TECHNICAL SPECIFICATION

CARBON AND LOW ALLOY STEEL PIPELINE FLANGES FOR USE IN OIL AND GAS OPERATIONS (AMENDMENTS/SUPPLEMENTS TO MSS SP-44)

DEP 31.40.21.34-Gen.

July 1998
(DEP Circular 61/99 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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PART I INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the manufacture and supply of carbon steel and low alloy pipeline flanges.

Part II of this DEP gives amendments and supplements to clauses of MSS SP-44 which are considered necessary to ensure pipeline integrity.

This DEP is applicable to flanges for use in both sour and non-sour service.

NOTE: Sour service is defined in DEP 31.22.20.31-Gen.

In addition to the flange types included in MSS SP-44, swivel ring flanges and anchor flanges are also covered by this DEP.

Bolting and gaskets are excluded from the scope of this DEP.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F", as described in DEP 00.00.05.05-Gen.).

This DEP specifies the minimum technical requirements for flanges to be used in the construction or maintenance of oil and/or gas pipelines and related facilities. It is intended for use in exploration and production facilities, transmission pipelines and, where applicable, oil refineries, chemical plants and supply/marketing installations

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Bevel	Replaces the term “welding end” as used in MSS SP-44
Defect (in NDT)	A discontinuity or group of discontinuities whose

	indication(s) do not meet specified acceptance criteria.
Flaw/discontinuity (in NDT)	An interruption, which may be either intentional or unintentional, in the physical structure or configuration of a pipe.
Indication (in NDT)	Evidence of a discontinuity that requires interpretation to determine its significance.
Minimum design temperature	The minimum temperature to which the pipeline or section of pipeline may be exposed during normal operational activities, including start-up and shut-down operations and controlled blowdown, but excluding abnormal situations such as pipeline ruptures.
Sample product	Flange selected for inspection and/or testing
Test unit	The number of flanges to be accepted or rejected together, on the basis of the tests carried out on sample products
Test welding ring	Sample of tubular material from the forging required for use in welding procedure and welder approval testing.
User	Term used in MSS SP-44 which shall be taken to mean the Principal.

1.4 ABBREVIATIONS

CE	Carbon equivalent
ID	Nominal internal diameter
MT	Magnetic particle testing
NDT	Non-destructive testing
UT	Ultrasonic testing
WPAR	Welding procedure approval record
WPS	Welding procedure specification

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (Part III).

1.6 GUIDANCE FOR USE

The amendments to MSS SP-44 given in Part II are directly related to equivalent sections in MSS SP-44. For clarity, the section and paragraph numbering of MSS SP-44 has been used as far as possible. Where clauses in MSS SP-44 are referenced within this DEP, it shall mean those clauses as amended by this DEP. Clauses in MSS SP-44 that are not amended by this DEP shall remain valid as written.

1.7 INFORMATION TO BE SUPPLIED BY THE PRINCIPAL

The following information shall be supplied by the Principal to the Manufacturer at the enquiry stage:

- the type of flange;

- the type of flange face;
- ID of flange;
- class (pressure and temperature rating);
- the grade of flange material;
- service: sour or non-sour;
- minimum design temperature;
- pipeline hydrotest pressure if in excess of 1.5 times the pressure rating for the class specified;
- grade, ID and wall thickness of adjoining pipe;
- type of ISO 10474 inspection certificate, or inspection report, required.

The Principal shall also supply the following supplementary information, where applicable, to the Manufacturer at the enquiry stage of the order:

- number and dimensions of test welding rings required for test welding;
- grade of temporary preservation compound required;
- whether flange design calculations are subject to the agreement of the Principal prior to manufacture;
- whether previous test data can be considered for approving manufacture;
- whether testing is required in the simulated stress-relieved condition;
- the number of sample products to be tested per test unit;
- whether the Manufacturer is required to submit a quality plan for agreement by the Principal prior to manufacture;
- whether the Principal intends to witness any of the Manufacturer's production and quality control operations;
- whether the chemical composition of the Manufacturer’s proposed flanges is subject to the agreement of the Principal prior to manufacture;
- whether specific quality assurance/control procedures of the Manufacturer shall be agreed by the Principal prior to manufacture;
- whether alternative bevel dimensions are required;
- the pipeline design, test and/or operating conditions, together with the load combinations e.g. internal pressure bearing loads plus bending moments, for which the flange design shall be verified by the Manufacturer;
- support details (for anchor flanges only).

