling requirement shall be one full set of test as defined above per each cast of steel, tee size and heat treatment batch. Grouping of tee sizes and materials may be agreed with COMPANY at the bid stage.
- d) Hardness tests on base material shall be carried out on every tees after heat treatment.

5.3.2 Tensile properties

Tensile tests shall be carried out in accordance with [ASTM A 370](#), using the round bar specimen of the largest practical size. Tensile specimens shall be located at material mid-thickness. The requirements to be met are stated in the table below.

Mechanical properties	Steel grade (MSS SP 75): WPHY...					
	42	46	52	56	60	65
Minimum Yield Strength (MPa)	290	317	358	386	413	448
Minimum TS (MPa)	413	434	455	468	517	530
Minimum Elongation in 2 in. (%)	25	25	25	22	20	20
Max. YS/TS	≤ 0.85	≤ 0.85	≤ 0.85	≤ 0.85	≤ 0.88	≤ 0.90
Max. Vickers Hardness (5 or 10 kg)	250	250	250	250	250	250

5.3.3 Impact properties

Charpy V-notch tests shall be carried out in accordance with [ASTM A 370](#) and [ASTM E 23](#). Each impact test shall consist of three full size specimens (10 mm x 10 mm) specimens cut at material mid-thickness with the notch perpendicular to the material surface.

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

Steel Grade (MSS SP 75)	Minimum average value (J)	Minimum individual value (J)
WPHY-42	30	24
WPHY-46	32	26
WPHY-52	36	30
WPHY-56	39	32
WPHY-60	42	35
WPHY-65	45	38

5.3.4 Hardness survey

A VICKERS hardness survey shall be carried out on each produced tee after final heat treatment, 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 each of the following locations of tee:

- Around the inside surface (or outside surface, when impracticable) close to each welding end
- Around the areas of tee which have been hot strained during manufacture.
- On body of run.

Hardness shall not exceed the hardness shown in table of para. 5.3.2 above, at any point. The Inspector reserves the right to ask for hardness checks at any other location on the tee, e.g. when any doubt occurs about consistency of results.

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

5.3.5 Simulated PWHT

When so required in the PPS (and in all cases when wall thickness at tee welding end exceeds 25 mm), tensile tests and impact tests as per para. 5.3.2 and 5.3.3 above shall be repeated after a simulated Post Weld Heat Treatment (PWHT) has been made on the tee material at a soaking temperature of $620^{\circ}\text{C} \pm 10^{\circ}\text{C}$ for 1 hour per 25 mm thickness of tee neck. These tests shall also be acceptance tests and test results shall meet the requirements of this specification.

PWHT shall also be required on tees when PWHT is made by the Manufacturer on weld between tee and pup piece, if any.

5.3.6 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 the result was not representative of the test sample. Otherwise, the failed test shall be carried out on every tees 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 tee minimum.

5.4 Material rings for welding tests

When it is agreed that tees can be supplied without welded pup pieces, then the Manufacturer shall supply three (3) test rings for qualification of weld procedures to be made by others. The rings shall be representative of the tee run and of the same material and size as the tees, and also shall have been forged and heat treated in the same way as the related supplied tees.

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

Marking of test rings shall be agreed with the COMPANY.

5.5 H₂S corrosion tests

H₂S corrosion tests shall be required for the base metal, for the circular weld (if welding of pup pieces is carried out by the tee MANUFACTURER) and for any other weld existing in the tee.

In base material and straight weld, Hydrogen Induced Cracking (HIC) tests and Sulfide Stress Cracking (SSC) tests shall be carried out in accordance with specification **GS PLR 212** using specimens cut in an extension ring at end of main run. The number of specimens shall be one set of three specimens for HIC tests and two sets (one set sub-surface at tee internal + one set at tee mid thickness) of three specimens for SSC tests. All specimens shall be cut longitudinally to run axis of tee and the three specimens of each set shall be at three equispaced locations around the run circumference. All SSC tests shall be made at 80% actual yield stress of tested material.

In circular weld (if any), Sulfide Stress Cracking (SSC) tests shall be carried out in accordance with specification **GS PLR 421**.

Test solutions and conditions shall be as stated in the said specifications for the specified sour service (Intermediate or Severe Sour Service) and pipeline effluent.

Test duration shall be 96 hours for HIC tests and 30 days for SSC tests. Acceptance criteria shall be as stated in the General Specifications stated here-above.

