



GS 142-4

PIPELINE FLANGES

November 1996

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SCOPE AND PURPOSE This specification covers BP's supplementary requirements for the design, manufacture and supply of forged steel pipeline flanges for use with linepipe to API 5L Grade B to Grade X 70 inclusive or equivalent grades in ISO 3183. Its purpose is to clarify the minimum design, testing, inspection and certification requirements for forged steel pipeline flanges as set out in ISO 7005-1 and ANSI/ASME B 16.5.											
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Issued by:- Engineering Practices Group, BP International Limited, Research & Engineering Centre Chertsey Road, Sunbury-on-Thames, Middlesex, TW16 7LN, UNITED KINGDOM Tel: +44 1932 76 4067 Fax: +44 1932 76 4077 Telex: 296041											

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FOREWORD

Introduction to BP Group Recommended Practice and Specifications for Engineering

The Introductory volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Guidance for Specification

This Guidance for Specification provides BP supplementary requirements for forged steel pipeline flanges for use with linepipe of [API 5L](#) Grade B to Grade X70 and equivalent grades in [ISO 3183](#) based on BP's knowledge and experience worldwide.

Application

This Guidance for Specification is intended to guide the purchaser in the use or creation of a fit-for-purpose specification for enquiry or purchasing activity.

Text in *italics* is Commentary. Commentary provides background information which supports the requirements of the Specification, and may discuss alternative options. It also gives guidance on the implementation of any "Specification" or "Approval" actions; specific actions are indicated by an asterisk (*) preceding a paragraph number.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Principal Changes from Previous Edition

This specification uses a "zero-based" approach to define BP's essential requirements.

Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSE's, to assist in the process of their continuous improvement.

For feedback and further information, please contact Standards Group, BP Engineering or the Custodian. See Quarterly Status List for contacts.



1. INTRODUCTION

1.1 Scope

- 1.1.1 This Specification defines BP general supplementary requirements for the design, manufacture and supply of forged steel pipeline flanges for use with linepipe to [API 5L](#) Grade B to Grade X70 inclusive or the equivalent grades from [ISO 3183](#). It includes requirements for welding neck, swivel ring and blank flanges. The use of slip-on flanges is not permitted. Where material grades stronger than X70 or the ISO equivalent grade are necessary requirements in addition to those defined herein may be appropriate.

An international standard encompassing the requirements of [API 5L](#) is currently being prepared by ISO. When all three parts of this Standard, [ISO 3183](#), have been issued reference to [API 5L](#) will be deleted from this Specification.

- * 1.1.2 This Specification applies to flanges in transmission pipeline systems both on land and offshore connecting wells, production and process plants and storage facilities, including any section of the pipeline constructed within the boundaries of such facilities for the purpose of its connection to such units.

- 1.1.3 This Specification shall not be applied to general refinery and chemical plant duties these applications are covered by the supplementary requirements of BP Group Specification [GS142-12](#) equivalent.

- 1.1.4 Additional requirements for the chemical composition, mechanical testing and non-destructive examination may be specified by BP for sour service.

BP [GS 136-1](#) defines the testing required on materials proposed for use in sour environments.

- 1.1.5 The first draft of a proposed International Standards Organisation (ISO) document covering the same scope as this Specification has recently been published. When that document is formally issued it is intended that this BP document will be withdrawn.

1.2 Quality Assurance

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser. The quality system should ensure that the technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services provided by sub-contractors and to any free issue materials.



