



PTT Exploration and Production Public Company Limited

PTTEP Engineering General Specification
(Engineering and Development Group)

Standard

**Design, Materials and Fabrication of Tees for Carbon Steel
Pipelines (Mild, Intermediate and Severe Sour Service)**

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1.0 INTRODUCTION

PEGS (PTTEP Engineering General Specification) is the PTT Exploration and Production PCL internal publishes standard. The objective of PEGS is to promote the best practices collecting from all PTTEP execution projects and to standardize those best practice to the future projects.

Every 5 years or upon request by the internal user, PEGS will be reviewed by related subject experts to reach decisions/agreements, then the document will be updated and publish to PTTEP intranet website. This is to ensure that all lesson learns from users can be applied to the future projects as the benefit to PTTEP.

2.0 PURPOSE

This specification defines the COMPANY's general technical requirements for the design, materials, manufacture, testing and inspection of hot extruded outlet, integral reinforcement type or fully forged type carbon steel tees (including barred tees and sphere tees) of the welding neck type, for use in onshore and offshore pipeline systems.

3.0 SCOPE

- Tees specified in this specification are to be used in "Mild", "Intermediate" or "Severe" Sour Service (i.e. corresponding respectively to region 1, 2 and 3) as defined in specification 10008-STD-6-COR-032, PEGS-0842-COR-032.
- This specification applies to tees with minimum specified yield strengths ranging from 290 N/mm² (42,100 psi) to 485 N/mm² (70,300 psi) (i.e. X42 to X70 grades of API 5L / ISO 3183).
- Tees shall comply in all aspects with the requirements of MSS SP 75 and B31.4 or B31.8, as applicable, and ISO 15590-2 class CS, whichever the stringent, except where otherwise noted in this specification. Pressure-temperature ratings shall be defined in Appendix 1.
- 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.
- Tees may be supplied welded onto piece(s) of pipe at least 500 mm long, when so required in the PPS or Purchaser. These welded pipe pieces are designated as "pup pieces" in this specification.

This specification shall be used in conjunction with a Project Particular Specification (PPS) detailing the additional test requirements or the possible modifications to the present specification, based on the particular design conditions of the pipeline Project.

4.0 RESPONSIBLE ACTION PARTIES

N/A

5.0 DEFINITIONS

A number of different terms are commonly used to describe the work stages, processes, and approvals which take place during the early stages of a development. This can often be a source of confusion so the following section is intended to show the PTTEP preferred terminology as used in this document.

5.1 LANGUAGE

In this document, the words should and shall have the following meanings:

Shall	Indicates a course of action with a mandatory status. The term “shall” shall be used if a requirement is considered to be necessary to claim compliance with a PEGS document.
Should	Indicates a preferred course of action. Should is a non-mandatory word and is not forbidden, but use in the body of the text should be the exception. Where none mandatory terms are used, each paragraph within these clauses shall also have an associated commentary paragraph that provides the rationale for why the stated choices and modifications are appropriate and circumstance under which the stated choices and modifications might be different.

5.2 TERMINOLOGY

Terminology	Description
Approval	The authorization in writing given by the COMPANY to the Contractor to proceed the work without releasing in any way the Contractor from any of his obligations to conform with the technical specifications, requisitions, etc. The words “Approve”, “Approved” and “Approval” shall be construed accordingly
Company	PTT Exploration and Production Public Company Limited and affiliates.
Contractor	Per contract: Contractor – ‘The contractor who is a PARTY to this CONTRACT and where the context so requires including, SUBCONTRACTORS utilized by CONTRACTOR for the performance of the WORK’
Inspector	The COMPANY’s or Supplier’s representative(s), (as applicable), or member(s) from an Inspection Agency duly appointed by the COMPANY or the Contractor or the Supplier (as applicable) to act as its representative(s) for the purpose of the contract.
Manufacturer	The company or its sub-contractors selected by the COMPANY or the Contractor or the Supplier (as applicable) as the Manufacturer of the said material.
Mill	The plants, mills, workshops, laboratories or other locations where the fabrication, inspection and testing of materials and tests are to be performed complete or in part.
PPS	Designates Project Particular Specification detailing the additional tests and requirements or the possible modifications to the present specification, based on the particular design conditions or the local legislation of the project.
Purchaser	The COMPANY or the Contractor or the Supplier (as applicable) which have placed the Purchase Order to the Supplier/Vendor/Manufacturer.
Supplier	The company or its sub-contractors designated by CONTRACTOR or COMPANY (where applicable), as defined on the Purchase Order or Contract, as being the selected Supplier of the said materials. In this specification, the company in charge of the tee manufacture is conventionally designated as SUPPLIER.