PART II AMENDMENTS/SUPPLEMENTS TO MSS SP-44

SECTION 1 SCOPE

1.1 GENERAL

Add the following:

Blind flanges for sour service shall be manufactured from forged steel.

Add new subsection:

1.3 QUALITY SYSTEM

The Manufacturer/Supplier should maintain and operate a quality system in accordance with ISO 9001, ISO 9002, or similar alternative standard agreed by the Principal.

SECTION 3 MATERIALS

3.1.2 Add the following:

The steel used shall be suitable for welding to line pipe manufactured in accordance with DEP 31.40.20.30-Gen or DEP 31.40.20.31-Gen. (as applicable), and to fitting materials manufactured in accordance with DEP 31.40.21.30-Gen.

3.1.3 Replace this section (including 3.1.3.1) with the following:

The chemical composition of the flanges, as determined by product analysis, shall comply with the following limits:

Element	Maximum permitted content, wt%	Notes
C	0.23	
Mn	1.60	5
Si	0.45	
P	0.025	5
S	0.010	
V	0.08	1
Nb	0.05	1
Ti	0.03	1
Cr	0.20	2
Mo	0.20	2
Ni	0.35	2
Cu	0.40	2
Al	0.05	3
N	0.012	3
B	0.0005	
CE sour	0.43	4
CE non-sour	0.45	4

NOTES:
1. V+Nb+Ti shall not exceed 0.15%.
2. Cr+Mo+Ni+Cu shall not exceed 0.6%.
3. The total Al: N ratio shall not be less than 2:1.
4. CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15.
5. For sour service Mn shall be $\leq$ 1.40 and P shall be $\leq$ 0.020

Product analysis shall be performed with a frequency of at least one per heat.

Retainer rings for swivel ring flanges should have the same composition as the flanges.

3.1.4 Replace this section with the following:

The mechanical properties of the flanges shall meet the requirements specified in Table 1 below and shall meet the Manufacturer's design conditions as given in Annex A or, for blind flanges, Annex B of MSS SP-44.

Replace Table 1 with the following:

Table 1 Tensile requirements

	Tensile test requirements (minimum)			Charpy impact test requirements	
Grade	**0.2% Proof stress, MPa**	**Tensile strength MPa**	**Elongation % of 50 mm**	**Minimum average absorbed energy (J)**	**Minimum individual absorbed energy (J)**
F42	290	415	20	29	24
F46	315	415	20	32	24
F48	330	425	20	36	27
F50	345	440	20	36	27
F52	360	455	20	36	27
F56	385	470	20	39	30
F60	415	515	20	42	32
F65	450	530	20	45	34
F70	485	565	20	50	38

If stress relieving is required for field welds, mechanical testing shall also be required in the simulated stress-relieved condition. The acceptance criteria shall be as shown in (Table 1). The Principal shall inform the Manufacturer at the time of enquiry of the need for, and details of, the stress-relieving operation.

Manufacture of each type and size of flange or swivel ring shall be approved by destructive testing of a test flange or test swivel ring which has been subjected to all forming and heat treatment operations.

The use of previous test data to approve manufacture is subject to the approval of the Principal.

3.1.4.1 Replace this section with the following:

For approval testing, tensile properties shall be determined using specimens removed from a test flange of each type and test swivel ring which has been subjected to all forming and heat treatment operations. Tensile test specimen location shall be as described in (Figures A, B, or C).

For production quality control testing, specimens may be taken from forging prolongations of the hub length, blind flange, anchor ring, or swivel ring length. The specimen orientation shall be tangential.

The testing procedure shall be in accordance with ASTM A 370.

Add new section:

3.1.4.2 The impact toughness of the flanges shall be determined by Charpy V-notch impact testing in accordance with ASTM A 370 using full-size specimens where possible.

Amended per Circular 61/99

The impact test temperature shall be lower than or equal to that specified below, with a maximum of O °C.