2. DESIGN

- 2.1 All flanges shall be made of forged steel. However, for certain applications and subject to a detailed proposal being submitted by the manufacturer, consideration may be given to the use of blank flanges manufactured from rolled plate.
- 2.2 Welding neck and blank flanges shall be designed as raised face, ring type joint flanges, in accordance with [ISO 7005-1](#) or other internationally recognised codes such as [ASME/ANSI B16.5](#) (inch dimensions), [ASME/ANSI B16.47 BS 1560](#) or [MSS SP 44](#), except as modified by this Specification.
- 2.3 The manufacturer's design basis for swivel ring flanges shall be explained in his offer. The swivel rings shall be secured to their welding hubs (for example by a thin retaining ring). Apart from this, the flanges shall be of unwelded construction.
- * 2.4 Unless the outside diameter at the weld bevel is increased, and a reduction in strength at the hub extension is then approved by BP, the minimum tensile properties there shall match those of the designated linepipe. Where a reduction in the strength level is agreed the revised minimum value shall be specified in the Purchase Order together with any revision to the notch ductility requirements of 4.2. Tensile properties of blank flanges shall be compatible with their mating pipeline flanges and meet the requirements of the design standard, while those of swivel rings shall meet the manufacturer's design strength, subject to approval by the BP Materials Engineer.
- 2.5 The internal diameter (bore) of the flange is defined by the pipeline data sheet, and shall have a tolerance of +/- 1.5mm (1/16 in).
- This restriction on internal bore dimension for flanges corresponds to that specified for linepipe.*
- 2.6 Where necessary, tapering of the flange to meet the outside diameter/wall thickness of the specified mating pipe shall be external machining only. Maximum angle of taper shall be 14°, equivalent to a slope of approximately 1 in 4.
- 2.7 The weld bevel angle shall be 30 degrees plus 5 degrees, minus 0 degrees for thicknesses up to 20mm. Above this thickness details of any alternative end bevel preparation will be provided in the Purchase Order.



2.8 The weld bevel root face shall be 1.5 +/- 0.5 mm (1/16 in +/- .020 in).

3. MANUFACTURE

3.1 The steel shall be made by the electric furnace or basic oxygen process, and shall be fully killed and of fine grain size.

3.2 The cast material shall be hot forged to bring it as close as is practicable to the final shape and size. All parts shall undergo a reduction of at least 2:1 during the forging process.

3.3 All flanges shall be heat treated by normalising, or quenching and tempering, to obtain the required mechanical properties. The tempering temperature shall take account of the stress-relieved property requirements of Section 4.2.5.

4. MATERIALS

4.1 Chemical Composition

4.1.1 Unless alternative analyses proposed by a manufacturer are approved by the BP Materials Engineer, each steel heat analysis and forged product analysis shall fall within the following limits. Alternative analyses which significantly infringe these limits on carbon equivalent are not normally acceptable.

Carbon	0.20% max
Manganese	0.80 to 1.70%
Silicon	0.15 to 0.40%
Nickel plus chromium plus molybdenum	0.30% max
Vanadium plus niobium plus titanium	0.15% max
Aluminium	0.025 to 0.060%
Sulphur	0.010% max
Phosphorus	0.015% max
Copper	0.35% max
Nitrogen	0.012% max
Boron	0.0005%
Calcium	0.006%
Nickel plus chromium plus molybdenum	0.30% max
Vanadium plus niobium plus titanium	0.15% max
Carbon Equivalent(CEV)	0.45% max.

where,



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

Additional limitations on Manganese (to 1.40% max.) and Sulphur (to 0.003% max.) may be necessary for flanges in sour service.

- 4.1.2 The analysis shall be determined both on each heat of steel used, and also on a broken mechanical test piece from each heat.
- 4.1.3 Other elements shall not be added to the steel without the approval of the BP Materials Engineer.
- 4.1.4 If any part of the product analyses fails to meet the requirements of 4.1.1, the whole heat shall be rejected or each individual item shall be fully analysed and all items failing to meet the requirements shall be rejected.

4.2 Mechanical Properties

- 4.2.1 The following mechanical tests shall be carried out on one flange of each type on every heat (or heat treatment lot if this occurs more frequently) which has been subject to all forming and heat treatment operations.
- 4.2.2 Tensile properties shall be determined using 10mm diameter longitudinal and transverse tensile test pieces taken from the locations shown in Figure 2, for weld neck and swivel flanges, and Figure 3 for blank flanges. The testing procedure shall be in accordance with [ASTM A 370](#) or agreed alternative.
- 4.2.3 The impact toughness of the flanges shall be determined by Charpy V-notch impact testing in accordance with [ASTM A 370](#). Full size, 10 x 10mm, Charpy V-notch test pieces shall be machined from the positions shown in Figures 2 and 3.
- 4.2.4 Unless stated otherwise on the Pipeline Data Sheet, the minimum acceptable Charpy toughness shall be an average, from three specimens, of 50J, with no individual value below 40J. The test temperature shall be established from Figure 1, using the wall thickness of the matching linepipe. The test temperature shall not be greater than the minimum design temperature. The yield strength, tensile strength, reduction of area and elongation shall be measured and the results shall comply with 2.3.