Terminology	Description
Supplier/Vendor	The company designed on the Purchase Order form or Contract as being the selected supplier of the said materials.

5.3 COMMON ACRONYMS

Set out below in alphabetical order are common acronyms as found within this document:

GTAW	Gas Tungsten Arc Welding
HIC	Hydrogen Induced Cracking
HV	Vickers hardness
MPI	Magnetic Particle Inspection
MPGT	Manufacturing Procedure Qualification Test
MPS	Manufacturing Procedure Specification
MSYS	Minimum Specified Yield Strength
NDT	Non-Destructive Testing
NCR	Non-Conformance Report
PPS	Project Particular Specification
PWHT	Post Weld Heat Treatment
QCP / ITP	Quality Control Plan / Inspection and Test Plan
SMAW	Shielded Metal Arc Welding
SSC	Sulphide Stress Cracking
SAW	Submerged Arc Welding
TS	Tensile Strength
UT	Ultrasonic Test
WPQR	Welding Procedure Qualification Record
WPQT	Welding Procedure Qualification Test
WPS	Welding Procedure Specification
YS	Yield Strength

6.0 REFERENCES

The reference documents listed below, including Industry Codes and Standards and COMPANY specifications, form an integral part of this Engineering General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published on the effective date of a contract.

The overall order of precedence of the applicable documents shall be:

1. Applicable Laws, Rules and Regulations of the country in which the system/equipment will be operated (if any);
2. Purchase Order/ Service Order/ Contract Documents (Only applicable for direct purchase by COMPANY);
3. Project Particular Specification (PPS), and relevant data sheet(s) if any;
4. COMPANY General Specification;
5. Codes and Standards in reference.

Any conflict between any of the Contract Documents, or between this specification and any other Contract Documents, shall be reported to COMPANY for decision. In such a case, and unless otherwise agreed or decided by COMPANY, it is understood that the more stringent requirement shall apply.

Exceptions to, or deviations from this specification are not permitted unless previously accepted in writing by COMPANY. For this purpose, requests for substitutions or changes of any kind shall be completed with all pertinent information required for COMPANY assessment. COMPANY's approval, nevertheless, will not, in any way, relieve the responsibility of the Contractor to meet the requirements of the industry Codes and Standards referred to and amended herein, in the event of conflict.

6.1 PTTEP INTERNAL REFERENCES

Internal documents applicable to this document are indicated in the table below.

Document Number	Document Title
10008-STD-6-GEN-005 , PEGS-12060-ADM-006	Quality Requirements for Vendor
10008-STD-6-GEN-007 , PEGS-12060-MMA-001	Material Traceability
10008-STD-6-PLR-006 , PEGS-12059-PLR-005	Longitudinally submerged arc welded pipes for carbon steel pipelines (mild, intermediate and severe sour service)
10008-STD-6-PLR-025 , PEGS-12059-PLR-012	Welding of carbon steel pipelines to API 1104 (mild, intermediate and severe sour service)
10008-STD-6-PLR-005 , PEGS-12059-PLR-017	Seamless pipes for carbon steel pipelines (mild, intermediate and severe sour service)
10008-STD-6-COR-032 , PEGS-0842-COR-032	Materials for sour service

6.2 INTERNATIONAL STANDARDS

International standards applicable to this document are indicated in the table below i.e. ISO, IEC or ITU.

Document Number	Document Title
ISO 10893-5	Non-destructive testing of steel tubes - Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections
ISO 10893-6	Non-destructive testing of steel tubes - Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections
ISO 148-1	Metallic materials - Charpy pendulum impact test - Part 1: Test method
ISO 15590-2	Petroleum and natural gas industries - Induction bends, fittings and flanges for pipeline transportation systems - Part 2 : Fittings
ISO 3183	Petroleum and natural gas industries - Steel pipe for pipeline transportation systems
ISO 6507-1	Metallic materials – Vickers hardness test – Part 1: Test method
ISO 6892	Tensile Test
ISO 9712	Non-destructive testing - Qualification and certification of personnel
ISO/ TS 29001	Quality systems: Model for quality assurance in production, installation and servicing
NACE MR 01 75 / ISO 15156-2	Petroleum and natural gas industries – Materials for use in H ₂ S – containing environments in oil and gas production

6.3 CODE AND OTHER STANDARDS

Codes, standards and regional legislation applicable to this document are indicated in the table below.