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.

6. Welding and welds

1. All longitudinal welds (if any) carried out at Mill shall be in full compliance with the COMPANY specification **GS PLR 212** and related PPS, including welding procedure qualification, welder qualification, non-destructive testing of weld, etc. Impact test requirements shall be as stated in table of para. 5.3.3 of this specification. All butt welds shall be double sided welds.
2. Any weld present in the tee during manufacture and heat treatment (e.g. longitudinal weld) shall be subject to the following mechanical tests at the same frequency as for the base material (refer to para. 5.3.1). Sampling shall be made on prolongations as well.
 - One tensile test transverse to weld using the round bar specimen of **API 5L Spec**.
 - Two guided bends tests

- Three sets of Charpy V-notch test:
 - On Weld Metal axis
 - On Fusion Line
 - On Fusion Line + 2 mm.
- One Vickers micro-hardness test under 5 kg load on a transverse macro-section.

All test procedures and acceptance criteria shall conform to COMPANY specification **GS PLR 212** and related PPS. Impact test and tensile test criteria are also stated in the present specification.

3. Welding of pup pieces (if any) shall comply with the Appendix 2 of this specification.
4. The chemical analysis of weld deposits of any welds shall not include more than 1.0% Nickel and 0.5% Molybdenum. All welds shall have a max hardness not exceeding the value stated in Table below. Hardness of fillet welds shall not exceed 250 HV5.

Sour service	Weld Rost	Weld Cap
Intermediate	280	300
Severe	250	275

5. Welds for fixing internal bars (barred tees) or internal sleeves (sphere tees) shall merge smoothly, without undercuts, with base metal of tee body. Welds shall be post heat treated. These welds shall be qualified by tests with visual, macrography and HV5 hardness survey only for acceptance tests.

7. Welding neck ends

The weld neck bevel shall be machined as per **MSS SP 75**, except that root face shall be 1.6 mm ± 0.6 mm. Bevelling and tapers (if any) shall be done by straight machining only.

8. Inspection and non-destructive testing

8.1 General

1. The SUPPLIER shall bear full responsibility for the conformity of his supply to all requirements of this specification. He shall, for this purpose, take all necessary measures, making use of suitable means, devices and qualified personnel, enabling him to ensure permanent and effective control at each stage of manufacture.
2. The MANUFACTURER shall develop a Quality Control Plan (refer to para. 3.3 of this specification) for approval and shall carry out all inspections and tests required by this specification.

Any inspection made by the Inspector shall not absolve the SUPPLIER from its responsibility to exercise such quality control procedures so as to ensure that the requirements of this specification are satisfied.

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

4. The Inspector shall be notified by the Manufacturer to enable him to witness the tests that are planned with Inspector's witness. Such notification shall be given at least five working days before the tests are to be performed.
5. Visual, dimensional and non-destructive testing for acceptance purposes shall be carried out following final heat treatment and bevelling.
6. All dimensional surveys, non-destructive inspections and mechanical testing shall be witnessed by the Inspector and results recorded by the SUPPLIER. Test reports shall be submitted to the Inspector for approval.
7. All Non-Destructive procedures shall have prior approval of the Inspector, and may be subject to qualification tests prior to their use in production. Further to acceptable results, qualification records shall be established by the Manufacturer where necessary, and duly signed by the Inspector.
8. All Non-destructive inspection personnel shall be properly certified according to EN 473 Std or equivalent COMPANY approved Std and shall have also been approved by the Inspector before any involvement on the order. NDT operators shall be certified level 2, as a minimum. The Manufacturer shall supply the Inspector with copies of the qualification certificates and a list of inspection personnel showing their scope and date of qualification.
9. The Manufacturer shall establish, before commencing production, an identification system so that each tee can be fully identified against the Mill inspection cards and test certificates, and that complete traceability can be demonstrated in all stages of manufacture and inspection.

8.2 Visual and Non-Destructive Testing (NDT)

1. All tees shall be visually inspected internally and externally to the maximum possible extent to ensure freedom from cracks, gouges, dents, grooves, wrinkles, bulges, kinks or surface spalling.

Gouges or grooves which do occur shall be removed by grinding providing that the wall thickness is not locally reduced below the specified minimum wall thickness.

Requirements relating to bulges, dents and flat areas are stated in para 10.7 of this specification.