The Charpy impact toughness requirement specified is that considered necessary to meet the HAZ toughness requirement specified in an applicable pipeline welding code e.g. [BS 4515](#).



- 4.2.5 On each flange selected for mechanical testing, hardness tests shall be carried out at 0.1 diameter intervals in a longitudinal direction along both the internal and external surfaces using a portable instrument approved by BP. In addition macro-sections shall be cut from each end of weld neck and swivel flanges and the hardness measured through the material thickness using a Rockwell or Vickers testing machine. The hardness shall not exceed 248 HV10 where service is sour, or 300 HV10 where service is non-sour.
- 4.2.6 The above mechanical property requirements shall also be met by samples from the first test flange of each size after an additional heat treatment of 2 hours at 600 C +/- 10 C (1112 F +/- 18 F).
- 4.2.7 For flanges in sour service BP may specify additional testing based on BP [GS 136-1](#). BP will confirm testing frequency and acceptance criteria prior to contract.
- 4.2.8 BP will permit a retest only if there is reason to believe that failure was due to some fault in preparation or testing, and was not representative of the test sample

The manufacturer may re-heat-treat the batch (including the original test flange) if he believes that subsequent tests will succeed in meeting the requirements.

5. GASKETS AND BOLTING

- 5.1 Gaskets shall be ring type, of soft iron, with a maximum Brinell hardness of 90 conforming to [ANSI B 16.20](#) as required by BP Group Specification [GS142-7](#).
- 5.2 All stud bolts and nuts shall meet the general requirements of BP [GS 142-9](#) and shall be threaded full length. The minimum length of point shall be:
- (a) For overland applications, in accordance with [BS 4882](#).
 - (b) For subsea applications, 10% of the bolt diameter. The length of stud bolts will be treated as special and will be specified in the enquiry and order.
- 5.3 For minimum design temperatures down to -20 C (-4 F) studbolts shall be to [BS 4882](#) (or [ASTM A193](#)) Grade B7 and hexagon nuts to [BS 4882](#) (or [ASTM A194](#)) grade 2H. Where design temperature is below -20°C the requirements of BP Group Specification [GS142-9](#) shall apply.



When specified on the order, the nuts shall be drilled to suit bolt tensioning equipment.

- 5.4 The protection of nuts and studbolts shall be as specified in the Purchase Order and shall comprise either heavy cadmium plated in accordance with [BS 1706](#) Class A Cd 4 (giving a minimum plating thickness of ten microns, and an average of 15 microns) or hot-dip zinc coating in accordance with [ASTM A153](#).
- 5.5 Charpy V-notch tests witnessed by BP shall be carried out on one studbolt from each batch. Results shall meet the requirements of 4.2.

6. NON-DESTRUCTIVE TESTING

- 6.1 Personnel performing NDT activities shall be qualified in the technique being applied in accordance with [ISO 9712](#) or approved equivalent.
- * 6.2 All NDT shall be carried out after final heat treatment using procedures approved by BP.
- 6.3 All surfaces of each flange shall be visually examined for defects and shall satisfy the requirements of [ASTM A 694](#). Illumination greater than 500 lux shall be required to enable proper inspection.
- 6.4 The neck of each flange shall be examined for laminations and other defects within 4t of the weld bevel, where 't' is the nominal thickness at the weld bevel, by ultrasonic testing in accordance with [ISO 11496](#) or [ASME V](#).
- 6.5 Planar defects of any size, pores or inclusions larger than 5 mm (3/16 in) in their greatest dimension and laminations exceeding 50mm² are unacceptable.
- 6.6 After final machining, each flange shall be examined for surface defects by wet magnetic particle inspection in accordance with [BS 6072](#) or [ASTM E 709](#).
- 6.7 Surface defects which do not encroach on the specified dimensions shall be removed by grinding or further machining. Grinding or machining below minimum thickness shall be cause for rejection.
- 6.8 Repair of any defect or imperfection by welding is not permitted.
- 6.9 Hardness tests shall be performed on the internal and external surfaces of each flange at approximate 0.1 diameter intervals along its length



using a portable instrument approved by BP e.g. EQUOTIP. Values shall not exceed those stated in 4.2.3.