Document Number	Document Title
ANSI B 16.9	Factory-Made Wrought Steel Butt welding Fittings
API 5L	Specification for Line Pipe
ASME B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
ASME B31.8	Gas Transmission & Distribution Piping Systems
ASME VIII, Division 2	Pressure Vessels
ASME, Section V	Boiler and Pressure Vessel code: Non-destructive Examination
ASME, Section VIII Division 1	Boiler and Pressure Vessel Code
ASTM A 370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 578	Standard Specification for Straight-beam ultrasonic examination of Rolled Steel Plates for special application
ASTM A 956	Standard Test method for Leeb Hardness Testing of Steel Products
DNV-OS-F-101	Submarine Pipeline System
EN 10204	Types of Inspection documents
EN 473	Non-destructive testing - Qualification and certification of NDT personnel - General principles
MSS SP 75	Specification for high test wrought buttwelding fittings
NACE TM0177	Testing of Metals for Resistance to Sulphide Stress Cracking at ambient Temperatures
NACE TM0284	Evaluation of Pipeline Steel for Resistance to Stepwise Cracking

7.0 REQUIREMENTS FOR DESIGN, MATERIALS AND FABRICATION OF TEES FOR CARBON STEEL PIPELINES

7.1 APPROVAL OF SUPPLIER'S PROCEDURES

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 (MPS) in accordance with MSS SP 75 and ISO 15590-2, 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 (or Inspection and Test 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 COMPANY.

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

7.2 QUALITY ASSURANCE / QUALITY CONTROL

1. SUPPLIER shall operate a Quality Assurance system in accordance with ISO/TS 29001 or equivalent, approved by a COMPANY recognised authority. The Quality Assurance Manual shall be submitted one month prior to commencement of work. It shall be made available to the Inspector.
2. Four weeks prior to commencement of tee manufacture, 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 (QCP) (or Inspection and Test Plan: ITP) shall set forth "witness", "hold", "review" and "monitor" points.

7.3 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 3.0).
2. The requirement to have the ID of tee same as that of matching pipes (i.e. constant internal diameter pipeline) (refer to section 7.4.2).
3. The minimum tee thickness above which the simulated PWHT is required, if this thickness is below or equal to 25 mm (refer to section 7.5.3.5).
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 section 7.5.5, 7.6, Appendix 1 and 4.4 of Appendix 2).
5. The PPS relating to PTTEP Engineering General Specifications in reference (refer to section 6.1)
6. The number of originals and copies required for the documentation (refer to section 7.15.1).
7. The tees characteristics, including impact test temperatures (refer to Appendix 1).

7.4 DESIGN

7.4.1 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.

A standard pressure – temperature rating as per B31.4 or B31.8, as applicable, shall be allocated to tees.

7.4.2 TEE DESIGN

1. Tees shall be designed to MSS SP 75, but shall also comply with pipeline Code B31.8 and B31.4 (where applicable), including temperature de-rating factor to decrease the allowable stresses. SUPPLIER shall, also, provide design calculations using non-linear Finite Element Analysis as per ASME VIII, Division 2, Appendix 4 or an approved equivalent standard, together with fabrication drawings, all for approval or COMPANY.