Nominal wall thickness, t (mm)	Test temperature (°C)
$t \leq 16.0$	T
$16.0 < t \leq 25$	T-10
$t > 25$	T-20

T is the minimum design temperature, which shall be specified by the Principal. If no minimum design temperature is indicated, the test temperature shall be 0 °C.

For approval testing, specimen location and orientation shall be as shown in (Figures A, B, and C). Tangential specimens shall have a through thickness notch aligned with the radial direction.

For production quality control testing, specimens may be taken from forging prolongations of the hub length, anchor ring length, blind flange length, or swivel ring length. The specimen orientation shall be tangential.

The Charpy energy acceptance criteria are shown in (Table 1) for full size 10 mm x 10 mm specimens. Where subsize specimens are used, the energy acceptance criteria may be adjusted proportionally.

The shear area at the fracture surface of the test specimens shall be recorded. Each specimen shall exhibit not less than 50% fibrous shear.

Add new section:

3.1.4.3 For approval testing, three through thickness macrosections shall be taken at 120º intervals from the hub and ring of the test flange, and from the test swivel ring.

For production quality control, macrosections may be extracted from forging prolongations.

Three hardness traverses shall be made on each macrosection as follows:

- 1.5 ± 0.5 mm from the outer surface
- Mid-thickness
- 1.5 ± 0.5 mm from the inner surface

Each traverse shall consist of five indents spaced in accordance with ASTM A370.

For sour service flanges, no hardness reading shall exceed 248 HV10. For non-sour service flanges, no hardness reading shall exceed 325 HV10.

Add new sub-subsection:

3.1.5 Test welding rings shall be of the same material as the flanges and subjected to the same heat treatment.

SECTION 4 HEAT TREATMENT

4.1 Replace this section with the following:

Flanges shall be furnished in the normalised, normalised and tempered, or quenched and tempered condition.

SECTION 5 FLANGE DESIGN

5.4 WELDING END

Replace this section with the following:

Unless otherwise specified by the Principal, the bevel dimensions for all flanges shall be as shown in Figure 2 of MSS SP-44.

Delete note a of Figure 2.

Add new section*:*

5.9 DESIGN CONDITIONS

Where required by the Principal, the flange design shall also be verified for the design conditions specified by the Principal in the purchase order.

Anchor flanges shall be designed for the combined internal pressure and bearing load on the flange.

Add new section:

5.10 INTERNAL DIAMETER

Except for blind flanges, flanges shall be supplied with the internal diameter specified by the Principal.

Add new section:

5.11 SWIVEL RING FLANGES

Swivel ring flanges shall have a swivel ring free to rotate through 360 degrees for alignment of bolt holes.

A retainer ring shall be attached to the flange, with a suitably dimensioned fillet weld to retain the swivel.

Add new section:

5.11.1 Welding of retainer ring

The content of the WPS shall be in accordance with ISO 9956-2. The WPS shall have been approved by welding procedure tests in accordance with ISO 9956-3. The WPAR supporting the WPS shall include hardness testing of the test weld and shall show that welds can meet the hardness acceptance criteria of this DEP. An increase in the carbon equivalent value of the flange or retainer ring material greater than 0.03 units compared to the material used for the test weld shall be considered as being outside the range of approval.

Welders shall be approved by a fillet welding test in accordance with ISO 9606-1.

SECTION 6 MARKING

6.1 Replace this section with the following:

The Manufacturer shall die stamp the periphery of each forging before final heat treatment with 10 mm high round nosed or dot stamps. The marking shall be the Manufacturer's mark, the flange size, rating, material grade, heat number, purchase order and item number.

Add new section:

6.3 TEMPORARY PRESERVATION

A temporary preservation compound specified by the Principal shall be applied to all flange faces after machining.

SECTION 9 FLANGE BOLTING DIMENSIONS

Delete this section.

SECTION 10 TOLERANCES

10.3.2 Replace this section with the following:

The tolerance on the internal diameter shall be ±1.5 mm of the nominal internal diameter.

Add new section:

SECTION 11 INSPECTION

11.1 VISUAL INSPECTION

The entire surface of each flange shall be visually examined, internally and externally, for surface defects. Illumination levels greater than 500 lux shall be provided to enable proper inspection.

11.2 NON-DESTRUCTIVE TESTING

All personnel performing NDT activities shall be certificated in the technique applied, in accordance with ISO 9712 or equivalent. Inspectors performing UT shall be certificated to at least level II; inspectors performing other NDT shall be certificated to at least level I.