- 6.10 For swivel ring flanges, the weld between the retaining ring and the hub shall be subject to wet magnetic particle inspection in accordance with [BS 6072](#) or [ASTM E 709](#).
- 6.11 Dimensional tolerances, in accordance with 2.0, 12.2 and the approved drawings, shall be verified for each flange.

7. HYDROSTATIC TEST

- * When the flanges have been installed they may be required to undergo a field hydrostatic test. BP will specify the pressure prior to contract. The manufacturer will be required to provide a warranty for all flanges supplied to this Specification at all pressures up to and including that advised for the field test following installation.

8. INSPECTION

- 8.1 BP or a BP appointed inspector may require:
- (a) Access at any reasonable time.
 - (b) Reasonable facilities for inspection.
 - (c) To inspect forgings dimensionally, to stamp or otherwise identify forgings and test pieces, and reject any material not complying with the requirements of this Specification.
 - (d) To witness all mechanical tests and confirm that all heat treatment and residual defects are within agreed limits, that the chemical analysis is within the agreed range.
 - (e) To check that surfaces of the flanges are clean and free from damage, that swivel rings and their welding hubs are machined smooth (and with sufficient free play so that the swivel rings can rotate freely), and that all items are correctly marked by stamping on the outer machined ring of the flange (using low stress stamps).
 - (f) To check that all flanges have the same external dimensions and bolt hole positions, so that flanges can be mated with (and bolted to) any other flange of the same size, that stud bolt threads are free from burrs and that the nuts run freely along the full thread length when turned by hand.



- (g) To investigate swivel ring flange design, the first swivel flange assembly shall be bolted to a blank flange (prior to attachment of the swivel retaining ring) and full field loading applied to the bolts. The assembly shall then be dismantled and the swivel ring and hub inspected by wet magnetic particle inspection, and a full dimension re-inspection carried out. Any defects found, and any dimensions out with the agreed tolerance range (other than those of the ring groove) will be cause for rejection.

NOTE:- Inspection by BP does not relieve the manufacturer of his responsibility to ensure that the quality plan is strictly implemented and that all related documentation is available.

9. CERTIFICATION

- * 9.1 The original steel makers certificates shall be supplied for each heat of steel used.

The flange manufacturer shall prepare a test certificate for each heat of steel used for each type of forging (or each heat treatment lot where more than one lot is made from the same heat). This shall show the heat number, the steelmaking process, the heat and product analysis, the heat treatment and the mechanical properties as determined from the test pieces from that heat or lot. The certificate shall identify by reference number, all flanges covered and shall be subject to approval by the BP Materials Engineer.

- 9.2 The manufacturer shall ensure that all documents related to this Specification and the purchase order are collated, indexed and retained for subsequent presentation to BP.

These shall be:-

- (a) List of flanges, identification and heat numbers.
- (b) Chemical and mechanical properties.
- (c) NDT results.
- (d) Dimensional drawings.
- (e) Weights.
- (f) Purchase order.
- (g) Test certificates as per 9.1.
- (h) Other documents required on the purchase order (e.g. inspection release forms).



The documentation shall be presented in data folders in chronological order, edited into sections and clearly indexed for ease of recovery and traceability.

10. MARKING, COATING AND PACKING

- 10.1 The flange reference number and class rating shall be stamped on the periphery of each flange, and of each swivel ring flange hub using low stress stamps.
- 10.2 All surfaces other than those which have been freshly machined shall be blast cleaned to Sa 2 1/2 or better as defined by ISO Standard [8501-1](#). Except for surfaces to be greased and surfaces within 25 mm (1 in) of the weld bevel, all surfaces shall be coated with epoxy primer to a dry film thickness of 50 microns (0.002 in).
- 10.3 Flange faces and swivel ring and hub bearing surfaces shall be given a protective coat of grease. The flanges shall be packed in such a way that the faces are protected from mechanical damage.
- 10.4 Protection, labelling and packing shall comply with the requirements specified in the Purchase Order. All nuts and studbolts shall be coated with a protective film of oil. The studbolts shall be individually packed in cardboard cartons; nuts may be loose-packed in cardboard cartons.