Tees shall be checked, as a minimum, for design and extreme conditions (corrosion allowance excluded) and for hydro-test condition (corrosion allowance included). All operating and environment forces transferred to the tee shall be considered. The actual bursting strength of tee shall be demonstrated to exceed that of the adjoining pipe.
2. Tees shall be designed in material with tensile properties at least equal to those of the matching pipes (refer to section 7.5.3 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 1, with a tolerance of ± 1.6 mm.
4. The minimum wall thickness at welding ends shall not be less than that of the matching pipelines. Where there is a difference in steel grade or material thickness between tee and the connecting pipe, the transition joint shall be designed according to ASME B31.8, appendix I, figure 15, or equivalent recognized code. 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 running longitudinally with the run and conform to the ID of the run, when nominal diameter of outlet neck is NPS 10" and above, unless otherwise stated in the PPS.
6. Bars may be integrated parts of the forging (i.e. no welds are present between bars and tee body), otherwise bar fixing welds shall be full penetration welds designed so that they do not affect the crotch radius areas around the extrusion neck or other high stress areas. Welds for bar fixing shall be carried out before final Heat Treatment.
7. SUPPLIER shall consider and meet the requirements stated about Design Proof Test in MSS SP 75. When SUPPLIER's records of successful Design Proof Test corresponding to the tee of the order is not available, then hydrostatic testing as stated in Section 7.11 of this specification is required for the said tee.
8. The design for the connection in between Branch and Header shall be governed by the OD ratio (OD Header v/s OD Branch). The required connection type is summarized in the Table of Appendix 3.
9. All calculation notes shall clearly show the input parameters and calculation methodology. All in-house softwares shall have proofs of validation to the satisfaction of COMPANY.

7.5 MATERIALS

7.5.1 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 within the range 800 – 1050°C, i.e. extruded branch or full solid forging. All parts of forging shall undergo a total reduction ratio of at least 4 to 1 during forging process. The branch shall be formed diametrically opposite to any longitudinal weld.
4. Tees shall be quenched and tempered after forging / forming operations.

For forged tees, the quenching and tempering shall be made after rough machining. Rough machining means that the product is pre-machined near to its final dimensions with an extra thickness of less than 10 mm against nominal finished thickness of product.

For water quenched tees, the time from removal of tee from the furnace until it is immersed in quenching water shall not exceed 90 seconds. The start and end temperatures of quenching water shall be recorded and shall not exceed 40 °C.

When S.PWHT is required, the tempering temperature shall be 605 °C minimum to allow a PWTH of 580 °C minimum.

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 3.0 of this specification), shall be selected among the pipes procured for the pipeline Project, and complying with the requirements of relevant Project specifications.

7.5.2 CHEMICAL COMPOSITION

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

Chemical element	Weight % max	
	Ladle	Product
Aluminum (total)	0.050	0.050
Calcium	0.006	0.006
Carbon	0.15	0.17
CE (IIW)	0.43	0.44
Chromium	0.30	0.30
Copper	0.30	0.30
Cr + Mo + Cu + Ni	0.75	0.75
Hydrogen	2ppm	2ppm
Manganese	1.20	1.30
Molybdenum	0.35	0.35
Nb+V+Ti	0.15	0.15
Nickel	1.00	1.00
Niobium	0.06	0.06
Nitrogen	0.012	0.012
Oxygen	0.003	0.003
Pcm	0.22	0.23
Phosphorus	0.020	0.020
Silicon	0.35	0.40
Sulphur	0.005	0.005
Titanium	0.04	0.04
Vanadium	0.06	0.06

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

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

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

SUPPLIER shall analyse for all the elements listed above and for any other intentionally added elements.

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.

7.5.3 MECHANICAL PROPERTIES

7.5.4 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(s).The specimen location shall not be less than 50mm from the tee end (s).
- b) Each set of tests shall consist of the following:
 - Two tensile test specimens (one longitudinal and one transverse to pipe axis)
 - Two sets of three Charpy V-notch specimens (one longitudinal and one axial to pipe axis).
 - For WT>25mm, one additional set of three Charpy V-notch specimens cut transverse to pipe axis 2mm below the internal surface.
- c) The sampling requirement shall be one full set of tests 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. When specimens are cut from rough machined products, the sketch showing locations of specimens in regard to rough forging (see section 7.5.1 here above) shall be submitted.
- d) Hardness tests on base material shall be carried out on every tees after final heat treatment.