2. All tees shall be 100% externally inspected by Magnetic Particle Inspection. The Manufacturer's procedure shall be in accordance with [ASME Section V](#), article 7, using wet particles and the yoke method.

Acceptance levels shall be in accordance with [ASME section VIII](#), Division 1.

3. An ultrasonic inspection shall be carried out on body of all tees. It shall also comprise a 100% survey on the areas where a hot straining has occurred, using both shear and compression probes.

The inspection with compression probes shall be carried out in accordance with [ASTM A 578 Std](#). Any isolated laminar imperfection, which is larger than 480 mm² shall not be acceptable.

The inspection with shear probes shall be carried out in accordance with [ASME Section V](#), the calibration being made using the N10 notch of [API 5L](#). No cracks or sharp bottom imperfections shall be acceptable, nor any imperfections showing a depth encroaching the specified minimum wall thickness of tee.

4. All tee ends shall be ultrasonically examined over 100% of the area within 100 mm of the tee end to check for laminations. Inspection procedure shall be as per ASTM A 578 Std. Any laminar imperfection exceeding an area of 60 mm² shall not be acceptable.
5. All welds shall be 100% inspected by radiography in accordance with ASME, Section V, Article 2, using fine grain films and lead screens, and acceptance criteria contained in ASME VIII, Division 1, clause UW-51, except that indications exceeding 6.4 mm in length are not acceptable.
6. All finished weld bevels shall be inspected by wet Magnetic Particle Inspection in accordance with ASME Section V, Article 7. Any indication exceeding 3 mm in length shall not be acceptable.

9. Repair of defects

1. Repair by welding of tees is not permitted, unless specifically permitted by the Inspector.
2. Defects including laps, shells and slivers may only be removed by grinding provided that the minimum specified wall thickness is maintained. Any grinding shall leave a smooth surface profile.
3. The locations of any repair work shall be recorded so that independent checks can be made at a later date.
4. A local Magnetic Particle Inspection (MPI) shall be carried out to verify that the defect has been completely removed and that the repair is acceptable. Wall thickness checks with ultrasonics shall be made on the ground areas (except for cosmetic grinding) to confirm that the specified minimum wall thickness is maintained.

10. Dimensional requirements and inspection

10.1 General

Dimensional checks and thickness measurements shall be made on each tee after final heat treatment, hydrostatic testing (if any) and bevel preparation.

10.2 Wall thickness

Wall thickness measurements shall be made using a suitably approved ultrasonic procedure (minimum accuracy: ± 0.1 mm) at four uniformly spaced points around the circumference of each end of tee and at random locations on body of tee, and on the parts of tee which have been hot strained during manufacture.

The wall thickness shall not be less than the specified minimum wall thickness of matching pipeline (refer to Appendix 1).

Any excess material (agreed with the COMPANY) shall be machined back to obtain a taper angle of 10° max. (i.e. 1 in 6 taper) at internal taper and 14° max. at external of tee. As a reminder (see para. 4.2.4), there should be no excess material on the internal diameter of tees when pipeline is designed as a constant internal diameter pipeline.



10.3 Diameter at tee ends

Diameter shall be checked against the specified Nominal Inside Diameter (NID) of matching pipes (refer to Appendix 1). The tolerance on NID within 100 mm of tee ends shall not exceed ± 1.6 mm.

$$\text{Nominal ID} = \text{nominal OD} - 2 \times \text{nominal WT}$$

Internal diameters shall be checked by internal circumferential tape or diameter tape. Any other method shall have the prior approval of the COMPANY.

10.4 Out-of-roundness

At any point throughout the body of tee, the difference between the maximum and minimum Outside Diameters shall not exceed 2.5% of the agreed nominal Outside Diameter. At ends of tee, the internal out-of-roundness shall not exceed 1.0% of the specified nominal Inside Diameter.

Nominal Inside Diameter shall be as stated in Appendix 1.

10.5 Tee end preparation

Tee shall have all ends bevelled to the profile angle and root face as stated in Section 7 of this specification. This requirement shall also apply to welded pup pieces, if any.

10.6 Pig gauge trial

The minimum internal diameter of the completed tees (including internal bars or internal sleeves, if any) shall be confirmed for scraper clearance by passing an internal pig gauge through the full length of main header bore. The pig gauge shall have 3 equispaced and parallel 6 mm thick circular plates, each at least 96% of, or 4 mm less than, the internal nominal bore of the matching line pipe, whichever is the greater, separated by a rigid bar of total length half the specified Nominal ID. All tees shall be suitable for the passage of intelligent pigs.