11. INFORMATION REQUIRED WITH BID

- 11.1 Any proposed deviations from this Specification.
- 11.2 The proposed manufacturing procedure and quality plan, including steelmaker, steelmaking and casting practice, dimensions before and after forging, forging method and reduction, heat treatment (times and temperatures), machining techniques, welding procedures, the appropriate qualification test results and consumables (for attachment of swivel retaining ring), non-destructive testing equipment and techniques, and final dimensions of the products.
- 11.3 The proposed range of chemical composition and the guaranteed minimum mechanical properties.
- 11.4 The design basis for any swivel ring flanges.
- 11.5 If appropriate, the names of companies to whom similar items have previously been supplied should be given, together with the actual composition used and mechanical properties achieved.



- 11.6 Proposals for warranty in the event of flange failure during field hydrostatic test.
- 11.7 Any items which are to be produced by sub-contractors, and the name of the sub-contractor proposed for each item.

12. INFORMATION REQUIRED BEFORE MANUFACTURE

- 12.1 BP will specify whether the fitting will operate in sour or non-sour service.
- 12.2 The manufacturer shall supply his design calculations and shop drawings for the flanges, and his proposals for protection during shipment.
- * 12.3 The dimensions with tolerances, manufacturing procedure and actual chemical analysis of the steel to be forged shall be subject to the approval of the BP Materials Engineer before forging begins.