7.5.5 TENSILE PROPERTIES

Tensile tests shall be carried out in accordance with ISO 6892 or ASTM A 370, using the round bar specimen of the largest practical size. Tensile specimens shall be located at material mid-thickness of welding necks. 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	70
Minimum Yield Strength (MPa)	290	320	360	390	415	450	485
Minimum TS (MPa)	415	435	460	490	520	535	570
Minimum Elongation in 2 in. (%)	25	25	25	22	20	20	18
Max. YS/TS	≤ 0.85	≤ 0.85	≤ 0.85	≤ 0.85	≤ 0.88	≤ 0.90	≤0.91
Max. Vickers Hardness (5 or 10 kg)	250	250	250	250	250	250	250

7.5.6 IMPACT PROPERTIES

Charpy V-notch tests shall be carried out in accordance with ISO 148-1 or ASTM A 370. Each impact test shall consist of three full size specimens (10 mm x 10 mm) cut at material mid-thickness of welding neck and below internal surface as per section 7.5.3.1b. with the notch perpendicular to the material surface.

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

Steel Grade (MSS SP 75)	Minimum average value (Joules)	Minimum individual value (Joules)	Minimum Shear area Avge(Single)
WPHY-42	40	30	85% (75%)
WPHY-46	40	30	85% (75%)
WPHY-52	40	30	85% (75%)
WPHY-56	40	30	85% (75%)
WPHY-60	40	30	85% (75%)
WPHY-65	54	40	85% (75%)
WHPY-70	54	40	85% (75%)

Note: Lateral expansion of broken specimens shall be recorded for information only

7.5.7 HARDNESS SURVEY

A VICKERS hardness survey shall be carried out on each produced tee after final heat treatment, in accordance with ISO 6507-1, or equivalent, using a 5 or 10 kg load. A minimum of eight equispaced 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 individual hardness shown in table of section 7.5.3.2 above, at any point. The Inspector reserves the right to ask for additional 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.

7.5.8 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 section 7.5.3.2 and 7.5.3.3 above shall be repeated after a simulated Post Weld Heat Treatment (PWHT) has been made on the tee material at a soaking temperature of not less than 25°C of the tempering temperature nor less than 580°C ± 10°C for 1 hour per 25 mm thickness of tee neck. This temperature shall be submitted to COMPANY. The PWHT procedure shall conform to Appendix C of DNV-OS-F01 and shall be approved by COMPANY. 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 tee Manufacturer on weld between tee and pup piece, if any.

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

7.5.9 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 of 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.

7.5.10 STORAGE OF TEST SPECIMEN

The test specimens and the remaining parts of tested pipes shall be stored by tee Manufacturer till the final release of goods. Those pieces may be used for any further investigation or counter tests as addressed in that present specification.

7.5.11 MATERIAL RINGS FOR WELDING TESTS

When it is agreed that tees can be supplied without welded pup pieces, then the tee Manufacturer shall supply three (3) test rings to COMPANY for qualification of welding 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 350 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 COMPANY.

7.5.12 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 10008-STD-6-PLR-006, PEGS-12059-PLR-005 (or 10008-STD-6-PLR-005, PEGS-12059-PLR-017 if there is no longitudinal weld) 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 under the stress as specified in above stated COMPANY General Specifications.

In circular weld (if any), Sulfide Stress Cracking (SSC) tests shall be carried out in accordance with specification 10008-STD-6-PLR-025, PEGS-12059-PLR-012. In longitudinal weld, if any, SSC test shall be made as per 10008-STD-6-PLR-006, PEGS-12059-PLR-005.

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.

H₂S Corrosion tests are not required for Mild Sour Service material.

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, tee size and heat treatment batch, on a product selected in agreement with the Inspector. Grouping of tees may be agreed with COMPANY.

7.6 WELDING AND WELDS

1. All longitudinal welds (if any) carried out at Mill shall be in full compliance with the COMPANY specification 10008-STD-6-PLR-005, PEGS-12059-PLR-017 and related PPS, including welding procedure qualification, welder qualification, non-destructive testing of welds, etc. Impact test requirements shall be as stated in table of section 7.5.3.1 and 7.5.3.3 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 section 7.5.3.1). Sampling for mechanical testing shall be carried out after final heat treatment (Q+T) and shall be made on tee run(s) prolongations.

Note: GMAW (STT process included) welding is not allowed for welding.

- One tensile test transverse to weld using the round bar specimen of API 5L /ISO 3183.
- Two guided bends tests
- Three sets of Charpy V-notch test:
 - a) On Weld Metal axis
 - b) On Fusion Line
 - c) 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 10008-STD-6-PLR-005, PEGS-12059-PLR-017 and 005 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 root	Weld cap
Mild	300	300
Intermediate	275	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. These welds shall be qualified by tests with visual, macrography and HV5 hardness survey only for acceptance tests.