10.7 Bulges, Dents and flat Areas

Deviations from the original contour of the tee shall not exceed 3 mm in depth nor shall they exceed 25% of the outside diameter in length. Sharp edged grooves shall be ground out by approved procedures before applying these criteria. Minimum wall thickness requirements shall not be compromised. A tee containing deviations not in accordance with the above limits shall be rejected.

10.8 Dimensional tolerances

Dimensional tolerances of tees shall be in accordance with [MSS SP 75](#), except as otherwise stated above.

11. Mill hydrostatic testing

1. When the SUPPLIER can provide records of successful Design Proof Test of tee (refer to para. 4.2 of this specification), then performance of the hydrostatic testing of tee is not required.

In that case, the SUPPLIER shall certify that the tee (including pup pieces, if any) can withstand the hydrostatic test pressure which develops a hoop stress of 90% of MSYS of

matching pipe, using the Barlow's formula and the specified nominal wall thickness of matching pipe for calculation. This test pressure shall be that stated in Appendix 1.

2. When provisions of above para. 1 cannot be met by the SUPPLIER, then hydrostatic testing shall be required.

Each tee shall be hydrostatically tested at a test pressure of 95% of MSYS of matching pipe (using the Barlow formula and nominal specified wall thickness of matching pipe for calculation) for a duration of two hours minimum. This test pressure shall be that stated in Appendix 1. The hydrostatic test shall be performed on the completed tee assembly, including bars, if any.

After completion of tee testing and acceptance, closures shall be cut off, ends prepared according to Section 7 of this specification and full inspection (i.e. visual, NDT and dimensional) shall be made as per this specification.

The SUPPLIER shall provide the COMPANY with details of the hydrostatic testing procedure and receive approval prior to proceed with tests.

12. Protection

The bevelled ends of tees shall be protected by a peel-off varnish. Tees (or their pup pieces) shall be fitted with bevel protectors or end caps of a type approved by the COMPANY.

13. Marking of tees

The following data shall be paint stencilled in white using 25 mm high or larger letters, at inside surface of each tee. A light clean coat of clear lacquer shall be sprayed over the stencilled area once the paint is dry.

- COMPANY's name
- Project name
- Purchase Order No.
- Mill name/Mark
- Item No./Requisition No.
- Tee serial number
- Steel grade (MSS SP 75)
- Heat number
- Pressure-temperature rating (MSS SP 75)
- Nominal diameters (run x branch)
- Nominal wall thickness (matching pipes)
- Weight (in kg).

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



The tee size (O.D. x W.T.), steel grade, class rating and applicable standard (e.g. [MSS SP 75](#)), as a minimum, shall be die stamped, using low stress die, on the bevel of the main header of each tee. The mark of the Inspector shall also be added.

14. Handling, storage and packing

The SUPPLIER shall ensure that all finished tees 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 tees are adequately protected against corrosion on a temporary basis (until installation).

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

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

15. Documentation

15.1 Mill certificates and production report

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

Mill certificates shall make reference to [MSS SP 75](#) together with the present specification and related PPS.

The following documentation shall be submitted to the Inspector prior to the dispatch of tees:

a) Mill test certificates of tees. They shall show the following content:

- MANUFACTURER'S name and trademark
- Product serial number/Requisition No.
- Tee diameters 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 number and temperature

All test certificates shall be referenced to cast number and heat treatment batch.

b) Mill test certificates of mother pipes and welded pup pieces, if any

c) Manufacturing Procedure Specification of tees

d) Report of tee manufacturing procedure qualification tests

e) Heat treatment chart stamped, dated and signed by the Inspector, showing date of treatment and a clear definition of scales

- f) Sketch showing test specimen removal (see para 5.3)
- g) Dimensional and NDT reports
- h) WPS, WPQR and Non-Destructive Testings made on production welds (if any)
- i) Hydrostatic testing report (where necessary)
- j) HIC and SSC test reports
- k) Quality Control Plan
- l) Compilation of concessions/deviations, if any, granted by the COMPANY.

The number of originals and copies of above documentation shall be stated in the Project Particular Specification (PPS).