NDT for acceptance of the flange (final inspection) shall take place after all heat treatment and machining operations.

All flanges shall be ultrasonically tested for laminations in accordance with ASTM A 388.

The entire final surface of all production flanges shall be subjected to wet MT in accordance with ASTM A 275.

11.3 ACCEPTANCE CRITERIA

11.3.1 General UT

The acceptance criteria shall be the recording levels specified in ASTM A 388.

11.3.2 Bevel faces

The bevel faces shall be machined and shall be free from cracks, laminations, notches, scores, pits etc.

11.3.3 Remainder of flange

Laminations, cracks, slivers, notches, scores, pits etc., shall be considered as defects.

11.4 REPAIR OF DEFECTS

Defects shall not be repaired by welding. Repairs may be made by machining or grinding if the remaining thickness is equal to or greater than the required minimum design thickness. In all cases where repairs are made as a result of imperfections or defects being disclosed by NDT, the repaired area shall be visually inspected and subjected to MT for confirmation of defect removal.

11.5 DIMENSIONAL CONTROL

The dimensions specified in Tables 6 to 10 of MSS SP-44 shall be checked on each flange.

Add new section:

SECTION 12 DOCUMENTATION TO BE PROVIDED BY THE MANUFACTURER

12.1 LANGUAGE

All documentation submissions required by this DEP shall be in the English language.

12.2 PRE-MANUFACTURING DOCUMENTATION

If required by the Principal, the Manufacturer's contract-specific quality plan shall be submitted to the Principal for agreement within the time period specified in the contract document and prior to commencement of flange manufacturing.

NOTE: Review of a draft quality plan at the enquiry stage of the contract may assist the process.

12.2.1 Content of the quality plan

The format and issue of the quality plan shall be consistent with the document control element of the Manufacturer's quality system.

The content of the quality plan should be based on ISO 10005 and shall include the following:

1. Identification of the product and contract to which the plan is to be applied.
2. Reference to MSS SP-44 and this DEP.
3. Location of manufacture.
4. Identification of the individuals responsible for controlling the activities defined in the plan.
5. Identification of the individuals with the authority to interface directly with the Principal.
6. Identification of all subcontractors.
7. The quality plans of all subcontractors.
8. All sequenced activities for the contract and references to the quality system procedures and work instructions which will be applied to these activities.
9. Copies of the quality system procedures and work instructions required by the Principal.
10. Test and inspection frequency and acceptance criteria, including the upper and lower process control limits where statistical process control is employed.
11. The location of each inspection and test point in the activity sequence.
12. Points where the Principal has established witnessing or verification requirements.

12.3 CERTIFICATION

The Manufacturer shall provide the Principal with an inspection certificate or report, as specified by the Principal in the purchase order, giving the results of all required tests and inspection. The certificate, or report, shall comply with the appropriate part of ISO 10474

12.4 RETENTION OF RECORDS

The Manufacturer/Supplier shall retain all quality records for a period of five years after completion of the order. Quality records shall be made available to the Principal upon request.

FIGURE A SCHEMATIC LONGITUDINAL SECTION OF WELDNECK AND ANCHOR SWIVEL RING FLANGES SHOWING THE POSITION OF THE MECHANICAL TEST SPECIMENS