7.7 WELDING NECK ENDS

The welding neck bevel shall be machined as per MSS SP 75, except that root face shall be 1.6 mm \pm 0.6 mm. Beveling and tapers (if any) shall be done by straight machining only.

Reference shall also be made to provisions of section 7.4.2 here above.

7.8 INSPECTION AND NON-DESTRUCTIVE TESTING

7.8.1 GENERAL

1. 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. 5.2 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 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 work 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 beveling.
6. All dimensional surveys, non-destructive inspections and mechanical testing shall be witnessed by the Inspector and results recorded by the Manufacturer. 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. ASNT in-house qualification is not acceptable, only qualification by an approved third party may be accepted. 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, testing and inspection.

7.8.2 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 section 7.10.7 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, larger than 80 mm^2 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 a V notch of depth $\leq 2.0 \text{ mm}$. 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 tees 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 or ISO 10893-8. Any laminar imperfection exceeding an area of 60 mm^2 shall not be acceptable.

5. Welds shall be 100% inspected by ultrasonics in accordance with ASME VIII Division 1, clause UW-53 and Appendix 12, for wall thickness exceeding 15mm.

For wall thickness equal to or lower than 15mm, 100% radiography (sensitivity to be 1.8% mini and ISO wire penetrameter is to be used) shall be made in accordance with ASME, Section V, Article 2, using fine grain films and (AGFA type D5, or equivalent) 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.

7.9 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.

7.10 DIMENSIONAL REQUIREMENTS AND INSPECTION

7.10.1 GENERAL

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

7.10.2 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 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 section 6.2.4), there should be no excess material on the internal diameter of tees when pipeline is designed as a constant internal diameter pipeline.

7.10.3 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. When a caliper gauge is used, measurement shall be made according to 4 equispaced diameters from bottom of bevel root face and the average value shall give the actual inside diameter.

7.10.4 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.

7.10.5 TEE END PREPARATION

Tee shall have all ends bevelled to the profile angle and root face as stated in section 7.7 of this specification. This requirement shall, also, apply to welded pup pieces, if any.

7.10.6 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 2 equispaced and parallel 6 mm thick aluminium 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 once the specified Nominal ID. All tees shall be suitable for the passage of intelligent pigs.

7.10.7 BULGES, DENTS AD 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. Bulges, dents and flat areas are not acceptable at tee ends. 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.

7.10.8 DIMENSIONAL TOLERANCES

Dimensional tolerances of tees shall be in accordance with MSS SP 75 and ISO 15590-2 except as otherwise stated above.

7.11 MILL HYDROSTATIC TESTING

1. When SUPPLIER can provide records of successful Design Proof Test of tee (refer to section 7.4.2 of this specification), then performance of the hydrostatic testing of tee is not required. In that case, 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 SMYS 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 section 7.11, item 1 hereabove cannot be met by SUPPLIER, then hydrostatic testing shall be required.

Each tee shall be hydrostatically tested at a test pressure of 90% of SMYS of matching pipeline system (using the Barlow formula and nominal specified wall thickness of matching pipe for calculation) for a duration of 4 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 and pup pieces if any.

After completion of tee testing and acceptance, closures shall be cut off, ends prepared according to section 7.7 of this specification and full inspection (i.e. visual, NDT and dimensional) shall be made as per this specification.

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

7.12 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.

7.13 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 or ISO 15590-2)

- 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 or ISO 15590-2), 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.

7.14 HANDLING, STORAGE AND PACKING

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.

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.

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

7.15 DOCUMENTATION

7.15.1 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 or ISO 15590-2 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
 - Cast 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 MPQT results
- 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 section 7.5.3)
- 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 (or Inspection and Test Plan)
- l) Compilation of concessions/deviations, if any, granted by 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.

7.15.2 SCHEDULE

1. The tees shall be dispatched only after a Release Certificate has been issued by the Inspector. Test rings may be release before the tees, when so agreed.
2. Mill certificates shall be supplied at the time of dispatch of the tees.
3. The final production report as above shall be transmitted to 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.