The original documentation shall be stamped, dated and signed by the Inspector. The copies shall be stamped (as a minimum) by the Inspector.

15.2 Schedule

1. The tees shall be dispatched only after a Release Certificate has been issued by the Inspector.
2. Mill certificates shall be supplied at the time of dispatch of the tees.
3. The full production report as above shall be transmitted to the COMPANY without delay after completion of tee production. The latest date of submission of this report shall be three weeks max. after dispatch of tees.

15.3 Documentation to submit by the SUPPLIER at bid stage

1. Full technical features of mother pipes: sourcing, aimed tensile properties, aimed chemical composition (including Carbon Equivalent and Pcm), minimum wall thickness, etc.
2. A simplified Manufacturing Procedure Specification (MPS) giving the main features of machine and manufacturing process, parameters that are monitored and recorded sampling of test specimens, etc.
3. Final heat treatment details.
4. Record of successful Design Proof Test as per **MSS SP 75** of tee(s) similar to those of the order.
5. Nominated company for conducting tee design/calculations.
6. Nominated laboratory for conducting the H₂S embrittlement tests.
7. Past experiences of SUPPLIER and laboratory on HIC and SSC tests performed as per this specification (including the laboratory preliminary or typical procedures).
8. Details of bevel protections.
9. Details of tee packing.
10. Quality Assurance certification (ISO 9002, etc.), SUPPLIER past experience in manufacturing tees similar to those of the order.
11. Deviations to present specification, if any.



16. Technical Queries/Non-Conformance Reports

1. 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.

2. 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.
3. 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 (NCR) to be issued by the SUPPLIER for submission to COMPANY. NCR report shall indicate corrective action intended by the SUPPLIER.



Appendix 1 Tees characteristics

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

Tee size (run dia. x branch dia.)	.....	.....
Pipeline service	.....	.....
Tee steel grade (MSS SP 75)	.....	.....
Tee pressure-temperature rating (MSS SP 75)	.....	.....
Design/Safety factor	.....	.....
Matching pipe/main header:	.....	.....
• Steel grade (API 5L)		
• Nominal Internal Diameter (Bore) (mm)		
• Nominal Wall Thickness (mm)		
Matching pipe/outlet neck:	.....	.....
• Steel grade (API 5L)		
• Nominal Internal Diameter (Bore) (mm)		
• Nominal Wall Thickness (mm)		
Max. Design Temperature (°C)	.....	.....
Min. Operating Temperature (°C)	.....	.....
Min. Steel Design Temperature (°C)	.....	.....
Design Pressure (Barg)	.....	.....
Corrosion Allowance (mm)	.....	.....
Mill Hydrostatic Test Pressure (Barg)	.....	.....
Charpy V impact test temperature	.....	.....

Appendix 2 Welding of pup pieces (if any)

1. General

Welding of pup pieces to tees shall be in accordance with the requirements of the COMPANY specification **GS PLR 421** and the additional requirements stated in the following.

2. Welding process

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

3. Welding Procedure Specification (WPS)

Before performance of qualification test welds (see para. 7 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's name, 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
- Welding consumable baking and handling procedures.

Consumables shall be selected so that chemical analysis of weld deposits shall not include more than 1.0% Nickel and 0.5% Molybdenum.

4. Welding procedure qualification tests

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 test shall be carried out on a butt weld between a ring of tee material and a pup piece of matching pipe. Size and wall thickness shall be agreed with the COMPANY.

The welding consumables used for weld procedure qualification test 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.

4.2. Examination of qualification weld

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

At the Inspector's request an ultrasonic examination shall be performed where there is any doubt over the weld quality after X-radiography inspection.

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

4.3. Destructive testing

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

a) Macrosection/Hardness tests

Hardness values shall not exceed the values stated in Table of Section 6 of this specification.

b) Impact tests

The specimen size shall be the largest practicable. The minimum values of impact energy absorption for weld and base material shall be as stated in the 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.

4.4. SSC tests

They shall be made according to the requirements of para. 5.5 of this specification and the requirement of **GS PLR 421** for the specified sour service and pipeline effluent.

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.

6. Inspection and testing

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 in accordance with **GS PLR 421**.

All welds shall then be 100% examined by radiography in accordance with a procedure which shall have been previously submitted to and approved by the Inspector. The procedure shall meet the requirements of **GS PLR 421**.



7. 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](#).