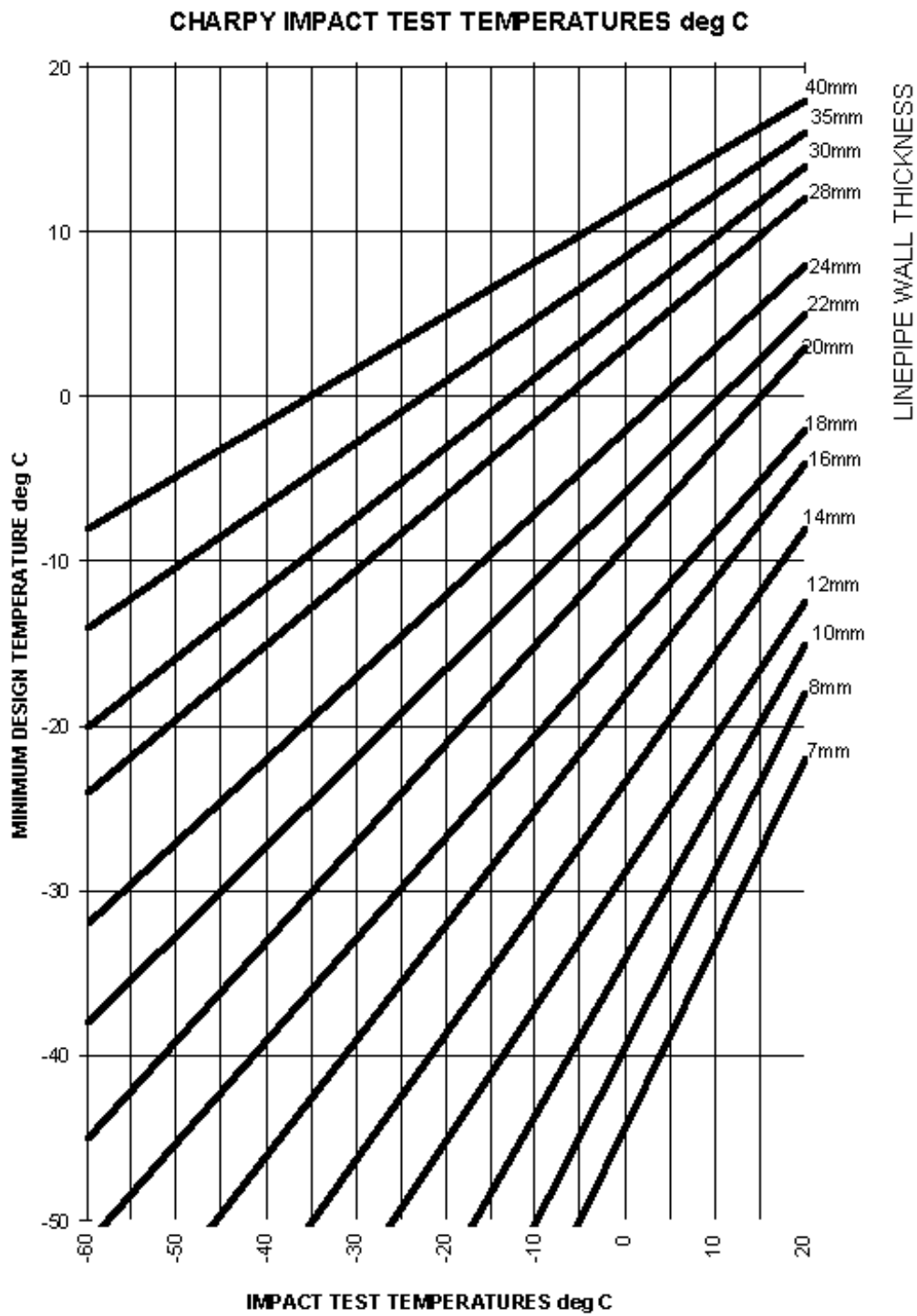


FIGURE 1

CHARPY IMPACT TEST TEMPERATURES



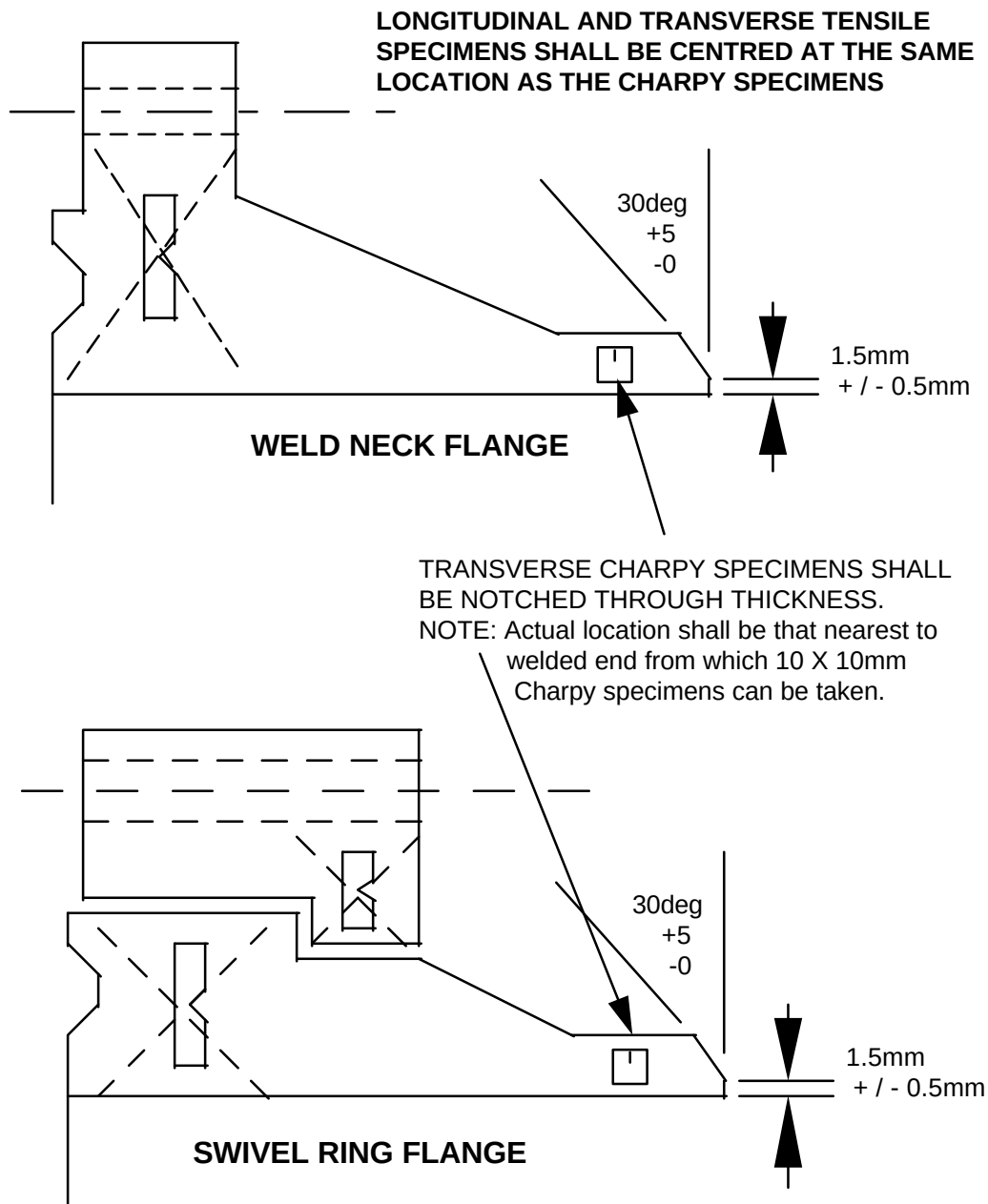


FIGURE 2

SCHEMATIC LONGITUDINAL SECTION OF WELDNECK AND SWIVEL RING FLANGES ILLUSTRATING THE POSITION OF THE MECHANICAL TEST SPECIMENS