7.15.3 DOCUMENTATION TO SUBMIT BY 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 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 laboratory on HIC and SSC tests performed as per this specification (including the laboratory preliminary or typical procedures).
8. Track record of SUPPLIER in manufacturing tees similar to this order.
9. Details of bevel protections.
10. Details of tee packing.
11. Quality Assurance certification (ISO/TS 29001).
12. Deviations to present specification, if any.

7.16 TECHNICAL QUERIES/NON-CONFORMANCE REPORTS

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

A deviation to specifications 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 COMPANY to any SUPPLIER's work procedures, specifications, equipment, etc. shall not release, in any way, the SUPPLIER from his obligation to meet 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 SUPPLIER for submission to COMPANY. NCR report shall indicate the submitted corrective action intended by SUPPLIER.

8.0 APPENDICES

Appendix 1. Tees characteristics

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

Tee size (run dia. x branch dia.)	.....	.....
Applicable pipeline code or standard	.....	.....
Charpy V impact test: <ul style="list-style-type: none"> • Test temperature (°C): • Absorbed energies (J) <ul style="list-style-type: none"> - Min. average: - Min. Single: .....	.....	.....
Corrosion Allowance (mm)	.....	.....
Design Pressure (Barg)	.....	.....
Design/Safety factor	.....	.....
Matching pipe/main header: <ul style="list-style-type: none"> • Steel grade (ISO 3183) • Nominal Internal Diameter (Bore) (mm) • Nominal Wall Thickness (mm)	.....	.....
Matching pipe/outlet neck: <ul style="list-style-type: none"> • Steel grade (ISO 3183) • Nominal Internal Diameter (Bore) (mm) • Nominal Wall Thickness (mm)	.....	.....
Max. Design Temperature (°C)	.....	.....
Mill Hydrostatic Test Pressure (Barg)	.....	.....
Min. Operating Temperature (°C)	.....	.....
Min. Steel Design Temperature (°C)	.....	.....
Pipeline service (Mild, Intermediate or Severe sour)	.....	.....
Tee pressure-temperature rating (B31.4/B31.8)	.....	.....
Tee steel grade (MSS SP 75) or ISO 15590-2	.....	.....
Type of effluent	.....	.....

Appendix 2. Welding of pup pieces (if any)

1. General

Welding of pup pieces to tees shall be in accordance with the requirements of COMPANY specification 10008-STD-6-PLR-025, PEGS-12059-PLR-012 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 COMPANY, except that GTAW is acceptable and recommended 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) 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, 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 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 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 10008-STD-6-PLR-025, PEGS-12059-PLR-012.

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 10008-STD-6-PLR-025, PEGS-12059-PLR-012. Tests and results shall comply with the requirements of specification 10008-STD-6-PLR-025, PEGS-12059-PLR-012.

a) Macrosection/Hardness tests

Hardness values shall not exceed the values stated in Table of section 7.6 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 section 7.5.5 of this specification and the requirement of 10008-STD-6-PLR-025, PEGS-12059-PLR-012 for the specified sour service and pipeline effluent.

5. Qualification of welders

Welders shall be qualified as per 10008-STD-6-PLR-025, PEGS-12059-PLR-012. 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 10008-STD-6-PLR-025, PEGS-12059-PLR-012.

All welds shall then be 100% examined by Magnetic Particle Inspection in accordance with 10008-STD-6-PLR-025, PEGS-12059-PLR-012.

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 10008-STD-6-PLR-025, PEGS-12059-PLR-012.

7. Weld acceptance criteria

The weld acceptance criteria for welding procedure qualification tests, welder qualification tests and production welds shall be as defined in 10008-STD-6-PLR-025, PEGS-12059-PLR-012.

Appendix 3. Required Connection Branch v/s Header

		OD Branch (Inch)																	
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
OD Header (Inch)	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	14	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0
	16	2	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0
	18	2	2	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0
	20	2	2	2	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0
	22	2	2	2	2	2	2	2	2	1	1	1	0	0	0	0	0	0	0
	24	2	2	2	2	2	2	2	2	2	1	1	1	0	0	0	0	0	0
	26	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0	0	0	0
	28	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0	0	0
	30	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0	0
	32	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0
	34	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0
36	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	

0 = Not allowed

1 = Tee

2 = Tee or Sweepolet or LWNSR (Long Weld Neck Self Reinforced)



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