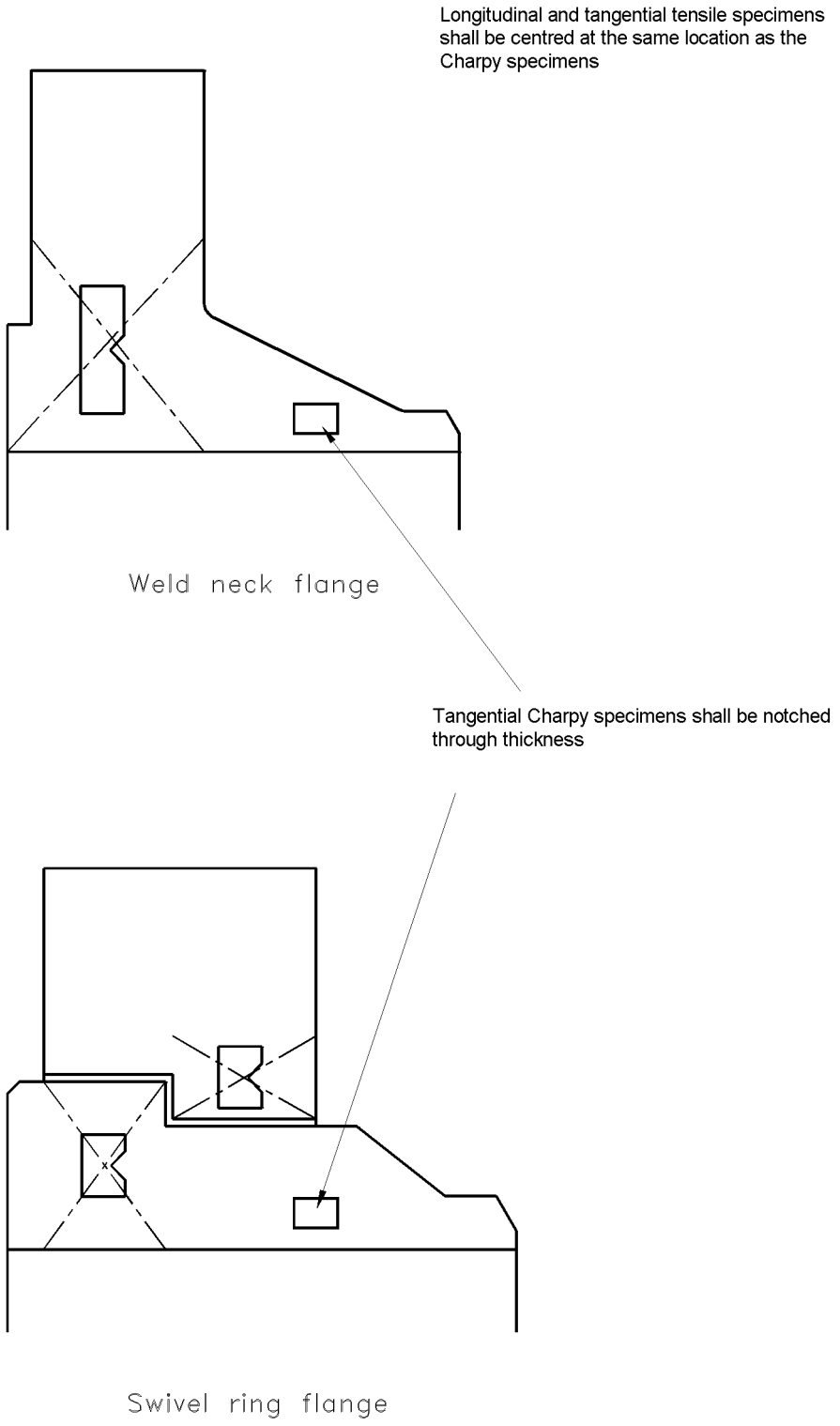


FIGURE B SCHEMATIC SECTION SHOWING LOCATION OF CHARPY AND TENSILE TEST SPECIMENS