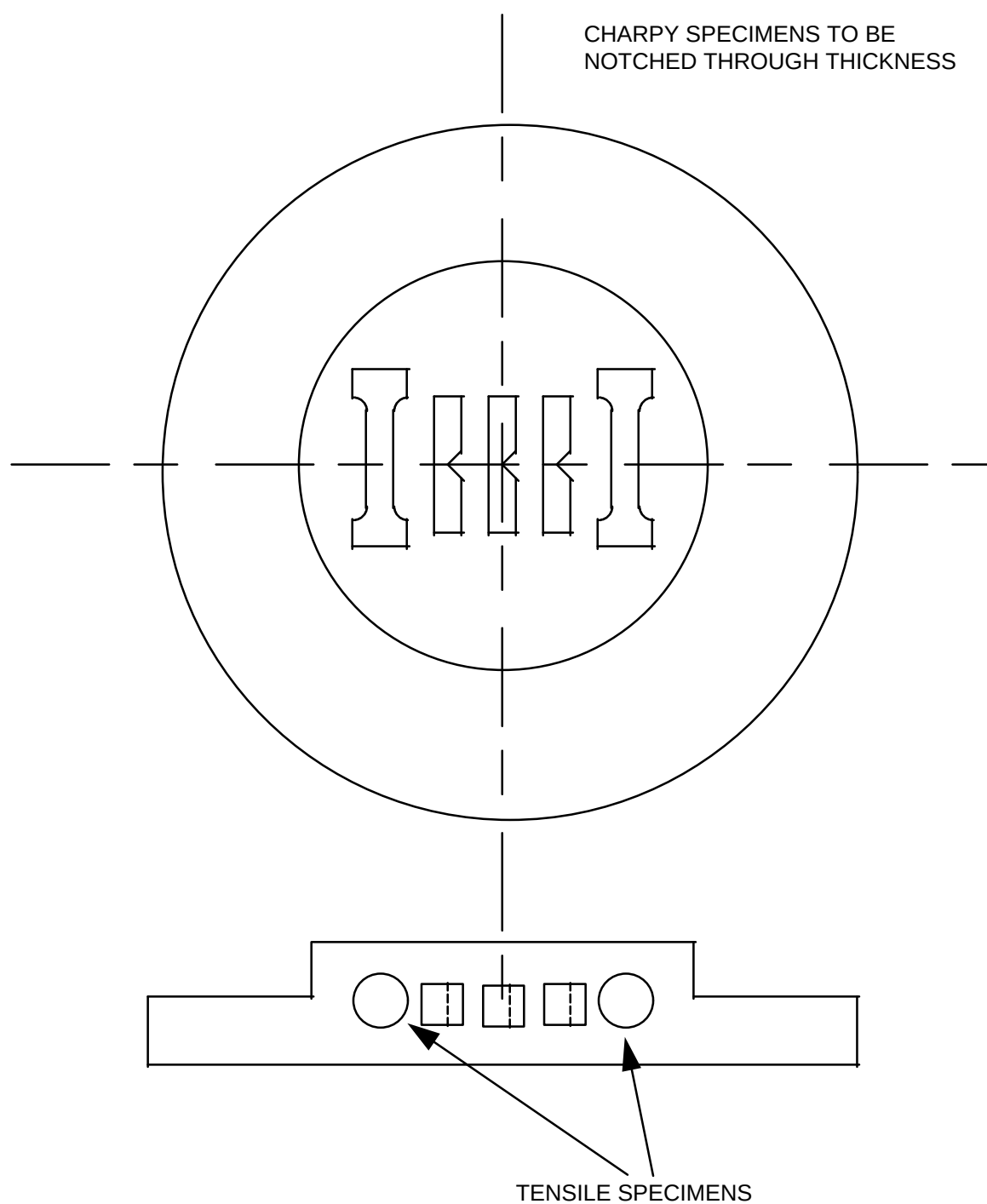


FIGURE 3

SCHEMATIC SECTION OF A BLANK FLANGE LOCATION OF MECHANICAL TEST SPECIMENS



DEFINITIONS AND ABBREVIATIONS

Definitions

Standardised definitions may be found in the BP Group RPSEs Introductory Volume.