FOR APPROVAL TESTING OF ANCHOR FLANGES

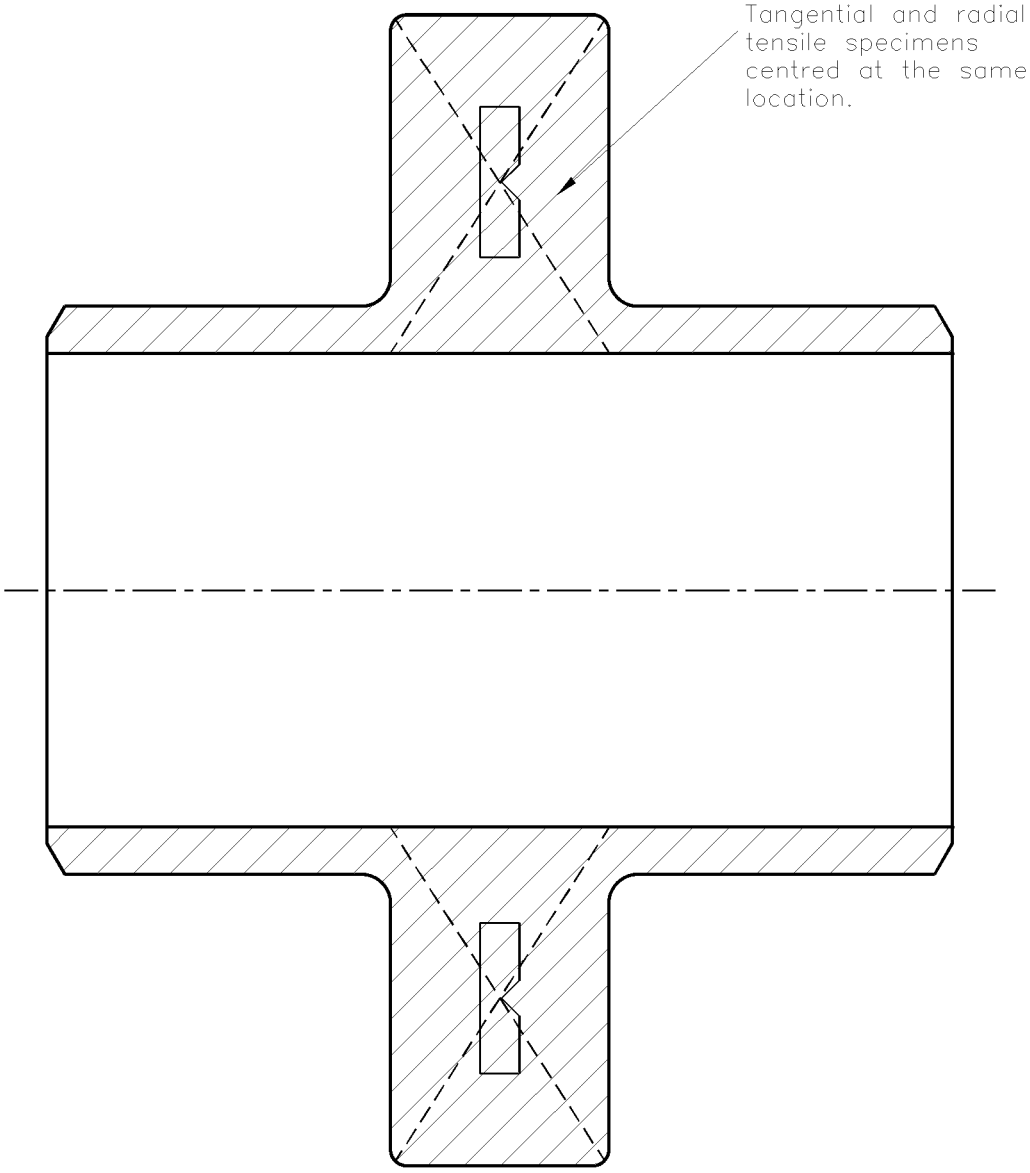
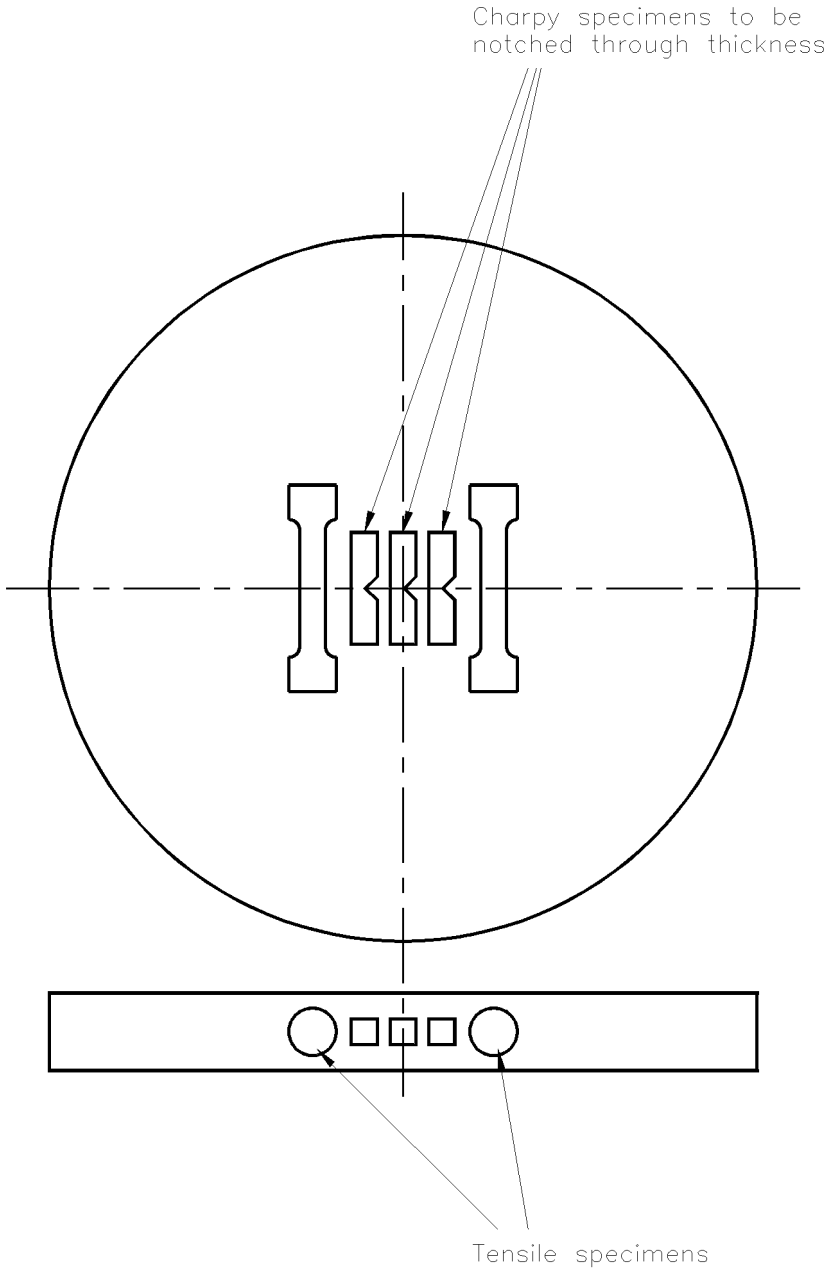