BP	The British Petroleum Company p.l.c., an associate or subsidiary or other organisation as defined in the Conditions of Contract on a project.
BP Materials Engineer:	a BP specialist engineer appointed to ensure that the provisions of this Standard are met.
defect:	an imperfection of sufficient magnitude to warrant rejection of the product based on the stipulations of this Specification.
imperfection:	a discontinuity or irregularity in the product detected by the methods outlined in this Specification.
inspector:	an inspector directly responsible to BP for checking work covered by this Specification.
manufacturer:	a manufacturer of flanges or his accredited agent.
sub-contractor:	a manufacturer or fabricator making flanges for or to the design of a supplier, manufacturer or contractor employed by BP.
Note:	Any specific application of these terms and the responsibilities for the parties defined above is a matter for the Conditions of Contract on the project.
quality assurance	(QA): all those planned and systematic actions necessary to ensure quality i.e. to provide adequate confidence that a product or service will be fit for its intended purpose.
quality manual:	a document setting out the general quality policies, procedures and practices of an organisation.
quality plan:	a document prepared by the contractor or supplier, setting out the specific quality practices, resources and activities relevant to a particular contract or order.



quality system: the organisation structure, responsibilities, activities, resources and events that together provide organised procedures and methods of implementation to ensure the capability of the organisation to meet quality requirements.

Abbreviations

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
BS	British Standard
HAZ	Heat Affected Zone
HV	Vickers Hardness
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
NDT	Non-Destructive Testing
SI	Systeme International d'Unites
ISO	International Standards Organisation



LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment issue unless stated otherwise. Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

BS 1560	Circular flanges for pipes, valves and fittings (Class designated) Section 3.1 Specification for steel flanges.
BS 1706	Electroplated Coatings of Cadmium and Zinc on Iron and Steel.
BS 4882	Bolting for Flanges and Pressure Containing Purposes.
BS EN ISO 9001	Quality Systems. Model for quality assurance in design, development, production, installation and servicing.
BS EN ISO 9002	Quality Systems. Model for quality assurance in production, installation and servicing.
BS EN ISO 9003	Quality Systems. Model for quality assurance in final inspection and test.
BS 5750: PART 4	Guide to Use of BS EN ISO 9002.
BS 6072	Method for Magnetic Particle Flaw Detection
API 5L	Specification for Line Pipe
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings
ANSI/ASME B 16.20	Ring-joint gaskets and grooves for steel pipe flanges.
ANSI/ASME B16.47	Large diameter steel flanges.
ASME V	Non destructive Examination
ASTM A 153	Zinc coating (hot-dip) on iron and steel hardware
ASTM A193	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Services
ASTM A 370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 694	Forgings, Carbon and Alloy Steel, for flanges, fittings, valves and parts for high-pressure transmission.
ASTM E 709	Practice for Magnetic Particle Examination
MSS SP 44	Steel Pipe Line Flanges
ISO 3183	Linepipe Standard
ISO 7005-1	Metallic flanges: Part 1: Steel flanges



ISO 8501-1	Preparation of steel substrates
ISO 9712	Non-destructive testing: qualification and certification of Personnel
ISO 11496	Seamless and Welded Steel Tube for Pressure Purposes - Ultrasonic Testing of Tube Ends for the Detection of Laminar Imperfections
BP GS 136-1	Materials for Sour Service to NACE Standard MR-01-75 (1980 Revision)
BP GS 142-7	Supply of Gaskets and Joint Rings for Bolted Flanged Joints
BP GS 142-9	Bolting for Flanged Joints (Unified Inch Series)
BP GS142-12	Supplementary Requirements for Pipe Flanges and Fittings