FIGURE C SCHEMATIC SECTION OF A BLIND FLANGE SHOWING THE LOCATION OF THE MECHANICAL TEST SPECIMENS FOR APPROVAL TESTING



PART III REFERENCES

In this DEP reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Pressure vessels (amendments/supplements to ASME Section VIII Division 1 and Division 2)	DEP 31.22.20.31-Gen
Linepipe for use in oil and gas operations under non-sour conditions (amendments/supplements to API Spec 5L)	DEP 31.40.20.30-Gen
Linepipe for use in oil and gas operations under sour conditions (amendments/supplements to API Spec 5L)	DEP 31.40.20.31-Gen
Pipeline fittings (amendments/supplements to MSS SP-75)	DEP 31.40.21.30-Gen

AMERICAN STANDARDS

Test method for magnetic particle examination of steel forgings	ASTM A 275
Test methods and definitions for mechanical testing of steel products	ASTM A 370
Ultrasonic examination of heavy steel forgings	ASTM A 388

Issued by:
American Society for Testing and Materials
1916 Race Street
Philadelphia PA 19103
USA.

Standard practice: Steel pipeline flanges, 1996 Edition	MSS SP-44

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Manufacturers Standardization Society
of the Valve and Fittings Industry, Inc.
127 Park Street, N.E.
Vienna, Virginia 22180
USA.

INTERNATIONAL STANDARDS

Quality Systems - Model for quality assurance in design, development, production, installation and servicing	ISO 9001
Quality Systems - Model for quality assurance in production, installation and servicing	ISO 9002
Approval testing of welders - Fusion welding - Part 1: Steels	ISO 9606-1
Non-destructive testing; qualification and certification of personnel	ISO 9712
Specification and approval of welding procedures for metallic materials - Part 2: Welding procedure specification for arc welding	ISO 9956-2
Specification and approval of welding procedures for metallic materials - Part 3: Welding procedure tests for the arc welding of steels	ISO 9956-3
Quality management - Guidelines for quality plans	ISO 10005

Steel and steel products, inspection documents ISO 10474

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Copies can also be obtained from national standards organizations.